Digital Financial Inclusion and Sales Growth of Agro-Based Small and Medium Enterprises (SMEs) In North-Eastern Nigeria

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ABSTRACT

This study examines how digital financial inclusion affects the sales growth of agro-based small and medium-sized enterprises (SMEs) in North-Eastern Nigeria. Digital financial inclusion is measured through five channels: mobile banking (MB), internet banking (IB), virtual banking (VB), point-of-sale (POS) terminals and automated teller machines (ATMs). The study used a quantitative survey design. Structured questionnaires, scored on a five-point Likert scale, were administered to owners and managers of agro-based SMEs across Adamawa, Bauchi, Borno, Gombe, Taraba and Yobe States. A target sample of 317 was drawn from a population of 1,525 using Yamane's formula and allocated proportionally across the six states. Of 285 questionnaires returned, 277 were usable, representing 87.4% of the 317 distributed. Reflective constructs, each measured with five Likert items, were analysed with partial least squares structural equation modelling (PLS-SEM) and a 5,000-sample bootstrap. The measurement model met reliability and validity criteria. The five channels explained 29.4% of the variance in sales growth. Mobile banking ($\beta = 0.205$), internet banking ($\beta = 0.190$), virtual banking ($\beta = 0.176$) and ATMs ($\beta = 0.155$) had significant positive effects, while POS had no significant effect ($\beta = 0.024$, $p = 0.674$). All effects were small ($f^2 \leq 0.043$). The study offers channel-specific evidence on sales growth for agro-based SMEs in a conflict-affected, infrastructure-poor region where such evidence is scarce. Providers and policymakers should prioritise mobile, virtual banking, and internet banking, improve connectivity for internet banking, and examine why POS terminals have not yet translated into sales growth in cash-dominated agro-trade.

Keywords: Digital Financial Inclusion; Mobile Banking; Virtual Banking; Point of Sale; Agro-based SMEs; Sales Growth; North-Eastern Nigeria.

INTRODUCTION

Small and medium enterprises (SMEs) are widely regarded as the engine of inclusive growth in developing economies, and Nigeria is no exception. The national survey shows that about 39.65 million MSMEs operate in the country, employing 87.9% of the workforce and contributing 46.31% of Gross Domestic Product (GDP) (Small and Medium Enterprise Development Agency of Nigeria [SMEDAN], 2020; National Bureau of Statistics [NBS], 2020). Within this sector, agro-based SMEs, including primary producers, processors, aggregators and traders of agricultural commodities, occupy a strategic position. They link rural production to urban and export markets, absorb a large share of rural labour, and underpin food security and agricultural value-chain development. Nowhere is this role more important than in the North-East (Adamawa, Bauchi, Borno, Gombe, Taraba and Yobe), where agriculture remains the dominant economic activity and the main source of livelihood. Sustained growth in sales is among the clearest signals that an SME is performing well. Rising sales indicate expanding market reach, stronger customer relationships, and better capacity to reinvest, hire and withstand shocks. Sales growth, however, depends on a firm's ability to transact, receive payments, save, and access working capital. These are all functions of the financial system. Where agro-based SMEs rely mainly on

cash, face long distances to bank branches, or cannot easily verify or receive payments, their transactions are slower, riskier and costlier, and their growth is constrained.

DFI is viewed as a way to get around these constraints (Shabeena et al., 2024). It refers to access to and use of formal financial services through digital channels, notably mobile banking, internet banking, virtual banking, point-of-sale (POS) terminals and automated teller machines. These channels lower transaction costs, shorten the distance between enterprises and financial services, create transaction records that can support credit assessment, and widen the customer base by letting firms accept electronic payments. Nigeria has pursued this agenda through the National Financial Inclusion Strategy (NFIS), the cashless policy, agent banking, the licensing of payment service banks and mobile money operators, and the growth of fin-tech platforms. The national numbers are real progress. The access to financial services survey (EFInA, 2026) found that financial inclusion increased from 74 percent in 2023 to 79 percent in 2026. That means 26% of adults were excluded in 2023 and 21% in 2026. Some 64.4% of Nigerians adults had access to digital financial services in 2026, compared with 45% in 2023 and 34% in 2020. Mobile phone penetration stood at 93% in the survey. Growth in formal inclusion was driven by non-bank channels, rising from 5% in 2023 to 16% in 2026, while bank-based access barely changed, moving from 51% to 52%. It implies that digital and agent-based channels are now the main route to inclusion, the route most relevant to dispersed rural enterprises. But the benefits have not been evenly distributed. EFInA (2026) reported formal financial inclusion for urban adults at 85% against 58% for rural adults. Financial exclusion is most acute in Northern Nigeria, where around three-quarters of adults live in the Northwest and Northeast. It said rural Nigerians are more likely to be excluded than urban ones and that farmers and dependents populations are among the most likely to be excluded. The survey also showed that all the Northeast states have exclusion levels higher than the national average. The Northeast therefore possesses the two factors most often associated with exclusion, a rural, agrarian economy and a northern location. This provides a unique and policy-relevant context to explore digital financial inclusion and agro-based performance. Agro-based SMEs in North-Eastern Nigeria are central to rural livelihoods and regional food systems, yet many struggle to sustain sales growth. Limited market reach, cash-dependent transactions, weak access to working capital and persistent insecurity all constrain their expansion. National surveys show that the problem of finance is severe. The report by SMEDAN (2021) revealed that 85% of MSMEs in Nigeria had no access to external financing between 2013 and 2017, while only 5.3 percent accessed credit during the period. The survey also identified power, funding and finance, tax and security as the top areas in which MSMEs need support.

Despite substantial investment in digital financial infrastructure, the North-East remains the part of the country where exclusion is among the highest, and farmers are among the groups least likely to be served. Nigeria has expanded mobile banking, internet banking, POS terminals, ATMs and virtual banking, but it is unclear whether access to these channels is being converted into actual use by agro-based SMEs, and whether use is improving their sales. EFInA (2024) observed that the rapid growth of access to payments is not translating into significant improvement in access to credit, savings, pensions and insurance, which are the services most likely to affect business outcomes. It also found that little or irregular income was the leading barrier to inclusion, rising from 31% to 49% between 2020 and 2023. Together these findings suggest that inclusion statistics may overstate the real benefit to productive enterprises, and that access alone may not be enough. The empirical literature does not resolve the question. Most Nigerian studies on digital financial inclusion and SMEs performance focus on south-western and north-central commercial hubs, on general SMEs rather than agro-based firms, or on aggregate national indicators. Few examine the individual digital channels separately (mobile, internet, virtual banking, POS and ATM), even though these differ in cost, infrastructure requirements and suitability for rural operators. Few studies have used primary firm-level data from the North-East, and isolate sales growth as the performance outcome, even though it is the most direct indicator of market expansion for a trading or processing enterprise. Findings are also mixed, some studies (Dandibi et al., 2019; Omeje et al., 2025; Gbadamosi & Ajobiewe, 2025) all reported significant positive effects of financial inclusion and digital finance on SME performance or agricultural payments, while Zajd (2020) finds weak or insignificant effects once infrastructure, literacy and trust are considered. This inconsistency suggests that effects are context-dependent and cannot be assumed to carry over to the North-East.

The consequence of this gap is practical as well as scholarly. Without evidence on which digital channels actually raise the sales of agro-based SMEs in the region, regulators, banks, fin-tech providers and development agencies risk designing interventions on the assumption that expanded access automatically yields enterprise growth.

Resources may then go to channels with little effect on sales, while those with real potential remain under-promoted. For a region already burdened by insecurity and high exclusion, misdirected effort has a high cost. The objective of this study was to examine the effect of digital financial inclusion on sales growth of agro-based SMEs in North-Eastern Nigeria. Specifically, the study examines the effect of digital financial inclusion, measured through mobile banking, internet banking, virtual banking, POS and ATM services, on the sales growth of agro-based SMEs in North-Eastern Nigeria, and the following hypotheses in null form were tested:

H01: MB has no significant effect on the sales growth of agro-based SMEs in North-eastern Nigeria.

H02: VB has no significant effect on the sales growth of agro-based SMEs in North-eastern Nigeria.

H03: IB has no significant effect on the sales growth of agro-based SMEs in North-eastern Nigeria.

H04: POS provisions have no significant effect on the sales growth of agro-based SMEs in North-eastern Nigeria.

H05: ATMs have no significant effect on the sales growth of agro-based SMEs in North-eastern Nigeria.

REVIEW OF RELATED LITERATURE

Digital financial inclusion:

Digital financial inclusion refers to the use of digital technologies to deliver affordable, accessible and user-friendly financial services to people who have been traditionally excluded from the formal financial system. Digital financial inclusion enables underserved populations, including rural communities, women and the unbanked, to participate in the global financial system, and to save, invest and grow economically. These services include mobile money services, internet banking, virtual banking, digital lending, e-wallets, and digital savings platforms. Digital Financial Inclusion is the provision of financial services to individuals and businesses through digital channels such as mobile phones, computers and other electronic devices. This idea has attracted much attention in recent years because of its ability to help bring more people into the financial system, reduce poverty and stimulate economic growth (Ozili, 2021). Digital financial inclusion encompasses not only traditional banking services but also modern solutions such as mobile money, fintech and digital wallets (Demirgüç-Kunt et al., 2022). Financial inclusion refers to the availability of financial products and services that are accessible, affordable, secure, effective, transparent and of high quality to businesses and households, as well as to the efficient operation of the financial system (Gadanecz & Tissot, 2017; Amidžic et al., 2014; Sahay et al., 2015). From the foregoing, therefore, financial inclusion can be seen as a situation where everyone has access to financial services regardless of gender, age, educational background, business, or region.

Mobile Banking (MB) and Sales Growth of Agro-based SMEs

Mobile banking refers to the use of mobile devices, particularly smartphones and tablets, to access financial services such as account management, payments, transfers, and other banking operations. It has emerged as a significant innovation in the financial sector, driven by advancements in information and communication technology (ICT) and the increasing penetration of mobile phones (Shaikh & Karjaluoto, 2015). The mobile banking channel has the most empirical support. Amony (2025) studied 259 SMEs in Wakiso District, Uganda and established that there was a positive correlation between adoption of mobile banking and growth of SMEs. Mobile banking and marketplace lending accounted for approximately 35.5% of the variance in growth. Lawal et al. (2026), using data from 234 owners in Ilorin-South reported a significant positive relationship between mobile banking and SME performance. Also, Mbah and Obiezekwem (2021) found a positive relationship between mobile banking and performance of SMEs in Anambra State. Gbadamosi and Ajobiewe (2026) revealed that digital financial inclusion through mobile banking, USSD, fin-tech applications and digital payment platforms significantly increases the growth of SMEs using data from 400 SMEs in Lagos and Ogun States. The effect is enhanced by digital proficiency and trust.

Agro-based SMEs Sales Growth & Virtual Banking (VB)

Virtual banks, unlike traditional banks, do not rely on physical structures. The electronic services offered to customers include savings and current accounts, fund transfers, bill payments, loans and investment management (Mhlanga, 2020). Virtual banking provides benefits such as improved access, quicker transactions, and enhanced financial inclusion, particularly in locations with limited access to physical bank branches (Ozili, 2018). Furthermore, virtual banking uses modern technologies such as artificial intelligence, blockchain and big data analysis to personalize services, improve security and enhance client experience (Arner et al., 2017). Virtual banking as defined here is branchless and agent or app delivered financial services. It is rarely isolated as a variable in the studies of SMEs. It is often treated as part of larger constructs such as fin-tech adoption or digital financial inclusion (Gbadamosi & Ajobiewe, 2026). Few studies addressing it in agriculture are conceptual. Odum et al. (2019) noted that digital financial services have positive implications for financial inclusion and agricultural value chain financing but these benefits have not reached most Nigerians and come with associated risks. Virtual banking, however, has its own set of challenges. The cybersecurity risks, data privacy concerns, and the digital divide because of the limited internet access in some regions are significant obstacles to its broad adoption (Zhang & Tang, 2020). Also, the regulatory systems in many developing economies are still evolving to effectively regulate and ensure the stability of fully digital banks (Mhlanga, 2020).

Sales Growth of Agro-based SMEs & Internet Banking (IB)

The arrival of internet banking has revolutionized the financial sector by offering convenience, lowering transaction costs and improving access to financial services for both individuals and businesses. Agro-based SMEs especially require access to internet banking. Agro-based SMEs often face structural barriers such as limited access to formal credit, geographic remoteness, and fluctuations in income during the seasons (Beck & Demirguc-Kunt, 2006). Digital banking can fill these gaps by offering avenues for online payments, mobile money transfers and online loan applications, thus decreasing dependency on physical bank branches (Ozili, 2018). Internet banking penetration has positive impact on agro based SMEs in several ways. First, it facilitates financial inclusion by enabling farmers and agribusiness owners to conduct business in rural areas where banking infrastructure is limited (Mago & Chitokwindo, 2014). Facilitates timely payment of inputs and sales of agricultural produce, thus enabling cash flow and working capital management (Nguyen, 2020). Secondly, internet banking allows access to financial records and online statements which can be used by agro-SMEs to establish creditworthiness and obtain financing from banks or microfinance institutions (Aminu, 2021). The evidence for internet banking is positive but weaker for small firms. In the Ilorin-South study, the coefficient for internet banking was significant but smaller (B = 0.383) than those for mobile and card-based channels (Lawal et al., 2026). At the bank level, studies show that the performance of deposit money banks is positively related to internet banking (Obayagbona, 2026). The channel benefits providers more clearly than it benefits small merchants. Reliable connectivity and security confidence remain conditions for SME benefit, particularly outside major cities.

Point of Sale (POS) and Sales Growth of Agro-based SMEs

The Point of Sale (POS) system is a payment channel that enables bank customers to complete transactions electronically through debit/credit cards or mobile payments. POS devices work as mini-bank branches to bring banking services closer to the rural and underserved areas in many economies, especially developing countries (Okeke & Eze, 2021). POS is said to be the most popular form of agent banking in Nigeria. Availability and access to POS services were found to significantly increase the sales performance of SMEs (Saleh et al., 2021). However, most of the sampled SMEs lacked either. They also cited service charges as a burden on low income operators. Lawal et al. (2026), also found that POS and card based services have a positive effect on the performance of SMEs (Mbah, & Obiezekwem, 2021). The study by Ogbari et al. (2024) examined the relationship between POS, online banking, mobile wallets and sales growth and profitability of small businesses in Lagos. But these benefits have some drawbacks. However, network downtimes, high transaction fees, fraud risks and low penetration of POS in remote areas hinder the full adoption (Mhlanga, 2020). To maximize the impact of POS on the growth of agro-SMEs, policies should focus on strengthening digital infrastructure, reducing transaction costs and establishing confidence in cashless payment systems.

Automated Teller Machines (ATM) and Sales Growth in Agro-based SMEs

ATMs have improved the banking operations by providing financial services other than the normal banking hours and locations thus enhancing convenience and efficiency in financial transactions (Abubakar & Tasmin, 2012). For agro-based SMEs, the availability of ATMs has a major impact on their growth and sustainability. Financial services are a major constraint for agro-SMEs, which are usually located in rural and semi-urban areas with limited banking infrastructure (Beck & Demirguc-Kunt, 2006). ATMs help to fill this gap by providing prompt and reliable access to cash that enables entrepreneurs and farmers to meet key business needs such as purchasing inputs, paying workers and moving goods to markets (Okeke & Eze, 2021). Agro-entrepreneurs can also directly access their bank accounts through an ATM which helps them check their balance and manage their expenses better. This leads to better financial management and business decision making (Nguyen, 2020). In addition, rural ATMs build confidence in formal financial institutions and motivate more agro-SMEs to use banking services, which enhances their creditworthiness and loan accessibility (Aminu, 2021). ATMs show the weakest and most inconsistent relationship to SME sales. There is a positive relationship between the use of Automated Teller Machines and the performance of the Small and Medium Enterprise in Anambra State (Mbah and Obiezekwem, 2021). However the Automated Teller Machines access is mainly for cash withdrawal and not for sales facing the customer. In contrast, negative ATM effects are mainly reported in the studies on bank performance due to maintenance costs (Obayagbona, 2026). Therefore, ATMs appear to be a supportive channel for liquidity among SMEs and not a direct driver of sales. But the challenges remain. For many developing countries, the rural areas are limited in ATM coverage, network downtime, and cash shortages, thus reducing the benefits for SMEs (Mhlanga, 2020). Also, security risks such as ATM fraud and theft do not allow full use. Policy reforms, expansion of infrastructure and enhanced security interventions are essential to gain the sales growth benefits from ATMs for agro-based SMEs.

Conceptual Framework

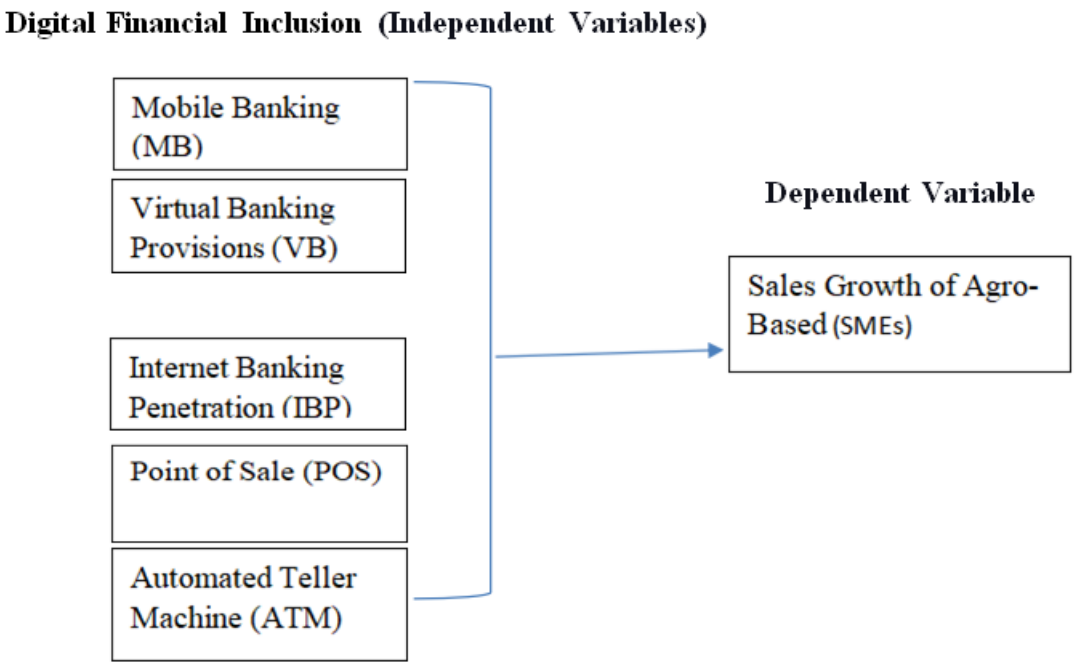


Figure 1: Conceptual Diagram

Theoretical Review

This study is anchor on Resource-Based View (RBV) theory. Penrose (1959), Wernerfelt (1984), and Barney (1991) argue that a firm's performance depends on the resources and capabilities it can access, deploy, and use better than competitors. For an agro-based SME, digital banking channels are financial and transaction resources. They reduce the costs of moving money, expand the reach of the market, speed up payment collection and make cash available for stock and operations. Sales growth is the outcome these capabilities should produce.

Financial Intermediation Theory (FI) is the mechanism. Gurley and Shaw (1960) and Diamond (1984) both explain that financial intermediaries reduce transaction costs and information asymmetry between savers and borrowers. Digital channels take this further and extend it to SMEs that have been excluded, allowing them to access payments, savings and transaction records. These records can support credit access, which allows expansion.

Diffusion of Innovations (DOI) also a supporting theory. Rogers (2003) explains why channels differ in effect. Adoption depends on perceived relative advantage, compatibility, complexity, and observability, so channels that are easier to use and more compatible with SME routines (for example mobile banking and POS) should show stronger effects than more complex ones.

The Technology Acceptance Model (TAM) emphasises perceived usefulness and ease of use (Davis, 1989); The Unified Theory of Acceptance and Use of Technology (UTAUT) adds performance expectancy, effort expectancy and facilitating conditions (Venkatesh et al., 2003).

Empirical Review

Dandibi et al. (2019) ascertained the impact of financial inclusion and financial literacy on the performance of agro-based SMEs in Yobe State, Nigeria. The study employed cross-sectional research design with a population of all registered agro-based SMEs in Yobe State and the sample size of the study was 300. Primary data were collected using Questionnaires, and hierarchical regression was adopted as data analysis technique. The study result revealed that availability, accessibility, affordability and usability of financial services all have significant effect on the performance of agro-based SMEs in Yobe State. Also, financial literacy fully mediated the relationship between the availability of financial services and the performance of agro-based SMEs in Yobe State while partially mediating the relationship between accessibility and affordability of financial services and performance.

Omeje et al (2025) examined digital finance and payments for agricultural goods in gieria. The study employed the Global Findex survey data 2021 for Nigeria and applied a multinomial logistic regression model to examine how digital finance has influenced payments for agricultural goods in Nigeria. The results revealed that online payment of bills using the internet and having a mobile money account significantly increase the likelihood of receiving payment into an account than not receiving payments. Digital finance channels such as online bill payments, operating a mobile money account, and using mobile phones to make in-store payments improve the payments for agricultural goods in Nigeria, which by extension, enhances the profitability of those who deal in agricultural goods. The policy implication of the study's findings, among others includes that there is a need for more improvements in the digital finance enablers which would help to encourage and sustain gains in agribusiness in Nigeria. Again, concerted efforts should be geared toward making financial technology and innovation companies and traditional financial institutions to financially include more people, especially those in agribusiness.

Gbadamosi & Ajobiewe (2026) examined the impact of digital financialiInclusion on SME growth and job creation in Lagos and Ogun States. Data were collected from 400 SMEs (firm-level) across the Lagos and Ogun, and the study employed a mixed-methods research design, multiple regression, mediation and moderation. The study revealed that digital financial inclusion has a positive and significant effect on SME growth and job creation. SME growth partially mediated the effect on employment; digital literacy and trust strengthened the relationships.

Diko-Koce et al. (2025) looked into the connection between digital financial inclusion and the growth of micro, small and medium enterprises (MSMEs) in Niger State, Nigeria. A total of 378 MSME operators across 25 local government areas were selected using multistage sampling under a quantitative survey research design. Access to digital finance and business outcomes were measured using structured questionnaires. Validity was estashed through pilot testing and the reliability using Cronbach's alpha ($\alpha > 0.70$). The regression analysis shows that digital financial inclusion has a significant positive effect on sales growth of MSMEs, and the model explains 58.5% of the variation in performance. The most influential was mobile banking, then mobile money and fin-

tech platforms. The findings suggest that integrated digital finance ecosystems are vital to MSME resilience, liquidity, and expansion.

METHODOLOGY

This study of digital financial inclusion and sales growth of agro-based SMEs in North Eastern Nigeria adopts a quantitative survey research design to test the relationships between the independent and dependent variables. The samples were proportionally allocated across all the states and selected by multistage sampling. Target population were all registered agro-based SMEs across the six states in North-Eastern Nigeria that engaged in crop production, livestock rearing, agro-processing, fishing, and agro-trading. The registered agro-based SMEs of each state were obtained with approval from the ministries, departments, and agencies of the states and SMEDAN as presented below. Structured questionnaires were administered to owners/managers, using a 5-point Likert scale (Strongly Disagree = 1 to Strongly Agree = 5). Questionnaires were administered face to face by six trained research assistants from February, 2026 to May, 2026. The questionnaire were in English language, but explanations were given in Hausa/Fulfulde, Mumuye, Jukum language and all respondents gave informed consent. Due to security reasons, access to some areas in Borno and Yobe State was not possible, and the filled questionnaires were coded by the researcher. Instrument validity was checked through a pilot (10% of the sample = 32 respondents) and expert review, reliability was confirmed by Cronbach's alpha coefficients for key scales (all $\alpha > 0.70$), indicating acceptable internal consistency. Data analysis proceeds from descriptive statistics to inferential testing using PLS-SEM. Reliability and construct validity were assessed via Cronbach's alpha. The data were analysed using PLS-SEM with the aid of SmartPLS 4 to assess the measurement and structural models simultaneously.

Sample Size Determination

Multi-stage sampling method was adopted for the study. The first stage was the stratification of the six states and allocation of the sample in proportionate to the number of agro-based SMEs in each of the states. In the second stage, the sample was divided among the subsectors (crop farming, livestock, farmers' cooperative, Fisheries and agriculture input supply) in proportion to the number in the register. In the third stage, senatorial districts were established and LGAs with agricultural strength selected purposively. In the fourth stage, the selection of SMEs from the selected LGAs using a random sampling method was conducted. The six states of North-East have been stratified into senatorial districts. From each district, LGA with agricultural strength were selected purposively. In the last section, agro-SMEs in the LGAs mentioned were randomly sampled to achieve a balanced representation of the different sub-sectors (crop production, livestock, Fisheries, and agricultural trading). The sample size was determined using Taro Yamane's formula (Yamane, 1967). $\mathbf{n = N/(1 + N (e)^2)}$, With N = 1525, and e = 0.05, giving 316.88 or 317.

The table able below, gives the breakdown of the sample size of each State.

Table 1: Sample Size

S/N	State	Population	Proportion	Sample Size
1	Adamawa State	465	30.5	97
2	Bauchi State	335	22.0	70
3	Borno State	293	19.2	60
4	Gombe State	115	7.5	24
5	Taraba State	129	8.5	27
6	Yobe State	188	12.3	39
	TOTAL	1,525	100	317

Source: Registers of State MDAs and SMEDAN; Sample allocation by the authors, 2026

Analysis

The model was estimated with PLS-SEM (Hair et al., 2021), which suits prediction-oriented models with several latent predictors, Likert data and no normality assumption. The path-weighting scheme was used and significance was tested with 5,000 bootstrap samples. The measurement model was assessed through outer loadings (> 0.708), Cronbach's alpha, rho_A and composite reliability (0.70–0.95), AVE (> 0.50), Fornell–Larcker (1981), cross-loadings and HTMT (< 0.85; Henseler et al., 2015). The structural model was assessed through VIF (< 3, at most 5), R^2 (Chin, 1998), f^2, Q^2 (blindfolding, D = 7), PLSpredict (10 folds, 10 repetitions) and SRMR (< 0.08; Hu & Bentler, 1999). Common method bias was checked with Harman's single-factor test and full collinearity (Kock, 2015).

The structural model is:

$SG = \beta 1\ MB + \beta 2\ VB + \beta 3\ IB + \beta 4\ POS + \beta 5\ ATM + \varepsilon$

The model specification was as follows:

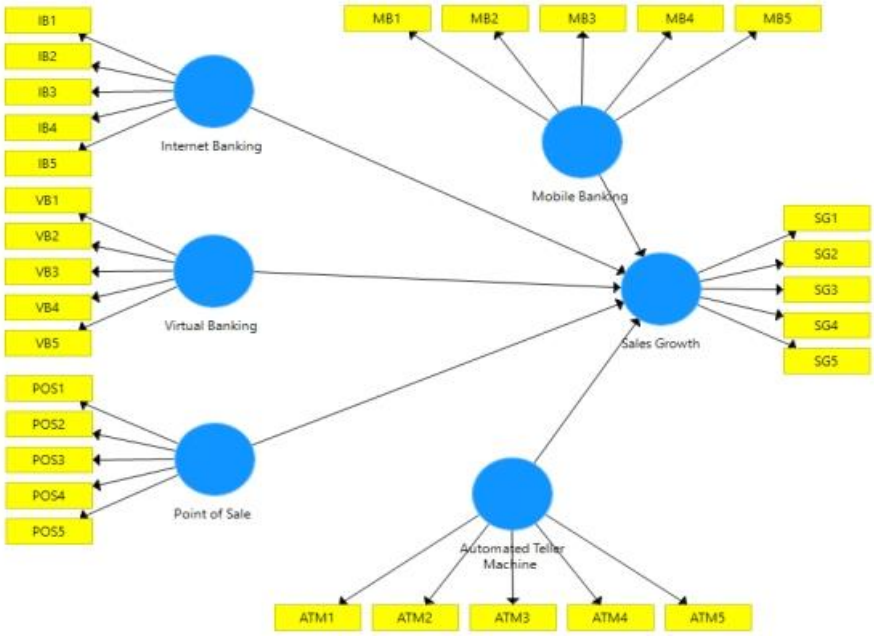


Figure 2: Model Specification

Source: SmartPLS 4, 2026

Where:

SG= Sales Growth of Agro-based SMEs

MB = Mobile Banking

IB = Internet Banking

VB = Virtual Banking

POS = Point of Sales

ATM = Automated Teller Machines

β_1, β_2, β_3 = Path coefficients

ε = Error term

Administration of Questionnaire and Response Rate

Table1 2 below presents the questionnaire administration and response rate across the six states, distributed proportionally.

Table 2: Questionnaire Administered

State	Distributed	Returned	Percentage	Usable	Usable (% of Distributed)	not properly filled
Adamawa	97	89	(91.8)	85	87.6	4
Bauchi	70	63	(90.0)	60	85.7	3
Borno	60	52	(86.7)	52	86.7	0
Gombe	24	24	(100)	23	95.8	1
Taraba	27	27	(100)	27	100	0
Yobe	39	30	(76.9)	30	76.9	0
TOTAL	317	285	(89.9)	277	87.4	8

Source: Field Survey, 2026.

A total of 317 questionnaires were administered to owners/managers of agro-based SMEs across the selected states in North-Eastern Nigeria. Of these, 285 questionnaires were returned, while 32 were not returned due to insecurity problem. Eight (8) questionnaires were excluded because of incomplete responses and other data-quality problems. Consequently, 277 valid questionnaires were retained for the analysis, representing a valid response rate of 87.4% of the 317 distributed.

Respondents Profile

This section highlights the demographic features of the respondents who took part in the study. The demographics of the respondents offer valuable information that enables one to understand the nature of the sample under study. The demographic factors analysed in this study include gender, age, respondent's role, education level, age in business, and number of employees. The distribution of the respondents on these factors is shown in Table 3.

Table 3:Demographic Background of Respondents (n = 277)

Characteristic	**Category**	**Number (n)**	**Percent (%)**
Gender	Male	167	60
	Female	110	40
Position	Owner	181	65
	Manager	96	35
Age	18–30	72	26
	31–40	83	30
	41–50	106	38
	Above 50	16	6
Education	None	45	16
	Primary	56	20

	Secondary	76	27
	Diploma-NCE	88	32
	Degree+	12	4
Age of business	< 2	42	15
	2–5	61	22
	6–10	101	36
	> 10 years	73	26
Employees	1–5	136	49
	6–10	65	23
	11–20	42	15
	> 20	34	12

Source: Field Survey, 2026.

All constructs were reflective and measured with five items on a five-point Likert scale (1 = strongly disagree, 5 = strongly agree): mobile banking (MB1–MB5), virtual banking (VB1–VB5), internet banking (IB1–IB5), POS (POS1–POS5) and ATM (ATM1–ATM5), adapted from earlier studies. Sales growth (SG1–SG5) captures commercial expansion through revenue growth over three years, number of customers, the contribution of digital payment channels to sales volume, steady growth in market demand and improved annual turnover. Sales growth is a core dimension of firm performance alongside profitability (Venkatraman, 1987) and one of the most widely used SME performance measures (Maduekwe and Kamala, 2016).

RESULTS

Common Method Bias

Common method bias (CMB) for the sales growth model was assessed using Harman's single-factor test and the full collinearity VIF approach (Kock, 2015). The analysis used the 30 items measuring Mobile Banking (MB), Internet Banking (IB), Virtual Banking (VB), Point-of-Sale (POS), ATM usage and Sales Growth (SG), based on 277 respondents.

Harman's Single-Factor Test

Table 4 shows that the first unrotated factor explained 34.34% of the total variance, below the 50% threshold. Six factors had eigenvalues above 1, matching the six constructs, and together explained 74.17% of the variance. No single factor therefore dominates the data.

Table 4: Harman's Single-Factor Test (Unrotated, 30 Items)

Factor	Eigenvalue	% of Variance	Cumulative %
1	**10.303**	**34.34**	**34.34**
2	**2.982**	**9.94**	**44.28**
3	**2.524**	**8.41**	**52.70**

4	**2.397**	**7.99**	**60.69**
5	**2.107**	**7.02**	**67.71**
6	**1.937**	**6.46**	**74.17**
7	**0.548**	**1.83**	**75.99**
8	**0.512**	**1.71**	**77.70**

Source: Smart pls 2026

Harman's single-factor test indicated that the first factor accounted for 34.34% of the total variance (less than 50%) and full collinearity VIFs were between 1.276 and 1.456 (less than 3.3). Together, these findings suggest that common method bias is unlikely to be a serious concern in the sales growth model (Kock, 2015; Podsakoff et al., 2003).

Full Collinearity VIF

The full collinearity of VIFs, in which each construct is regressed on all other constructs in the model. All values were below the 3.3 threshold, indicating that the sales growth model is free of common method bias.

Table 5: Full Collinearity VIF (Sales Growth Model)

	VIF
ATM1	**2.433**
ATM2	**2.389**
ATM3	**2.400**
ATM4	**2.919**
ATM5	**2.666**
IB1	**2.720**
IB2	**2.479**
IB3	**2.056**
IB4	3.026
IB5	**2.196**
MB1	**2.821**
MB2	**2.707**
MB3	3.230
MB4	**2.384**
MB5	**2.920**
POS1	**2.325**
POS2	**2.333**

POS3	**2.514**
POS4	**2.686**
POS5	**2.727**
SG1	**2.379**
SG2	**2.608**
SG3	**2.614**
SG4	**2.167**
SG5	**2.472**
VB1	**2.292**
VB2	**2.923**
VB3	**2.328**
VB4	**2.714**
VB5	**2.249**

Source: Smart pls 2026

Outer VIFs were at most 3.23 and inner VIFs at most 1.45, so collinearity was not a concern(the highest outer is marginally above 3 but well below the upper limit of 5). The first factor in Harman's test explained 34.4% of variance, below 50%, so common method bias is unlikely to drive the results.

Reliability and Convergent Validity

All 30 indicators loaded between 0.81 and 0.90, above the 0.708 benchmark. Reliability and convergent validity were satisfactory for every construct (Table 6). Discriminant validity held on all three criteria: the square root of each AVE exceeded the construct's correlations with other constructs, each item loaded highest on its own construct, and the highest HTMT across the six constructs of the study was 0.477, far below 0.85.

Table 6: Reliability and Convergent Validity

	Cronbach's Alpha	**rho_A**	**Composite Reliability**	**Average Variance Extracted (AVE)**
ATM	**0.912**	**0.920**	**0.934**	**0.738**
IB	**0.906**	**0.909**	**0.930**	**0.726**
MB	**0.922**	**0.924**	**0.941**	**0.763**
POS	**0.909**	**0.925**	**0.932**	**0.732**
SG	**0.904**	**0.908**	**0.928**	**0.721**
VB	**0.909**	**0.914**	**0.932**	**0.732**

Source: Smart pls 2026

Table 6 above presents the internal consistency reliability and convergent validity results. Cronbach's Alpha, which measures the internal consistency of indicators within a construct based on their inter-correlations, recorded values ranging from 0.904 (SG) to 0.922 (MB), which shows that, all have substantially exceeded the recommended threshold of 0.70 (Nunnally, 1978) and indeed the more stringent 0.90 benchmark, indicating excellent internal consistency across all six constructs.

Indicator Reliability / Outer Loadings

This result checks whether the questionnaire items properly measure the constructs. Indicator reliability (also called item reliability) is the extent to which each observed indicator (item) reliably measures its associated latent construct. This is measured with outer loadings which are correlations between an indicator and its corresponding construct. According to the recommendations of Hair et al. (2021, 2022) and Hulland (1999), outer loadings must be 0.708 or higher, meaning that the construct explains more than 50% of the indicator variance (loading$^2 \geq 0.50$), and thus showing a satisfactory indicator reliability. Loadings between 0.40 and 0.70 should only be retained if their removal does not improve composite reliability or AVE; loadings below 0.40 should generally be removed.

Table 7: Indicators Loading, Composite Reliability, and AVE of Construct

latent Construct	**Items**	**Item Loading**	**Composite Reliability**	**Average Variance Extracted (AVE)**
Automated Teller Machine	ATM1	**0.861**	0.934	0.738
	ATM2	**0.837**		
	ATM3	**0.863**		
	ATM4	**0.870**		
	ATM5	**0.865**		
Internet Banking	IB1	**0.876**	0.930	0.726
	IB2	**0.859**		
	IB3	**0.822**		
	IB4	**0.878**		
	IB5	**0.824**		
Mobile Banking	MB1	**0.876**	0.941	0.763
	MB2	**0.869**		
	MB3	**0.900**		
	MB4	**0.841**		
	MB5	**0.881**		
Point of Sale	POS1	**0.814**	0.932	0.732
	POS2	**0.859**		
	POS3	**0.867**		

	POS4	**0.878**		
	POS5	**0.859**		
Sales Growth	SG1	**0.854**	0.928	0.721
	SG2	**0.855**		
	SG3	**0.851**		
	SG4	**0.826**		
	SG5	**0.860**		
Virtual Banking	VB1	**0.837**	0.932	0.732
	VB2	**0.878**		
	VB3	**0.859**		
	VB4	**0.864**		
	VB5	**0.839**		

Source: SmartPLS 4, 2026.

From the above table, the outer loadings ranging from 0.814 to 0.900 shows that all indicators across the six constructs recorded well above the recommended minimum threshold. This confirms that every item is strong and reliable measure of its construct, and no items required removal from the measurement model. Furthermore, individual constructs, ranging from the Automated Teller Machine items (ATM1 to ATM5) recorded outer loadings ranging between 0.837 and 0.870, demonstrates a consistent measurement of its construct across all five indicators. The Internet Banking items (IB1 to IB5) ranged from 0.822 to 0.878, as IB1 and IB4 demonstrated as the strongest indicators. With regard to Mobile Banking (MB1-MB5) which emerged the highest loadings in the entire model, ranging from 0.841 to 0.900, suggesting that its indicators are the most robust measures across the six constructs. In addition, Point of Sale items (POS1-POS5) with loadings ranging from 0.814 to 0.878, also indicating strong indicator reliability, with POS1 recording the lowest loading in the entire model, although this value still substantially exceeds the acceptable threshold. Sales Growth loadings ranged from 0.826 to 0.860. Finally from the outer loading, Virtual Banking indicators items (VB1-VB5) ranged between 0.837 and 0.878, reflecting excellent and highly stable measurement of the construct. Therefore, since all outer loadings exceeded the 0.708 benchmark, with the majority above 0.80, it can be concluded that indicator reliability was satisfactorily established for all six constructs. Each indicator shares a substantial proportion of variance with its respective latent construct, providing a sound basis for the subsequent assessment of internal consistency reliability and convergent validity in the measurement model.

Discriminant Validity

Table 8 below shows whether one construct is statistically different from other constructs

Table 8: Fornell-Larcker Criterion

	Automated Teller Machine	**Internet Banking**	**Mobile Banking**	**Point of Sale**	**Sales Growth**	**Virtual Banking**
ATM	**0.859**					
IB	0.388	**0.852**				

MB	0.321	0.438	**0.874**			
POS	0.376	0.344	0.287	**0.856**		
SG	0.371	0.405	0.414	0.264	**0.849**	
VB	0.385	0.323	0.393	0.325	0.386	**0.855**

Source: Smart PLS, 2026

As presented in Table 8 above, the results confirm that discriminant validity was established for all constructs in the measurement model. Specifically, the square root of the AVE for each construct comprising Automated Teller Machine (0.859), Internet Banking (0.852), Mobile Banking (0.874), Point of Sale (0.856), Sales Growth (0.849), and Virtual Banking (0.855) was greater than its corresponding correlations with all other constructs in the model. This satisfies the Fornell-Larcker (1981) threshold criterion and indicates that each construct shares more variance with its own indicators than with indicators measuring other constructs. The highest inter-construct correlation was Mobile Banking and Internet Banking (r = 0.438) followed by Mobile Banking and Internet Banking (r = 0.438). Although these values indicate a moderate degree of association, theoretically plausible given that both are electronic/digital banking delivery channels, they remain substantially lower than the respective AVE square roots of the two constructs (0.874 and 0.852), confirming that the two constructs, while conceptually related, are empirically distinguishable.

Conversely, Point of Sale and Sales Growth recorded the lowest inter-construct correlation (r = 0.264), followed by Point of Sales and Mobile Banking(r =0.287), suggesting these are the most empirically distinct constructs in the model. Therefore, since no off-diagonal value exceeds its corresponding diagonal value in any row or column, it can be concluded that discriminant validity was satisfactorily established for the constructs examined in this study (ATM, Internet banking, Mobile banking, Point of Sale, Sales and Virtual Banking). This finding provides empirical support for the distinctiveness of the measurement model and confirms that the constructs, though conceptually related as electronic banking channels influencing sales growth, are not redundant. This satisfies a key prerequisite for proceeding to structural model (inner model) evaluation and hypothesis testing.

Table 9: Heterotrait-Monotrait Ratio HTMT)

	Automated Teller Machines	**Internet Banking**	**Mobile Banking**	**Point of Sale**	**Sales Growth**	**Virtual Banking**
ATM						
IB	**0.423**					
MB	**0.348**	**0.477**				
POS	**0.409**	**0.373**	**0.315**			
SG	**0.401**	**0.440**	**0.450**	**0.282**		
VB	**0.422**	**0.353**	**0.430**	**0.358**	**0.418**	

Source: Smart PLS 4, 2026

From the above table 9, discriminant validity tested using Heterotrait-Monotrait Ratio (HTMT). All values ranged from 0.282 to 0.477, well below the conservative threshold of 0.85 (Henseler et al., 2015), confirming that each construct is empirically distinct from the others.

Table 10: Model Fit

	Saturated Model	Estimated Model
SRMR	0.042	0.042
d_ULS	0.837	0.837
d_G	0.386	0.386
Chi-Square	629.500	629.500
NFI	0.896	0.896

Source: Smart PLS 4, 2026

Model fit was assessed using SRMR, d_ULS, d_G, Chi-Square, and NFI. The SRMR value of 0.042 is below the recommended threshold of 0.08 (Hu & Bentler, 1999), indicating a good fit. The NFI value of 0.896 is close to the 0.90 benchmark, suggesting an acceptable model fit. Because the structural model is saturated, the saturated and estimated values are identical, so these indices mainly reflect the quality of the measurement model ratter than the structural paths.

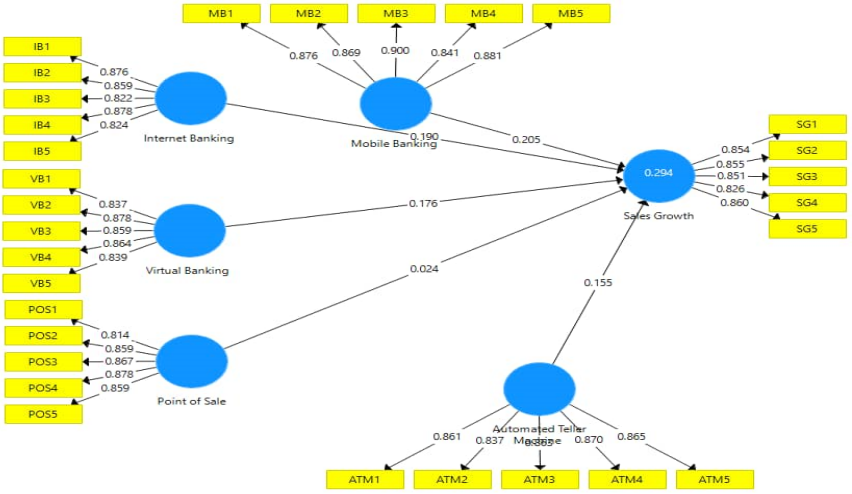


Figure 3: Structural Model

Table 11: Path Coefficients and hypothesis tests (5,000 bootstrap samples)

Hypothesis	Path	B	SE	T	p	95% CI	f²	Decision
H1	MB → SG	0.205	0.060	3.386	0.001	0.088, 0.322	0.043	Supported
H2	VB → SG	0.176	0.060	2.947	0.003	0.060, 0.292	0.033	Supported
H3	IB → SG	0.190	0.063	3.033	0.003	0.065, 0.312	0.036	Supported
H4	POS → SG	0.024	0.057	0.421	0.674	−0.085, 0.140	0.001	Not supported
H5	ATM → SG	0.155	0.058	2.646	0.009	0.042, 0.276	0.025	Supported

Source: Smart PLS, 2026

The five channels explained 29.4% of the variance in sales growth ($R^2 = 0.294$; adjusted $R^2 = 0.281$), a weak to modest level. The Q^2 was 0.199 and the prediction errors in PLS were lower than the benchmark for the linear

model for all five sales growth indicators, supporting predictive relevance. SRMR was 0.042 and NFI 0.896, indicating good fit. Mobile banking had the largest effect, followed by internet banking, virtual banking and ATMs, although the confidence intervals of these paths overlaps, so the diffences between them should not be over-interpreted. The confidence intervals for these four paths exclude zero. POS was close to zero and its interval spans zero. All f^2 values were below 0.05, so each channel's unique contribution is small; for the four significant paths this contribution is reliably different from zero, where POS contributes essentially nothing.

Measure of R-squared

The coefficient of determination (R2) is a measure of the predictive accuracy of the structural model, because it measures the variation in the endogenous constructs that is explained by the corresponding exogenous constructs. The R-square value of Sales Growth is 0.294 which implies that the independent variables together explain 29.4% of the variance of sales growth among agro-based SMEs. This result is also reliable as it is confirmed by the adjusted R-square value of 0.281. This value lies between the weak (0.25) and moderate (0.50) benchmarks, indicating modest explanatory power for sales growth. This implies that digital financial inclusion channels especially Mobile Banking, Internet Banking, Virtual Banking and ATMs are significantly and positively associated with the sales growth of agro-based SMEs in North-Easter Nigeria, but each account for only a small share of it. The remaining 70.6% may be attributed to other factors such as market demand, product quality, customer relationships, and competitive dynamics.

Table 12: R-Square Values of Dependent Variables

Dependent Variable	R-Square	R-Square Adjusted
Sales Growth (SG)	**0.294**	**0.281**

Source: Smart PLS 4, 2026

Hypotheses Testing

The following hypotheses that relate to the Model are tested:

H01: Mobile banking has no significant effect on the sales growth of agro-based SMEs in North-eastern Nigeria. The result shows that Mobile Banking had the largest positive and statistically significant effect on Sales Growth among all five constructs ($\beta = 0.205$, $t = 3.386$, $p = 0.001$; 95% CI [0.088, 0.322]). Therefore, the null hypothesis (H01) is rejected, since the p-value is less than 0.05. This implies that Mobile Banking has a statistically significant positive effect on the sales growth of agro-based SMEs in North-eastern Nigeria, although the effect size is small ($f^2 = 0.043$).

H02: Virtual banking has no significant effect on the sales growth of agro-based SMEs in North-eastern Nigeria. The result shows that Virtual Banking recorded a positive and statistically significant effect on Sales Growth (β =0.176, $t = 2.947$, $p = 0.003$; 95% CI[0.060, 0.292]). Therefore, the null hypothesis (H02) is rejected, since the p-value is less than 0.05. This implies that Virtual Banking has a statistically significant positive effect on the sales growth of agro-based SMEs in North-eastern Nigeria ($f^2 = 0.033$).

H03: Internet banking has no significant effect on the sales growth of agro-based SMEs in North-eastern Nigeria. The result shows that Internet Banking had a positive and statistically significant effect on Sales Growth (β 0.190, $t = 3.033$, $p = 0.003$; 95% CI[.065,0.312]), the second largest effect among the five channel. Therefore, the null hypothesis (H03) is rejected, since the p-value is less than 0.05. This implies that Internet Banking has a statistically significant positive effect on the sales growth of agro-based SMEs in North-eastern Nigeria ($f^2 =$ 0.036).

H04: Point of Sale (POS) provisions have no significant effect on the sales growth of agro-based SMEs in North-eastern Nigeria. The result shows that Point of Sale had no statistically significant effect on Sales Growth ($\beta =$ 0.024, $t = 0.421$, $p = 0.674$; 95%CI[-0.085, 0.140]), which includes zero $f^2 = 0.001$). Therefore, the null

hypothesis (H04) is not rejected, since the p-value is greater than 0.05. This implies that Point of Sale provisions have no statistically significant positive effect on the sales growth of agro-based SMEs in North-eastern Nigeria.

H05: Automated Teller Machines (ATMs) have no significant effect on the sales growth of agro-based SMEs in North-eastern Nigeria. The result shows that Automated Teller Machines had a positive and statistically significant effect on Sales Growth ($\beta = 0.155$, $t = 2.646$, $p = 0.009$; 95% CI [0.042, 0.276]), the weakest of the effects. Therefore, the null hypothesis (H05) is rejected, since the p-value is less than 0.05. This implies that Automated Teller Machines have a statistically significant positive effect on the sales growth of agro-based SMEs in North-eastern Nigeria, although the effect size is small ($f^2 = 0.025$).

DISCUSSION

The Objectives of this study was to examine the effect of digital financial inclusion on sales growth of agro-based SMEs in North-Eastern Nigeria.

First, Mobile banking has a positive statistically significant effect on sales growth. This was consistent with evidence from the study by Diko-Koce et al. (2025) conducted in Niger State, where mobile banking was also revealed as the strongest predictor of MSME sales growth, and with multi-country evidence linking mobile banking to SME sales growth (Enaigbe & Ezeliora, 2025). Seen through the adoption lens, a phone-based channel needs little effort and no branch visit (effort expectancy). It also makes payments to and from suppliers and customers easier and faster (performance expectancy), and it has a relative advantage over cash in speed and reach. These features are likely to broaden the customer base and speed up settlement, which is good for sales.

Secondly, the Internet banking has a significant increase in sales growth, consistent with findings that it can increase sales and markets by overcoming distance (Dedi et al., 2019; Iyke-Ofoedu et al., 2022). Internet banking, is mainly used for outward-facing activities such as receiving payments and checking account balances, which need only accasional access, so it may support sales even where connectivity is unreliable (an interpretation not directly tested in this study).This is in line with the facilitating-conditions argument that benefits are contingent on connectivity and digital skills (Melubo & Musau, 2020).

Third, POS did not have a significant effect on sales growth. The result is surprising because POS is compatible with face-to-face trade, and it is contrary to studies showing positive effects of POS. This finding is consistent with the research that found that POS had no significant effects on some performance outcomes (Khatib, 2022). A likely reason is that a lot of agro-SME transactions in the region are still informal and cash-based and thus card and transfer payments at the point of sale may be too small a share of sales to be visible. Notably, POS correlates positively with sales growth on its own($r = 0.264$. Table 8) and moderately with the other channels ($r = 0.287 - 0.376$), so its near zero path coefficient indicates that it adds no unique explanatory power once the other channels are controlled for. This also runs against the diffusion of innovations expectation that POS, being compatible with face -to-face trade, should show a strong effect.

Finally, the small but significant effect ATMs on sales growth is consistent with studies of ATMs and other financial innovations and the growth of small and medium industries in Nigeria (Ubi & Mba, 2019; Ugwuoke et al., 2022; Onyeogo et al., 2025). Quick access to cash speeds routine transactions in cash-based trade, which is a relative advantage under Diffusion of Innovations theory. The effect was the weakest of the significant channels, possibly because ATM coverage in rural parts of the region is limited, although, distance to the nearest ATM was not measured in this study.

CONCLUSION

Digital financial inclusion is positively associated with the sales growth of agro-based SMEs in North-Eastern Nigeria, but the association is channel-specific and small. Mobile, internet, virtual and ATM channels each had a significant positive effect, while POS did not.

Banks and fintech operators should support mobile, virtual and internet channels, which showed consistent positive associations, and pair internet banking with improvements in connectivity and user training. Regulators

and development agencies should investigate why POS adoption has not yet raised sales, including terminal reliability, merchant fees and customer payment habits, before subsidising further roll-out. Because all effects are small, channel expansion should be combined with measures that address the other constraints on agro-SME growth. The results support using adoption theories together with the Resource-Based View: a channel raises sales only where it fits the firm's way of trading and the supporting infrastructure exists. The cross-sectional, single-respondent design relies on perceptions and cannot establish causality; the paths should be read as associations. Security conditions limited access to parts of Borno and Yobe, so those areas may be under-represented. Sales growth was measured with perceptual items rather than audited financial records. Future studies could use panel or objective sales data, test moderators such as digital literacy, connectivity and gender, and examine why POS shows no effect.

RECOMMENDATIONS

Based on the findings and conclusions drawn from this study, the following recommendations are proposed for policymakers, financial institutions, and agro-based SMEs operators in North-eastern Nigeria.

1. Considering the infrastructure challenges in the region, banks and fin-tech should accelerate the acceptance and promotion of mobile banking platforms, especially USSD-based services that do not need Internet connectivity. Banks and mobile network operators should work together to increase the network coverage in rural agro-based SMEs clusters.

2. Financial institutions and other regulatory authorities should prioritise the expansion of virtual banking networks into rural and semi-urban communities where agro-based SMEs are predominantly located.

3. Banks and other financial institutions should invest in improving the reliability, speed, and user-friendliness of internet banking platforms specifically tailored to the operational needs of agro-based SMEs.

4. Banks should review the cost structure associated with ATM usage, including withdrawal charges and transaction fees, to ensure that the operational benefits derived from ATM services translate more directly in improving agro-based SME sales growth.

5. Regulators and other financial institutions should support POS by improving terminal reliability, keeping merchant fees reasonable and encouraging customers to pay electronically, so that POS can begin to contribute to sales growth.

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