

The efficacy of Agricultural Financing on Agricultural Production in Zimbabwe

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Abstract

This research investigates the effectiveness of agricultural financing in enhancing agricultural production in Zimbabwe. This study explores the key drivers of agricultural production in Zimbabwe and specifically assesses the influence of agricultural loans, foreign direct investment (FDI), and domestic agricultural capital on agricultural output within the country. The study seeks to gain a better understanding of how these financial resources contribute to agricultural output and assesses their overall effectiveness in stimulating agricultural productivity. The study used the Autoregressive Distributed Lag (ARDL) to analyse the short-term and long-term relationship among agricultural output, agricultural loans, foreign direct investment (FDI), and domestic agricultural capital. The findings indicate a robust positive correlation between agricultural loans and agricultural output. Increased access to financing enables farmers to invest in inputs, machinery, and technology, leading to significant boosts in productivity. While FDI has the potential to introduce advanced technologies and capital, the findings suggest a non-significant direct impact on production. However, it may indirectly contribute through improved infrastructure and market access. Additionally, the research confirms a significant positive link between domestic agricultural capital and agricultural production. Sufficient availability of capital, for land improvement, irrigation, and modern techniques, is strongly linked to increased production. The study highlights the critical role of agricultural financing in driving agricultural growth in Zimbabwe. It also emphasizes the need for strategic investments and supportive infrastructure to maximize the benefits of FDI.

Keywords: Autoregressive Distributed Lag; agricultural financing; agricultural loans, agricultural output, FDI

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1. Introduction

It is evident that poverty remains a major challenge in the SADC region, with approximately half of the population living on less than \$1 per day. The majority of the region's population relies on agriculture for sustenance, income, and employment, accounting for nearly 70% of their livelihoods. The SADC REPORT (2020) highlights that ensuring food and nutrition security in the region is dependent on various developmental factors such as access to land, credit, education, employment opportunities, as well as affordable agricultural inputs like fertilizers, seeds, and water. According to the SADC REPORT (2020), economic growth in Southern Africa is projected to be slower compared to other regions of the continent. The Southern African Development Community (SADC) is made of 16 member states, namely Angola, Botswana, Comoros, Democratic Republic of the Congo (DRC), Eswatini, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Tanzania, Zimbabwe, and Zambia.

Established in Windhoek, Namibia, on August 17, 1992, SADC emerged as the successor to the Southern African Development Coordination Conference, sharing the same objectives of achieving economic development, peace and security, economic growth, poverty reduction, and improvement in the standard of living for the people of Southern Africa through regional integration (Lundblad and Rissanen, 2018). According to Alize le Roux (2024), agriculture serves as the primary source of income, employment, and subsistence for 61 percent of the population in the SADC region. However, agricultural productivity and growth have remained low over the past two decades, despite the region's abundant natural resources. To reverse the decline in agricultural productivity and foster rapid economic growth and poverty reduction, comprehensive initiatives must be urgently implemented. Developing effective strategies for agricultural development is challenging given the diverse farming and livelihood systems within the region. Nevertheless, many nations in the region face similar issues and opportunities, making cooperation in crucial areas potentially advantageous, leveraging their natural comparative advantages (Okunlola, Osuma, and Omankhanlen, 2019). One of the challenges faced by smallholder farmers in Africa, including those within the SADC region, is the lack of adequate support needed for their success. Donors and governments have shifted their policies away from agriculture and reduced public funding for agricultural livelihood support, neglecting the needs of smallholder farmers.

Scientific research has often been narrowly focused on specific crops, leading to a mono-disciplinary approach that overlooks the complexity and diversity of small-scale farming systems. Farm extension services, which should address the needs of underprivileged smallholder farmers, have been underfunded, understaffed, and stuck in a top-down technology transfer model, failing to act as a bridge to the scientific community (Shkodra and Shkodra, 2018). Governments have not given sufficient attention to small-scale farming systems, impeding their potential to become sustainable and commercially viable sources of income. Inadequate institutional innovations, financial assistance, and policy and legal framework changes have hindered their long-term development (Taremwu, 2022). Addressing these issues and providing comprehensive support to smallholder farmers is crucial for promoting agricultural growth and improving the livelihoods of rural communities in the SADC region.

Instead, there has been a misguided belief that expanding agriculture in more favourable locations would be sufficient to increase agricultural employment and food production, overlooking the underdeveloped areas and marginalized farmers (Lundblad and Rissanen, 2018).

The decline of small farms has made it challenging to produce an adequate number of staple foods and low-value goods to sustain farming families (Tekle, 2017). While rapid integration into food market chains and globalization have presented new high-value opportunities for some farms, they have also created obstacles for disadvantaged smallholder farmers, such as high transaction costs and the need to meet stringent quality standards (Tekle, 2017). These farmers are now more vulnerable to price fluctuations and increased competition from global trade. The promotion of sustainable agriculture is crucial, as it encompasses an integrated approach to plant and animal production practices that meet human needs for food and fibre, improve the environment, utilize resources efficiently, and integrate natural biological cycles and controls (Shkodra and Shkodra, 2018).

Agriculture financing (AF) plays a significant role in enhancing the quality of life for farmers and society as a whole. Achieving agricultural sustainability is a key developmental objective in Africa and other developing countries. Agriculture is recognized as the backbone of economies in these nations and a vital strategy for achieving the Millennium Development Goals, particularly in reducing poverty and hunger (United Nations, 2012). Small-scale agricultural producers face numerous challenges and operate under constrained conditions, assuming multiple roles as entrepreneurs, traders, investors, and consumers (Okunlola, Osuma, and Omankhanlen, 2019). Therefore, employing suitable financial tools to maximize investment opportunities is crucial for modernizing and commercializing agriculture, ensuring the long-term viability of farmers' income sources. Agriculture financing supports the accumulation of domestic agricultural capital and facilitates the transformation of the agricultural sector, contributing to its sustainability. Well-functioning markets are essential for structural changes and the formation of domestic agricultural capital, enabling transactions involving a wide range of commodities and services across different locations and periods. As structural transformation progresses, markets for land, labour, capital, and finance become more complex, integrating specialized producers and consumers. Agriculture financing supports the financial, logistical, and market access requirements necessary for the modernization and capital formation in agriculture, facilitating a broader division of labour (Okunlola, Osuma, and Omankhanlen, 2019; Shkodra and Shkodra, 2018). The SADC RVAA System Vulnerability Assessments and Analysis Guidelines were established to facilitate assessments in the context of the COVID-19 pandemic. These guidelines assisted SADC member states in conducting urban assessments while considering the implications of COVID-19 on urban settings. With support from the Regional Vulnerability Assessment and Analysis (RVAA) Programme, 13 out of the 16 SADC member states (excluding Comoros, Mauritius, and Seychelles) carried out their annual vulnerability assessments in 2020. The results were documented in the 2020 Synthesis Report on the State of Food and Nutrition Security and Vulnerability in Southern Africa, which was released in July 2020. The report revealed that over 50 million people in the region were experiencing food insecurity, the highest number ever recorded.

For the 2020 assessments, at least five member states (Eswatini, the Democratic Republic of the Congo, Madagascar,

Mozambique, and Zimbabwe) included chronic vulnerability in their data collection and analysis. It is expected that additional member states will follow suit for the 2021 assessments. Furthermore, twelve National Vulnerability Assessment Committees (VACs) incorporated various topics into their annual assessments, such as nutrition, HIV/AIDS, gender, markets, the Integrated Food Security Phase Classification, poverty reduction, and climate change resilience. Among the four nations that reported on poverty assessment (Botswana, Mozambique, South Africa, and Zimbabwe), only Zimbabwe conducted an analysis on resilience for the year 2020. Efforts were made to align Member States' Food and Nutrition Security Strategies (FNSS) with the Regional FNSS, and this task was successfully completed in January 2021. Evaluation of national food and nutrition security strategies was carried out for 11 member states (Comoros, DRC, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Seychelles, South Africa, Tanzania, and Zambia), while the implementation status of eight of these strategies was reviewed.

The region also approved the registration and release of an additional 24 crop varieties through the SADC Harmonised Seed Regulatory System (HSRS), expanding the range of crops that can be produced and traded within the region. These crops include soybeans, sorghum, groundnuts, beans, wheat, and maize. The HSRS was established to enhance seed accessibility and availability in line with the goals set in the Regional Agricultural Policy (RAP). Access to high-quality seeds also helps rural agriculture mitigate genetic degradation and diversify food resources. The Secretariat continues to implement the Regional Agricultural Policy (RAP) to improve regional and global trade, increase market access for agricultural products, encourage private and public sector involvement and investment in agricultural value chains, and reduce the social and economic vulnerability of the region's population in relation to food and nutrition security and changing economic conditions. Cyclones and flooding in the eastern part of the country resulted in significant losses of food and cash crops. In addition, prolonged dry spells during the corn-growing season in February 2022 and the 2023 to 2024 seasons caused crops in Matabeleland, Zimbabwe, to permanently wither. As a result, households in Matabeleland have become increasingly reliant on income from the sale of livestock and animal products. The drought estimates indicate that it led to the deaths of 141,549 cattle, 81,923 sheep, 56,882 goats, and at least 6,445 donkeys. The drought's impact has also resulted in an increase in the prevalence and risks of animal diseases, the deterioration of pastures, and significantly reduced access to water, all of which have severe long-term negative effects. In 2020, Zimbabwe produced 1.060 million tons of cereals due to a severe drought, while the country required approximately 2.223 million tons, resulting in a national cereal deficit of 52% for the 2020-21 consumption year (SADC 2020). With 7.7 million people facing food insecurity, Zimbabwe's macroeconomic situation has now evolved into an ongoing crisis (Magomana, 2020). The country has experienced numerous acute shocks, which have been exacerbated by widespread chronic food insecurity. According to the ZIMSTAT Poverty Consumption and Expenditure Survey (2017), 29.3% of the population was classified as extremely poor, and 70.5% of the population was considered poor. The table below illustrates the number of individuals identified as food insecure in the SADC region as of 2020.

Table 1: Food insecurity in the SADC region

Country	Total affected 2019/20	Rural affected 2020/21	Urban affected 2020/21	Total affected 2020/21	Rural population	% rural population affected 2020/21	Notes
Angola	1,139,064	1,051,800		1,051,800	11,087,737	9	The Government of Angola and WFP (Hotspot Analysis)
Botswana	38,300	38,300		38,300	664,641	6	2019 number
DRC	15,878,661	13,141,056		13,141,056	60,722,174	22	IPC Phase 3+, valid Jan to May 2020
Eswatini	232,373	335,421	30,840	366,261	882,208	38	IPC Phase 3+ for 4 rural and 2 urban districts, valid Oct to Mar 2021
Lesotho	433,410	433,000		433,000	1,321,263	33	2019 number, IPC Phase 3+
Madagascar	916,201	554,000		554,000	16,072,148	3	IPC Phase 3+ rural, valid to Jul 2020
Malawi	1,126,147	1,900,000	800,000	2,700,000	14,747,257	13	2019 number, IPC Phase 3+rural
Mozambique	1,648,646	1,648,646	364,389	2,013,035	18,361,753	9	IPC Phase 3+ rural from 2019 & urban (Maputo and Matola), valid to Sep
Namibia	289,644	354,438		354,438	1,209,564	29	IPC Phase 3+, rural & urban, valid to Sep 2020
South Africa	13,670,000	5,800,000	7,800,000	13,600,000	19,771,910	29	2019 number
Tanzania	985,267	488,661		488,661	35,890,686	1	IPC Phase 3+, valid to Sep 2020
Zambia	2,330,182	2,330,182		2,330,182	9,897,231	24	2019 number, IPC Phase 3+
Zimbabwe	5,529,209	5,529,209	2,200,000	7,729,209	9,962,261	56	2019 number: 5.5 rural & 2.2 urban
SADC	41,193,176	33,604,713	11,195,229	44,799,942	200,590,832	17	

According to the SADC (2020) Regional Vulnerability Assessment and Analysis Programme Synthesis Report, the Democratic Republic of the Congo (DRC) had the highest number of individuals experiencing food insecurity, totalling 15,878,661. South Africa ranked second with 13,670,000 individuals. Among the 38,300 people worldwide, Botswana had the lowest number of people lacking access to food. In the SADC region, a total of 41,193,176 people were identified as food insecure, with 33,604,713 residing in rural areas and 11,195,229 in urban areas. The Sustainable Development Goals

(SDGs) have garnered attention from governments, business leaders, and academics worldwide as they provide a roadmap for sustainable development. To achieve sustainable economic growth and establish a prominent position in the global market, nations need to carefully design policies that not only guide progress in the right direction but also ensure that this progress is achieved through sustainable means. In other words, countries must focus on employing sustainable approaches to facilitate better levels of growth.

According to Mladen (2015), economic growth refers to the continuous increase in a nation's production volume or the rise in gross domestic product, which are the primary quantitative measures of production over a year. The SADC region has been significantly impacted by various factors as it strives for economic development, including population growth, weather changes, shifts in global market requirements, and fluctuations in the global financial market. The region experienced the consequences of the 2008 global financial crisis, which led to currency devaluations in several countries, such as Zimbabwe. Additionally, cyclones and heavy rains have affected SADC countries, resulting in loss of life and welfare across the region. Furthermore, the recent COVID-19 pandemic has disrupted production in the region, forcing families to rely more on the food they can produce themselves. Given the SADC region's economic objectives of poverty eradication, food security, and sustainable economic development, the agricultural sector plays a crucial role. However, the sector has been susceptible to various unpredictable challenges, leaving member states vulnerable to economic hardships. In light of these circumstances, the study focuses on examining the effectiveness of agricultural financing on agricultural production specifically in Zimbabwe. The objective of the study is to investigate the impact of agricultural finance on agricultural production in Zimbabwe. This study provides valuable insights for scholars interested in exploring the impact of agricultural value chain finance on economic growth, poverty eradication, and food security in their respective countries. By integrating various studies and theories, this comprehensive research offers a well-rounded perspective on the subject matter. The findings of this study are particularly relevant to key ministries, such as the Ministry of Lands, Agriculture, Fisheries, Water, Climate, and Rural Development, as well as the Ministry of Finance and Economic Development. These ministries play a crucial role in formulating the government's key developmental tool, the National Budget, and collaborate with other line ministries and fiscal authorities. The research informs them about fiscal policy and aids in their decision-making processes. Given that many African countries heavily rely on agriculture for food, income, and employment, this study provides valuable insights into the current state of the impact of agricultural value chain finance on economic growth, poverty eradication, and food security. Furthermore, since Central Banks play a significant role in formulating and implementing monetary policies, which indirectly influence fiscal policies, the findings of this study will contribute to the formulation of these policies based on sound research and analysis.

2. Literature Review

2.1. Theoretical Literature Review

Dependency theory, a perspective aimed at comprehending the economic underdevelopment, focuses on the perceived constraints imposed by the global political and economic order. Raúl Prebisch, an Argentine economist and statesman, first proposed this theory in the late 1950s, and it gained prominence during the 1960s and '70s. According to dependency theory, the underdevelopment of countries primarily stems from their peripheral position within the global economy. Typically, underdeveloped countries offer inexpensive labour and raw materials in the global market (Kvangraven, 2021). These resources are then purchased by advanced economies, which possess the means to transform them into finished goods. Consequently, underdeveloped countries end up buying these finished products at high prices, depleting the capital that could have been allocated to improving their own productive capacity (Kvangraven, 2021). The dependency theory suggests that foreign agricultural financing can have both positive and negative impacts on agricultural production in recipient countries. Proponents argue that foreign financing can offer much-needed capital and facilitate the transfer of technology, leading to increased agricultural productivity. However, critics contend that relying on foreign financing may foster dependence on external sources, resulting in unequal power dynamics and limited control over decisions related to agricultural production. The effectiveness of foreign agricultural financing on production depends on how it is managed and whether it promotes sustainable development and self-sufficiency.

Modernization Theory

The Alliance received ideological support from the modernization theory, which was developed by political scientist Walt Whitman Rostow in the 1960s (Clement, 2019). This theory promotes the idea of a modernized nation and sets universal standards for economic, social, and cultural development applicable to all countries (Kyianytsia, 2021). According to the modernization theory, foreign agricultural financing plays a vital role in the modernization and development of the agricultural sectors in recipient countries. By providing financial resources, technology, and knowledge, foreign financing enables farmers to adopt improved farming techniques, acquire modern machinery and equipment, and enhance productivity. The theory argues that through the infusion of foreign capital and expertise, agricultural production can undergo a transformative process, leading to increased yields, improved product quality, and overall economic advancement. Foreign agricultural financing offers the necessary funds for farmers to invest in modern farming practices,

such as precision agriculture, integrated pest management, and efficient irrigation systems (Kyianytsia, 2021). By implementing these advanced techniques, farmers can optimize resource utilization, minimize waste, and boost productivity. Additionally, foreign financing facilitates the purchase of state-of-the-art machinery and equipment, enabling farmers to mechanize labour-intensive tasks, save time and effort, and improve operational efficiency. Furthermore, foreign financing brings technological advancements and knowledge transfer. It provides access to research and development breakthroughs, including improved crop varieties, disease-resistant seeds, and tailor-made agronomic practices suitable for local conditions. This knowledge exchange enhances farmers' understanding of sustainable farming methods, crop rotation, soil fertility management, and post-harvest techniques, resulting in improved yields, reduced losses, and enhanced food security.

Institutional Theory

In the late 1970s, John Meyer and Brian Rowan introduced institutional theory as a framework to examine how organizations align with, relate to, and are influenced by their societal, state, national, and global contexts (Takanori Kashino, 2021). This theory serves as a complementary perspective in understanding the effects of foreign agricultural financing by emphasizing the importance of supportive institutions and governance structures (Bolaji, 2020). According to institutional theory, the success of foreign financing initiatives depends on the presence of transparent, accountable, and well-functioning institutional frameworks. Effective legal systems, appropriate regulations, and efficient governance mechanisms are crucial in ensuring the effective utilization of foreign financing for agricultural production. Robust institutions facilitate the proper allocation of funds, ensure fair market competition, and safeguard the rights of farmers. They establish an enabling environment for the implementation of foreign financing programs, including transparent procurement processes, secure land tenure systems, and access to credit for smallholder farmers. Furthermore, strong institutional frameworks foster trust among stakeholders, encourage private sector engagement, and attract investments in the agricultural sector (Carolina Johnson, 2017). Conversely, weak institutional environments can impede the impact of foreign agricultural financing. Corruption, bureaucratic inefficiencies, and inadequate enforcement of regulations may lead to mismanagement of funds, exclusion of smallholder farmers, and limited access to credit and agricultural inputs. In such cases, the potential benefits of foreign financing in improving agricultural productivity may not be fully realized.

2.2. Empirical Literature Review

In the past decade, there has been a notable increase in the adoption of Agriculture Value Chain Finance (AF) in SADC countries. Lundblad and Rissanen (2018) have extensively studied and promoted this approach as a reliable means of providing loans to the agricultural sector. The AF approach capitalizes on the power and connections within agricultural value chains, which encompass the processes involved in transporting agricultural products to the final consumers. Ngong (2023) describes it as a "from farm to fork" concept, highlighting the interdependencies within the agricultural value chain and its ultimate objective. Osabohien et al. (2020) further explain that AF allows financial institutions to tailor their product offerings to different stages along the agricultural value chains, thereby reducing credit risk for lenders and lowering funding costs for participants. This is due to the self-reinforcing and self-settling nature of transactions within the value chain (Sagbo, 2019). AF is considered the most effective approach to stimulate credit flow into the agricultural sector, particularly in developing nations like the SADC countries, where agricultural operations often face chronic underfunding. Consequently, governments, policymakers, civil society organizations, and development partners have shown great interest in the agricultural value chain finance approach (Zabatantou Bouity and Owonda, 2023). Economic think tanks, government agencies, development partners, and agricultural research institutes have also focused their attention on AF due to its potential to make agriculture a profitable industry and transform farmers into entrepreneurs (Shaibu et al., 2022). Moreover, AF can lead to reduced borrowing costs, lower credit risk for lenders, and provide solutions to the financial challenges faced by farmers who lack collateral (Sharmiladevi, 2023).

The significance of domestic agricultural capital in driving productivity and efficiency in the agricultural sector is widely acknowledged, as highlighted by Blessing-Mike Camillus and Cletus (2022) in a study conducted in Nigeria. Domestic agricultural capital, encompassing machinery, equipment, infrastructure, and technological advancements, plays a crucial role in improving agricultural practices and ultimately influencing agricultural output, as emphasized by Owuor (2022) in Uganda. Investments in domestic agricultural capital have a direct positive impact on agricultural output (Sikandar, Erokhin, Wang, Rehman, and Ivolga, 2021). Access to modern machinery and equipment enables farmers to enhance efficiency, reduce labour requirements, and improve overall productivity. For example, advanced tractors, harvesters, and irrigation systems contribute to better land preparation, crop maintenance, and irrigation management, resulting in higher crop yields and improved agricultural output (Ikpesu and Okpe, 2019a). Moreover, domestic agricultural capital facilitates the adoption of innovative technologies and practices (Ra' and Mohammed, 2020). Research and development investments lead to the development of high-yielding crop varieties, disease-resistant seeds, and precision farming techniques (Amadhila, 2016). When combined with adequate domestic agricultural capital, these advancements optimize resource utilization, minimize wastage, and increase agricultural output.

Infrastructure development is another crucial aspect of domestic agricultural capital that significantly influences output. Efficient transportation networks, storage facilities, and processing plants ensure timely and safe delivery of produce to

markets, reducing post-harvest losses and enhancing market access (Deresse and Zerihun, 2018). Reliable infrastructure supports value addition, facilitates trade, and ultimately boosts agricultural output (Ikpesu and Okpe, 2019a). Domestic agricultural capital also plays a key role in mitigating risks and uncertainties in farming. Adequate capital enables farmers to adopt risk management strategies, such as crop insurance, protecting against yield losses due to adverse weather or unforeseen events (Blessing-Mike Camillus and Cletus, 2022). Effectively managing risks contributes to stability in agricultural output (Eke and Effiong, 2016). It is important to note that the relationship between domestic agricultural capital and agricultural output is not linear and is influenced by various factors. Factors such as access to capital, affordability, and farmers' ability to utilize and maintain agricultural assets play significant roles (Owuor, 2022). Furthermore, Gültekin (2023) underscores the importance of policies and institutions that support the availability of agricultural credit, technological transfer, and infrastructure development in promoting effective utilization of domestic agricultural capital.

The relationship between foreign direct investment (FDI) and agricultural output is a complex and multifaceted subject, with arguments both in favor of and against its impact on agricultural productivity. However, evidence suggests that FDI can have a positive influence on agricultural output under certain conditions, as highlighted by Djokoto, Agyei, and Badu-Prah (2022). Proponents argue that FDI in the agricultural sector can bring significant benefits (Tekle, 2017), as seen in a study conducted in Somalia. One of the key advantages of FDI is the transfer of technology, knowledge, and expertise from foreign investors to the domestic agricultural industry (Isabella, Amukule, and Gibba, 2023). This infusion of advanced techniques, modern farming practices, and improved infrastructure can enhance productivity and efficiency, leading to increased agricultural output (Rahman et al., 2024). Moreover, FDI can stimulate investment in research and development, promoting innovation and the introduction of new crop varieties or farming techniques that further enhance yields. Furthermore, FDI can contribute to increased access to capital and financial resources, as asserted by Epaphra and Mwakalasya (2017) in a study conducted in Tanzania. Foreign investors may inject funds into the agricultural sector, providing farmers with the necessary resources to invest in inputs, machinery, and technology.

This financial support can lead to improved access to quality inputs, better irrigation systems, and enhanced post-harvest infrastructure, all of which can positively impact agricultural output (Sultana and Sadekin, 2023). However, it is important to consider potential drawbacks and challenges associated with FDI in agriculture, as noted by Djokoto, Agyei, and Badu-Prah (2022). Critics argue that FDI can lead to land grabbing, where large-scale foreign investors acquire vast areas of agricultural land, displacing smallholder farmers and negatively affecting local food security (Martin, 2021). Additionally, the focus of FDI may prioritize export-oriented crops rather than staple food production, potentially exacerbating food insecurity in the host country (Isabella, Amukule, and Gibba, 2023). Moreover, the success of FDI in agriculture depends on various factors, including the regulatory environment, institutional capacity, and the ability of the domestic agricultural sector to absorb and adapt to foreign investments (Epaphra and Mwakalasya, 2017). Weak governance, inadequate infrastructure, and limited knowledge transfer can hinder the potential benefits of FDI on agricultural output (Magomana, 2020).

Agricultural loans play a vital role in driving productivity and overall sectoral performance, as indicated by Adewale, Lawal, Aberu, and Toriola (2022) in a study conducted in Nigeria. They have a significant and positive relationship with agricultural output. Access to agricultural loans provides farmers with the necessary financial resources to invest in inputs, machinery, and technology, ultimately leading to increased agricultural output, as highlighted by Maloba and Alhassan (2018) in Kenya. Farmers, as emphasized by Amadhila and Ikhida (2016) in Namibia, can utilize these loans to make essential investments, expand production capacity, and adopt modern agricultural practices that enhance efficiency and productivity. Agricultural loans also serve as a risk management tool, allowing farmers to mitigate the negative impact of yield fluctuations and external shocks, thereby maintaining stability in agricultural output, as suggested by Caetano and de Castro (2023) in Angola. Furthermore, these loans facilitate the adoption of new technologies and innovations, enabling farmers to acquire advanced machinery and irrigation systems that optimize resource utilization and improve output, as noted by Atef and Marzouk (2021). In addition, agricultural loans ensure the availability of essential inputs, such as high-quality seeds and fertilizers, which contribute to optimized crop growth and higher yields. Therefore, the relationship between agricultural loans and agricultural output underscores the importance of financial accessibility in driving productivity, as highlighted by Chaiya, Sikandar, Pinthong, and Saqib (2023). Policymakers should prioritize the development of effective loan programs to support farmers and promote sustainable agricultural development.

3. Methodology

3.1. Model Specification

In this study, the Autoregressive Distributed Lag (ARDL) model, a time series technique, was utilized. Various tests, including the co-integration test, error correction model, and residual and stability diagnostics, were conducted to obtain empirical evidence supporting the study. The ARDL Model, employing a bounds test approach, was applied to assess the

effectiveness of agricultural financing on agricultural production in Zimbabwe and to examine the existence of a long-run relationship among the relevant variables. The selection of the ARDL model was based on its advantages over other models, as developed by Pesaran and Pesaran (1997) and used by Pesaran et al. (2001). One of its main advantages is its ability to be applied regardless of whether the variables are I(0) or I(1). Additionally, this approach allows for the inclusion of a sufficient number of lags to capture the data generating process within a general-to-specific modelling framework. The study drew inspiration from Rahman (2024), who employed an autoregressive distributed lag approach to study the nexus between foreign direct investment and agricultural output in Bangladesh.

The model is presented below as

$$\Delta \ln AP_t = C + \sum_{i=1}^p \alpha_{1i} \Delta \ln AC_{t-i} + \sum_{i=1}^q \alpha_{2i} \Delta \ln FDI_{t-i} + \sum_{i=1}^q \alpha_{3i} \Delta \ln LN_{t-i} + \beta_1 AC + \beta_2 FDI_{t-1} + \beta_3 LN_{t-1} + \mu_t$$

Where:

AP: Agricultural Production

AC: Domestic agricultural capital

FDI: Foreign Direct Investment

LN: Agricultural Loans

Δ : The first difference

$\alpha_1 \dots \alpha_3$ = Short term dynamics

p, q: The maximum number of lags for each variable in the study

$\beta_1 \dots \beta_3$: Long term dynamics

μ_t : Error term

3.2. Justification of Variables

Agricultural production (AP)

The inclusion of Agricultural Production (AP) as a variable in the research was due to its direct measurement of the quantity of agricultural goods and commodities produced. AP serves as a valuable metric for assessing the performance and productivity of the agricultural sector, allowing for comparisons across regions, time periods, or different farming systems. Furthermore, AP is linked to economic growth and development, as it has implications for employment, income generation, trade balances, and overall economic well-being. The study of AP enabled the researcher to analyse the economic impact of agriculture, evaluate the effectiveness of agricultural policies, monitor levels of food security, and address nutritional needs. It plays a crucial role in comprehending the dynamics of agricultural systems and provides a basis for evidence-based decision-making in promoting sustainable agricultural development. By considering AP as a variable, researcher gained insights into the contributions of the agricultural sector to broader socio-economic outcomes and can identify areas for improvement and targeted interventions.

Domestic agricultural capital

The inclusion of domestic agricultural capital as a variable in the regression model of this study is justified based on its significant influence on agricultural productivity and efficiency. Domestic agricultural capital, which comprises machinery, equipment, infrastructure, and technology, plays a crucial role in improving agricultural practices, optimizing resource utilization, and increasing crop yields. The objective of this study is to examine the relationship between domestic agricultural capital and production outcomes to assess the impact of capital investments on agricultural growth and development. By understanding the role of domestic agricultural capital, valuable insights can be gained regarding the effectiveness of technological advancements and infrastructure development in driving agricultural productivity, ensuring resource sustainability, and enhancing overall sectoral performance. Therefore, incorporating the "CAPITAL" variable in the regression model is essential for conducting a comprehensive analysis of the factors contributing to agricultural production and providing evidence-based guidance for policymakers, farmers, and other stakeholders involved in the agricultural sector.

Foreign Direct Investment

Foreign Direct Investment (FDI) refers to investments made by individuals or entities from one country into another. FDI inflows represent investments brought into the host country by foreign investors, and in this context, FDI net inflow is measured as a percentage of the Gross Domestic Product (GDP). FDI is widely recognized as a significant factor influencing economic growth due to its involvement in establishing factories for production and creating employment opportunities. These factors, in turn, contribute to increased incomes for individuals and overall output for the country. A study conducted by Anthony-Orji et al. (2023) also incorporated FDI as a variable in their analysis of its impact on economic growth. The expected sign of the slope coefficient for FDI is positive, indicating that an increase in FDI is anticipated to have a favourable effect on economic growth.

Agricultural loans

The incorporation of agricultural loans as a variable in the regression model of this study is justified due to their significant role in the agricultural sector. Agricultural loans play a crucial role in providing essential financial support to farmers and

agricultural businesses, enabling them to make investments in inputs, machinery, and infrastructure. This financial assistance enhances productivity and facilitates the expansion of agricultural activities. By investigating the relationship between agricultural loans and production outcomes, this study aims to gain a deeper understanding of the effectiveness of financial accessibility in driving agricultural growth and development. Furthermore, comprehending the impact of agricultural loan programs can offer valuable insights to policymakers and stakeholders in formulating effective policies and interventions to support the agricultural sector. The inclusion of the "LOANS" variable in the regression model is therefore essential, as it allows for a comprehensive analysis of the relationship between agricultural finance and production outcomes. The findings of this study have implications for both research endeavours and policy-making processes, contributing to a better understanding of the factors influencing agricultural productivity and informing evidence-based decision-making in the agricultural sector. The study was tested for unit root, cointegration, and multicollinearity among other tests.

Short-run and long-run asymmetric effects test

Once the long-run cointegrating relationship between the dependent variable and its corresponding independent variables is established in the selected Autoregressive Distributed Lag (ARDL) model, the study will proceed to determine the coefficients for both the long run and short run. These coefficients will help explain the impact of the independent variables on the dependent variable. To calculate the long run and short run coefficients in this research, the study utilised the following equation:

$$\Delta \ln AP_t = a_0 + a_1 \ln AC_{t-1} + a_2 \ln FDI_{t-1} + a_3 \ln LN_{t-1} + b_1 \sum_{i=1}^p \Delta \ln AC_{t-i} + b_2 \sum_{i=1}^q \Delta \ln FDI_{t-i} + b_3 \sum_{i=1}^q \Delta \ln LN_{t-i} + \varepsilon_t$$

3.3. Error Correction Model

After obtaining the long run coefficients, the study proceeded to calculate the error correction representation for the selected ARDL model, which will also serve as the short run coefficients. The short run equation included a one-period lagged term and first differenced terms of all the selected variables. Additionally, the one-period lagged term of the error term should be negative and statistically significant. This provides evidence that the proposed functional form in the study has the capability to converge to a long run and stable equilibrium if any macroeconomic shock disrupts the long run equilibrium. The coefficient of the one-period lagged term of the error term indicates the speed of adjustment, representing how quickly the system adjusts back to equilibrium (Hassan et al., 2022). To estimate the coefficients for the short run, the following equation was used

$$\Delta \ln AP_t = b_1 \sum_{i=1}^p \Delta \ln AC_{t-i} + b_2 \sum_{i=1}^q \Delta \ln FDI_{t-i} + b_3 \sum_{i=1}^q \Delta \ln LN_{t-i} + \lambda_1 ECM_{t-1} + \delta_1$$

3.4. CUSUM and CUSUM-Squared test

The CUSUM and CUSUM-Squared tests are employed as stability diagnostic tests to assess whether the mean and variance of the error term in a model are stable or unstable (Hassan et al., 2022). By utilizing these tests, it is possible to determine if a model is structurally stable. A model is considered structurally stable when the mean and variance of the error term fall within their critical bounds.

4. Results Presentation and Analysis

4.1. Descriptive Statistics Results

This section aims to provide an overview of the variables used in this study during the specified period, utilizing statistics such as standard deviation, mean, minimum, and maximum. Descriptive statistics, as highlighted by Maddala and Lahiri (2009), serve to summarize key characteristics of the data employed for estimation. These results, as emphasized by Boslaugh (2012), are essential for understanding the distribution, central tendency, and dispersion of the data used for analysis.

Data Normalization

The relevant data set had extremely big values that were in the billions. The data was adjusted in order to recreate relevant coefficients. The technique used for doing feature scaling is mean normalization. Values are rescaled and altered during the normalization process to make them fall between 0 and 1. The following formulas were employed.

$$x_{\text{normalized}} = (x - x_{\text{minimum}}) / \text{range of } x$$

The descriptive measurements obtained from the figures utilized in this study are presented and summarized in Table 2.

Table 2. Descriptive statistics

	Crop Production	Domestic agricultural capital	FDI	Agricultural Loans
Mean	0.580215	0.043824	0.203953	0.756932
Median	0.572675	0.012397	0.175740	0.892568
Maximum	1.000000	1.000000	1.000000	1.000000
Minimum	0.000000	0.000000	0.000000	0.000000
Std. Dev.	0.262955	0.158153	0.181018	0.295848
Skewness	-0.295432	5.747292	2.363467	-1.300650
Kurtosis	2.184232	35.15329	10.68729	3.280184
Sum	23.20860	1.752961	8.158130	30.27730
Sum Sq. Dev.	2.696671	0.975487	1.277927	3.413512

Author's computations (2024)

The provided summary statistics offer information about four variables: Crop Production, Capital, FDI, and Loans. For Crop Production, the mean is approximately 0.580215, the median is 0.572675, the maximum value is 1.000000, and the minimum value is 0.000000. The standard deviation of 0.262955 indicates some variability around the mean. The distribution of Crop Production is slightly left-skewed with a value of -0.295432 and exhibits positive kurtosis with a value of 2.184232. The Jarque-Bera test suggests that the distribution of Crop Production is not significantly different from a normal distribution. The interpretations are the same for Capital, FDI, and Loans.

4.2. Diagnostics Test

Unit root test

The study employed the Augmented Dickey Fuller (ADF) test to assess the stationarity of the data. In this test, a variable is considered stationary if the p-value of the t-statistic is less than 5%. The results presented in Table 3 indicate that variables such as Crop Production and Capital are classified as I(1) variables. The specification of an Autoregressive Distributed Lag (ARDL) model can involve variables with mixed orders of integration (I(0) and I(1)), or all variables can have a first-order integration. FDI and Loans are of I(0).

Table 3: ADF Test for Unit Root

Variable	ADF test statistic F	Probability	Order of integration	Decision
Crop Production	-9.792354	0.0000	1(1)	Non-Stationary
Capital	-8.486998	0.0000	1(1)	Non-Stationary
FDI	-4.257748	0.0017	1(0)	Stationary
Loans	-3.249335	0.0249	1(0)	Stationary

Source: Author's computations (2024)

The ADF test results indicate the stationarity properties of different variables. For Crop Production, the ADF test statistic of -9.792354 with a probability of 0.0000 provides strong evidence against the presence of a unit root, suggesting that crop production is stationary at order 1. Similarly, for Capital, the ADF test statistic of -8.486998 with a probability of 0.0000 indicates strong evidence against the presence of a unit root, indicating that capital is stationary at order 1. On the other hand, for FDI, the ADF test statistic of -4.257748 with a probability of 0.0017 suggests strong evidence against the presence of a unit root, implying that FDI is stationary at order 0. Lastly, for Loans, the ADF test statistic of -3.249335 with a probability of 0.0249 provides evidence against the presence of a unit root, indicating that loans are stationary at order 0.

Lag length determination

In order to perform the long-run form and bounds test and estimate the Error Correction Model (ECM), it is necessary to determine the lag order. Gujarati (2004) emphasizes the importance of selecting the correct number of lags to address serial correlation and prevent over-parameterization. Several lag selection criteria, including the Likelihood Ratio (LR), Final Prediction Error (FPE), Lag length (LL), Akaike's Information Criteria (AIC), and Hannan and Quinn information criterion (HQIC), were utilized. The majority of these criteria suggested that two lags were sufficient. Therefore, for the purpose of this study, four lags were chosen to fit the ECM model and produce estimates for inferential purposes. The selection of an appropriate lag length was determined using the Akaike Information Criteria (AIC), which imposes substantial penalties for over-parameterization. The test results indicated that the optimal lag length is four, indicating

that including four lags in the model was most suitable.

Cointegration test

The results of the ARDL bound test of cointegration are presented in Table 4. Based on the obtained F-statistics value of 0.393940, we have significant evidence to reject the null hypothesis of no long-term relationship at a 1% significance level. This suggests the potential presence of cointegration among the variables examined.

Table 4: Result of ARDL Bound Test for Long Run Cointegration

Test Statistic	Bound Test Result	Decision	
F-Statistic	0.393940		Cointegration exists
Critical Test Bounds			
	10%	5%	1%
Sample Size	I(0)	I(1)	I(0) I(1) I(0) I(1)
35	2.618	3.532	3.164 4.194 4.428 5.816
40	2.592	3.454	3.100 4.088 4.310 5.544
Asymptotic	2.370	3.200	2.790 3.670 3.650 4.660

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

The null hypothesis in this case asserts that there is no long-term relationship or cointegration among the variables being examined. However, the test results provide evidence to reject this null hypothesis, indicating the presence of three cointegrating variables among the variables under consideration. Cointegration implies the existence of a stable, long-term relationship between these variables. Specifically, the cointegration relationship is characterized by a restricted constant trend (Case 2). This implies that there is a constant term included in the cointegration equation, while other trends such as linear or quadratic trends are not accounted for.

Autocorrelation test

The researchers utilized the Breusch-Godfrey Serial Correlation LM test and examined the correlogram of squared residuals to test for autocorrelation in the study. As the calculated probability value is 0.7275, which exceeds the critical value of 0.05, the study does not reject the null hypothesis. This leads to the conclusion that there is no evidence of serial correlation in the model.

Heteroscedasticity test

The researchers conducted the Breusch-Pagan-Godfrey test to examine the presence of heteroscedasticity in the model. As the probability value associated with the F-statistic (0.9535) is greater than the critical value of 0.05, the study does not reject the null hypothesis. This leads to the conclusion that the model is homoscedastic, indicating that the error terms have a constant variance in the model. Consequently, the ordinary least squares (OLS) estimates are efficient.

Normality test

In this study, the researchers utilized the Jarque-Bera test to assess the normality of the residual distribution. This test examines the disturbance mean and evaluates the level of normality through a histogram. Based on the results of the Jarque-Bera statistic, which has a value of 3.367777, and the associated probability value of 0.185651 (greater than the critical value of 0.05), the study does not reject the null hypothesis. Therefore, it can be concluded that the residuals of the model follow a normal distribution.

Model specification test

In the study, the researchers conducted the Ramsey RESET test to identify any potential specification errors and assess the stability of the model. A well-specified model provides a comprehensive understanding of the factors influencing agricultural production. The results of the test are presented in Table 5, indicating the outcomes of this analysis.

Table 5: Ramsey RESET Test

F-statistic	Probability (p)	R ²	Adjusted R ²
1.634114	0.2145	0.630190	0.411666

Author’s computations (2024)

As the probability value (0.2145) exceeds the critical value of 0.05, the study does not reject the null hypothesis and concludes that the model is correctly specified. Additionally, the R2 value of 0.630190 indicates a good fit, ruling out the possibility of obtaining spurious results.

Stability tests

To ensure the reliability of the results, it is crucial to assess the stability of the model. Stability, as defined by Heij, Boer, Franses, Kloek, and Dijk (2004), refers to a state where the model parameters remain constant over time. In this analysis, the stability of the model was evaluated using the CUSUM (cumulative sum) and CUSUMSQ (cumulative sum square) techniques in recursive regression.

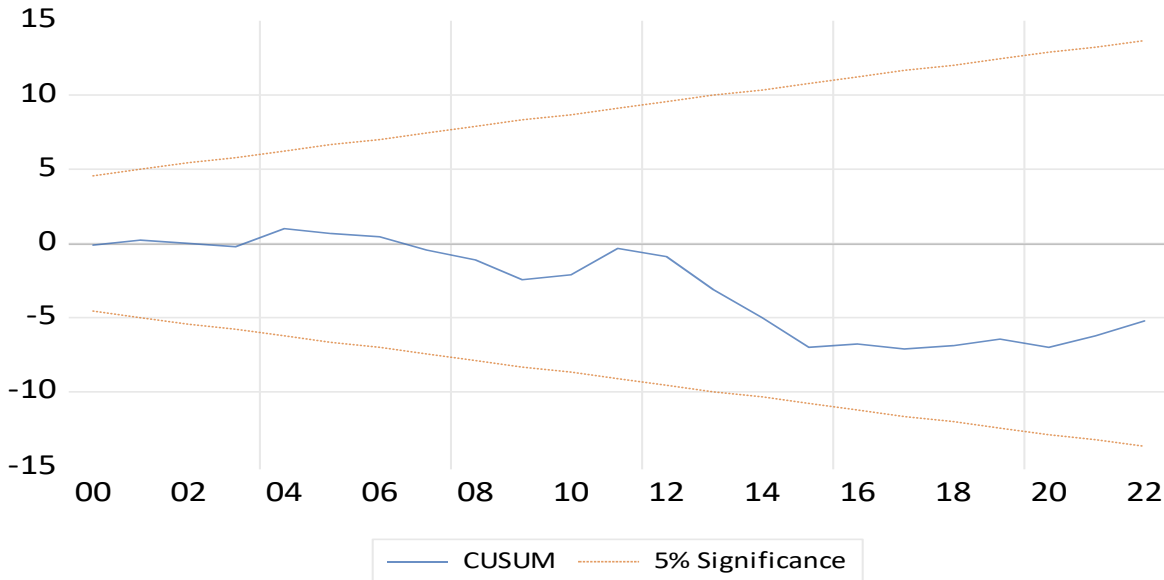


Figure 1: CUSUM

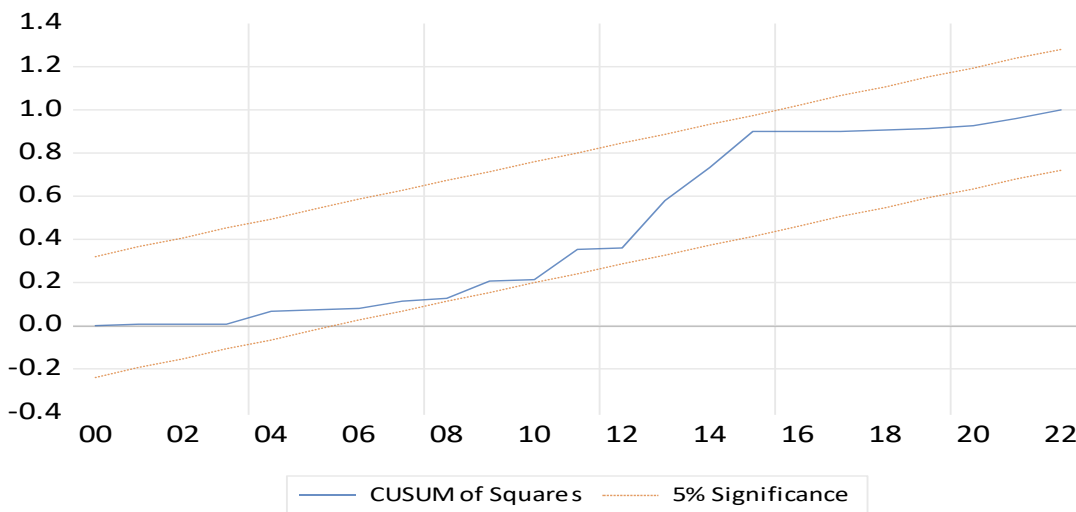


Figure 2: CUSUM-Squared test

The CUSUM test displays the important lines and test sequences used in the analysis. The graphs illustrate the CUSUM and CUSMSQ tests, showing that the significance intervals for both tests are within the 5% threshold. This suggests that the model can be considered stable.

4.3. ARDL Regression Results

The long-run ARDL results are presented in table 4.10. The table indicates that if the variables are cointegrated, any deviation from the equilibrium level is corrected over time. This correction is achieved through a negative and significant error correction term. In this specific case, the error correction term is both negative and statistically significant with a value of 0.000.

Short run relationship

The subsequent analysis examines the short-run relationship between the variables.

Table 10: Short run ARDL Regression Results

SR	Coef.	Std. Err.	t	P>t
Capital	1.432049	0.374941	3.819399	0.0009
FDI	0.086101	0.255489	0.337005	0.7392
Loans	1.514617	0.640601	2.364369	0.0269

Table 11 displays the outcomes of the long-run ARDL regression. Concerning the variable Capital, the p-value ($P>t$) is 0.0001, indicating that the coefficient is statistically significant at the conventional significance level of 0.05. The positive coefficient implies that there is a favorable impact of capital on production in the long run. Precisely, a one-unit increase in capital is estimated to lead to a growth of 1.432049 units in production. Regarding the variable loans, the p-value ($P>t$) is 0.0118, indicating that the coefficient is statistically significant at the conventional significance level of 0.05. The positive coefficient suggests that there is a positive effect of loans on production in the long run. Specifically, a one-unit increase in loans is associated with an estimated increase of 1.514617 units in production.

4.4. Discussion of the results

Based on the available short-run and long-run regression results, the relationships between variables can be analyzed and interpreted as follows:

Relationship between domestic agricultural capital and agricultural output

In the short run, the statistical analysis reveals that there is a significant positive relationship between domestic agricultural capital and agricultural output. Specifically, an increase of one unit in domestic agricultural capital is associated with an estimated increase of 1.432049 units in agricultural output (p-value of 0.0009). Similarly, in the long run, the relationship between domestic agricultural capital and agricultural output remains positive and statistically significant. A one-unit increase in domestic agricultural capital is associated with an estimated increase of 1.432049 units in agricultural output (p-value of 0.0001). Therefore, both the short-run and long-run results indicate that domestic agricultural capital plays a critical role in driving agricultural output. Increasing investments in domestic agricultural capital can result in higher levels of agricultural production.

Relationship between foreign direct investment (FDI) and agricultural output

In the short run, the statistical analysis indicates that there is no significant relationship between foreign direct investment (FDI) as a proportion of GDP and agricultural output. The coefficient estimate suggests that FDI does not have a substantial effect on agricultural output, with a p-value of 0.7392. However, the provided results do not include information about the long-run relationship between FDI and agricultural output. Therefore, we cannot draw any conclusions regarding the long-term impact of FDI on agricultural output based on the available data.

Relationship between agricultural loans and agricultural output

In the short run, the regression analysis reveals a statistically significant positive effect of agricultural loans on agricultural output. Specifically, an increase of one unit in agricultural loans is associated with an estimated increase of 1.514617 units in agricultural output (p-value of 0.0269). Similarly, in the long run, the relationship between agricultural loans and agricultural output remains positive and statistically significant. A one-unit increase in agricultural loans is associated with an estimated increase of 1.514617 units in agricultural output (p-value of 0.0118). These findings from both the short-run and long-run regression results demonstrate that agricultural loans have a significant positive impact on agricultural output. Thus, it can be inferred that access to agricultural loans contributes to increased agricultural production in both the short and long term.

5. Conclusion and Recommendations

Based on the regression analysis results, several conclusions can be derived regarding the relationships between agricultural variables and agricultural output. Firstly, both in the short run and long run, there is a statistically significant positive association between domestic agricultural capital and agricultural output. This implies that increasing investments in domestic agricultural capital can lead to higher levels of agricultural production. Secondly, the findings indicate that agricultural loans also have a significant positive impact on agricultural output, suggesting that access to agricultural loans can contribute to increased agricultural production over time. However, it is worth noting that the relationship between foreign direct investment (FDI) and agricultural output did not yield statistically significant results in the short run, and no long-run effects were provided. Therefore, further investigation into the long-run relationship between FDI and agricultural output is necessary to draw definitive insights in this aspect. The findings of this study hold practical implications for policymakers and practitioners involved in the agricultural sector. The significant and positive impact of domestic agricultural capital on agricultural output underscores the importance of promoting investments in agricultural infrastructure, equipment, and technology. Policymakers should prioritize the creation of a conducive environment that encourages and facilitates access to capital for farmers. This can be achieved through initiatives such as offering financial incentives, improving credit accessibility, and promoting agricultural investment programs. Furthermore, the positive correlation between agricultural loans and agricultural output highlights the necessity for financial institutions to develop

and implement loan products specifically tailored for the agricultural sector. By providing farmers with affordable and easily accessible credit, they can invest in essential inputs, expand their operations, and ultimately enhance agricultural productivity. It is crucial for financial institutions to recognize the unique financial needs and challenges faced by farmers and design loan products that address these specific requirements.

Based on the findings of this study, several recommendations can be proposed to enhance agricultural productivity. Firstly, it is crucial for governments and policymakers to prioritize the development of agricultural infrastructure. This entails investing in irrigation systems, storage facilities, and transportation networks, which can significantly improve the overall efficiency and capacity of the agricultural sector. Secondly, financial institutions should design loan products that cater specifically to the unique needs of farmers. These loan products should consider the seasonal cash flows and specific challenges encountered in the agricultural sector. By providing appropriate financial support, farmers can effectively utilize capital and loans, thereby maximizing their impact on agricultural production. Additionally, there is a need to strengthen farmer training and extension services. By providing farmers with the necessary knowledge and skills, they can better utilize capital and loans, leading to improved agricultural production. Accessible and comprehensive training programs can equip farmers with up-to-date techniques, best practices, and innovative approaches. Lastly, further research is required to explore the long-run relationship between foreign direct investment (FDI) and agricultural output. This research will provide valuable insights to policymakers and stakeholders, enabling them to formulate effective policies and strategies related to foreign investments in the agricultural sector.

Conflict of Interest

The authors declare that they have no conflicting interests.

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Data availability statement

The data used to support the findings of this study are available from the corresponding author upon request.

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