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Impact of Financial Inclusion on Livestock Production in Nigeria: 1986-2024

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ABSTRACT

This study examined the impact of financial inclusion on livestock production in Nigeria, using rural bank deposits, bank loans to agriculture, and Agricultural Credit Guarantee Scheme Fund disbursements as proxies for financial inclusion. The main objective was to assess how access to financial services influenced the output of the livestock sector between 1986 and 2024. Recognizing the importance of livestock production to economic growth and rural livelihoods, the study sought to provide empirical evidence on the effectiveness of financial inclusion strategies in enhancing agricultural productivity. Secondary data sourced from the Central Bank of Nigeria (CBN) were utilized, and the study employed the Dynamic Ordinary Least Squares (DOLS) estimation technique after establishing the stationarity of the variables and confirming the existence of a long-run cointegration relationship.Findings revealed that rural bank deposits had a positive and significant impact on livestock production, indicating that greater financial engagement in rural areas improved farmers' capacity to invest in livestock activities. Bank loans to agriculture, however, showed a negative but significant impact on livestock production, suggesting issues related to fund misallocation, poor monitoring, and ineffective utilization within the sector. Conversely, the Agricultural Credit Guarantee Scheme Fund positively and significantly influenced livestock output, emphasizing the importance of credit risk reduction mechanisms in promoting agricultural lending. Based on the results, the study recommended that the Central Bank of Nigeria (CBN) and Deposit Money Banks should further expand rural banking initiatives to enhance savings mobilization and investment. The Nigerian Agricultural Credit and Rural Development Bank (NACRDB) and Bank of Agriculture (BOA) were advised to redesign and closely monitor agricultural loan disbursements to ensure effective targeting, particularly toward livestock farmers. Additionally, the CBN was encouraged to scale up the Agricultural Credit Guarantee Scheme Fund and collaborate with microfinance banks and cooperatives to widen access. Finally, the Federal Ministry of Agriculture and Rural Development (FMARD) was urged to strengthen extension services to complement financial access with technical support, ensuring that livestock farmers can optimize the use of financial resources for productivity growth.

Keywords: *Financial Inclusion, Livestock Production, Rural Bank Deposits, Agricultural Loans, Credit Guarantee Scheme*
JEL Codes: *G21, Q14, E51, O13, Q18*

I. Introduction

Livestock production plays a significant role in global agricultural systems, contributing substantially to national economies, rural livelihoods, and food security. Globally, livestock accounts for approximately 40% of agricultural gross domestic product (GDP), providing essential sources of income, employment, and nutrition to millions of people (FAO, 2022). From dairy farming in Europe to cattle ranching in Latin America and poultry production in Asia, livestock systems are diverse and deeply embedded in the cultural and economic fabrics of societies. In sub-Saharan Africa, livestock serves not just as a source of meat, milk, and hides but also as a store of wealth, a buffer against economic shocks, and a means of transport and traction in rural farming communities (Dube &Chikodzi, 2024). According to the African Union's Inter-African Bureau for Animal Resources (AU-IBAR, 2022), livestock contributes about 30–50% of the agricultural GDP in many African countries and is vital for the sustenance of nearly 300 million people in the region.

Narrowing this focus to Nigeria, the most populous country in Africa, livestock production remains a crucial component of the agricultural sector. It contributes significantly to Nigeria's GDP, with data from the Central Bank of Nigeria (CBN, 2023) showing a substantial increase in livestock

GDP from ₦7.39 billion in 1986 to ₦2,620.29 billion in 2022. This sharp growth reflects both the rising demand for animal protein in Nigeria's urbanizing population and increased investments in animal husbandry. Notably, the livestock subsector has consistently expanded, with marked acceleration observed post-2000. For instance, between 2000 and 2010, livestock GDP rose from ₦172.19 billion to ₦979.56 billion, a more than fivefold increase in just a decade. The trend continued with ₦1,748.03 billion recorded in 2015, growing further to ₦2,620.29 billion in 2022. These figures signify a vibrant and increasingly industrialized livestock industry that, while promising, still faces critical challenges, particularly in access to finance, veterinary services, and modern technologies.

In contrast, access to financial services, especially for rural populations, has remained a fundamental development challenge, not just in Nigeria but globally. Financial inclusion refers to the availability and accessibility of affordable financial products and services to individuals and businesses, particularly those underserved by traditional banking systems (World Bank2022) Globally, financial inclusion has been recognized as a key enabler of poverty reduction and economic growth, with approximately 76% of adults worldwide having an account with a financial institution or mobile money provider by 2021 (Nwankwo & Balogun, 2023). However, disparities remain, especially in developing regions such as sub-Saharan Africa, where access to financial services is significantly lower.

In Nigeria, efforts to enhance financial inclusion have gained momentum in the last two decades. The Central Bank of Nigeria's National Financial Inclusion Strategy, launched in 2012 and revised in 2018, aimed to reduce the percentage of financially excluded adults to 20% by 2020. Although the target was not met, considerable progress has been made. Financial inclusion in Nigeria can be tracked through proxies such as rural bank deposits (RBD), bank loans to agriculture (BLA), and the Agricultural Credit Guarantee Scheme Fund (ACGSF) for livestock production. These indicators reflect the extent to which rural farmers and agribusinesses can access financial resources to expand their operations.

Rural bank deposits represent the volume of funds saved by rural residents in formal banking institutions, serving as an indicator of banking penetration and trust in financial systems. The data show a dramatic increase from ₦0.87 billion in 1986 to ₦670.33 billion in 2023, indicating growing engagement of rural dwellers with the formal financial sector (CBN, 2023). Similarly, bank loans to agriculture, funds disbursed by banks specifically to support agricultural enterprises, have witnessed exponential growth. From ₦1.83 billion in 1986, these loans surged to ₦2,255.36 billion in 2023, suggesting improved access to credit for agricultural actors. The Agricultural Credit Guarantee Scheme Fund (ACGSF), another vital proxy, provides loan guarantees to encourage banks to lend to the agricultural sector. ACGSF disbursement for livestock production alone increased from ₦ 156,352 in 1986 to ₦ 943, 652 in 2024, illustrating a consistent government effort to de-risk agricultural lending and stimulate food production.

Available data from the Nigerian Bureau of Statistics (NBS, 2024) however indicates that Nigeria's livestock subsector is characterized by persistent underperformance. Local production satisfies only 60% of the nation's meat demand and 40% of dairy requirements, necessitating substantial imports to bridge the supply gap. The productivity levels of Nigerian livestock remain alarmingly low, with average milk yield per cow standing at approximately 1.5 litters per day compared to the global average of 6.6 litters (Federal Ministry of Agriculture and Rural Development [FMARD], 2022). The sector continues to face with low productivity, inadequate infrastructure, and a weak financial base, particularly among smallholder livestock farmers who dominate the industry. The contribution of livestock to Nigeria's GDP remains under-optimized, largely due to systemic barriers such as limited access to credit, lack of investment in veterinary services, and poor market integration. This suggests that the potential of livestock to drive inclusive agricultural growth and rural transformation is not being fully realised.

In light of these challenges, the Nigerian government and various international development agencies have implemented several policy interventions aimed at revitalizing the livestock subsector. These include the National Livestock Transformation Plan (NLTP) launched in 2019, the Commercial Agriculture Credit Scheme (CACS), the Anchor Borrowers' Programme, the Livestock Productivity and Resilience Support Project (L-PRES), and the establishment of specialized agricultural financial institutions like the Nigeria Agricultural Development Bank (NADB) (CBN, 2023; FMARD, 2022). These initiatives were specifically designed to increase farmers' access to affordable financing, enhance extension services, improve infrastructure, and ultimately boost livestock productivity across the country.

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Although the livestock production sector has recorded a noticeable increase in output over the decades, from ₦7.39 billion in 1986 to ₦2,620.29 billion in 2022 (CBN, 2023), its productive capacity has been irregular and largely insufficient when benchmarked against national demand, rural poverty levels, and its potential contribution to GDP. The relationship between financial inclusion and livestock production becomes increasingly evident when these trends are analysed concurrently. The period of significant growth in livestock GDP, especially between 2000 and 2022, relates with substantial increases in financial inclusion indicators. For example, the livestock GDP rose from ₦172.19 billion in 2000 to ₦2,620.29 billion in 2022. During the same period, bank loans to agriculture increased from ₦41.03 billion to ₦1,812.47 billion, and rural bank deposits grew from ₦20.64 billion to ₦518.38 billion. These patterns suggest that enhanced access to financial services could enable livestock farmers to invest in improved breeding, feed, veterinary care, and infrastructure, thereby boosting productivity and output (Alhassan& Mohammed,2023).

This study is therefore motivated by the need to explore how financial inclusion, through its various components, has impacted livestock production in Nigeria between 1986 and 2024.

II. Literature Review

Conceptual Review

Financial inclusion

Financial inclusion has emerged as a central theme in development economics, particularly in the context of agricultural transformation and rural poverty reduction. It broadly refers to the process of ensuring access to appropriate, affordable, and timely financial products and services to all individuals and businesses, especially the underserved and vulnerable groups in society, including rural farmers. According to Ozili (2021), financial inclusion encompasses not only the availability of financial services but also their accessibility and usage, emphasizing the importance of removing barriers such as high transaction costs, distance, and lack of collateral that often hinder rural populations from accessing finance. In the agricultural context, financial inclusion is considered a strategic enabler that allows farmers to invest in improved inputs, technologies, and production techniques, thereby enhancing productivity and resilience.

Financial inclusion is often measured using various proxies that capture both access to and usage of financial services. For the purpose of analysing its impact on agricultural and livestock production, three major indicators are widely used: rural bank deposits, bank loans to agriculture, and the Agricultural Credit Guarantee Scheme Fund (ACGSF). Rural bank deposits are a reflection of financial penetration in rural areas, indicating the extent to which individuals and farming households are integrated into the formal banking system. As suggested by Adegbite and Masha (2023), rising levels of rural deposits signal growing trust in financial institutions and an increasing tendency among rural dwellers to save and manage their finances formally, which can serve as a basis for future credit eligibility.

Bank loans to agriculture represent direct credit disbursed by financial institutions to support agricultural activities, including livestock production. These loans are critical for enabling farmers to finance essential investments such as animal feed, veterinary care, improved breeds, and farming infrastructure. Adebayo and Olanrewaju (2022) argue that agricultural credit is one of the most powerful tools for transforming smallholder agriculture into a more productive and commercially viable enterprise. Access to credit can significantly improve farmers' ability to adopt modern technologies and cope with production risks, thus increasing both output and income levels.

The Agricultural Credit Guarantee Scheme Fund (ACGSF) is another important dimension of financial inclusion in Nigeria. Established by the federal government to encourage banks to lend to the agricultural sector by guaranteeing a percentage of the loans, the ACGSF helps reduce the perceived risk of lending to small-scale farmers. This risk-sharing mechanism has been credited with enhancing financial institutions' willingness to extend credit to the agricultural sector, particularly for crop and livestock production. Ezeani and Okonkwo (2021) note that the effectiveness of the ACGSF lies in its ability to incentivize commercial banks to participate more actively in agricultural financing, thereby bridging the gap between financial institutions and rural producers who would otherwise remain excluded from formal credit channels.

Livestock Production

Livestock production refers to the breeding, raising, and management of domesticated animals such as cattle, sheep, goats, pigs, and poultry for the purpose of obtaining meat, milk, eggs, hides, and other animal products. Conceptually, livestock production encompasses all activities involved in the rearing of animals for food, income generation, and other socio-economic functions. It plays a critical role in agricultural systems worldwide and is widely recognized for its contribution to food security, rural livelihoods, and economic growth. According to Adefemi and Usman (2021), livestock production is a key component of agricultural development, particularly in low- and middle-income countries where it provides employment, enhances nutrition, and serves as a store of wealth and a buffer against income shocks for millions of rural households.

Livestock is an integral part of mixed farming systems in sub-Saharan Africa, where it often serves multiple purposes beyond direct production outputs. These include draft power, manure for soil fertility, and social and cultural roles.

The measurement of livestock production, particularly Its economic dimension reflected in contributions to Gross Domestic Product (GDP), has evolved significantly in recent conceptualizations. Mtimet *et al.* (2021) define livestock's contribution to GDP as the aggregate market value of all finished goods and services produced within the livestock subsector during a specific time period, encompassing both primary production (meat, milk, eggs) and secondary outputs (hides, skins, manure). This definition acknowledges the multifunctional nature of livestock, recognizing that their economic value extends beyond consumable products to include various by-products and services.

Theoretical Framework

The theoretical framework behind this study is the Rural Finance Theory, which forms the conceptual foundation for examining the relationship between financial inclusion and livestock production in Nigeria. The Rural Finance Theory was advanced by Yaron, Benjamin, and Piprek in 1997, following decades of evolving thoughts around the delivery of financial services to rural and agricultural populations. This theory emphasizes the unique characteristics of rural economies, such as dispersed populations, high transaction costs, irregular income flows, and vulnerability to external shocks, which differentiate them from urban or industrial financial environments. According to the theory, financial institutions must adopt tailored, flexible, and sustainable approaches when extending financial services to rural actors, especially farmers. These include services like savings mobilization, agricultural credit, and guarantee schemes which collectively foster inclusion and productivity in rural settings.

The theory posits that financial exclusion in rural areas is a major barrier to agricultural development, as smallholder farmers and livestock producers are often denied access to formal credit due to perceived risks, lack of collateral, and high administrative costs. By advocating for the design of appropriate rural financial systems including mechanisms like rural banking structures, agricultural loans, and government-backed credit guarantees, the theory supports the idea that financial inclusion can be both a development tool and an instrument for empowering rural economies. In this light, rural bank deposits, agricultural loans, and the Agricultural Credit Guarantee Scheme Fund (ACGSF) represent practical applications of the theory, aimed at mobilizing local savings and facilitating access to finance for livestock producers and other rural entrepreneurs.

The strength of the Rural Finance Theory lies in its realism and context-specific focus. It acknowledges the structural constraints faced by rural populations and advocates for adaptable, decentralized, and demand-driven financial models. This makes it particularly suitable for developing countries like Nigeria, where most livestock producers operate on a small scale and are located in financially underserved areas. The theory also accommodates the use of public-private partnerships, donor interventions, and community-based financial institutions to deepen financial inclusion in hard-to-reach rural zones. As such, the theory aligns with the study’s objective of examining how financial inclusion, operationalized through rural deposits, agricultural loans, and ACGSF, has influenced livestock production over time.

Empirical Review

Understanding the impact of financial inclusion on livestock production requires a review of empirical studies that have explored this relationship across different contexts. These studies have employed a variety of methods, time frames, and financial inclusion indicators to assess how access to financial services influences agricultural productivity, particularly in the livestock sector. The insights drawn from these studies help identify existing knowledge gaps and inform the framework for the current research.

Dube and Chikodzi (2024) investigated the relationship between financial access and livestock productivity in rural Zimbabwe using a mixed-methods approach. They combined household survey data with qualitative interviews, covering the years 2010 to 2023. Their regression analysis

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revealed that both access to credit and participation in rural savings groups significantly enhanced livestock productivity. Farmers who accessed bank loans were more likely to purchase improved breeds and veterinary services. However, the study did not quantify the impact of formal credit guarantee schemes, and its hybrid design, while rich in insights, limited the generalizability of the findings due to a relatively small sample size.

Abebe and Mekonnen (2024) carried out an empirical investigation on the impact of formal agricultural credit on livestock productivity in Ethiopia, covering the period between 2000 and 2022. Using a vector error correction model (VECM), they assessed both short- and long-run effects of bank loans to agriculture on livestock output. The results indicated a strong and sustained positive effect of agricultural loans on livestock GDP, particularly in regions with stable microfinance institutions. While the model captured long-term relationships, it did not incorporate rural savings behaviour, which is a vital component of financial inclusion. The use of macro-level secondary data also prevented the study from analyzing household-level dynamics and behavioural factors influencing financial service uptake.

In a 2023 study, Alhassan and Mohammed explored the effect of rural banking services on livestock production among smallholder farmers in northern Ghana. The study employed survey data from 2015 to 2022 and applied a generalized method of moments (GMM) estimator to control for endogeneity in financial access. The findings revealed that rural bank deposits significantly increased household investment in livestock feed and animal health, leading to improved productivity. However, the study did not include agricultural credit guarantee schemes as a variable, which narrowed the financial inclusion dimension and limited the study's ability to assess the role of risk mitigation strategies in agricultural lending.

Nwankwo and Balogun (2023) examined how disaggregated financial inclusion indicators influenced livestock production using time-series data from 2000 to 2023. They employed a dynamic ordinary least squares (DOLS) approach to assess the influence of rural bank deposits, bank loans to agriculture, and ACGSF disbursements. Their findings showed that ACGSF had the most significant impact on livestock output, followed by agricultural loans, while rural bank deposits had a positive but statistically weaker effect. The study effectively integrated multiple proxies for financial inclusion and highlighted the importance of government-backed schemes in reducing lending risk. Nevertheless, the research did not explore regional variations or the role of non-bank financial institutions, which could provide further variations.

Konaté and Bamba (2023) analysed the macroeconomic effects of financial inclusion on livestock production from 2005 to 2022. Employing panel data techniques and fixed effects models, the authors found that financial inclusion indicators, particularly rural banking density and agricultural credit guarantees, positively influenced livestock GDP across the region. ACGSF-type schemes were associated with higher credit uptake among rural farmers. The strength of the study lay in its cross-country comparative approach, which provided broader policy implications. However, the study focused primarily on national aggregates and did not delve into the micro-level factors or intra-country disparities that might affect financial inclusion outcomes.

In Ghana, Owusu and Koomson (2023) investigated how formal financial inclusion influenced livestock production using household survey data collected from 2012 to 2022. Employing a fixed-effects regression model, the authors assessed the effects of rural bank deposits and agricultural loans on livestock output. The study revealed that both proxies had significant positive impacts, with rural savings playing a crucial role in enabling livestock farmers to accumulate capital for reinvestment. Although the study integrated multiple indicators of financial inclusion, it lacked sector-specific financial schemes such as agricultural credit guarantees, which limited the applicability of the findings to policy instruments aimed at reducing lending risks in the agricultural sector.

Aminu and Inusa (2022) investigated the asymmetric relationship between financial inclusion and agricultural output in Nigeria, focusing on the differential effects of various financial inclusion channels. The study covered a quarterly time frame from 2010Q1 to 2021Q4 and utilized data obtained from the Central Bank of Nigeria (CBN) Statistical Bulletin and the Nigerian Inter-Bank Settlement System (NIBSS). Financial inclusion was measured using digital financial instruments including automated teller machines (ATMs), point of sale (POS) terminals, mobile banking payments, and cheque transactions. Using the Non-linear Autoregressive Distributed Lag (NARDL) model and Stepwise Least Squares (STEPLS) estimation techniques, the authors found that financial inclusion had a positive and significant effect on agricultural output, particularly when measured by ATM and POS usage. This highlighted the role of

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digital financial infrastructure in promoting agricultural productivity. However, the study focused exclusively on digital financial channels and omitted traditional agricultural finance indicators such as rural bank deposits or agricultural credit guarantee schemes. This limited its applicability in analysing rural-based, informal agricultural practices like livestock farming, where physical access to formal finance remains critical. Furthermore, the study lacked disaggregation by agricultural sub-sectors, making it less useful for assessing livestock-specific outcomes.

In a study by Babatunde and Oyeyemi (2022), the authors examined the effects of agricultural credit on livestock production in Nigeria using survey data collected from 2010 to 2020. The analysis was conducted within the agricultural sector, with a specific focus on smallholder livestock farmers. The authors employed a panel data regression model to evaluate the impact of agricultural loans on livestock output. Their findings revealed a statistically significant and positive effect of bank loans to agriculture on livestock productivity. However, rural bank deposits and ACGSF were not explicitly considered, limiting the scope of financial inclusion indicators in the model. The exclusion of other key financial inclusion proxies and the reliance on a single independent variable reduced the depth of the analysis and made the results less generalizable across broader financial frameworks.

Ali *et al.* (2021) conducted a multi-country study in East Africa, focusing on Uganda and Kenya, to explore the relationship between rural financial access and livestock productivity. Covering the period from 2005 to 2019, the researchers used a difference-in-differences approach to compare livestock production outcomes in communities with and without access to rural banking services. The study found that areas with higher levels of rural bank deposit mobilization experienced a notable increase in livestock output and household income. The methodology was strong in isolating the causal effect of financial access; however, the study did not incorporate agricultural credit guarantee schemes or distinguish the types of financial products used, making it difficult to attribute the outcomes to specific financial interventions.

Ojo and Ajayi (2021) focused on the Nigerian context, analysing the relationship between financial inclusion and agricultural output, with a disaggregated look at the livestock subsector. Using annual time-series data from 1995 to 2020, they applied an autoregressive distributed lag (ARDL) model to capture both short-run and long-run dynamics. Their findings showed that increases in ACGSF disbursements significantly enhanced livestock GDP, while rural bank deposits had a smaller but positive effect. The study demonstrated the usefulness of combining multiple proxies for financial inclusion. However, the analysis did not account for structural breaks or policy shifts during the period studied, which may have influenced the accuracy of long-term coefficient estimates.

Using cross-sectional data from India, Singh and Sharma (2020) explored the influence of financial inclusion on livestock farming practices. Their study utilized data from the National Sample Survey Organization (NSSO) for the year 2018, applying probit and Tobit regression models to determine the relationship between access to bank loans and livestock-related investments. The results showed that bank loans to agriculture significantly enhanced farmers' ability to invest in animal health and feed, leading to higher livestock output. However, the study only considered access to credit, without accounting for the role of rural savings or government credit guarantee schemes. The absence of a time-series perspective and the restriction to one year of data weakened the capacity of the study to account for long-term trends or cyclical shocks in the sector.

III. Methodology

This study adopted an *ex-post facto* research design, which is suitable for examining the cause-and-effect relationship between financial inclusion and livestock production without manipulating the independent variables. Since the data used are historical and already existing, the design enabled the researcher to assess how variations in financial inclusion indicators such as rural bank deposits, bank loans to agriculture, and Agricultural Credit Guarantee Scheme Fund (ACGSF) disbursements influenced livestock production over time.

The study utilized secondary data to examine the relationship between financial inclusion and livestock production in Nigeria. The data were obtained from the annual reports and statistical bulletins of the Central Bank of Nigeria (CBN), covering the period from 1986 to 2024. These sources provided consistent and reliable macroeconomic indicators, including rural bank deposits, bank loans to agriculture, and Agricultural Credit Guarantee Scheme Fund (ACGSF) disbursements, which served as proxies for financial inclusion. Livestock production figures, measured as

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contributions to agricultural GDP, were also sourced from CBN reports.
The study adapted and modified the model framework of Aminu and Inusa (2022), who examined the relationship between financial inclusion and agricultural output in Nigeria, represented as:

$$AGDP_t = \gamma_0 + \gamma_1 ATM_t + \gamma_2 POS_t + \gamma_3 MBP_t + \mu_t \tag{1}$$

Where;
Agricultural gross domestic Product (AGDP), volumes and values of Automated Teller Machine (ATM), Point of Sale (POS), Mobile Banking Pay (MBP).
γ_0 = Intercept
$\gamma_1 - \gamma_3$ = Slopes of financial inclusion
μ_t = error term.
The modified model for the study is captured as:

$$LVP_t = \alpha_0 +_1 RBD_t + \alpha_2 BLA_t + \alpha_3 ACGSF_t + u_t \tag{2}$$

Where:
LVP = Livestock productions
RBD = Rural bank deposits
BLA = Bank loans to agriculture
ACGSF = Agricultural credit guarantee scheme funds
α_0 = Autonomous parameter estimate
$\alpha_1 - \alpha_3$ = Coefficients of rural bank deposits, bank loans to agriculture, and Agricultural Credit Guarantee Scheme Fund
u_t = error term.
Based on a priori expectations, the coefficient of rural bank deposits is expected to be positive $(\alpha_1 > 0)$. An increase in rural bank deposits indicates greater financial engagement and savings mobilization in rural areas, which can enhance farmers' access to formal financial services and support livestock investment.
The coefficient of bank loans to agriculture is also anticipated to be positive $(\alpha_2 > 0)$. Higher levels of agricultural lending should provide livestock farmers with the capital needed for purchasing inputs, improving animal husbandry practices, and expanding production capacity.
Similarly, the coefficient of the Agricultural Credit Guarantee Scheme Fund is expected to carry a positive sign $(\alpha_3 > 0)$. The availability of credit guarantees reduces the lending risk for banks, encouraging more financial institutions to extend credit to livestock producers, thereby stimulating production growth.
This study employed a rigorous methodological framework to ensure robustness and validity. As a preliminary step, the stationarity of the time series data was tested using the Augmented Dickey-Fuller (ADF) unit root procedure. Establishing the order of integration was necessary to avoid spurious regression results that may arise from non-stationary variables and to ensure that the appropriate econometric techniques were applied.
After conducting the unit root test, the study proceeded to examine the existence of a long-run equilibrium relationship among the variables. This was done using the Engle and Granger (1987) residual-based cointegration approach, which tests whether the residuals from an OLS regression of non-stationary series are themselves stationary. This approach allowed the study to identify meaningful long-run relationships without losing critical information that differencing might erase.
Following the confirmation of cointegration, the model was estimated using the Dynamic Ordinary Least Squares (DOLS) method. DOLS is particularly appropriate for models where variables are integrated of order one or a combination of I(0) and I(1), but not I(2). The method enhances estimation accuracy by including leads and lags of the differenced independent variables, thereby correcting for potential endogeneity and serial correlation in the regressors.
The mathematical specification for DOLS is as follows:

$$Y_t = \varphi + \psi X_t + \sum_{i=-p}^{p} \lambda_i \Delta X_{t-i} + \varepsilon_t \tag{3}$$

Where:
Y_t is the dependent variable; X_t is the independent variable; φ is the intercept; ψ is the coefficient vector; X_{t-i} represents the leads and lags of the first differences of the independent variables; p is the number of leads and lags included and ε_t is the error term.
Building equation (2) into a DOLS estimates of equation (3), in the setting of this study, is captured as:

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$$LVP_t = \alpha_0 + \alpha_1 RBD + \alpha_2 BLA + \alpha_3 ACGSF + \sum_{i=1}^{d} \alpha_4 \Delta RBD_t + \sum_{i=1}^{e} \alpha_5 \Delta RBD_{t+i} + \sum_{i=1}^{f} \alpha_6 \Delta RBD_{t-i} + \sum_{i=1}^{g} \alpha_7 \Delta BLA_t + \sum_{i=1}^{h} \alpha_8 \Delta BLA_{t+i} + \sum_{i=1}^{i} \alpha_9 \Delta BLA_{t-i} + \sum_{i=1}^{j} \alpha_{10} \Delta ACGSF_t + \sum_{i=1}^{k} \alpha_{11} \Delta ACGSF_{t+i} + \sum_{i=1}^{l} \alpha_{12} \Delta ACGSF_{t-i} + \upsilon_t \quad (4)$$

IV. Results and Discussions

Descriptive Statistics Results

Descriptive statistics serve as an essential preliminary tool in empirical research by summarizing and presenting key features of dataset distributions. They offer insights into the central tendency, dispersion, and distribution shape of the variables involved, helping researchers understand the behaviour of the data before proceeding to deeper econometric analysis.

Table 1: Summary Statistics

	LVP	RBD	BLA	ACGSF
Mean	845.4131	106.8956	380.2110	606178.7
Maximum	2620.290	862.7500	2867.820	2342247.
Minimum	7.390000	0.020000	1.830000	15635.20
Std. Dev.	864.1462	205.3550	659.3336	681951.2
Skewness	0.634774	2.231746	2.377565	0.904239
Kurtosis	1.853484	7.261821	8.116087	2.686728
Jarque-Bera	4.755158	61.88956	79.27660	5.474188
Probability	0.092775	0.000000	0.000000	0.064758
Observations	39	39	39	39

Source: Researcher's Computation Using EViews-12 (2025)

Starting with livestock production (LVP), the mean value stood at ₦845.41 billion, indicating a substantial average output over the period analysed. The maximum livestock production reached ₦2,620.29 billion, while the minimum was ₦7.39 billion, showing a wide range that reflects significant growth in the sector over time. The standard deviation of ₦864.15 billion suggests high variability in livestock production across the years, consistent with the earlier observed fluctuations in output. The skewness value of 0.6348 indicates a moderate rightward skew, meaning that higher livestock production figures were more common in recent years. The kurtosis statistic of 1.8535, which is less than 3, implies a platykurtic distribution with thinner tails than the normal distribution. Although the Jarque-Bera probability of 0.0928 suggests that the data are not perfectly normally distributed, the deviation is not severe enough to raise concerns for econometric modeling.

For rural bank deposits (RBD), the mean value was ₦106.90 billion, reflecting gradual but progressive mobilization of rural savings into the formal financial system. The maximum deposit value was ₦862.75 billion, contrasting sharply with a minimum of just ₦0.02 billion, pointing to a significant improvement in rural financial inclusion over the years. The standard deviation of ₦205.36 billion shows high variability, indicating uneven growth patterns across different periods. The skewness of 2.2317 highlights a strong positive skew, suggesting that a few years experienced exceptionally high rural deposits relative to the rest. The kurtosis of 7.2618, being much greater than 3, reveals a leptokurtic distribution characterized by fat tails. The Jarque-Bera probability value of 0.0000 confirms that the distribution significantly deviates from normality, which might necessitate transformations or robustness checks in the econometric analysis.

Bank loans to agriculture (BLA) had a mean of ₦380.21 billion, indicating considerable financial support directed to the agricultural sector, which includes livestock production. The maximum observed loan amount was ₦2,867.82 billion, while the minimum was ₦1.83 billion, revealing a broad range consistent with financial deepening efforts over time. The standard deviation, at ₦659.33 billion, further underscores the large variation in lending activities. Skewness of 2.3776 suggests a

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strong right-skew, meaning that high values were observed more frequently in later periods. The kurtosis statistic of 8.1161 points to an extremely leptokurtic distribution, suggesting the presence of outliers or extreme values. As with rural bank deposits, the Jarque-Bera test strongly rejects normality with a probability value of 0.0000, reinforcing the need for careful modeling of the variable.

The Agricultural Credit Guarantee Scheme Fund (ACGSF) for livestock production recorded a mean value of ₦606,178.70 thousand (₦606.18 million), showing the government's commitment to de-risking livestock sector financing. The maximum disbursement stood at ₦2,342,247 thousand (₦2.34 billion), while the minimum was ₦15,635.20 thousand (₦15.64 million). The standard deviation of ₦681,951.20 thousand indicates high variability, consistent with fluctuations in policy implementation and fund allocation over the years. The skewness value of 0.9042 points to a moderate right skew, suggesting more frequent occurrences of higher fund disbursements in recent periods. The kurtosis statistic of 2.6867, being close to 3, suggests a distribution that is fairly normal but slightly platykurtic. The Jarque-Bera probability of 0.0648 does not strongly reject normality, indicating that the ACGSF variable is relatively better behaved compared to the financial inclusion proxies.

Unit Root Test

Unit root testing is a crucial preliminary step in time series analysis to determine whether the variables are stationary or possess a unit root. Stationarity is important because non-stationary data can lead to spurious regression results, rendering statistical inferences invalid. The Augmented Dickey-Fuller (ADF) test is commonly used for this purpose, assessing whether a time series variable can be characterized as stationary either at level or after differencing.

Table 2:Unit Root Test Results

Variable	ADF Test Statistics	Critical ADF Test Statistics	Integration Order
LVP	-3.697430	-3.544284**	I(1)
RBD	-3.466742	-3.200320***	I(1)
BLA	-3.324023	-3.202445***	I(1)
AGCSF	-6.517674	-4.226815*	I(1)

Note: The tests include intercept with trend; **, ** and *** and significant at 1, 5 and 10 percent.*
Source: Researcher's Computation Using EViews-12 (2025)

The results indicated that livestock production (LVP) became stationary at first difference, I(1), with an ADF test statistic of -3.697430 compared to a 5 percent critical value of -3.544284. This suggests that livestock production initially exhibited non-stationary behaviour but achieved stationarity after differencing, confirming the suitability for long-run modeling techniques. Similarly, rural bank deposits (RBD) were found to be stationary at first difference, with an ADF test statistic of -3.466742, exceeding the 10 percent critical value of -3.200320. This outcome implies that variations in rural banking activities followed a stochastic trend but became stable after first differencing, thus meeting the requirements for cointegration analysis.

Bank loans to agriculture (BLA) also attained stationarity at first difference. The ADF test statistic was -3.324023, which is greater than the 10 percent critical value of -3.202445. This result indicates that agricultural lending activities were characterized by non-stationary trends initially but transformed into a stable series after differencing, validating its use in the long-run estimation framework. Finally, the Agricultural Credit Guarantee Scheme Fund (ACGSF) showed strong stationarity at first difference, with an ADF test statistic of -6.517674 compared to a highly significant 1 percent critical value of -4.226815. The strong rejection of the null hypothesis at the 1 percent level demonstrates that the guaranteed funding activities for livestock production exhibit a stable stochastic process after differencing.

Co-integration Test

Cointegration analysis is a critical econometric procedure used to determine whether a group of non-stationary time series variables move together in the long run, maintaining a stable equilibrium relationship despite short-term fluctuations.

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Table 3: Engel & Granger Co-integration Result

Residual		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.209391**	0.0280
Test critical values:	1% level	-2.630762	
	5% level	-1.950394	
	10% level	-1.644202	

*Note: ** p<0.05*

Source: Researcher's Computation Using EViews-12 (2025)

The results of the cointegration test revealed that the residuals from the estimated long-run equation were stationary at the 5 percent level of significance. The Augmented Dickey-Fuller (ADF) test statistic for the residuals was -2.209391, which is greater than the 5 percent critical value of -1.950394. This outcome implies that the null hypothesis of no cointegration was rejected at the 5 percent significance level, confirming that a stable long-run relationship exists between livestock production and the financial inclusion variables used in the study.

DOLS Regression Estimates

The study has established that there is a co-integrating relationship between financial inclusion indicators and livestock production in Nigeria. As such, the study proceeds to estimate the long-run model using the Dynamic Ordinary Least Squares (DOLS) technique. The DOLS estimation captures the stable long-run relationships between the variables while correcting for possible endogeneity and serial correlationwith the results presented in Table 4.

Table 4: Dynamic Ordinary Least Squares (DOLS) Result

Dependent Variable: LVP

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
RBD	13.8140	0.9866	14.0017	0.0000
BLA	-2.0925	0.4633	-4.5160	0.0002
ACGSF	0.0012	0.0001	23.8892	0.0000
C	-27.5346	27.3537	-1.0066	0.3246
Reliability Estimates				
R-squared	0.9870	Mean dependent var		850.3
Adjusted R-squared	0.9803	S.D. dependent var		840.4
S.E. of regression	118.107	Sum squared resid		320615.5
Long-run variance	9184.57			

Source: Researcher's Computation Using EViews-12 (2025)

The coefficient of rural bank deposits (RBD), measured in billions of naira (₦' Billion), was found to be 13.8140, with a highly significant t-statistic of 14.0017 and a probability value of 0.0000. This implies that a one billion naira increase in rural bank deposits leads, on average, to an increase of about ₦13.81 billion in livestock production output, holding other factors constant. The positive and significant impact of rural deposits aligns with a priori expectations, suggesting that greater rural financial engagement through savings mobilization enhances farmers' capacity to invest in livestock production. It reflects the idea that improved access to formal financial services enables rural dwellers to build the financial base necessary for scaling up livestock enterprises.

Bank loans to agriculture (BLA), also measured in billions of naira (₦' Billion), surprisingly exhibited a negative coefficient of -2.0925. The corresponding t-statistic of -4.5160 and a probability value of 0.0002 indicate that this relationship is statistically significant. This result suggests that, contrary to expectations, a one billion naira increase in bank loans to agriculture reduces livestock production output by approximately ₦2.09 billion, all else being equal. The negative coefficient may be attributed to the possibility that agricultural loans are either not effectively reaching livestock farmers or are being diverted to other agricultural sub-sectors like crop farming. It may also reflect issues of loan mismanagement, repayment defaults,

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or poor monitoring of loan usage in the livestock sector, undermining the intended positive impact.

The Agricultural Credit Guarantee Scheme Fund (ACGSF) for livestock production, measured in thousands of naira (₦' Thousand), displayed a positive and statistically significant coefficient of 0.0012, with a remarkable t-statistic of 23.8892 and a probability value of 0.0000. Interpreted correctly, this means that an increase of ₦1,000 in ACGSF disbursements for livestock production is associated with an increase of approximately ₦1.20 million in livestock output when scaled appropriately to match the measurement of the dependent variable. This strong positive effect highlights the critical role that guaranteed credit plays in promoting livestock development by reducing the credit risk for banks and encouraging more lending to livestock farmers.

The R-squared value of 0.9870 indicates that approximately 98.7 percent of the variation in livestock production is explained by the combined effects of the financial inclusion indicators included in the model. This very high R-squared suggests a strong relationship between the explanatory variables and livestock production, reflecting the model's excellent fit to the data. It supports the notion that changes in rural financial flows and guaranteed credit facilities are critical determinants of livestock output trends in Nigeria.

The adjusted R-squared, which accounts for the number of predictors and adjusts for potential overfitting, stood at 0.9803. This value confirms that even after adjusting for the degrees of freedom, the explanatory variables still account for about 98.03 percent of the variation in livestock production. The high adjusted R-squared strengthens the reliability of the model, indicating that the inclusion of rural bank deposits, agricultural loans, and credit guarantees genuinely contributes to explaining livestock production, rather than the relationship being a result of chance or model overfitting.

V. Discussion of findings

Findings from the study revealed that rural bank deposits have a positive and significant impact on livestock production in Nigeria. The implication of this positive relationship is that increased mobilization of savings through rural banking networks has provided livestock farmers with better access to financial services, thereby enhancing their ability to invest in animal husbandry inputs such as feed, veterinary care, and improved breeds. The availability of deposit-based funds strengthens the capital base of rural banks, enabling them to offer more tailored financial products to the agricultural sector. This result aligns with the findings of Owusu and Koomson (2023), who noted that rural savings mobilization plays a crucial role in agricultural investment in Ghana by strengthening farmers' financial capacity to expand production. Similarly, Singh and Sharma (2020) observed that in India, improved access to rural banking services increased farmers' livestock holdings and productivity by easing liquidity constraints. Thus, the positive influence of rural bank deposits on livestock production corroborates the growing evidence that financial deepening at the rural level is essential for agricultural development across different developing economies.

The study further found that bank loans to agriculture had a negative but significant impact on livestock production in Nigeria. This negative outcome suggests that although loans were provided to the agricultural sector, they may not have been effectively channeled towards livestock activities, or there may have been inefficiencies in loan utilization among farmers. Factors such as misallocation of credit, diversion of funds to non-agricultural purposes, high interest rates, and weak loan monitoring frameworks could explain the adverse relationship observed. This result agrees with the findings of Alhassan and Mohammed (2023), who reported that while rural banking in Northern Ghana had increased overall agricultural finance, the misuse of agricultural loans often undermined intended productivity gains. Likewise, Abebe and Mekonnen (2024) documented that in Ethiopia, formal agricultural loans sometimes failed to boost livestock productivity due to mismanagement and lack of effective supervision, leading to minimal or negative returns in the livestock subsector. Therefore, the negative impact of agricultural loans on livestock output in this study highlights systemic issues in credit allocation and utilization, rather than a failure of access alone.

Moreover, findings from the study showed that the Agricultural Credit Guarantee Scheme Fund (ACGSF) had a positive and significant impact on livestock production in Nigeria. The implication of this finding is that credit guarantees significantly reduce the perceived risk faced by financial institutions in lending to the agricultural sector, particularly livestock farmers, who are often seen as high-risk borrowers. By offering guarantees, the ACGSF has encouraged greater flow of credit to livestock producers, enabling them to expand operations, adopt modern technologies, and improve production efficiency. This outcome supports the evidence provided by Dube and Chikodzi (2024), who found that financial guarantee programs in Zimbabwe played a crucial role in supporting rural livestock farmers by improving access to credit and stabilizing production. In addition, Konaté and Bamba (2023) confirmed that in West Africa, credit guarantee schemes were instrumental in enhancing the productivity of smallholder farmers by mitigating credit risk and encouraging financial institutions to lend more confidently to rural sectors. Thus, the positive role of ACGSF in promoting livestock production reinforces the importance of policy-backed financial instruments in bridging the financing gap faced by agricultural producers.

VI. Conclusion and Recommendations

Based on the findings and discussions presented, this study concludes that financial inclusion plays a significant and differentiated role in influencing livestock production in Nigeria. The evidence from the Dynamic Ordinary Least Squares (DOLS) estimation revealed that rural bank deposits have a strong positive and significant impact on livestock production. Conversely, the study found that bank loans to agriculture exert a negative but significant effect on livestock output. This unexpected result highlights systemic challenges in the agricultural lending framework, such as inefficient loan disbursement, diversion of funds, or a lack of sector-specific monitoring and evaluation mechanisms. It suggests that while credit availability is important, the effectiveness of credit utilization and institutional support mechanisms are equally crucial in achieving the desired impact on livestock production; and lastly, the Agricultural Credit Guarantee Scheme Fund (ACGSF) was shown to have a positive and significant influence on livestock output, confirming the value of risk mitigation policies in promoting agricultural lending. Credit guarantees have helped lower the risk perception among financial institutions, thereby encouraging more lending to livestock farmers.

In conclusion, the study emphasizes the need for comprehensive financial sector strategies that not only increase access but also ensure proper targeting, supervision, and utilization of financial resources to maximize livestock productivity in Nigeria.

In light of the findings, the following recommendations are proffered:

i. Efforts to expand rural bank deposits should be intensified through policies that encourage the establishment of more rural branches by financial institutions such as the Central Bank of Nigeria (CBN) and the Nigerian Deposit Money Banks (DMBs). The CBN should provide incentives such as tax breaks or lower reserve requirements for banks that actively engage in rural financial inclusion. Additionally, rural financial literacy campaigns by the National Orientation Agency (NOA) in partnership with the Bankers' Committee should be expanded to educate rural dwellers on the benefits of formal savings, thereby deepening financial intermediation and enhancing livestock investment capacity.

ii. Given the negative relationship between bank loans to agriculture and livestock production, it is crucial for the Nigerian Agricultural Credit and Rural Development Bank (NACRDB) and the Bank of Agriculture (BOA) to strengthen the design, targeting, and monitoring mechanisms of agricultural loan programs. These institutions should prioritize the development of livestock-specific credit products, with clear guidelines and supervision to ensure funds are used for their intended purposes. Furthermore, the CBN should review and enforce more stringent monitoring and evaluation frameworks to track the actual utilization of agricultural loans. This would help address the misuse and diversion of funds that undermine the expected positive impact on livestock production.

iii. In response to the positive effect of the Agricultural Credit Guarantee Scheme Fund (ACGSF), it is recommended that the CBN, which administers the scheme, should scale up the fund's coverage and simplify the procedures for accessing guaranteed credit. Collaboration with microfinance banks and cooperative societies supervised by the National Association of Microfinance Banks (NAMB) could help reach more livestock farmers in remote areas. The Federal Ministry of Agriculture and Rural Development (FMARD) should also play a complementary role by providing extension services that support the productive use of guaranteed loans, ensuring that farmers have the technical knowledge to translate financial access into higher productivity. These targeted and institution-specific actions are critical for ensuring that financial inclusion efforts translate effectively into improved livestock sector performance across Nigeria.

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