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Financial access and agricultural productivity in sub-Saharan Africa

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A B S T R A C T
The agricultural sector is one of the vital sectors in most developing countries. However, unfortunately, the sector is often less important in most of these developing countries, which has led to a continued decline in agricultural output. While the sector is faced with several challenges, it is believed that a major obstacle to agricultural productivity is the lack of access to credit. This study, therefore, assesses the impact of financial access on agricultural productivity in 17 countries in Sub-Saharan Africa for the period 2001 to 2023. The study employed the ARDL on agricultural productivity measured by the Food Production index, financial access, and technological innovation, among others. The result revealed that financial access through agricultural credit to farmers was found to have an inverse and substantial impact on agricultural productivity only in the long run and an insignificant impact in the short run. Therefore, the study advocates among others for government expansion of financial access to smallholder farmers at lower interest rates and flexible repayment scheme as well as the introduction of innovative financial packages such as green finance and value-chain finance.

Keywords:
Agriculture, Auto Regressive Distribution Lag, Developing countries, Financial Access, Panel Data

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1. INTRODUCTION

One of the vital sectors in most of the developing countries is the Agricultural sector. The agricultural sector is a major source of food, employment, and income for a greater population of the world. Many developing countries have put in great efforts in developing the agricultural sector, particularly as a means of increasing foreign exchange from earnings of the exportation of agricultural products, towards enhancing their economic growth and development. However, unfortunately, agriculture is considered less important in some developing countries, as agricultural outputs continue to experience a drastic decline. One of the major obstacles to efforts towards enhancing agricultural productivity is believed to be the lack of access to credit. The farmers, especially the smallholders who form the larger proportion of the agricultural producers, have often received little or no incentives to improve the production of agriculture particularly in accessing the needed credit. The financial industry plays a vital role in any economy by facilitating growth and stability through capital accumulation and financial intermediation. Its services are integral to economic operations, investment, and social development by supporting domestic and international transactions, efficiently allocating domestic funds, and increasing credit access for Micro, Small-and-Medium Enterprises (MSMEs) and consumers. Access to finance has emerged as a pivotal tool for enhancing agricultural productivity, particularly in developing economies like Nigeria, where the agricultural sector serves as the backbone of the economy (Osabohien *et al.*, 2020). There seems to be a controversial issue on the productivity impact of agricultural credit, even when about 40% of the population of the country depends on agriculture (World Bank, 2022). With about 87% of the available loans in developing countries coming from Commercial banks, only about 5% get to agribusiness (WTO, 2014).

Financial inclusion has been highlighted to play a critical role in tackling agricultural challenges and, by extension, agricultural productivity by providing farmers with the necessary resources to afford and implement these new technologies (Sharimakin & Dada, 2020; Beaman *et al.*, 2023). Access to credit, for instance, enables farmers to purchase high-quality seeds, fertilizers, and machinery, increasing productivity and food security (Balana & Oyeyemi, 2022). Unfortunately, despite recent policy initiatives to enhance financial inclusion, a significant portion of Africa's agricultural workforce, especially smallholder farmers, still lack adequate access to formal financial services (Khan *et al.*, 2024). Jayne and Sanchez (2021) argue that even with input availability, the absence of supportive policy frameworks, rural infrastructure, and land tenure security continues to constrain meaningful productivity improvements. These institutional weaknesses often result in misaligned incentives, where farmers are either unable or unwilling to invest in long-term soil and land improvements.

Sub-Saharan Africa houses 469 million individuals living in extreme poverty, of the total of 700 million multidimensionally poor people globally. 67% of this population are surviving on less than $2.15 daily (World Bank, 2024), and these are particularly farmers, inclusive. Although the region's financial inclusion rate (account ownership) is rising with an improvement from 34% in 2014 to 49% in 2021 (Global Findex, 2021), categorical statistics on the proportion of farmers experiencing financial inclusion in Africa are absent. Data showed that in Sub-Saharan Africa, access to finance through savings, affordable credit, financial advisory, and insurance remains a significant barrier for smallholder farmers, restricting farmers' ability to invest in quality inputs, modern equipment, and infrastructure, thereby stifling productivity (IFAD, 2021). As a result, they are left vulnerable to economic shocks, biological risks such as pests and diseases, and climate-related risks and perpetuating a cycle of low yields and productivity (Khan et al., 2024). Various international efforts have been put in place to enhance agricultural productivity, for instance, the initiatives by the African Development Bank, African Union, USAID, among other institutions, to address the regional problem of low agricultural productivity (Ukonu et al., 2023). Also, initiatives such as the African Continental Free Trade Area (AfCFTA), Feed the Future by the United States government, and financing of the Special Agro-industrial Processing Zones by ADB have shown a relentless commitment to agricultural productivity in the Sub-Saharan region. Many of the continent's smallholder farmers remain excluded from these initiatives, and the food crisis continues to rise, which is aggravated by the growing population, unstable household income, and occurrences of insurgency (World Bank, 2024).

Furthermore, the high cost of borrowing and stringent collateral requirements in SSA often exclude smallholders from formal financial systems, forcing them to rely on informal and often exploitative lending sources. This informs the need to evaluate the significance and direction that financial access imposes on agricultural productivity in SSA countries. Thus, consistent with previous research, this study seeks to explore the current condition of technical and financial accessibility in Africa's agricultural sector and estimate the influence of these variables on agricultural productivity on the continent. Therefore, this study seeks to assess the impact of financial access on agricultural productivity in Sub-Saharan Africa. This study will significantly contribute to the understanding of the strong long-run effect of financial access (banks, microfinance institutions, and agricultural cooperatives) on productivity.

2. LITERATURE REVIEW

2.1 Conceptual Review

Agriculture refers to cultivation of soil, production of crops, raising of livestock, with specific processes such as land preparation, planting, irrigation, fertilizing, pest control, harvesting, and post-harvest processing (Olabinjo & Opatola, 2023). Financial access on the other hand is a component of a broader term, financial inclusion which is the affordable, long-term provision of financial services that integrate marginalized populations into the formal economy (The International Telecommunication Union, 2016). Financial access is a key measure of financial inclusion (FI), reflecting the availability and affordability of such services for households and businesses. Financial access is expected to optimize the use of productive assets, improve resource efficiency, and reduce informal sector inefficiencies. Financial inclusion is defined as the rate as which people have the access to and the use of financial products and services (El-said et al., 2020). Oladimeji and Adegbite (2019) on the other hand defined financial inclusion as the process of ensuring ease access, the availability, and the use of various formal financial system for the growth and development of the economy. Agriculture and financial access can be explained as the availability and suitability of financial services to farmers and agri-businesses, to empower these farmers to invest in modern inputs and technology, manage risks, and stabilize income in the face of volatile market and climate conditions. Khan *et al.* (2023) opines that access to financial services such as credit, savings, and insurance enables farmers to invest in improved seeds, fertilizers, and modern farming equipment, thereby enhancing productivity. Agricultural productivity is also accounted for and integrated in other macroeconomic circumstances that contribute to wellbeing of any economy (Demirgüç-Kunt *et al.*, 2022). As a result, this study controls for a number of macroeconomic parameters drawn from related literature, such as population growth (Onwe *et al.*, 2024), poverty (Demirgüç-Kunt *et al.*, 2019), urban migration Asiedu and Chimbar (2020), remittances (Eleke *et al.*, 2024) and insurgency (Kafando & Sakurai, 2024). Adeyombo *et al.* (2024) emphasize that financial literacy is essential for smallholder farmers to utilize credit effectively and manage risks associated with agricultural investments. Conversely, financial institutions fail to simplify their products for low-literacy populations, further excluding vulnerable and unbanked groups. While adult education and extension services have been proposed as solutions, Eleke *et al.* (2024) argues that the slow pace of such interventions limits their impact on illiteracy and, by extension, agricultural productivity.

Exchange rate has also been raised as impactful on agricultural productivity especially in trade-sensitive and import-dependent economies like Sub-Saharan Africa, where most agricultural inputs are imported (Adeyemo et al, 2024). A depreciating exchange rate can improve agricultural export competitiveness but can also increase input costs, reducing farmers' purchasing power and margins (Simelane & Worth, 2020). The relationship between exchange rate fluctuations and agricultural productivity is ambiguous and context-dependent. Undervalued currencies can stimulate export-oriented agriculture but increase input costs, especially for smallholders relying on imported tools and chemicals while the opposite is the case of overvalued exchange rate (Adeyemo et al, 2024).

2.2 Theoretical Review

Production theory: One of the basic theories on agricultural productivity is the theory of production. The theory analyzes how factor inputs (capital and labour) are combined to produce goods and services. It explores the impact of information technology on productivity and the implications of asymmetric information distribution in market dynamics. The is stated mathematical in the production function. The production function mathematically shows the quantity of output produced from a given set of input with the given technology. It is expressed as:

$Q=f(L,K)$

Where:

Q is the quantity of output produced.

L is the quantity of labor used.

K is the quantity of capital used (including finance).

A Basic theory of production is the Neoclassical production theory which looks at investment as a variation over time and capital used. It represented in the standard (Cobb–Douglas) production function as: $Qt=Lt^{1-\beta}Kt^{\beta}$

where L and K are, respectively, the amounts of labour and capital employed over a period of time, investment is the variation in capital levels ΔK, which takes place between one period and the next.

Financial Inclusion Theory: initiatives and activities on financial inclusion are expected to be channeled towards the members of the society that are most vulnerable (the poor, young people, mothers, and the elderly). These people are often affected disproportionately by economic inequality and crises. Getting the poor people into the banking market shall particularly impact them through financial bubbles and economic recessions (Menkeh, 2021).

Financial Literacy Theory: The financial literacy theory holds that education should accompany financial inclusion activities for a better outcome. Thus, programmes and activities on financial inclusion channeled through increasing the financial literacy of the people will increase their acceptance and engagement in the formal financial sector. Through financial literacy the people are educated on the available financial goods and services at their disposals as well as motivating them to use these formal financial services and goods. This can also enhance their standard of living (Okello, et al., 2020; Ozili, 2022).

Rational choice theory: a theory of demand for financial services put forward by neo-classical economists believes that individuals who are making decision are representatives of a group in a financial market, such as farmers. Individuals face the problem of choice among services (savings, credit, and money transfer), their desire for financial services, the nature and type of services provided and the condition under which these services are provided by the financial institutions. The theory is based on the believe that the individuals make the best choice and financial services is a function of the characteristics of the service, the characteristics of the provider, and the unit making the decision. The theory was criticized based on the failure to take into account situations outside the control of the individual as a determining factor to the success of the decision to demand for financial services. However, the theory still remains important being able to explain the role of the characteristics of individuals determining the demand and supply of financial services.

2.3 Empirical Review

Some studies have been carried out around agricultural finance and agricultural productivity. Fowowe, (2020) investigated on how financial inclusion affects agricultural productivity in Nigeria. Using data of the Living Standards Measurement Study– Integrated Surveys on Agriculture (LSMS-ISA) for 2010–2011, 2012–2013 and 2015–2015 from about 7,183 observations, it was revealed that financial inclusion exerted positive and statistically significant effects on agricultural productivity. Teye and Quarshie (2021) analyzed the effect of agricultural finance on the adoption of improved rice production technologies by farmers in Ghana's Shai-Osudoku district. Focus groups, interviews, and household surveys showed that high demands on collateral, bureaucratic delay, and general mistrust from financial institutions were the limitations to farmers' access to credit. Availability of access to finance showed a positive influence on the adoption of technologies and improved productivity with higher levels of income. Asongu and Odhiambo (2022) assessed the relevance of financial access on value added in three sectors (agricultural, manufacturing, and service) using 25 countries in Sub-Saharan Africa. They employed data for the period 1980-2014 which was estimated using the Generalized Method of Moments. Financial access was measured by private domestic credit. It was found that values added were not substantially improve by increasing access to financial access in the agricultural and manufacturing sectors but does so in the service sector.

Mapanje et al. (2023) investigated the role of financial technologies, FinTech, in enhancing sustainable agriculture in Sub-Saharan Africa (SSA). Making use of 17 SSA countries it was revealed that FinTech-enhanced financial products addressed challenges in agricultural production and marketing and were, thus, more efficient and applicable on a wider scale for sustainable practices. Thus, FinTech could act as an important support system for agricultural financing. This requires the training of farmers on how to optimally use the digital platforms and addressing the infrastructure gaps across urban and rural divides as key in maximizing the benefit of FinTech. Louyindoula, Bouity, and Owonda, (2023) explored how impactful is agricultural credit to agricultural productivity in Congo. Building on the neoclassical theory and employing the ESR model the results showed that agricultural credit positively and substantially impacted agricultural productivity with about 92.2%. Access to credit by farmers resulted in great probability productivity improvement. Literacy rate, group membership and age of famers were also found to be determining factors of access to agricultural credit. In a similar study, Assouto and Houngbeme (2023) investigated on determination of agricultural productivity in Benin by access to finance. Using different measures of productivity and employing the endogenous switching regression model to account for heterogeneity, it was revealed by the result that adopting improved seeds, geographic location, and the membership of peasant organization are determinate of access to credit by producers. Access to credit by farmers led to about 40.07% and 31.97% gain in per hectare production and per FCFA production invested.

He *et al.* (2024) examined the role of digital finance in promoting green agricultural development among 395 Chinese agribusiness

enterprises. Based on the improved WLS fixed-effects model, this research identified that digital finance considerably improved green innovation in agribusiness, benefiting most of those with strong social responsibility. The heterogeneity analysis showed that the most advantages were gained by the processing and distribution enterprises of growth-stage companies in eastern regions. The study underlined the integration of digital finance into green innovation strategies and suggested the collaboration of government and enterprises to foster green symbiotic ecosystems for sustainable agricultural growth. Khan *et al.* (2024) carried out systematic research with the aim of investigating constraints to agricultural finance in 31 developing and underdeveloped countries using a Qualitative Evidence Synthesis (QES) method. The barriers presented in this study included limited access to credit, inappropriate infrastructure, and the interaction of stakeholder challenges. It proposed an integrated framework addressing these constraints and suggested that improvement strategies for improving financial services within remote areas have to be multifaceted. The study cited the unintended consequences of the poorly structured agricultural credit arrangement and called for collaborative efforts among stakeholders toward sustainable agriculture financing.

Iddrisu, Donkor, and Abor, (2025) explored how impactful green finance is and effect of financial inclusion on agricultural production in Africa. The Fixed effects estimation method in a Linear Dynamic Panel model was used on the bank- and country-level data of 29 African countries for the period 2002–2013. Green finance was revealed to increase financial inclusion while the usage of finance and access to stock market do not significantly impact agricultural production. However, increasing financial access and green finance will increase agricultural production.

2.4 Knowledge Gap and contribution to knowledge

While researched have often emphasizes farming techniques, indigenous knowledge, or financial access independently (Akpabio et al, 2024). Morden financial practices such as blockchain for agricultural finance, and mobile banking tools are underexplored in relation to sub-Sahara African agriculture (Adeyemo *et al.*, 2024). The limited understanding exists of how modern technological innovations intersect with financial access to improve agricultural productivity in the Sub-Saharan context. The study explored emerging financial technologies and their integration with financial systems to enhance productivity. Hence, the ARDL approach was employed as well. ARDL presents a dynamic estimation technique and introduces lags into the estimation while allowing variables integrated at different levels. It also estimates both short-run and long-run relationships in a single equation giving a more robust modeling of agricultural productivity.

3. METHOD OF ESTIMATION

3.1 Theoretical framework

This study is built on the theory of production which analyzes the combination of factor inputs (capital and labour) to produce goods and services. It is often represented mathematically in the production function. The production function mathematically shows the amount of output produced from a given set of input with the given technology. It is expressed as:

$Q=f(L,K)$

Where:

Q is the quantity of output produced.

L is the quantity of labor used.

K is the quantity of capital used (including finance).

The Neoclassical production theory is a basic theory of production and represented in the standard (Cobb–Douglas) production function, we have: $Qt=Lt^{1-\beta}Kt^{\beta}$

where L and K are, respectively, the amounts of labour and capital employed over a period of time, investment is the variation in capital levels ΔK, which takes place between one period and the next. The theory emphasizes that Economic growth and development is driven by capital investment in research and development (R&D). This results in technical changes bringing about increased productivity. For agricultural productivity, increased inputs are not the only requirement but of specific R&D and innovation. This requires the access to credit that are need to finance investments that lead to new technologies, better seeds, and more efficient farming methods.

3.2 Model specification

This study builds on the model of Iddrisu, Donkor, and Abor, (2025) looking at the green finance and financial inclusion independent impact on the increase of agricultural production. The model is given as:

$APi,t = \varphi 1 + \varphi 2GFi,t + \varphi 3FIi,t + \sum_{j=4}^{k} \varphi jXij + \omega t + \pi i$, ...(3.1)

Where FIi,t = financial inclusion of country i at period t,

GFi,t = green finance of country i at period t,

APi,t = agricultural production of country i at period t.

Xi,j are a set of {K} covariates including; bank age, loan/total assets, market share, financial development, inflation among other variables.

φ′s, = parameters to be determined,

ωt, = fixed effects accounting for time differences while πi,t, is the random error terms. Adopting the above mode with some modifications, financial inclusion is replaced with financial access, technological innovation is added to account for the role of technology in the model productivity of agricultural sector. Also, the covariates variables were dropped and replaced with gross fixed capital formation and exchange rate to account for the function of machines in the productivity of the agricultural sector as well as the function of international economies in the productivity of the countries (SSA countries). Thus, the model of this study is given as:

$APit= \alpha_0 + \alpha_1 FI\,it + \alpha_2 TIit + \epsilon_{it}$ .....(3.2)

The basic form of the long run ARDL is given as

Long run Equation:

$$Y_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i Y_{t-i} + \sum_{j=0}^{q1} \beta_{1,j} X_{1,t-j} + \sum_{k=0}^{q2} \beta_{2,k} X_{2,t-k} + \cdots + \sum_{m=0}^{qn} \beta_{n,m} X_{n,t-m} + \epsilon_t \ldots. (3.2)$$

where: Y_t = outcome variable; $X_{1,t}$ = predictor variable; p = number of lags of y; qi = number of lags of predictor variable; α_0 = constant term.

In the short run form, the ARDL is given as

Short run Equation/ Error Correction Term

$$\Delta Y_t = \alpha_0 + \sum_{i=1}^{p-1} \alpha_i \Delta Y_{t-i} + \sum_{j=0}^{q1-1} \beta_{1,j} \Delta X_{1,t-j} + \sum_{k=0}^{q2} \beta_{2,k} \Delta X_{2,t-k} + \cdots + \sum_{m=0}^{qn} \beta_{n,m} \Delta X_{n,t-m} + \lambda ECM_{,t-1} + \epsilon_t \ldots (3.2)$$

Δ = variable at first differencing, ECM_{t-1} = the error correction term.

Introducing the variables of the study of the model our new equations can be written as:

Long run Equation (Model 1 AP):

$$AP_t = \alpha_0 + \sum_{i=1}^{p} \alpha_1 FA_{it-1} + \sum_{j=0}^{q1} \beta_{1,0} TI_{1,t} + \epsilon_t \ldots (3.4)$$

Short run Equation:

$$\Delta AP_{it} = \alpha_0 + \sum_{i=1}^{p-1} \alpha_i \Delta AP_{it-1}\alpha_0 + \sum_{i=2}^{p-2} \alpha_i \Delta AP_{it-2}\alpha_0 + \sum_{i=3}^{p-3} \alpha_i \Delta AP_{it-3} + \sum_{j=0}^{q1-1} \beta_{1,j} \Delta FA_{1,t-j} + \sum_{j=0}^{q1-1} \beta_{1,j} \Delta TI_{1,t-j} + \lambda ECM_{,t-1} + \epsilon_t \ldots (3.5)$$

Accounting for the impact of controlling macroeconomic variables, a new model (model 2) is given as:

Long run Equation (Model 2 AP):

$$APi_t = \alpha_0 + \sum_{i=1}^{p} \alpha_1 FAi_{t-1} + \sum_{j=0}^{q1} \beta_{1,0} TI_{1,t} + \sum_{j=0}^{q1} \beta_{1,0} EXR_{1,t} + \sum_{j=0}^{q1} \beta_{1,0} GCFC_{1,t} + \epsilon_t \ldots (3.6)$$

Short run Equation:

$$\Delta AP_{it} = \alpha_0 + \sum_{i=1}^{p-1} \alpha_i \Delta AP_{it-1}\alpha_0 + + \sum_{j=0}^{q-1} \beta_{1,j} \Delta FA_{1,t-j} + \sum_{j=0}^{q-2} \beta_{1,j} \Delta TI_{1,t-j} + \sum_{j=0}^{q-3} \beta_{1,0} \Delta EXR_{1,t} + \sum_{j=0}^{q-4} \beta_{1,0} \Delta GCFC_{1,t} + \lambda ECM_{,t-1} + \epsilon_t \ldots (3.7)$$

Where:

Ap is agricultural productivity: measured by Food Production index

FA is financial access: which is the availability and accessibility of credit to farmers measured by Credit to Agriculture, Forestry & Fishery

TI is technological innovation: Adoption of modern agricultural technologies proxied by Total Bio-energy Consumed in Agriculture

EXR is exchange rate: USD per local currency unit

GCFC is gross fixed capital formation: Capital investment/ Infrastructure proxied by GCFC in current US dollars

3.3 Study Data and method of estimation

The study made use of secondary data on agricultural productivity, financial access, and other control variables for seventeen (17) Sub-Saharan Africa countries from 2001 to 2023. The countries are: Angola, Botswana, Cameroon, Cote d'Ivoire, Ghana, Kenya, Liberia, Mauritania, Nigeria, Rwanda, Senegal, Sierra Leone, South Africa, Togo, Uganda, Zambia and Zimbabwe. The choice of this geographic scope is to allow for relative uniformity of research environments to reduce bias in the results. Furthermore, these countries are popular for their involvement in Agriculture and their positions within the Upper and Lower-middle Income category by the World Bank. The period for the study coincides with spill-over effects from landmark changes in economic policy in the countries under study, such as the introduction of strategies to propagate financial inclusion in the early 2000s through different agricultural modernization drives. The data were sourced from the World Bank, and the Food and Agriculture Organization (FAO). The data used in this study was analyzed by descriptive statistics, diagnostic tests, and inferential statistics. Diagnostic tests were carried out to establish the stationarity and appropriateness of the econometric models. The panel series were subjected to cross-sectional dependency test (Pesaran's CD Test) to detect if cross-sections (countries data) are correlated as correlation could imply

use of different tests in subsequent analysis to prevent biased estimates (Woolridge, 2010).

$$CD = \sqrt{\frac{2T}{N(N-1)}} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \hat{p}_{ij} \ldots\ldots \text{(XXI)}$$

Where: N = Number of cross-sectional units (e.g., countries); T = Number of time periods; $\hat{p}_{ij}$ = Estimated correlation coefficient of residuals between cross-sectional units i and j

- Null hypothesis (H_0): No cross-sectional dependence
- Alternative hypothesis (H_1): Presence of cross-sectional dependence

Decision Rule: A significant CD statistic (e.g., p-value < 0.05) implies cross-sectional dependence in the data, indicating that shocks or effects in one unit (e.g., country) may be related to others. The presence of cross-sectional dependence required that the model captures cross-sectional dependence effects. Hence, the Dynamic Common Correlated Effects Mean Group technique was employed manually for the SEM model. In controlling for the bias that comes with cross-sectional dependence, the time-specific cross-sectional averages for each variable in the model were calculated and included in the model. Heteroskedasticity tests (Breusch-Pagan Test) was also conducted to ascertain whether variance of error term remains constant or varies across observations (Woolridge, 2010). Pesaran's (2007) cross-sectionally augmented panel unit root test (CIPS) was used to analyze stationary of data (absence of unit root). Co-integration tests among the variables were carried out to check their long-run relationship using the Pedroni test for Co-integration.

4. ANALYSIS

4.1 Illustrative statistics

Table 4.1. illustrative Statistics

	AP	FA	TI	GCFC	EXR
Mean	94.28026	25567.28	512960.7	9.583915	0.214593
Median	96.16500	81.40589	178556.0	9.586211	0.010418
Maximum	183.4500	425305.0	5484264.	10.91170	18.14938
Minimum	33.02000	0.000000	5846.000	8.046214	1.49E-10
Std. Dev.	22.46766	82727.92	1121355.	0.606614	1.468748
Skewness	0.302101	3.291798	3.309212	-0.148725	11.88275
Kurtosis	4.434108	12.81302	12.66200	2.965608	145.2309
Jarque-Bera	31.07879	1792.036	1760.190	1.150627	266862.0
Probability	0.000000	0.000000	0.000000	0.562528	0.000000
Sum	29038.32	7874723.	1.58E+08	2951.846	66.09463
Sum Sq. Dev.	154972.2	2.10E+12	3.86E+14	112.9702	662.2665
Observations	308	308	308	308	308

Source: E-Views 13

Agricultural productivity measured by food production index measures production of edible and nutritional food crops. The Sub-Saharan group of countries examined had an overall mean agricultural production of 94.28 and this was found to be quite volatile with a standard deviation of 22.46. The average financial access rate across sampled nations is USD$25567.28 million and this is also very volatile with a standard deviation of 82727.92.

4.2 Pre-Diagnostic Tests

Table 4.2. Cross-Sectional Dependence Test: Pesaran CD Test

Periods included: 23 Cross-sections included: 18 Total panel (unbalanced) observations: 405			
Test	Statistic	d.f.	Prob.
Agricultural Productivity Model	41.68105	153	0.0000

Source: E-Views 13

The Pesaran CD test statistic was significant at 1% level of significance for the model and thus confirms the acceptance of the alternate hypothesis of the test that cross-sectional dependence is present among the study cross-sections (countries). The results confirm that study variables are dependent across countries/units. To correct cross-sectional dependence bias in subsequent analysis, time-specific cross-sectional averages for model variables were included in the models as control variables accounting for CD bias. This approach had the CD bias in the dataset entrenched in the cross-sectional average of the outcome variable as denoted by significance in the term (p<.05) across analytical tools.

Table 4.3. Unit Root Tests

	Unit Root Pesaran CIPS I(0)	Unit Root Pesaran CIPS I(1)
AP	-1.77911	-4.43433***
TI	2.37823***	
FA	0.59897	-11.9298***
EXR	-1.67543**	
GCFC	-1.67543**	

Significance at 0.001 ***; 0.05 **; (...) Standard errors
Source: E-Views 13

The Pesaran CIPS test statistics are outlined in Table 4.3. At level, technological innovation, exchange rate and gross fixed capital formation were stationary while agricultural productivity, and financial access were found to be stationary after integrating after the order of 1 (first-differencing). Thus, the study had a mixed order of integration as variables were stationary at both first differencing and levels.

Table 4.4. Pedroni Co-integration Test run this test again

Modified Phillips-Perron t	-6.3523***
Phillips-Perron t	-.13.0224***
Augmented Dicker Fuller t	-12.8305***
Number of panels	17

*** *p value<0.001*
Source: Stata 15

The presence of variables stationary at first differencing gave rise to the need to conduct co-integration test on variables to determine the presence of long run relationship among variables. The study used the Pedroni Panel Co-Integration test which showed the existence of co-integration.

4.3 Auto Regressive Distribution Lag (ARDL) Results for Agricultural Productivity

The study engaged the ARDL model to differentiate long and short-term effects of financial access in promoting agricultural productivity. The ARDL determined the response of agricultural productivity to innovations or changes in itself, financial access, technological innovation and the cross-sectional variable.

Table 4.6. ARDL Estimates

Variable	ARDL 1	ARDL 2
Long-run (Pooled) Coefficients		
AP(-1)	2.3193** (0.1628)	-1.9224** (0.81519)
FA	-2.2739** (0.1717)	-21.1327** (8.5988)
TI	0.147428** (0.0187)	
EXR		-9.7998 (6.7715)
GCFC		2.7401** (0.9935)
Short-run (Mean-Group) Coefficients		
COINTEQ	-0.9051** (0.2398)	-0.0243** (0.0117)
D(AP(-1))	0.0387 (0.2149)	-0.2613** (0.1179)
D(AP(-2))	-0.1558 (0.1653)	
D(AP(-3))	0.15432	
D(FA)	-273.82 (278.25)	18.701 (18.677)
D(FA(-1))	-185.324 (186.63)	
D(FA(-2))	94.345 (94.10)	
D(FA(-3))	6.6768 (7.6029)	
D(TI)	3.1479 (2.2379)	

D(TI(-1))	-1.2270 (1.5717)	
D(TI(-2))	2.7991 (2.2379)	
D(TI(-3))	4.1040 (3.0858)	
D(EXR)		-379.198 (412.48)
D(GCFC)		1.3415** (0.6719)
D(CSMEAN_AP1)		0.203824 (0.0465)
C		2.82119 (1.6676)
Model	PMG(4,4,4)	PMG(2,1,1,1,1)
Log-Likelihood:	-692.2960	-99.7036
PMG Hausman Specification Test		2.617

*Significance at 0.001 ***; 0.05 **; (…) Standard errors*
Source: E-Views 13

Modelling agricultural productivity with ARDL, long run estimation reveal that the immediate past value of agricultural productivity is significant in predicting current values with a coefficient of 2.319. The result provides evidence on the dynamic nature of agricultural output in the region, where outcomes are influenced by cumulative efforts and previous season effects, including soil fertility management, retained knowledge, and reinvestment from past agricultural harvests. Financial access was observed to exert a significant and pessimistic impact on agricultural productivity in the long run. The coefficient of -2.278 indicates that for every one-unit increase in financial access, agricultural productivity falls by approximately 2.28 units, *ceteris paribus*. This relationship is statistically significant ($p< 0.05$), confirming that improved access to financial services such as credit, loans, and banking facilities achieves the productivity for which they are provided for over time in the Sub-Saharan region in the long run. The result can only reflect smallholder farmers and rural settlements are able to obtain these funds and use them adequately to boost agricultural systems and on the productivity of agriculture. However, in the short run, financial access was revealed a positive but unimportant impact on agricultural productivity.

This suggests that smallholder farmers are likely battling challenges with access to credit facilities for agricultural purposes such as high interest rates, short repayment periods, and limited financial literacy when accessing credit, which could result in debt and frustration. Additionally, some funds may be diverted to non-agricultural uses, especially in households with prioritizing needs like immediate feeding, education and healthcare. This results in limited resources being stretched across competing priorities, rather than resulting in increased agricultural investment. This is largely inconsistent with Mapanje *et al.* (2023) that found that financial access enhanced sustainable agricultural practices, which in turn increased productivity. The findings of Louyindoula, Bouity, and Owonda, (2023) as well that of Assouto and Houngbeme (2023) are also in dissonance with the results of the present study as they found that financial access, credit to the agricultural sector and financial investments in agricultural businesses improved productivity in the long term. However, on the contrary, the study of Asongu and Odhiambo (2022) on the importance of financial access on agricultural sector's value added using 25 countries in Sub-Saharan Africa was in conformity with this current study that financial access does not substantially improve agricultural productivity.

Technological innovation in the long run on the other hand, exhibits a significant positive relationship with agricultural productivity ($p<.05$). The coefficient of 0.1477 implies that an increase in technological innovation is associated with improved agricultural productivity in the region. In the short-run, technological innovation was found to have a positive bit insignificant impact on agricultural productivity. The positive impact found confirm that technology adoption by farmers significantly increased agricultural output as time is saved from the replacement of manual labour and use of climate-smart and disaster-resistant techniques and inputs. This finding aligns with the reality that technological innovation often takes time to produce tangible benefits in the agricultural sector, especially in Sub-Saharan Africa, where adoption is gradual. Over time, however, the cumulative effect of innovations such as improved seed varieties, irrigation systems, precision farming tools, and digital extension services being significantly enhancing productivity. A clear example can be drawn from Ghana, where the Savanna Agricultural Research Institute (SARI) has developed drought-resistant maize and rice varieties, and over time, their adoption has contributed to increased output in northern farming zones. For short term estimations however, no significance was found, drawing concerns to the explanatory power of the model. It is also worthy of note that the study's control variables were also introduced into the model and none affected results significantly.

Given the initial short-run ARDL estimations did not reveal a significant effect of financial access and technological innovation on agricultural productivity, the inclusion of exchange rate and gross fixed capital formation, following the approach of Adeyemo et al. (2024), serves two primary purposes. First, the variables sought to capture broader structural factors potentially influencing agricultural performance. Secondly, introducing them was to boost robustness and specification of the model by accounting for external economic dynamics that affect productivity shifts in Sub-Saharan African economies. In the long run for the new ARDL model, financial access maintained its negative and significant effect on agricultural productivity as found in the first ARDL model with a coefficient of -21.1327 ($p<05$) and a positive and insignificant impact in the short run. GCFC, which reflects investment in physical assets like machinery, irrigation systems, and rural infrastructure, showed a positive and statistically significant impact on agricultural productivity in both the long and short run. This confirms that long-term capital investments contribute directly to enhancing production capacity and improving agricultural efficiency. It also implies that increased public and private sector investment in agriculture-related capital goods translates to higher yields and productivity gains over time. On the other hand, the exchange rate was found to be statistically insignificant both in the short and long run. This result indicates that fluctuations in the foreign exchange market may not have a direct or immediate influence on agricultural productivity, possibly due to the subsistence nature of farming in many Sub-Saharan African countries, where a significant portion of inputs are locally sourced and production is less tied to international trade or imported goods. These findings of GCFC as a significant predictor of agricultural productivity, and exchange rate volatility as a weak factor highlight the importance of sustained domestic investment in productive infrastructure over reliance on external financial conditions. For the ARDL estimation with extra control variables, computation could not be initially completed given the problem of collinear independent variables. Hence, technological innovation had to be exempted as it was found to be collinear with other variables except financial access and exchange rate.

In the short run, the error correction term (COINTEQ) is negative and statistically significant, with a coefficient of -0.0243, depicting that about 2.4% of disequilibrium is corrected annually. It suggests that the adjustment back to equilibrium is slow and it would take several periods to return to the long-run path fully. Significance in prediction variables was observed in the lagged value of agricultural productivity and gross fixed capital formation (one of the new variables added) alone, reiterating the weak significance of financial access in the short run in Sub-Saharan Africa. The significance of the lag of agricultural productivity suggests some degree of autoregressive behavior where past productivity levels influence current performance. Therefore, the study confirms that efforts to improve agricultural productivity in the Sub-Saharan region do not significantly reflect in productivity until after some time. Financial access does not significantly impact agricultural productivity immediately, although the effects become evident in the long run. Rather, agricultural infrastructural development such as roads for distribution, will have quick impacts on agricultural productivity in Sub-Saharan Africa.

5. SUMMARY OF FINDINGS

This study investigated on the impact of financial access on the productivity of agriculture in Sub-Saharan African. The study made use of a panel of seventeen countries in Sub-Saharan African over the period 2001 to 2023 and was estimated using the ARDL method of estimation. The finding suggests that while financial access is expected to enhance productivity, in reality, rising agricultural credit statistics was found not to reflect significantly on agricultural productivity in the short run but significantly impacted on agricultural productivity in the long run. Thus, Sub-Saharan situation confirms that credit may not be reaching smallholder farmers, or credits are burdensome to the famers from the interest rates particularly in the short run. There is also the diversion of credit given to the famers away from agricultural activities to meet general household needs. Technological innovation was also found to have significant impact on agricultural productivity only in the long run only. GFCF was found to be positively related and significantly impacting on agricultural productivity both in the long run and the short run while exchange rate was found not to have significant impact on agricultural productivity both in the short and long-run. The policy implication of this finding is that, financial access demonstrated an inverse and significant impact on agricultural productivity, reinforcing the importance of more-targeted efforts at translating investments in financial systems to actual growth in agricultural productivity. However, its short-run impact

remained statistically insignificant, indicating that improvements in financial inclusion require time to translate into measurable productivity gains. This is especially relevant in Sub-Saharan Africa, where the uptake of financial services among rural and smallholder farmers remains limited by infrastructure, literacy, and trust.

5.1 Recommendations

Following the outcome of the study, the following policy recommendations are made:

i. Government and other stakeholders in the financial sector could expand financial access to smallholder farmers by implementing long-term, low-interest agricultural loans with flexible repayment schedules, and support mobile banking and fin-tech solutions to reach remote communities.
ii. Financial institutions should be encouraged to track loan use and offer credit tied to technical support or insurance.
iii. We also highly recommend the adoption of innovative financial products such as green finance as well as value-chain finance where farmers are connected to agribusinesses through as well as provision of upfront financing for inputs. This will increase the spread of finance to different aspect of agricultural practices.
iv. Government provision of simplified requirement for accessing loan. This includes reduction of the strict requirement for collateral which often hinders the poor farmer and introduction of alternative ways for the collateral such as stored produce through warehouse receipt techniques.

5.2 Contributions to Knowledge

The study challenges the assumption that financial access boost productivity by highlighting how availability of agricultural credit on statistical dashboards may not actually translate to farm productivity especially in the short run either because the farmers are completely unaware of such schemes or the funds are misappropriated through corruption or for other household needs, if they ever reach the farmers.

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