

The Dynamics of Agricultural Development in Sudan: Government and Bank Financing in Focus (1990-2020)

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Summary: This research delves into the multifaceted challenges facing Sudan's agricultural sector, employing a dual approach of analytical data examination and an extensive literature survey. The study spans a three-decade period, from 1990 to 2020, to comprehensively assess the dynamics shaping the sector. Analytical data exploration revealed challenges in government and bank financing, including suboptimal allocation, limited financial commitment, and a disparity in focus. The literature survey further substantiated these challenges, emphasizing issues such as financial scarcity, weak infrastructure, and policy ineffectuality.

To elucidate the long-term dynamics, the study employed the Autoregressive Distributed Lag (ARDL) model, establishing a robust connection between government development expenditure, bank financing, and agricultural output. Results highlighted the significant positive impact of both government spending and bank financing on agricultural output over an extended period, emphasizing their pivotal roles in sustaining sectoral development.

The short-term analysis uncovered a self-correction mechanism within the economy, indicating its resilience to immediate disruptions. This insight underscores the necessity of implementing enduring policies that consider the time frame required for their full effects to materialize. Policy implications stress the importance of aligning government expenditures with the sector's long-term requirements and enhancing the accessibility of bank financing to drive short-term agricultural expansion.

Keywords: Agricultural Development; Government Development Expenditure; Bank Financing; ARDL; Sudan.

Jel Classification Codes : O13; H54 ; O16 ; C22

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I- Introduction :

Agriculture is not only a fundamental component of Sudan's economy but also a source of livelihood for a significant portion of its population. In a nation where the majority of the rural population depends on agriculture for their sustenance, the sector's development is not just a matter of economic growth but a vital driver of overall well-being. However, ensuring sustainable agricultural development in a country as diverse and vast as Sudan presents multifaceted challenges. Among these, access to financial resources remains a critical factor that can either facilitate or impede progress.

Sudan's unique agricultural landscape, characterized by diverse climates, soil types, and cropping patterns, demands a nuanced approach to development. The dynamics of agricultural growth are influenced by various factors, including policy decisions, investment patterns, and access to funding. Government development expenditure allocated to the agricultural sector and bank financing earmarked for agriculture represent two key pillars of financial support. Understanding their respective roles, effectiveness, and long-term impacts is crucial for informed policy formulation and sustainable development.

The problem of the study revolves around focuses on the relative effectiveness of government and bank financing in driving agricultural growth in Sudan, considering the challenges arising from limited access to financial resources. Consequently, the research question can be articulated as follows:

How have government and bank financing impacted the growth and development of Sudan's agricultural sector, and what are the effects of these financing dynamics on the long-term and short-term equilibrium relationships with agricultural output in Sudan?

We have formulated the following hypotheses to offer guidance in addressing our research question:

- There is a long-term equilibrium relationship between agricultural output, government expenditure, and bank financing, where an increase in government expenditure and bank financing leads to an increase in agricultural output over time
- The dynamics of government and bank financing exert substantial influence on both long-term and short-term equilibrium relationships with agricultural output in Sudan. Nevertheless, the long-term effects are anticipated to be more pronounced, given the time required for farmers to invest in new technologies and expand their operations.

The objective of this research is to investigate the relative impact of government and bank financing on the agricultural sector's growth and development in Sudan, considering the constraints imposed by limited access to financial resources.

Our approach to data processing, analysis, and result derivation encompasses two principal methodologies: descriptive and experimental. The descriptive methodology offers a comprehensive overview of Sudan's agricultural financing landscape, drawing on data from government and bank reports. Descriptive statistics will illuminate key trends. Complementing this, the experimental approach utilizes quantitative techniques to assess the impact of government and bank financing on agricultural development. This involves analyzing trends in government spending and bank financing, conducting a t-test for comparison, and employing the ARDL regression model to establish relationships. The overarching aim is to empirically demonstrate the relative effectiveness of different financing sources, ensuring a nuanced understanding of the intricate relationship between government and bank financing in promoting agricultural growth in Sudan.

Furthermore, the study's methodology incorporates an analytical framework that divides the research timeline into three distinct phases, each closely linked to pivotal economic and political events that have significantly shaped Sudan's trajectory. Specifically, the years 1999, 2005, and 2011 are identified as critical milestones, marked respectively by the commencement of oil commercialization and export, the implementation of political reconfiguration following the Comprehensive Peace Agreement, and the emergence of South Sudan as an independent nation. Spanning from 1990 to 2020, these phases facilitate a detailed and comprehensive analysis of Sudan's economic evolution.

Both governmental institutions and banks play pivotal roles in cultivating agricultural growth in Sudan. These roles are substantiated by findings from prior research:

Government's Role: Governmental support is of paramount importance in establishing an environment conducive to agricultural growth. Policies, incentives, and directives issued by the government shape resource allocation and facilitate sectoral progress. (Mohammad, 2016) underscored the necessity for the Central Bank of Sudan to prioritize financing for genuinely productive sectors, particularly agriculture and industry. This governmental guidance optimizes the allocation of financial resources towards sectors poised for sustainable expansion.

Banking Sector's Role: Banks assume a critical intermediary role by channeling financial resources towards the agricultural sector. (Suleiman, 2013) underscored that despite challenges, banks play an instrumental role in extending financing to the agricultural sector. Despite risk considerations associated with agricultural financing, banks remain indispensable in bridging the gap between available funds and the financial needs of the agricultural sector. Additionally, (Musnad, 2012) study highlighted the establishment of specialized banks for agriculture, attesting to the banking sector's acknowledgement of its pivotal role in agricultural financing.

By recognizing and leveraging the collaborative roles of both governmental institutions and banks, Sudan can facilitate a holistic approach to agricultural development, capitalizing on their combined contributions to foster sustainable growth.

I.1. A Closer Look at Sudan's Agricultural Sector: Components and Performance:

In this exploration, we delve into Sudan's agricultural sector, dissecting its elements, evaluating its performance, and examining the obstacles it faces. This comprehensive analysis aims to uncover the sector's strengths, challenges, and potential for growth, contributing to informed strategies for sustainable development.

I.1.1 Constituents of the Agricultural Sector:

The agricultural sector is considered the leading sector in the Sudanese economy due to its abundant land, water, and human resources. Sudan's total land area is 243 million hectares, with approximately 84 million hectares suitable for agriculture, constituting around 34.57% of the total area. However, only a fraction of this suitable area, ranging from 16.1 to 17.8 million hectares (about 21%), is currently utilized for agriculture. Forests and natural pastures cover approximately 113 million hectares, equivalent to 46.5% of the total area. The remaining land includes deserts, swamps, and surface water bodies (Central Bureau of Statistics, 2010).

Sudan's agricultural lands are characterized by fertility and diverse climatic environments, enabling the production of various agricultural products. The agricultural sector is divided into crop production and animal production, with the livestock population estimated at around 105 million head of cattle, camels, and sheep (Suleiman, 2013).

Water resources in Sudan are essential for various sectors, particularly agriculture. Sudan benefits from a range of water sources, as indicated in the Table (1). The Nile River, a critical lifeline, contributes 18.5 billion cubic meters, underlining its historical significance and Sudan's reliance on it. Seasonal streams, or wadis, yield 5-7 billion cubic meters during rainy periods, supplementing water availability. Renewable groundwater, accounting for 4 billion cubic meters, is invaluable for regions with limited surface water. Additionally, anticipated contributions from swamp rehabilitation hold the potential to add 6 billion cubic meters. Altogether, these sources provide a comprehensive total of 34.5 billion cubic meters of water, underscoring the significance of effective water management to support Sudan's agricultural sector and broader development efforts (Fanack Water, 2021).

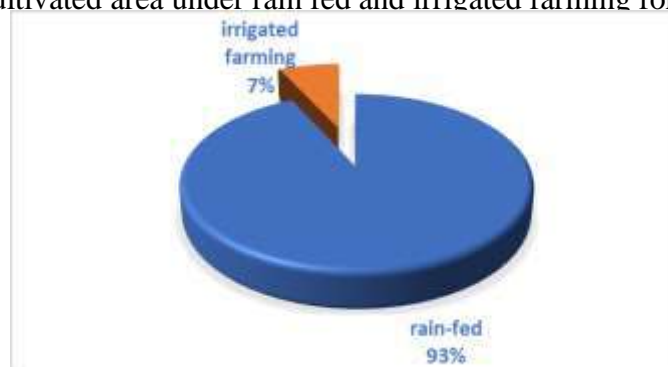
Table (1). Volume and Sources of Available Water Resources in Sudan

Water Resource Sources	Quantity (Billion Cubic Meters)
Sudan's Share of the Nile River Water	18.5
Wadi (Seasonal Stream) Water	5-7
Renewable Groundwater	4
Expected from Swamp Rehabilitation	6
Total	34.5

The source : Fanack Water

Plant production in Sudan is cultivated through two primary sectors: rain-fed and irrigated agriculture. The data presented in Figure (1) highlights the prevalence of rain-fed agriculture, constituting 93% of practices, while irrigated agriculture accounts for merely 7%. This distribution underscores the substantial reliance on rainfall and limited utilization of irrigation techniques. These circumstances have far-reaching implications, encompassing climate adaptability, efficient water management, productivity disparities, and the imperative for technology integration and risk mitigation strategies.

Figure (1): Average cultivated area under rain fed and irrigated farming for the period (2000-2020)



The source: Ministry of Agriculture and Forests.

The distribution of agricultural practices in Sudan has significant implications, particularly in the context of the country's abundant Nile water resources. With the majority of agriculture being rain-fed (93%), there is a missed opportunity to utilize the extensive Nile water for irrigation (7%). This underutilization has several consequences.

- Firstly, it limits the agricultural sector's potential for productivity. Irrigation provides a stable water supply throughout the year, leading to increased crop yields and diversified cultivation.
- Secondly, it hampers climate resilience efforts. Rain-dependent agriculture is

vulnerable to unpredictable weather patterns, including droughts and erratic rainfall. Effective irrigation systems could mitigate these risks by providing a consistent water source regardless of weather conditions.

- Thirdly, the underutilization of Nile water for irrigation creates disparities in productivity between rain-fed and irrigated regions. This can lead to uneven economic development and hinder overall agricultural growth.

To address these implications, Sudan needs strategic planning, infrastructure development, and investment in irrigation technologies. Maximizing the Nile water's potential for irrigation could enhance agricultural productivity, bolster climate resilience, bridge productivity gaps, and contribute to overall economic development and food security in the country.

I.1.2 Agricultural Output Performance:

The assessment of Agricultural GDP (Agri-GDP) performance holds significant importance in understanding a country's economic landscape and ensuring food security. By analyzing agricultural product yield, quality, and trends, valuable insights emerge about the sector's contributions and its potential for growth. This section delves deeply into a comprehensive exploration of Sudan's agricultural output performance, shedding light on crucial indicators, challenges, and strategies aimed at enhancing productivity. The ensuing content will outline the extent and achievements of agricultural output.

Table (2). Size and Performance of Agricultural GDP During the Period (1990-2020)

Period	Agri-GDP (Million SDG)	Agri-GDP Growth Rate (%)
1990-1999	3.94	13.81
2000-2011	6.24	0.83
2012-2020	9.44	1.80
Overall Mean	6.73	5.63

The source: Preparation by the researcher based on reports from the Central Bank of Sudan. Through Table 2, the following observations are evident:

- 1990-1999 Period: During this decade, the agricultural sector exhibited robust growth with an Agri-GDP of 3.94 million SDG and a remarkable growth rate of 13.81%. This phase corresponds to a period of economic liberalization, marked by policies that aimed to boost agricultural development. Strategies such as sectoral financing and credit ceilings were enacted, directing resources towards priority sectors, including agriculture. This period's high growth rate indicates that these policies contributed to substantial agricultural expansion.
- 2000-2011 Period: The subsequent years witnessed an increase in Agri-GDP to 6.24 million SDG, yet the growth rate decreased to 0.83%. This can be attributed to multiple factors, including the emergence of the oil sector as a significant economic driver due to oil exports starting in 2000. Additionally, the signing of the Comprehensive Peace Agreement in 2005 contributed to a more stable economic environment. However, the slower growth rate suggests that attention shifted away from the agricultural sector, possibly due to the prominence of the oil industry.
- 2012-2020 Period: This era saw a further rise in Agri-GDP to 9.44 million SDG, with a growth rate of 1.80%. Notably, this period coincides with the secession of South Sudan in 2012, leading to a loss of a substantial portion of oil revenues for Sudan. Despite this economic setback, the agricultural sector managed to maintain positive growth, reflecting its resilience and potential as a source of stability in times of broader economic challenges.

The Agricultural Sector's Contribution to Food Provision: Throughout the study timeframe (1990-2020), the agricultural sector played a pivotal role in supplying food, constituting 81.94% of the total contribution. Nonetheless, the sector faced a food deficit of 18.06%. This inadequacy is primarily attributable to the continuous deficit in wheat production, which alone contributed to 67.27% of the overall deficit within the same period (Abdalla, 2023).

The Agricultural Sector's Contribution to Foreign Trade: In Sudan, the agricultural sector has undergone notable changes in its role in foreign trade. In the 1990s, it was a major contributor, accounting for 55.6% of total exports. However, from 2000 to 2011, its contribution fell sharply to 7.06%, primarily due to the dominance of the oil sector, which is less labor-dependent. From 2012

to 2020, there was a resurgence in agricultural exports, making up 27.43% of total exports. This indicates a renewed emphasis on agriculture's potential in foreign trade. Nevertheless, this increase was accompanied by a substantial decline in the petroleum sector, largely because of South Sudan's secession. This highlights how external events, policy decisions, and sectoral contributions interplay in shaping Sudan's foreign trade dynamics (Abdalla, 2023).

I. 2. Agricultural Financing in Sudan: Government and Bank Policies, Performance, and Challenges

I.2.1 Government and Bank Policies Shaping Agricultural Financing in Sudan:

The following are the most important policies pursued by both the government and banks to foster the development of Sudan's agricultural sector:

Government Policies: Specific government policies concerning agricultural financing in Sudan encompass several aspects. First, the country's public investment policy plays a pivotal role in shaping the agricultural sector's financial landscape by determining the allocation of resources toward agriculture, influencing the availability of financing resources (Abdelwahab et al., 2020). Second, recognizing the scarcity of capital accumulation and limited financial reserves, the Sudanese government frequently steps in to provide funding for the agricultural sector (Abdelwahab et al., 2020). The extent to which the government can allocate adequate funds significantly influences the availability of agricultural financing.

Furthermore, the government's agricultural development objectives, as outlined by the Ministry of Agriculture and Forests, are multifaceted. They encompass objectives such as poverty reduction and ensuring food security nationwide (OCHD, 2021). These overarching goals can steer government policies related to agricultural financing, potentially leading to the provision of loans or subsidies to farmers as a means of achieving these objectives (OCC.gov, 2020). Moreover, the government extends technical support to farmers to enhance their production practices and boost yields (Lencucha et al., 2020).

Bank Policies: The Central Bank of Sudan implemented a policy of setting sectoral credit ceilings to prioritize financing for key sectors like agriculture and industry. In the early 1990s, 80% of financing was allocated to priority sectors, with agriculture receiving 40%. This policy aimed to boost economic growth and achieve self-sufficiency in agricultural commodities (Mohammed et al., 2004). Banks failing to meet these allocations were required to freeze the difference (Central Bank of Sudan, 1993). However, this policy had negative consequences. Banks' involvement in agricultural financing exposed them to risks due to production fluctuations and low sector productivity (Sheikh Musa, 2012).

I.2.2 Assessing the Volume and Performance of Government and Bank Financing for Sudan's Agricultural Sector:

This section delves into a comprehensive analysis of the volume and effectiveness of Government and Bank Financing within the agricultural sector. By scrutinizing allocation trends, this investigation aims to yield valuable insights into how Government and Bank Financing shape the sector's trajectory.

I.2.2.1 Analyzing the Impact of Government and Bank Financing on Sudan's Agricultural Sector:

The following Table 3 discusses the volume and performance of government development spending allocated to the agricultural sector and bank financing provided to the agricultural sector during the study period.

Table (3). Size and Performance of Government Expenditure and Bank Financing in the Agricultural Sector during the Period (1990-2020)

Period	GDEAS (Million SDG)	GRDEAS %	PGEAS %	BF (Million SDG)	GRBF %	PBF %
1990-1999	1.81	30.00	26.99	4.31	3.82	26.69
2000-2011	7.15	19.06	32.27	7.69	11.82	11.09
2012-2020	0.84	4.20	10.29	23.07	17.74	21.14
Overall Mean	3.60	17.88	24.19	11.07	11.20	19.04

The source : Prepared by the researcher based on data from the Ministry of Finance and Economic Planning and the Bank of Sudan.

Where:

GDEAS: Government development spending allocated to the agricultural sector.

GRDEAS: Growth rate of government development spending allocated to the agricultural sector.

PGEAS: Percentage of government development spending allocated to the agricultural sector out of total government development spending.

BF: Bank financing provided to the agricultural sector.

GBF: Growth rate of bank financing provided to the agricultural sector.

PBF: Percentage of bank financing provided to the agricultural sector out of total bank financing.

Through Table 3, the following observations are evident:

During the Period 1990-1999:

- Government Development Spending allocated to the agricultural sector ("GDEAS") amounted to 1.81 million Sudanese Pounds (SDG), experiencing a significant growth rate ("GRDEAS") of 30.00%, indicating substantial investment growth. Simultaneously, the percentage of government development expenditure allocated to agriculture ("PGEAS") was 26.99% of the total, demonstrating a significant increase in allocation to the agricultural sector, indicating a commitment to promote agriculture. This aligns with the implementation of policies aimed at boosting productive sectors like agriculture, such as setting sectoral credit ceilings.
- Bank Financing provided to the agricultural sector during this period ("BF") reached 4.31 million SDG, with a growth rate ("GBF") of 3.82%, indicating moderate growth. Moreover, the percentage of bank financing allocated to agriculture out of the total bank financing ("PBF") was 26.69%.

Period 2000-2011:

- Government Development Spending allocated to the agricultural sector during the period 2000-2011 significantly increased to 7.15 million Sudanese Pounds (SDG). However, the growth rate ("GRDEAS") was comparatively lower at 19.06%, indicating a slower pace of growth in government investment in agriculture. Despite this, the percentage of government development expenditure allocated to agriculture ("PGEAS") expanded significantly to 32.27% of the total, reflecting a growing emphasis on the agricultural sector within government spending. This surge in investment can be attributed to the availability of oil revenues entering the state treasury, and the signing of the Comprehensive Peace Agreement in 2005 likely created a conducive environment for economic development during this period.
- Bank financing provided to the agricultural sector ("BF") amounted to 7.69 million SDG. The growth rate of bank financing provided to the agricultural sector ("GBF") was 11.82%, indicating robust growth. The percentage of bank financing allocated to agriculture out of the total bank financing ("PBF") was 11.09%.

Period 2012-2020:

- In contrast to previous periods, Government Development Spending on the agricultural sector ("GDEAS") dropped considerably to 0.84 million SDG. The growth rate ("GRDEAS") during this period was only 4.20%, signifying a minimal increase in government investment. The most striking change was in the percentage of government development expenditure allocated to agriculture ("PGEAS"), which decreased significantly to 10.29%. This reduction in allocation could be attributed to the loss of oil revenues after the secession of the south and the economic challenges faced by Sudan during this time. These trends suggest a reduced emphasis on agriculture within government spending during these years.
- On the contrary, during this period, bank financing provided to the agricultural sector ("BF") saw a substantial increase, reaching 23.07 million SDG. The growth rate of bank financing provided to the agricultural sector ("GBF") was 17.74%, indicating robust growth. Furthermore, the percentage of bank financing allocated to agriculture out of the total bank financing ("PBF") stood at 21.14%. The significant growth in bank financing provided to the sector suggests a proactive response to limitations in government support.

1.2.2.2 Agriculture Orientation:

Agriculture Orientation is a key concept in economics and policy analysis. It measures the extent to which a government or financial institutions prioritize the agricultural sector through resource allocation and financial support. It plays a significant role in the economic development of agricultural-dependent nations like Sudan. This orientation is determined by examining the allocation of funding to agriculture compared to other sectors and provides insights into the sector's importance and its potential impact on the nation's overall economic well-being. Understanding

agriculture orientation is vital for assessing policies and financial decisions that affect sustainable agricultural development.

Agriculture Orientation Index (AOI): The "AOI" is a metric that quantifies the degree to which a government's expenditure is directed towards the agricultural sector in relation to other sectors. This index provides insights into the priority given to agriculture in terms of resource allocation and spending (FAO, 2018). Mathematically, the index is represented as:

$$AOI = \frac{\text{Government Expenditure Percentage on Agriculture}}{\text{Average Expenditure Percentage of Other Sectors}}$$

When the index exceeds 1, it signifies a higher allocation of expenditures towards agriculture than its economic contribution. Conversely, an index value less than 1 indicates that the agricultural sector receives a smaller proportion of expenditures compared to its economic significance. This measurement method provides a comprehensive perspective on the equilibrium between government support and the economic relevance of the agricultural sector, offering insights for policy evaluation and informed decision-making (SDGDATA, 2023).

Bank Financing Orientation Index (BFOI): You can create a parallel indicator for bank financing known as the Bank Financing Orientation Index (BFOI). Similar to the Agricultural Orientation Index (AOI), the BFOI would evaluate the allocation of bank financing resources to the agricultural sector relative to other sectors. This index would provide insights into the prioritization of the agricultural sector in terms of bank financing allocation compared to its economic significance. It can help evaluate whether banks are allocating a proportionate amount of their financing to the agricultural sector. The formula for calculating the BFOI would be as follows:

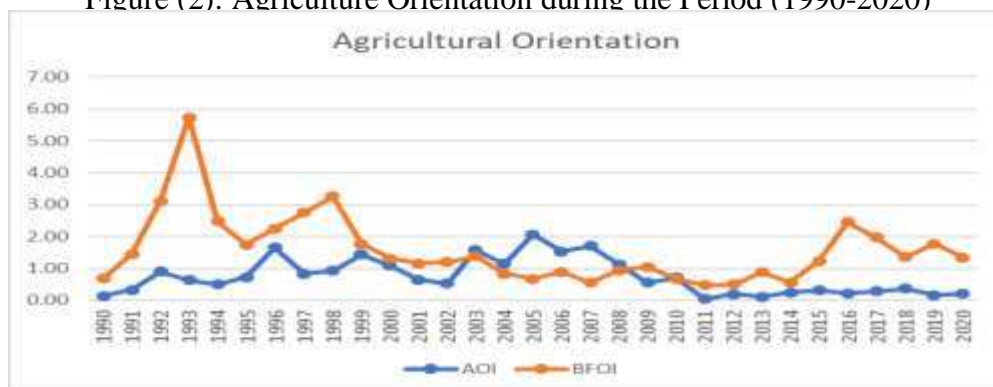
$$BAOI = \frac{\text{Bank Financing Percentage on Agriculture}}{\text{Average Financing Percentage of Other Sectors}}$$

BFOI > 1: it indicates that banks are allocating a higher proportion of their financing to the agricultural sector compared to its economic contribution. This could suggest that banks prioritize agriculture in their financing, potentially indicating strong support for the agricultural sector.

BFOI < 1: it signifies that banks allocate a smaller proportion of their financing to the agricultural sector compared to its economic significance. This might suggest that banks are not giving as much priority to agriculture in their financing, potentially signaling a need for increased support to the agricultural sector.

BFOI = 1: it means that banks allocate financing to the agricultural sector in proportion to its economic importance. In this case, banks maintain a balanced approach to financing across various sectors, including agriculture.

Figure (2): Agriculture Orientation during the Period (1990-2020)



The source: *Prepared by the researcher based on data from the Central Bank of Sudan and Ministry of Finance and Economic Planning*

Figure 2 illustrates the following:

- **AOI:** It started at a relatively low value in 1990 (0.13) and showed an increasing trend over the years. This indicates that the government progressively allocated more resources to the agricultural sector compared to other sectors during this period. This could signify a recognition of the sector's importance for economic development, especially in a country like Sudan, where agriculture plays a significant role. Nonetheless, the value of this indicator remained below 1 for most years of the study, indicating that the agricultural sector receives a smaller proportion of expenditures compared to its economic significance.

This suboptimal allocation might indicate the need for the government to further prioritize agriculture to harness its full economic potential.

- **BFOI** values exceeded 1 for the majority of the study years. This signifies that banks allocated a greater proportion of their financing to the agricultural sector compared to its economic contribution. This suggests that during these periods, banks gave priority to agriculture in their funding, potentially reflecting robust support for the agricultural sector.
- From the presented figure, it's evident that the BFOI curve consistently surpasses the AOI curve across the majority of the study periods. This indicates that banks tend to prioritize agriculture in their financing to a greater extent than the government does. This difference in prioritization could have positive implications for the agricultural sector, as it suggests that there is substantial financial support available from the banking sector, which can complement government efforts.

In summary, the government has shown an increasing commitment to the agricultural sector, but there is room for improvement in the allocation of resources. On the other hand, the banking sector has consistently demonstrated strong support for agriculture, potentially contributing significantly to the sector's development. The collaboration between these two sectors could lead to enhanced growth and development in Sudan's agricultural sector.

I.2.3 Challenges in Sudan's Agricultural Sector: An Analytical Data Perspective and Literature Survey

I.2.3.1 Challenges Through Analytical Data Examination:

During the research period, the agricultural sector in Sudan encountered a spectrum of challenges that significantly influenced the allocation and growth of government and bank financing. These challenges, discerned from observed data trends, can be categorized and analyzed as follows:

- **Suboptimal Government Allocation:** The agricultural sector faced a challenge as the government's allocation, as represented by AOI, remained consistently below 1. This suboptimal allocation suggested a potential gap in prioritizing agriculture despite its significant economic role.
- **Limited Government Financial Commitment:** Although the AOI increased over the years, the absolute values remained relatively low. This indicated that the agricultural sector might not have received a proportionate financial commitment from the government, posing a challenge to its growth and development.
- **Bank-Focused Allocation Discrepancy:** While banks consistently prioritized agriculture (BFOI values consistently above 1), the government's prioritization lagged. This divergence in focus could present challenges in achieving a harmonized and comprehensive approach to supporting the agricultural sector.
- **Need for Enhanced Government Support:** The findings imply a potential need for increased government support, both in terms of financial commitment and strategic prioritization. Addressing this challenge is crucial for unlocking the full economic potential of the agricultural sector.
- **Potential Imbalance in Sectoral Support:** The continuous difference between AOI and BFOI curves indicates a potential imbalance in sectoral support. Aligning government and bank priorities could be a challenge, requiring coordinated efforts to ensure a more balanced and effective financing strategy for the agricultural sector.

I.2.3.2 Challenges Through Literature Review:

There are several challenges that present significant obstacles to Sudan's agricultural sector. In the following section, we will delve into the most prominent of these challenges (Suleiman, 2013):

- **Scarcity of Financial Resources :** The agricultural sector grapples with a lack of financial resources and low savings, hindering its growth and development despite promising investment opportunities.
- **Weak Expenditure and Infrastructure :** Inadequate investment in agriculture, coupled with the deterioration of production and export infrastructure, poses significant hurdles.
- **Vulnerability of Producers:** Producers face challenges like illiteracy, poverty, malnutrition, and diseases, limiting their capacity to contribute effectively.
- **Escalating Production Costs:** Rising costs, particularly for inputs such as machinery, fuels, fertilizers, and pesticides impacted by currency depreciation, undermine the sector's

viability.

- **Multiple Levies on Production** : The imposition of numerous levies on agricultural production creates significant impediments to the sector's development.
- **Transportation Challenges** : Increased transportation and logistical expenses, notably due to railway deterioration, hamper the sector's efficiency.
- **Ineffectual Policies**: Insufficient overarching and sector-specific policies, coupled with a lack of a clear vision for the agricultural sector, impede its growth. Underdeveloped policies concerning agricultural financing may hinder the government's capacity to provide effective support to the sector (FAO, 1998).
- **Limitations in Productivity** : Limited adoption of modern techniques results in low and stagnant productivity.
- **Marketing Challenges** : Both domestic and international marketing pose obstacles, with market distortions causing harmful speculation that affects producers and consumers alike.
- **Instability and Internal Conflicts**: The presence of instability and internal conflicts contributes to an increase in military spending at the expense of financial allocations, particularly in the agricultural sector.
- The instability and internal conflicts in Sudan lead to a rise in military spending, diverting funds away from crucial financial allocations, especially within the agricultural sector. The government's role in agricultural markets is intricately linked to global political and economic dynamics, influencing the availability of credit and affecting costs for farmers (Lencucha et al., 2020).
- **Limited Access to Long-Term Finance**: Banks may face constraints in accessing long-term finance, limiting their capacity to offer extended loans to farmers (The World Bank, 2022).
- The policy of sectoral credit ceilings had detrimental effects on banks, as their involvement in financing the agricultural sector exposed them to high risks due to the sector's inherent fluctuations and low productivity. This resulted in a surge in non-performing debts for the agricultural sector, reaching around 59 million pounds by the end of 1999, constituting 30.5% of the total non-performing debts in banks. The repercussions included a negative impact on banks' ability to finance other sectors, leading to a decline in their resources and profitability. In response, the policy was revised as part of the banking sector reform program, with sectoral ceilings abolished by the end of 1999. Banks were granted the flexibility to allocate resources to different sectors based on data and each sector's capacity to attract financing (Sheikh Musa, 2012).

II- Methods and Materials:

II-1 Data Collection and Sources:

This research relies on the collection of secondary data from authoritative institutions, including the Central Statistical Organization, the Central Bank of Sudan, and the Ministry of Finance and Economic Planning. These sources provide comprehensive and reliable data on government and bank financing for agricultural development in Sudan from 1990 to 2020. The utilization of official data ensures the accuracy and credibility of the research findings, facilitating a rigorous comparative analysis of the financing trends and their impact on agricultural development in the country.

II-2 Modeling Government and Bank Financing Impact on Agricultural Development

In our quest to conduct a Comparative Study of Government and Bank Financing for Promoting Agricultural Development, and to substantiate our research hypotheses, we have chosen to employ the ARDL (Autoregressive Distributed Lag) autoregressive model. This modeling approach, as introduced by (Pesaran et al. 2001), incorporates the Bounds Test methodology. The Bounds Test is particularly valuable when examining level relationships, especially in cases where uncertainty surrounds whether time series data are stationary at their levels (I(0)) or stationary in their first differences (I(1)). Importantly, the ARDL methodology's versatility allows for application regardless of the characteristics of the time series data, be it stationary at their levels (I(0)), stationary in their first differences (I(1)), or a combination of both I(0) and I(1). Consequently, this methodology presents various boundary testing procedures to explore these relationships comprehensively.

Equation 1: General formula

$$AGGDP = f(GDEAS, BF) \quad \text{---(1)}$$

Where:

AGGDP: Agricultural Production at Constant Prices (Million Pounds).

GDEAS: Real Government Development Spending Allocated to the Agricultural Sector (Million Sudanese Pounds).

BF: Real Bank Financing Granted to the Agricultural Sector (Million Sudanese Pounds).

Equation 2: Special formula

Based on equation (1), the ARDL model will be estimated according to the following equation:

$$\Delta LAGGDP_t = c + \alpha_1 LAGGDP_{t-1} + \alpha_2 LGDEAS_{t-1} + \alpha_3 LBF_{t-1} + \sum_{i=1}^p \beta_{1i} \Delta LAGGDP_{t-i} + \sum_{i=0}^{q_1} \beta_2 \Delta LGDEAS_{t-i} + \sum_{i=0}^{q_2} \beta_3 \Delta LBF_{t-i} + \varepsilon_t \quad - (2)$$

Where:

c: Constant term.

L: Natural logarithm of variables.

Δ: First difference.

p, q₁, q₂: Upper bound of the lag order for variables (GDEAS, BF).

β₁, β₂, β₃: Short-term relationship coefficients.

α₁, α₂, α₃: Long-term relationship coefficients.

II-3 Results and Analysis

II.3.1 Unit root test

We conducted an Augmented Dickey-Fuller (ADF) test on the time series data, considering both the level and first difference, with significance levels of 1%, 5%, and 10%. Various specifications were employed, including only the constant term, the constant term with a trend, and neither. The lag length was determined to prevent autocorrelation, utilizing the Akaike Information Criterion (AIC) for selection. The outcomes are displayed in Table 4 as follows:

Table (4). Unit root test

variables	Augmented Dickey-Fuller Unit Root Test						integration case I(d)
	At Level			1st Difference			
	With Constant	With Constant & Trend	Without Constant & Trend	With Constant	With Constant & Trend	Without Constant & Trend	
AGGDP	0.3007	0.6987	0.9877	0.0010***	0.0015***	0.0007***	I(1)
GDEAS	0.1016	0.7563	0.1625	0.0001***	0.0008***	0.0000***	I(1)
BF	0.1340	0.1596	0.1581	0.0000***	0.0000***	0.0000***	I(1)

The source : Authors

Note: a: (*)Significant at the 10%; (**)Significant at the 5%; (***) Significant at the 1%

The table above clearly indicates that the time series data for each variable (AGGDP, GDEAS, BF) were non-stationary at their original levels. Consequently, we accepted the null hypothesis, which suggests the presence of a unit root in the series. To address this, we took the first difference of these variables, both with a constant, with a constant and a time trend, and without them, at a significance level of 1%. This implies that these series are integrated of order I(1).

II-3.2 Unrestricted Error Correction Model (UECM) Test

The Distributed Lag Autoregressive (DLAR) Model with High Sensitivity to Lags automatically selects the lag length during the test using the Eviews program. The selection criterion employed in this case is the Akaike Information Criterion (AIC). The lag lengths determined through Eviews 9 were ARDL(1, 7, 5), indicating one lag for AGGDP, seven lags for GDEAS, and five lags for BF.

Table (5). UECM Test

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LOG(AGGDP(-1))	0.521808	0.185441	2.813876	0.0227
LOG(GDEAS)	0.002430	0.018188	0.133618	0.8970
LOG(BF)	0.109516	0.042364	2.585102	0.0324
C	0.684348	0.293292	2.333336	0.0479
R-squared	0.986908	Adjusted R-squared	0.962362	

The source : Authors

The statistical tests conducted for the regression equation in Table 5 yield a coefficient of determination (R^2) of 0.98. This suggests that the independent variables, specifically "Government Development Expenditure on the Agricultural Sector" and "Bank Financing," collectively explain 98% of the variability in agricultural GDP.

II-3.3 ARDL Bounds Test

To ascertain the presence of a shared cointegration relationship among the variables, we employed the Bounds Testing methodology. The results of this test are displayed in Table 6 below:

Table (6). ARDL Bounds Test

F-statistic = 5.132705							
		10%		5%		1%	
Sample Size	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	
30	2.915	3.695	3.538	4.428	5.155	6.265	
Asymptotic	2.630	3.350	3.100	3.870	4.130	5.000	

The source: Authors

Note: * I(0) and I(1) are respectively the stationary and non-stationary bounds.

As indicated in Table 6, the F-statistic value of 5.13 surpasses the upper critical values at a 5% significance level. This leads to the rejection of the null hypothesis, which implies no common cointegration, and the acceptance of the alternative hypothesis, signifying the presence of a shared cointegration among the model variables. This substantiates the existence of a long-term equilibrium relationship between agricultural output and the independent variables "Government Development Expenditure on the Agricultural Sector" and "Bank Financing.". The implications of cointegration in this context are significant:

- Long-Term Relationship : Cointegration suggests the existence of a long-term relationship between agricultural output and the independent variables "Government Development Expenditure on the Agricultural Sector" and "Bank Financing." This means that changes in these independent variables have a lasting impact on agricultural output over time.
- Stability: Cointegration indicates stability in the relationship between these variables. It implies that any deviations from the long-term equilibrium are temporary and tend to correct themselves in the long run.
- Policy Relevance: This finding is particularly relevant for policymakers. It suggests that strategic changes in government development spending on agriculture and bank financing can have a sustained impact on agricultural productivity. This information can guide policy decisions aimed at promoting agricultural development in Sudan.

II-3.4 ARDL Cointegration and Long-Run Form

The long-term analysis through ARDL Cointegration provides valuable insights into the sustainable impact of government and bank financing on agricultural development in Sudan. In this section, we unveil the results of this rigorous examination, revealing the enduring relationship between financial factors and agricultural output. These findings serve as a cornerstone for understanding the long-term implications of financial decisions on Sudan's agricultural sector.

Table (7). ARDL Cointegration and Long-Run Form

Variable *	Coefficient	Std. Error	t-Statistic	Prob.
LOG(GDEAS(-1))	0.055713	0.019767	2.818485	0.0154
LOG(BF(-1))	0.276452	0.064032	4.317394	0.0003
C	1.431115	0.115273	12.41502	0.0000

The source : Authors

Based on the outcomes presented in Table (7), the formulation of the long-run model equation is as follows:

$$\text{LOG(AGGDP(-1))} = 0.055713 * \text{LOG(GDEAS(-1))} + 0.276452 * \text{LOG(BF(-1))} + 1.431115 \quad \text{---(3)}$$

It is evident from Table (7) that:

- The long-term equation of the model illustrates a positive relationship between all explanatory variables and agricultural output, which aligns with the study's hypothesis.
- The coefficient of LOG(BF(-1)), representing the lagged bank financing for the agricultural

sector, is 0.276452. This positive coefficient implies that a 1% increase in lagged bank financing leads to a 0.2764% increase in the long-run agricultural output. This indicates that bank financing plays a crucial role in supporting and promoting agricultural production over the long run.

- The coefficient of LOG(GDEAS(-1)), representing the lagged government development expenditure on the agricultural sector, is 0.055713. This positive coefficient suggests that a 1% increase in lagged government development expenditure leads to a 0.0557% increase in the long-run agricultural output. It indicates a positive and significant relationship between government spending and agricultural output in the long run.
- In summary, the results indicate that both government development expenditure and bank financing have positive and significant effects on long-term agricultural output in Sudan. These findings underscore the importance of continued investment by both the government and banks in the agricultural sector to enhance agricultural productivity and contribute to the overall economic development of the country.

II-3.5 Error Correction Model (ECM) Test

The Error Correction Model (ECM) test provides a critical lens through which we can examine the short-term dynamics of our model. This test allows us to explore how deviations from long-term equilibrium relationships impact the short-term behavior of agricultural output, government development expenditure, and bank financing. In this section, we delve into the results of the ECM test to gain deeper insights into the intricate interplay of these variables in the short run, Based on the following equation:

$$\Delta \text{Log}(\text{AGGDP}_t) = \beta_1 \Delta \text{log}(\text{GDEAS}_t) + \beta_2 \Delta \text{log}(\text{BF}_t) + \beta_4 \text{ECM}_{t-1} \quad \text{--(4)}$$

Table (8) presents the outcomes of the constrained error correction test for the short-term correlation of the model in equation (4).

Table (8). ECM Test

Variable	Coefficient	Std. Error	t-Statistic	Prob.
COINTEQ*	-0.478192	0.090001	-5.313180	0.0002
DLOG(GDEAS)	0.002430	0.012334	0.197044	0.8474
DLOG(BF)	0.109516	0.027555	3.974460	0.0022
R-squared	0.845754	Adjusted R-squared		0.677485

The Source: Authors

The findings from Table (8) are as follows:

- The error correction parameter meets two critical criteria: it exhibits statistical significance at the 1% level and carries a negative coefficient. With a calculated CointEq value of -0.48, it greatly bolsters the accuracy and reliability of the long-term equilibrium relationship. This observation indicates that the model possesses the capacity to rectify deviations and gradually return to its inherent equilibrium state over an estimated period of approximately two years. More specifically, when agricultural output strays from its long-term equilibrium in the short term (t-1), the model can correct around 48% of this disparity in the subsequent period (t), progressively approaching equilibrium in the long run. This phenomenon reveals an inherent self-correction tendency within the economy over time, assuming there are no significant shocks or persistent imbalances impeding the return to long-term equilibrium. Consequently, policymakers should prioritize swift and effective measures to address disparities while also strategically investing in long-term planning. This insight underscores the intrinsic stability of the agricultural sector and the economy's resilience to short-term disruptions. It further emphasizes the necessity of implementing enduring policies that account for the required time frame for their full effects to materialize.
- The coefficient for DLOG(BF), representing the change in bank financing for the agricultural sector in the short term, is 0.109516. It is statistically significant with a t-statistic of 3.974460 and a p-value of 0.0022. This implies that short-term changes in bank financing do have a significant positive impact on agricultural output.
- In the short term, Government Development Expenditure shows no statistical significance, indicating that immediate alterations in government spending do not exert a considerable influence on agricultural output. This lack of significance can be rationalized by considering the inherent nature of these expenditures. Government development allocations directed toward the agricultural sector primarily fund long-term development projects, such as infrastructure initiatives tailored for the sector. These projects are strategically designed

to yield substantial returns over an extended period. Consequently, their impact on agricultural output may not manifest immediately in the short term. This aligns with our observation that short-term fluctuations in government expenditure do not significantly impact agricultural output, emphasizing the enduring nature of their intended effects.

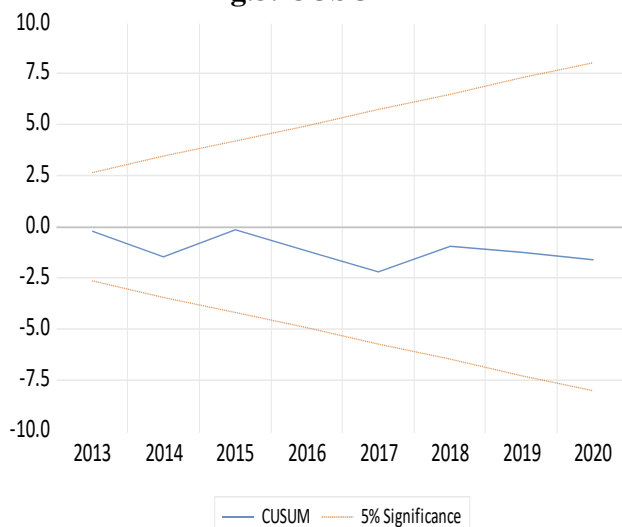
II-3.6 Diagnostic Tests for the Study Model:

First: Test for Structural Stability of the Model

Structural stability of the estimated coefficients within the ARDL model is confirmed when the plots of the CUSUM and CUSUM of Squares tests remain within the critical boundaries at a significant level of 5%. Conversely, if the plots exceed these critical boundaries, it signifies instability in the equation. (Abdalla, 2023).

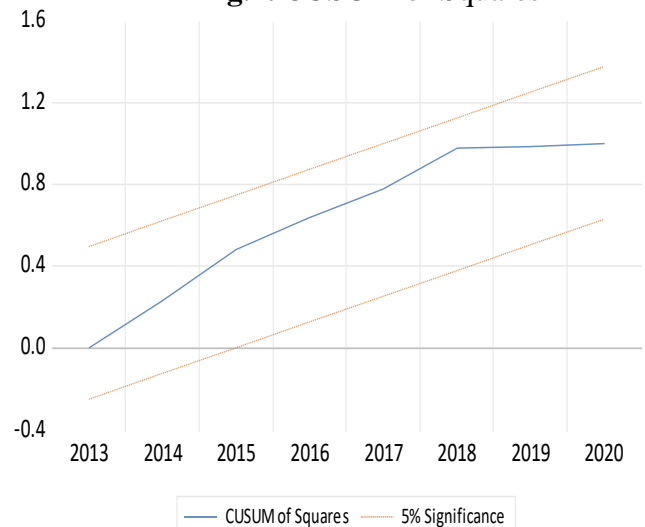
Upon reviewing Figures 3 and 4, it becomes evident that the plotted lines for the CUSUM of Squares tests consistently stay within the critical boundaries at a significance level of 5%. This outcome is indicative of the structural stability of the estimated coefficients within the model.

Fig.3. CUSUM



The Source : Authors

Fig.4. CUSUM of Squares



The Source : Authors

Secondly: Standard Diagnostic Tests

To verify the absence of serial autocorrelation, the Breusch-Godfrey Serial Correlation LM Test was conducted, yielding results that indicate the absence of autocorrelation issues. Additionally, the ARCH test was employed to identify potential error covariance problems, revealing that the model is devoid of such issues. The normal distribution assumption of the data was assessed using the Jarque-Bera test, and the outcomes affirm that the model's residuals adhere to a normal distribution, as presented in Table 9. These findings collectively affirm the reliability and effectiveness of the model.

Table (9). Diagnostic Tests Results

Test	Uses	Test Value	Decision
LM Test	Detection of Serial Autocorrelation	0.4956	no problem
ARCH Test	Detection of Error Covariance Problem	0.6560	no problem
Jarque-Bera	Detection of Normal Distribution	0.1023	The residuals exhibit a normal distribution

Source : Authors

III- Results and discussion :

This section presents the key findings of the study, which delves into the relationship between government and bank financing and their impact on agricultural development in Sudan over the period from 1990 to 2020. The study employed a combination of statistical techniques, including ARDL cointegration analysis and error correction modeling, to investigate the short-term and long-term dynamics of these variables.

Long-Term Analysis:

- The long-term analysis, conducted using ARDL cointegration analysis, revealed significant insights into the relationships between the variables. Notably, the study found a strong positive association between government development expenditure in the agricultural sector (GDEAS) and agricultural output (AGGDP) over the long run. This suggests that an increase in government spending in the sector leads to a corresponding increase in agricultural production, a result in line with the study's hypothesis.
- Likewise, bank financing (BF) exhibited a positive and significant relationship with agricultural output in the long run. The findings indicate that bank financing plays a crucial role in promoting agricultural development, emphasizing the importance of financial support from the banking sector in sustaining and expanding agricultural activities.

Short-Term Analysis:

- Furthermore, the study's error correction modeling (ECM) results showcased the presence of a robust mechanism for self-correction within the economy. The error correction parameter (CointEq) exhibited statistical significance and a negative coefficient, signifying the model's ability to rectify deviations and return to its equilibrium state over approximately two years. This phenomenon highlights the inherent stability of the agricultural sector and the economy's resilience to short-term disruptions.
- In contrast, the short-term analysis indicated that government development expenditure (GDEAS) does not have a significant impact on agricultural output within a short time frame. This observation is consistent with the nature of government spending in the agricultural sector, which often focuses on long-term development projects with delayed returns, such as infrastructure initiatives. Consequently, the immediate effects of these investments on agricultural output may not be pronounced.
- Conversely, the study found that bank financing (BF) has a significant positive impact on agricultural output in the short term. Short-term changes in bank financing can lead to increased agricultural production, underlining the importance of timely financial support from the banking sector in boosting agricultural activities.

Policy Implications:

- These results have several policy implications for promoting agricultural development in Sudan. Policymakers should recognize the long-term nature of government development expenditures and ensure that they align with the sector's requirements for sustained growth. Additionally, enhancing the availability and accessibility of bank financing can be instrumental in driving short-term agricultural expansion.

IV- Conclusion:

In conclusion, the research conducted on Sudan's agricultural sector financing provides valuable insights into the dynamics of government and bank financing and their impact on agricultural development. The study employed a comprehensive methodology, including ARDL modeling, unit root tests, error correction modeling, and cointegration analysis, to assess both short-term and long-term relationships among variables. Key findings from the research include:

- **Government Allocation and Financial Commitment:** The analysis of government allocation to the agricultural sector revealed a suboptimal trend, with the Agricultural Output Index (AOI) consistently below 1. This indicates a potential gap in prioritizing agriculture despite its crucial economic role. Although the AOI increased over the years, the absolute values remained relatively low, suggesting a limited financial commitment from the government. This underscores the need for enhanced government support in terms of both financial commitment and strategic prioritization.
- **Discrepancy in Focus Between Government and Banks:** A notable finding is the divergence in focus between government and bank financing for the agricultural sector. While banks consistently prioritized agriculture, as evident from Bank-Focused Allocation Discrepancy (BFOI) values consistently above 1, the government's prioritization lagged. This discrepancy poses challenges in achieving a harmonized and comprehensive approach to supporting the agricultural sector, emphasizing the importance of aligning priorities for effective sectoral support.

- **Literature Review Insights:** The literature review reinforced the challenges identified through data analysis. Scarcity of financial resources, weak expenditure and infrastructure, vulnerability of producers, escalating production costs, and policy ineffectuality were among the prominent challenges outlined in the literature. These challenges collectively contribute to hindrances in the sector's growth and require targeted interventions for sustainable development.
- **Long-Term Relationships and Impacts:** The ARDL cointegration analysis revealed significant long-term relationships between government development expenditure, bank financing, and agricultural output. Both government spending and bank financing exhibited positive and significant impacts on agricultural output over the long run. This implies that strategic changes in these financial factors can have a sustained impact on agricultural productivity, highlighting their crucial roles in the sector's long-term development.
- **Short-Term Dynamics and Self-Correction Mechanism:** The error correction mechanism indicates that the model can correct around 48% of short-term disparities in agricultural output in the subsequent period. This intrinsic stability suggests resilience to short-term disruptions, emphasizing the need for enduring policies that account for the required time frame for their full effects to materialize.
- **Policy Implications:** The study's results carry significant policy implications. Policymakers should recognize the long-term nature of government development expenditures and ensure alignment with the sector's requirements for sustained growth. Additionally, enhancing the availability and accessibility of bank financing, given its positive short-term impact, can be instrumental in driving agricultural expansion.

These findings underscore the importance of continued investment by both the government and banks in Sudan's agricultural sector to enhance agricultural productivity and contribute to overall economic development. Policymakers should prioritize effective measures that account for both short-term and long-term impacts on agricultural development.

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