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Research

Do public debt and debt service support or constrain Indonesia's agricultural sector?

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ABSTRACT
Numerous studies have been conducted that concentrate on enhancing the efficacy of the agricultural sector, highlighting the significance of technical factors as well as the implications of climate change. To this point, there exists a deficiency of research exploring the impact of fiscal policy on the agricultural sector in Indonesia. This study provides novel empirical evidence on how debt and its associated risks influence the agricultural sector. Annual macroeconomic data from 1990 to 2023 were used to examine the relationship between debt, debt service, foreign direct investment, fertilizer consumption, and land area to the GDP of the agricultural sector in Indonesia. The examination was conducted employing the Vector Error Correction Model (VECM) methodology to discern both short-term and long-term associations among the variables. The results show that in the long run, public debt is positively related to the share of GDP in the agricultural sector, while the cost of debt service is negatively related. In the short term, only a few specific variables show a significant influence on the GDP of the agricultural sector. These results affirm that indebtedness contributes positively to the agricultural sector, whereas the expenses associated with servicing that debt may hinder the sector's contribution. This study provides empirical evidence that fiscal policy plays a crucial role in the agricultural sector and needs to be considered. Therefore, debt management must be directed at an efficient and effective allocation, taking into account the benefits of loans and the risks posed by interest payment obligations and debt installments. The study builds on the fiscal policy literature that affects key sectors of developing countries. The use of annual data with 34 observations, as well as indicators of GDP in the agricultural sector, implies that the results of the study reflect more structural changes and sectoral proportions in the economy.

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INTRODUCTION

The agricultural sector in Indonesia has made significant contributions, not merely as a catalyst for economic advancement but also as a pillar for public welfare. By 2025, the agricultural sector in Indonesia is expected to remain a primary source of livelihood for the population and to employ around 28 percent of the national workforce (Kementerian Pertanian, 2025). To achieve sustainable and effective development, governments frequently face financing constraints that result in budget deficits (Utama, 2020). According to an interview with the Finance Minister of Indonesia, the budget deficit is projected to rise from 2.30 percent in 2024 to 2.78 percent in 2025, with the anticipated budget deficit for 2025 being approximately Rp. 662 trillion (Yudi, 2025). At the same time, state revenues from taxation and other sources have been insufficient to cover the financing needs of strategic sectors. As a result, many developing countries, including Indonesia, rely on borrowing or debt-based financing to meet these funding requirements.

Debt may have both positive and negative effects within an economy (Alsamara et al., 2024; Sekarani, 2025). Public debt in Indonesia, sourced from private sectors as well as bilateral and multilateral arrangements, has been shown to contribute positively to national output and economic development (Junaedi et al., 2022; Suryandaru, 2023; World Bank, 2024). Rising debt burdens and the associated interest payments can limit the government's fiscal space to finance other productive sectors (Rahim et al., 2023). As a result, national output may be adversely affected (Toriola et al., 2024). This predicament is faced by many countries, including Indonesia, as public debt has increased. According to the 2023 report from the Center for Budget Analysis and Fiscal Accountability, Indonesia's public debt increased by 201 percent between 2014 and 2023, reaching a total of IDR 7,855.53 trillion as of July 2023 (Pratiwi, 2024). The growing level of indebtedness has led to higher fiscal costs and burdens, which tend to reduce government spending in productive sectors such as agriculture (Liu et al., 2025; Shabbir & Yasin, 2015). Data from the World Bank suggest that Indonesia's debt service costs did not follow a stable pattern during 2017–2023. The highest value was recorded in 2019 at 39.49 percent. After that year, the figure declined and reached 19.53 percent in 2023. Debt service costs increased sharply during 2019 and 2020. The escalation in debt servicing expenses during the years 2019 and 2020 indicates significant fiscal strains that may constrain the government's fiscal capacity and diminish the state's capability to finance the productive sector. The agricultural sector has a strategic role in food security in the absorption of labor and the welfare of poor households and is a sensitive sector to fiscal pressure. When budgets are pressured by debt repayment obligations, spending on infrastructure and farmer protection risks declining and hindering the contribution of the agricultural sector. This raises crucial questions about the extent to which high debt burdens

can disrupt the performance of strategic sectors, as well as how fiscal sustainability can be maintained without compromising the agricultural development agenda. Research by Kalinin & Samokhvalov (2020); Kuzman et al. (2017) support that the lack of budget can hinder the provision of agricultural infrastructure, research and technology, inputs, and other needs, causing the performance of the agricultural sector to slow down.

According to report by the Central Bureau of Statistics Indonesia (2025), the Gross Domestic Product (GDP) of Indonesia's agricultural sector experienced positive absolute growth. However, its contribution to total national GDP has a downward trend with the share of GDP in the agricultural sector, which previously reached 13.7% in 2020, decreasing to 12.5% in 2023. The absolute contribution increased nominally but the relative contribution of the agricultural sector to the national Gross Domestic Product (GDP) decreased in the long term. This decline in growth rate reflects the structural challenges faced by the agricultural sector in Indonesia with financing policies including high debt growth and debt burdens that also weigh on the development budget. This research has become increasingly relevant as public debt levels increase in many countries, especially developing countries after the global financial crisis, pandemic, and monetary policy tightening in developed countries (Sekarani, 2025). At the same time, the world is facing a serious challenge in the form of a global food crisis that is increasingly suppressing the productivity and stability of the agricultural sector (Xu, 2019). This puts the agricultural sector in a crucial yet vulnerable position, especially in countries that rely heavily on debt-based financing. If this trend continues without proper intervention, the role of the agricultural sector as a food provider, labour absorber, and support for community welfare will be increasingly marginalized in the dynamics of national economic development.

In the context of the agricultural sector, several studies have explained its development from various perspectives. Drean & Lestari (2021) emphasize the role of education and health in making significant contributions to agricultural sector development and improving community welfare in Indonesia. From a technical perspective, Anh et al. (2023) and Gul et al. (2022) find that land area significantly enhances the performance of the agricultural sector in Indonesia. In the long run, fertilizer consumption in Indonesia has a positive impact, indicating that improvements in agricultural performance are influenced by fertilizer use and relatively appropriate fertilizer application practices (Anh et al., 2023; Chandio et al., 2023). On the other hand, rural population size and technology adoption in Indonesia have been found to exert positive and significant effects on the agricultural sector (Ardianti & Hartono, 2022; Onyeneke et al., 2023). These findings suggest that labor availability and the utilization of technology can enhance agricultural sector performance, and foreign direct investment does have a significant impact on the agricultural sector (Nugroho et al., 2021; Ozdemir, 2024). From a financial perspective, Ma & Li (2025) highlight the importance of support from the banking sector and

financial institutions in financing agricultural activities to achieve higher agricultural productivity. While numerous studies explain how the development of the agricultural sector in Indonesia is shaped by multiple factors, the fiscal dimension, particularly the role of public debt and debt servicing costs, remains insufficiently explored. Yet, the success of agricultural sector policies is highly dependent on the state's fiscal capacity, thereby underscoring the novelty of this study in examining the role of public debt and debt servicing costs in shaping the agricultural sector in Indonesia.

Public debt is one of the fiscal instruments commonly used by the government in order to finance the budget deficit, aims to encourage economic growth, as well as meet the needs of state spending when domestic revenues are insufficient (Barro, 1979). State debt is still a hot debate about its impact, in line with Nuta (2025), which states that debt has a significant impact on increasing GHP emissions in the European region. Mehar (2025) analyzed the influence of debt and economic growth and found that debt has a positive influence on infrastructure. Similar results were found in the research of Sogah et al. (2024) which showed that foreign debt has a positive and significant influence on the growth of the agricultural sector both in the long and short term. The study found that debt is a catalyst that can increase agricultural GDP and encourage increased agricultural production in Ghana. However, some studies show otherwise, the latest research from Dauda & Adamu (2024) found that public debt has no influence on the GDP of the agricultural sector in Nigeria and is in line with the research of Hammad et al. (2024) who found that in-state debt has no influence and has no long-term (non-cointegrated) relationship to government investment in the agricultural sector in Iraq. A counter result was also found in the research of Toriola et al. (2024) using Fully Modified Ordinary Least Squares (FMOLS) that public debt has a negative and significant influence on the GDP growth of the agricultural sector in Nigeria.

In contrast to the results of Sogah et al. (2024), the cost of debt servicing has a positive and significant relationship with GDP growth in the agricultural sector. These findings indicate that any increase in government spending on debt installment payments is followed by an increase in the performance of the agricultural sector. Ghana with its smooth debt repayment can boost the confidence of international creditors and strengthen the country's fiscal reputation, thus opening up access to new financing with lower interest rates or more favorable terms. So far, empirical studies on the relationship between debt service costs and the performance of the agricultural sector in Indonesia have not provided a definitive conclusion. Research from Shabbir & Yasin (2015) found that debt service costs have a negative influence on government spending and output in the Asian region, including Indonesia. Most studies in Indonesia have focused more on the relationship between public debt and national gross domestic product (GDP) growth in aggregate. As a result, there is no strong empirical evidence that directly links

the burden of debt installment payments to the performance of the agricultural sector in Indonesia. The absence of this study shows the need for a study that focuses on the relationship between debt service costs and the GDP of Indonesia's agricultural sector. Such studies will provide a more specific and evidence-based understanding, as well as complement the literature that has been dominated by analysis on economic growth.

Although in theory there is a potential for a strong relationship between public debt and the performance of the agricultural sector, given that debt can serve as a source of financing to promote investment in strategic sectors including agriculture, academic studies that specifically examine this linkage remain very limited. In many developing countries such as Indonesia, research directly addressing the impact of public debt and debt service costs on agricultural performance is scarcely found. Most existing studies focus on the broader macroeconomic implications of public debt, such as its effects on economic growth, exchange rates, and the human development index (Hardi et al., 2023; Rangkuty & Hidayat, 2021; Suryandaru, 2023). Consequently, this limited body of literature points to a significant gap in our understanding of how debt mechanisms may influence the agricultural sector. By adopting Indonesia as a case study of a developing country, this research provides an important empirical contribution to the global literature on development economics and public finance, while also offering policy insights into the extent to which debt-based development financing strategies can support the sustainability of the food sector amid increasingly uncertain global economic dynamics. This research aims to enhance academic discourse in agricultural development and fiscal policy. This study aims to assess the implications of indebtedness, associated financial burdens, and various other factors on the performance of the agricultural sector, employing econometric methodologies and statistical frameworks for comprehensive analysis. In contrast to prior studies, this investigation specifically examines Indonesia from 1990 to 2023.

METHOD

The unit of analysis in this study is the national agricultural sector of Indonesia, using aggregate annual macroeconomic time series data for the period 1990 to 2023 or 34 years which is considered adequate to identify potential long-term relationships between research variables. Data on agricultural GDP (GDPAGR), debt (GD), debt service costs (DS), foreign direct investment (FDI), fertilizer consumption (FC) and arable land (AL) were obtained from the World Development Indicators (WDI), the International Monetary Fund (IMF), the Ministry of Agriculture and the Indonesian Ministry of Finance.

GDPAGR represents the contribution of the agricultural sector, which is the percentage of net value added from the agriculture, forestry, and fisheries sectors to the Gross Domestic Product

(GDP). This indicator reflects the net contribution of the agriculture, forestry, and fisheries sectors to the Gross Domestic Product (GDP), thus being able to illustrate the role of the primary sector in the economic structure of a country. GD or Gross public debt is a measure that shows how large the total government debt is compared to the total value of economic output or Gross Domestic Product (GDP) of a country. This indicator describes all government obligations in the form of loans, bonds, and other forms of debt.

Table 1. Symbols and Units of Research Variables

Variable	Symbol	Unit of measurement	Expected signs
Agricultural sector contribution	GDPAGR	% of GDP	
Public debt	GD	% of GDP	+
Debt service	DS	% of exports	-
Foreign direct investment	FDI	% of GDP	+
Fertilizer consumption	FC	kg/ha	+
Agricultural land	AL	ha	+

Source: Author, 2026

DS or Debt service fee is an indicator that shows the comparison between total foreign debt payments and foreign exchange receipts from exports of goods, services, and primary income. If the DS is high, it means that most of the foreign exchange from exports is used up to pay debts, so the space for imports, investments, or other needs becomes narrow. FDI or Foreign direct investment is the net inflow of investment to acquire sustainable managerial ownership in a company operating in a country other than the investor's country of origin (net inflows). FDI is the amount of equity capital, profit reinvestment, other long-term capital, and short-term capital as recorded in the balance of payments. FC or fertilizer consumption is the amount of plant nutrients used per hectare of agricultural land (nitrogen, phosphate, and potassium). AL or arable land is an area of land that can be used for productive agricultural activities, especially to plant various types of food crops and other crops that are managed intensively. Therefore, a mathematical equation model can be compiled as follows.

$$YAGR = f(GD, CC, RPG, GE, PA, FE) \quad (1)$$

Table 2 presents the descriptive statistics for the variables used in this study, with a total of 34 observations. The mean value of GDPAGR is 15.166, with a minimum of 12.399 and a maximum of 21.548. The average values for GD, DS, FDI, FC, and AL are 40.767, 27.123, 1.2956, 228.9855, and 22340817 respectively. Among all variables, FDI exhibits the highest standard deviation and AL shows the lowest.

Table 2. Descriptive statistics of the variables

Variable	GDPAGR	GD	DS	FDI	FC	AL
Average	15.16664	40.76707	27.12317	1.295656	228.9855	22340817
Maximum	21.54872	95.8935	39.48599	2.916115	386.2241	26300000
Minimum	12.39988	22.95466	14.414	-2.75744	123.478	17126000
Standard deviations	2.408744	17.97163	6.816272	1.298976	89.28229	2965087
Observations	34	34	34	34	34	34

Source: Data processed, 2026

Several empirical studies have employed the Vector Error Correction Model (VECM) to identify linkages or convergence among macroeconomic variables and economic output output (Alam, 2022; Danish et al., 2018; Menegaki, 2021). The steps of data processing can be seen in Figure 1. The first step in the analysis involves testing the stationarity of the data using two approaches, namely the Augmented Dickey–Fuller (ADF) and Phillips–Perron (PP) tests (Breitung & Franses, 1998; Dickey & Fuller, 1979).

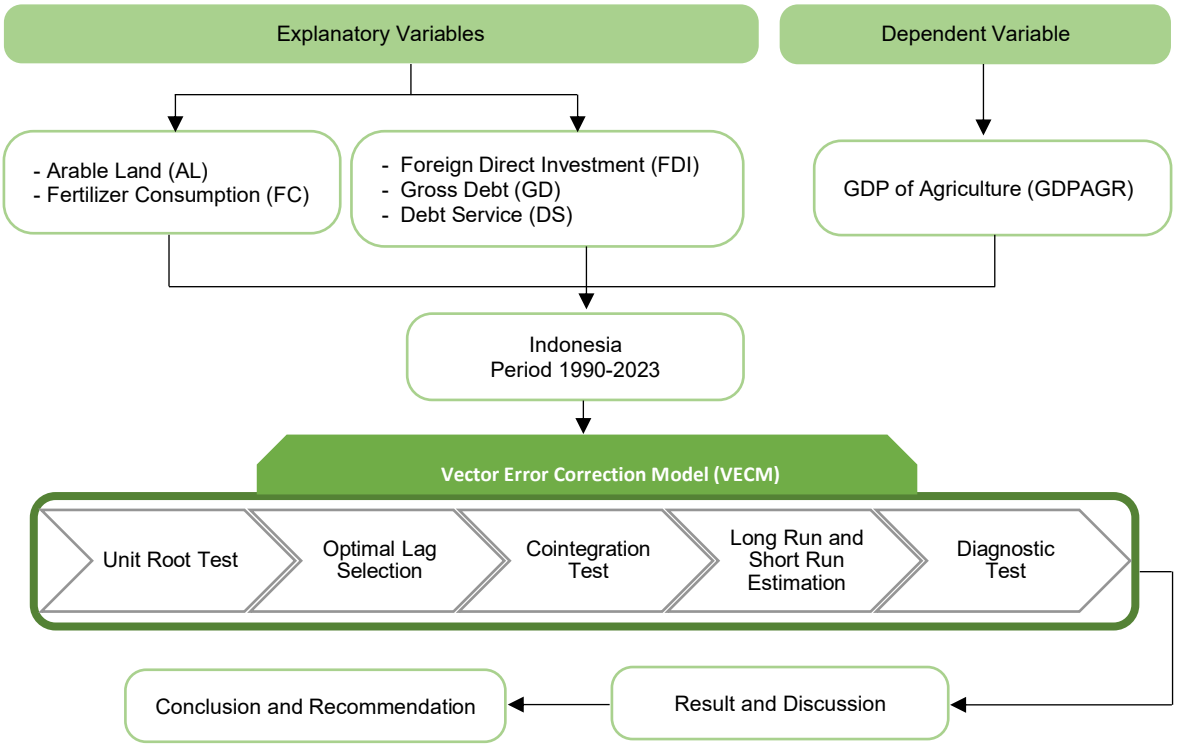

Figure 1. Empirical estimation steps of the VECM model.

The use of both tests aims to ensure the robustness and consistency of the results, as they differ in addressing issues of autocorrelation and heteroskedasticity in the residuals.

Stationarity at level I(0) is a prerequisite in time series analysis. However, when the economic variables are non-stationary at level but integrated, a special approach is required. Sims et al. (1990) further explored the analysis of variables with unit roots, and from these developments, the Vector Error Correction Model (VECM) was formally introduced. This model serves to capture short-term dynamics while maintaining the consistency of long-run equilibrium relationships. According to the prerequisites of the VECM, all variables must be stationary at the first difference level, or I(1). After confirming the order of integration, the Johansen cointegration test is then applied to determine whether a long-run relationship exists between the dependent and independent variables (Engle & Granger, 1987; Johansen, 1988).

The VECM is a restricted form of the Vector Autoregressive (VAR) model, constructed as a system of equations in which each endogenous variable is expressed as a function of its own past values and the past values of other endogenous variables. The reduced form of the VAR model can be expressed as follows:

$$Y_t = A_0 + \sum_{i=1}^{k} A_i Y_{t-i} + \emptyset X_t + \varepsilon_t \quad (2)$$

In this model, Y_t and Y_{t-i} are column vectors of dimension $j \times 1$, where j denotes the number of endogenous variables. Y_t represents the endogenous variables at time t, while Y_{t-i} corresponds to the i^{th} lag of those endogenous variables. A_0 is a $j \times 1$ vector of intercept constants. X_t is a $m \times 1$ column vector containing m exogenous variables, and ε_t is $j \times 1$ vector representing the disturbance terms. If the variables are found to be integrated of order one, I(1), and exhibit cointegration, the VAR model can be expressed in the form of an Error Correction Model (ECM) as follows:

$$\Delta Y_t = A_0 + \Pi Y_{t-1} + \sum_{i=1}^{k-1} A_i^* Y_{t-i} + \emptyset X_t + \varepsilon_t \quad (3)$$

In Equation 2, ΔY_t represents the first difference of the endogenous variables, capturing short-term changes, capturing short-term changes. The matrix Π contains information on the long-run relationships among the variables, where the rank of Π ($\Pi = \alpha\beta'$) indicates the number of cointegrating vectors (r) in the system. The matrices α and β, both of dimension ($j \times r$) represent the adjustment speed toward long-run equilibrium and the long-run parameter coefficients, respectively. X_t denotes the vector of exogenous variables, while A_0 is a matrix containing short-run dynamic information within the cointegrated system. Accordingly, the VECM framework enables the simultaneous examination of both short-run dynamics and long-run equilibrium relationships among variables within a unified analytical structure. The transformed model specification based on Dauda & Adamu (2024); Habanabakize & Dickason-Koekemoer (2024) and the variables presented in Table 1 can be formulated as follows:

$$GDPAGR_t = \alpha_0 + \sum_{i=1}^{m} \beta_1 GDPAGR_{t-i} + \sum_{i=1}^{m} \beta_2 GD_{t-i} + \sum_{i=1}^{m} \beta_3 DS_{t-i} + \sum_{i=1}^{m} \beta_4 FDI_{t-i} + \sum_{i=1}^{m} \beta_5 LnFC_{t-i} + \sum_{i=1}^{m} \beta_6 AL_{t-i} + \varepsilon_t \quad (4)$$

$$\Delta GDPAGR_t = \alpha_0 + \sum_{i=1}^{m} \beta_1 \Delta GDPAGR_{t-i} + \sum_{i=1}^{m} \beta_2 \Delta GD_{t-i} + \sum_{i=1}^{m} \beta_3 \Delta DS_{t-i} + \sum_{i=1}^{m} \beta_4 \Delta FDI_{t-i} + \sum_{i=1}^{m} \beta_5 \Delta FC_{t-i} + \sum_{i=1}^{m} \beta_6 \Delta AL_{t-i} + \beta_7 ECT_{t-1} + \varepsilon_t \quad (5)$$

Equation 3 represents the long-run relationship between agricultural gross domestic product (GDPAGR) and the independent variables, including government debt (GD), debt service cost (DS), foreign direct investment (FDI), fertilizer consumption (FC), and agricultural land area (AL). Equation 4 represents a short-term relationship written in the form of the first differentiation (Δ) which means the change or growth of each variable. Equation 4 is equipped with an Error Correction Term (ECT) component that serves to capture short-term deviations or imbalances from long-term relationships, as well as measure the speed of adjustment to return the system to balance. If the ECT coefficient is significant and negative, then it indicates the existence of a valid correction mechanism in the model, where the short-term imbalance will be corrected towards a stable long-term relationship.

RESULTS AND DISCUSSION

Table 3 is the result of unit root testing using the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) approaches, which show that all variables, namely GDPAGR, GD, DS, FDI, FC, and AL, are not stationary at the level because the p-value is more than 5%, but become stationary after the first difference is made. It is known that all variables are at I(1) and the data have met the prerequisites for cointegration analysis and estimation of the VECM model because the p-value is less than 5%.

Table 3. Unit Root Test

Variable	ADF		PP		Conclusion
	Level	1st difference	Level	1st difference	
GDPAGR	0.1059	0.0000***	0.0834*	0.0000***	I(1)
GD	0.081*	0.0005***	0.3179	0.0033***	I(1)
DS	0.1599	0.0000***	0.1633	0.0000***	I(1)
FDI	0.1422	0.0011***	0.1528	0.0000***	I(1)
FC	0.9004	0.0000***	0.8899	0.0000***	I(1)
AL	0.6467	0.0248**	0.9395	0.0000***	I(1)

Note: ***, ** & * represent statistical significance at the 1%, 5% and 10% level.

Source: Processed by the Author, 2026

The lag length test uses several information criteria and the statistical test in Table 4 shows that the Akaike Information Criterion (AIC) and the Likelihood Ratio (LR) criteria support lag 2. However, the majority of the criteria, namely the Final Prediction Error (FPE), Hannan-Quinn Information Criterion (HQIC), and Schwarz Bayesian Information Criterion (SBIC), support the use of lag 1. Thus, it can be concluded that optimal lag 1 is more suitable for the VECM model that has been built.

Table 4. Lag order selection criteria

Lag	LL	LR	FPE	AIC	HQIC	SBIC
0	-993.363	.	5.40E+19	624.602	625.513	62.735
1	-867.231	252.260	2.0e+17*	56.827	57.465*	58.751*
2	-829.184	76.095*	2.30E+17	56.699*	578.833	602.717

Source: Processed by the Author, 2026

Table 5 shows that the trace statistic value of 102.860 exceeds the critical value of 94.15 for the null hypothesis r = 0 and the maximum eigenvalue statistic value of 45.854 is also greater than the critical value of 39.37. The results of the values in table 5 reject the null hypothesis so that there is at least one cointegration relationship between variables in the model. In the test for r = 1 and above, both the trace statistic and the maximum eigenvalue statistic no longer exceed their critical value so that the null hypothesis cannot be rejected and there is evidence of the existence of 1 cointegration equation in the system built.

Table 5. Johansen tests for cointegration

Null hypo-thesis	Trace Statistic			Max-Eigen		
	Eigenvalue	Statistic	Critical Value	Eigenvalue	Statistic	Critical Value
0*	.	102.860	94.15	.	45.854	39.37
1*	0.75081	57.006	68.52	0.75081	23.496	33.46
2	0.50933	33.510	47.21	0.50933	14.584	27.07
3	0.35722	18.925	29.68	0.35722	11.747	20.97
4	0.29946	7.18	15.41	0.29946	6.648	14.07
5	0.18247	0.5322	3.76	0.18247	0.5322	3.76
6	0.016			0.016		

Note: *Trace and maximum Eigenvalue tests indicate one cointegrating at the 0.05 level
Source: Processed by the Author, 2026

Long-term analysis aims to look at how explanatory variables permanently affect dependent variables over a longer period of time that reflects structural equilibrium relationships. Short-

term analysis focuses on the dynamics of adjustment between variables from period to period and how deviations from long-term equilibrium can be corrected through the error correction term (ECT). Table 6 is the result of long-term VECM estimates and shows a significant long-term relationship between the contribution of the agricultural sector and explanatory variables, namely debt (GD), debt service costs (DS), foreign direct investment (FDI), fertilizer consumption (FC), and land area (AL) in Indonesia.

Table 6. Long-run estimation results of the VECM

Variable	Coefficient	Std. err.	z-statistics	*p* Value
GD	0.0994849	0.0137209	7.25	0.000
DS	-0.0846082	0.014949	-5.66	0.000
FDI	1.830	0.1842225	9.94	0.000
FC	0.0089422	0.0026857	3.79	0.000
AL	2.74E-07	7.21e-08	3.33	0.001

Source: Processed by the Author, 2026

The results of the estimation show that state debt, foreign direct investment, fertilizer consumption, and land area have a positive and significant influence on the agricultural sector, and debt service costs have a negative effect on the contribution of the agricultural sector in Indonesia. Statistical results show that an increase in foreign direct investment (FDI) of 1 percent can increase the GDP of the agricultural sector by 1.83 percent and is in line with the results of research by Dhahri & Omri (2020); Ding et al. (2021); Nugroho et al. (2021); Wabwile et al. (2024) that an increase in foreign direct investment flows encourages the growth of the agricultural sector through capital transfer mechanisms, technology, market access, and human resources. The results of this estimate contradict Ngatini (2024) research that FDI in the ASEAN region has a negative influence on output. Furthermore, the results in table 6 show that an increase in the fertilizer consumption variable (FC) of 1 Kg/Ha can increase the output of the agricultural sector in Indonesia by 0.009 percent and is in line with the research of Arowolo & Ekum (2016) and Rosyadi et al. (2023) that fertilizer is one of the key inputs in the agricultural production process that functions to improve soil quality, increase nutrient availability, and encourage optimal plant growth.

In line with the above variable, an increase in land area (AL) of 1 hectare can also increase the GDP of the agricultural sector by 2.74E-07 percent so that the area of agricultural land contributes to improving the contribution of the agricultural sector in Indonesia, increasing the land area can increase production capacity through increasing the output produced (Arowolo & Ekum, 2016). The state debt (GD) shows a positive and significant influence on the contribution of the agricultural sector in Indonesia, with a coefficient of 0.0994 at a significance

level of 1%. Increasing public debt accumulation can provide a boost to increase agricultural output in the long term (Sogah et al., 2024). In contrast, the debt service fee (DS) variable exerts a negative influence with a significant coefficient of -0.0846 at the level of 1%. The results of the debt and debt cost estimates reflect that the greater the burden of interest payments and debt installments, the more the government's fiscal space to support the productive sector is reduced.

The Error Correction model in Table 7 shows short-term dynamics, when agricultural GDP is out of equilibrium, 71.6% of the imbalance can be corrected every year. The results in Table 7 show that the increase in foreign direct investment in the previous period (ΔFDI) made a positive contribution to the contribution of the agricultural sector in the short term and the estimated results are consistent with the literature that emphasizes the role of FDI as one of the drivers of productivity growth through technology transfer, capital increase, and integration of the agricultural sector into the global value chain (Mustafa et al., 2025). On the other hand, the ΔFC variable shows a negative coefficient of –9.07E–07 with a high significance at the level of 1%, which means that the increase in fertilizer consumption in the previous period actually contributed to the decline in agricultural contribution in the short term. Furthermore, the estimated results also show that the state debt (ΔGD) has a positive and significant effect on agricultural GDP in the current period with a coefficient of 0.0575 which means that when the debt increases by 1 percent in the previous period, it will boost the current agricultural GDP by 0.057 percent.

Over the past 30 years, the agricultural sector has become the backbone of Indonesia's economy and has been able to survive the COVID-19 pandemic with positive growth (Kementerian Pertanian, 2023; Fadhilah et al., 2025). The strategic role of the agricultural sector is reflected in its major contribution to labor absorption and the formation of gross domestic product (Kementerian Pertanian, 2025). The ability and adaptation of the agricultural sector is reflected in the value of the Error Correction Term (ECT), which confirms the existence of an effective correction mechanism in the long-term relationship of the GDP of the agricultural sector, where any deviations that occur due to short-term shocks will be gradually corrected so that the system returns to balance. The estimation results are strengthened by the results of the Impulse Response Function (IRF) in Figure 3, which shows that the agricultural GDP response remains on a positive path despite the shock of explanatory variables, and the agricultural sector shows a tendency to maintain sustainable growth in the long term.

The agricultural sector is showing resilience to shocks and is likely to return to long-term equilibrium, but the risk of GDP decline remains if other factors are not carefully managed.

The use of fertilizers plays an important role in encouraging GDP growth in the agricultural sector and has a positive relationship. Within the framework of Solow's theory of growth, fertilizer can be seen as part of physical capital that plays a role in increasing the productivity of production factors (Solow, 1957). Increased fertilizer use allows the soil to produce higher output through improved nutrient content, efficiency of plant nutrient absorption, and improved plant biological response to other inputs.

Table 7. Short-run estimation results and diagnostic tests

Variable	**Coefficient**	**Std. err.**	**z-statistics**	***p* Value**
ECM	-0.7160765	0.1820625	-3.93	0.000
$\Delta GDPAGR_{t-1}$	0.1533862	0.1943175	0.79	0.430
ΔGD_{t-1}	0.0575052	0.0279236	2.06	0.039
ΔDS_{t-1}	-0.0422023	0.0345738	-1.22	0.222
ΔFDI_{t-1}	0.4345736	0.2534828	1.71	0.086
ΔFC_{t-1}	-9.07E-07	2.98E-07	-3.05	0.002
ΔAL_{t-1}	-0.0037525	0.0059172	-0.63	0.526
Diagnostic Test	Chi2	df	Prob	
Serial correlation LM Test				
Lag 1	370.754	36	0.41919	
Normality				
Jarque-Bera	0.059	2	0.97107	
Skewness	6.87	5	0.23090	
Kurtosis	1.12	1	0.29070	
Heteroskedasticity				
White's test	20.33	20	0.43760	
Multicollinearity				
Centered VIF				
GD	DS	FDI	FC	AL
4.66	1.16	4.43	5.65	5.02

Source: Processed by the Author, 2026

However, in the short term, there is a negative relationship between fertilizer consumption and agricultural performance in Indonesia. In many areas, subsidized fertilizers often reach farmers too late so that their use may not be in accordance with the plant growth phase. This makes the addition of fertilizer in the previous period not contribute optimally to production yields and can even cause an imbalance of nutrients in the land. In addition, there is still abuse of subsidized fertilizers for non-food commodities or resale outside the official mechanism, so that their effectiveness in supporting increased agricultural production is reduced (Pambudi, 2025).This condition reflects that structural problems in fertilizer distribution and utilization can hinder agricultural productivity and explain why increased fertilizer consumption is negatively correlated with agricultural performance in the short term in Indonesia.

Increasing land area directly increases production capacity through the increase in the main input factors that can be combined with fertilizers to encourage an increase in agricultural output, and is in line with Solow's growth theory framework, which places production factors with land as a form of capital (Semin & Namyatova, 2019). Foreign Direct Investment (FDI) plays an important role in improving the performance of the agricultural sector both in the short and long term. The influx of foreign investment increases the financing capacity of the agricultural sector, which was previously limited to domestic sources, and the effects of technology that introduces production techniques, seeds, fertilizers, or irrigation methods that are able to increase agricultural production (Sangulla et al., 2025). FDI also plays a role in market effects through trade networks so that Indonesian agricultural products can penetrate the export market, and the involvement of FDI is able to encourage the transfer of skills and knowledge to local farmers and labor, so that it can increase output (Mabeta et al., 2025).

The role of state debt in the long and short term is the same, making a positive contribution to the contribution of the agricultural sector, and in line with the debt productivity theory that debt can boost real sector contribution when allocated to productive expenditures such as infrastructure and public investment (Greiner & Fincke, 2014). Conversely, government debt continuing un-offset by significant increases in revenue or economic performance will be able to increase the fiscal burden through debt servicing costs that are in line with the crowding-out effect. When budget constraints occur, agriculture becomes one of the sectors that is vulnerable to public spending cuts. This condition is strengthened by research by Cheng & Chang, (2025); Guo et al. (2025); Fosu (2010) that when a financial crisis or deficit occurs, the burden of debt services makes the public budget depressed, so that government spending is more inclined to the social sector. As a result, budget allocations for agriculture are relatively reduced and squeeze the fiscal space that should be used to support agricultural productivity and sustainability. In addition, the high cost of debt service has the potential to shift budget allocation from development financing to debt, causing a crowding-out effect on productive investment in the agricultural sector and reducing agricultural output in the long term.

Supported by Figure 2, which shows a downward trend in the Agriculture Orientation Index (AOI) for Indonesian government spending during the period 2017 to 2022, which continues to be below one and even experienced a sharp decline from 0.3826 in 2017 to only 0.1613 in 2022. As the government's debt burden increases through an increase in the debt ratio, the portion of the budget available for productive expenditures such as agriculture, education, and health is narrowing further because most of the budget must be allocated for interest payments and principal installments (Fosu, 2010; Hartanto et al., 2020). In fact, there have been many data and studies showing that the agricultural sector is still one of the largest contributors to GDP, but this sector is often marginalized in the national development agenda, which is

reflected in the relatively smaller and declining proportion of state spending on agriculture (Figure 2). When viewed from the ASEAN region, Indonesia is far from Thailand, Vietnam, the Philippines, and other countries in investment in the agricultural sector.

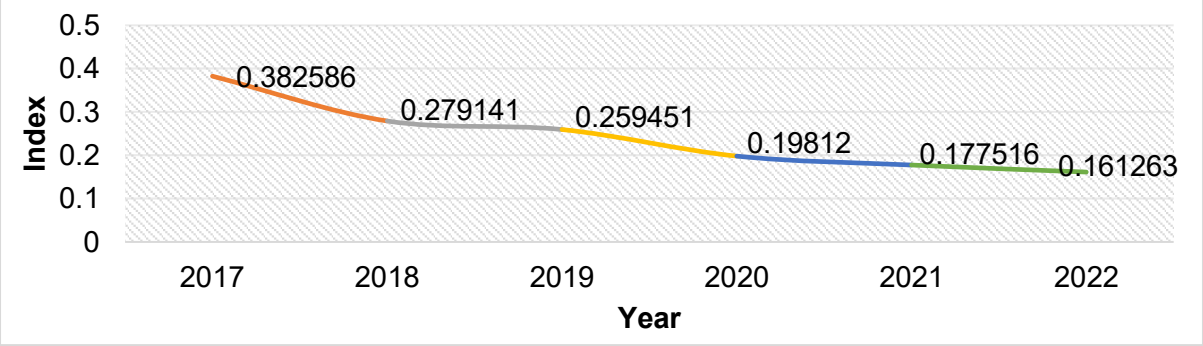

Figure 2. Agriculture orientation index for government spending

Source: Food and Agriculture Organization of the United Nations (2024)

Since independence, it has experienced a significant decline. Debt has increased in recent years due to the need for financing, and the results of each country's estimates show that the role of debt and the cost of debt differ in the short and long term. Nigeria's debt has a positive impact, and the cost of debt has a negative impact. On the other hand, the debt and debt cost in the country of Ghana have a positive impact on the agricultural sector. Data from each country shows that production in the agricultural sector is increasingly marginalized in the national development agenda (Dauda & Adamu, 2024; Sogah et al., 2024). The relationship between public debt and the performance of the agricultural sector is contextual and highly dependent on the economic structure and fiscal capacity of a country. Debt-based financing can sustain productive investment in the agricultural sector in countries with good governance, and agricultural development financing strategies depend not only on the amount of debt but also on the government's ability to manage interest costs and direct public spending effectively. Therefore, a sustainable debt policy is an important prerequisite for strengthening the agricultural sector, both in developing countries and in the context of the global economy.

The main contribution of the results of this study lies in the contradiction of findings in the literature through the differentiation of the influence between debt and debt costs. The results of the analysis described above expand on the findings of previous research that affirm that debt has a positive impact and that debt is not good or bad for the agricultural sector, but rather highly dependent on the financing structure and the accompanying cost pressures. Therefore, this discussion places the results of the research not only as empirical confirmation, but as a strengthening and refinement of the theoretical framework regarding the relationship between fiscal and agricultural sector development.

Table 7 is the result of a diagnostic test, and no problems of autocorrelation, heteroscedasticity, normality, or multicollinearity were found, providing a strong basis that the econometric model used has met the feasibility assumptions. The autocorrelation test found no indication of a serial correlation problem, and the normality test also confirmed that the residual distribution followed a normal pattern. The results of the heteroscedasticity test did not show the presence of a non-constant residual variance, and the multicollinearity test indicated that there was no strong linear relationship between independent variables. Thus, each variable is able to explain the variation in the contribution of the agricultural sector independently without any information redundancy.

Impulse Response Function

Figure 3 illustrates the impulse response results, showing that the agricultural sector's gross domestic product (GDPAGR) exhibits a dynamic response to shocks in the endogenous variables throughout the analysis period. In the first period, the agricultural GDP records a positive response, primarily driven by government debt, which initially stimulates agricultural contribution. However, foreign direct investment, fertilizer consumption, land availability, and debt service costs exert downward pressure on the role of the agricultural sector.

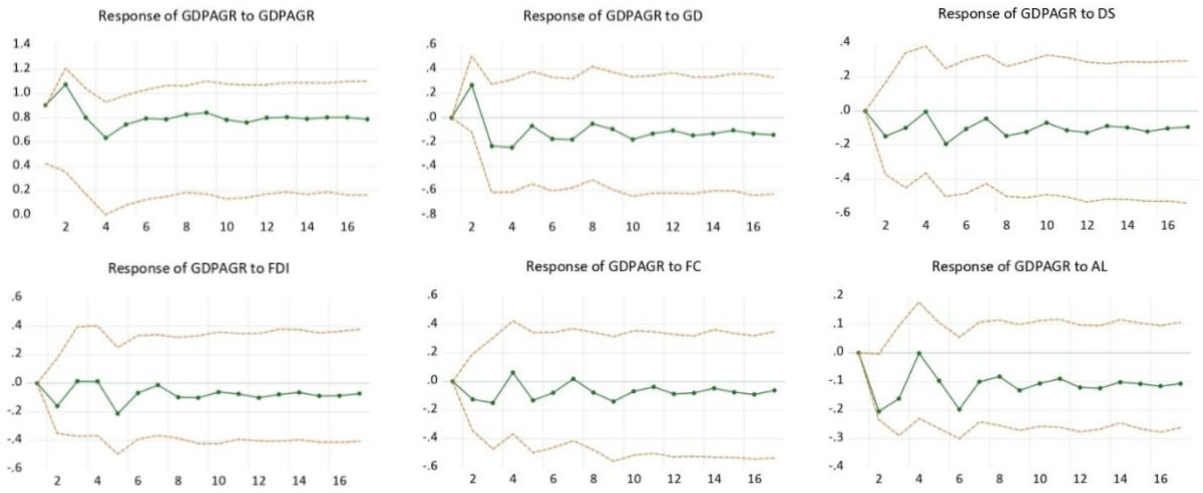

Figure 3. Response of GDPAGR

Source: Processed by the Author, 2026

In dynamic terms, responses are initially positive, but from the second period onward, shocks from public debt, debt service, fertilizer consumption, land area, and foreign direct investment generate negative and fluctuating effects during the middle periods, before gradually converging toward equilibrium in the long run. The initial IRF analysis suggests that the increase in government debt may temporarily stimulate agricultural economic activity, likely due to the expansionary fiscal effects of government spending or productive investment.

Nevertheless, after the first period, the response of agricultural contribution (GDPAGR) to public debt (GD) turns negative, indicating that in the medium to long term, rising debt levels may constrain agricultural growth as debt servicing obligations increase.

These findings highlight the adaptive capacity of Indonesia's agricultural sector to maintain its performance despite short-term shocks. However, the sustainability of its growth depends heavily on the consistency and prudence of policy implementation in managing foreign investment, public debt, debt service obligations, fertilizer consumption, and land utilization. The IRF results presented in Figure 3 underscore the need for careful policy design and coordination, as shocks to GD, DS, FDI, FC, and AL can lead to a decline in agricultural sector contribution.

Variance Decomposition

The variance decomposition was used to describe the variation in the prediction error of a variable in the form of the contribution of each variable shock. In this study, the method was used to describe how much the relative influence of each variable (GD, DS, FDI, FC, AL GDPAGR) on the dynamics of the analyzed variable, namely agricultural GDP. Based on the results of the variance decomposition in Figure 4, in the initial period the common conditions occurred in the analysis. The variation in GDPAGR was fully explained by the variable itself with a contribution of 100% and the other variables had not exerted an influence.

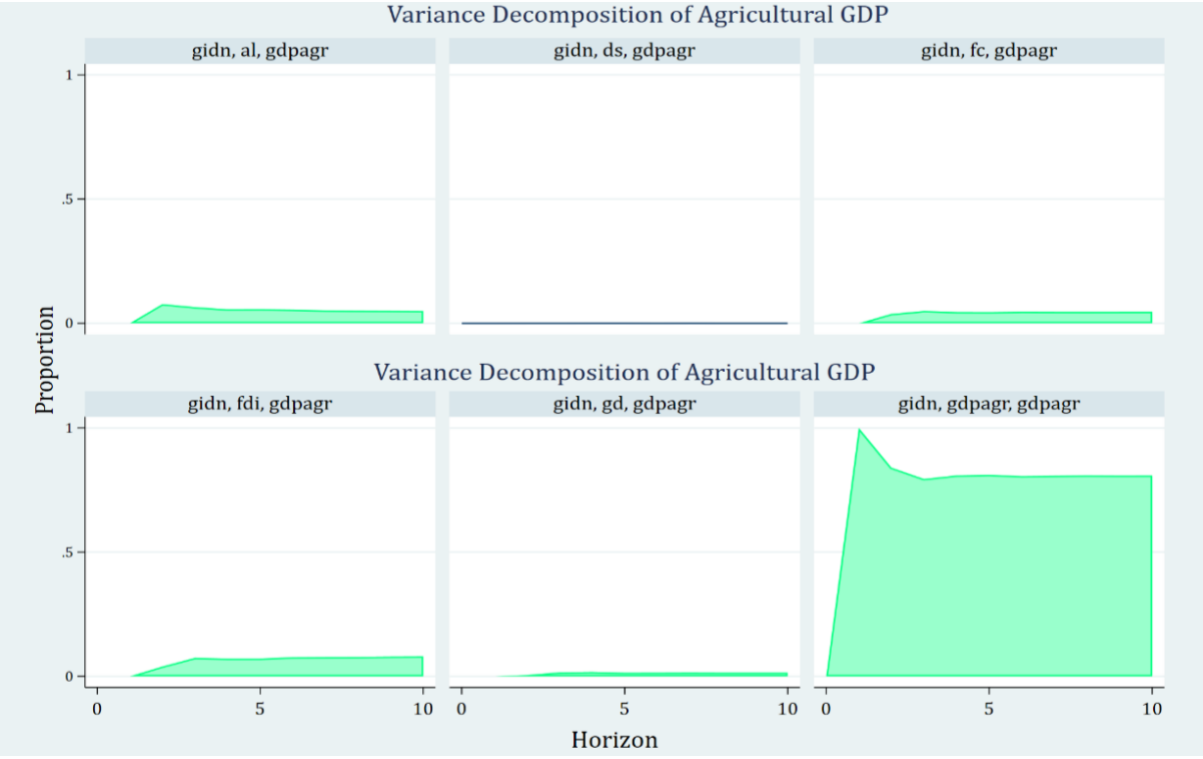

Figure 4. Variance Decomposition of GDPAGR

Source: Processed by the Author, 2026

In the second period, the internal condition of GDPAGR began to decrease to 84% with other variables starting to contribute AL by 7.75%, FC by 3.77%, FDI by 3.96%, GD by 0.5% and DS by 0.0036%. Entering the third and fifth periods, GDPAGR remained dominant but the contribution of other variables was increasing except for AL. Changes in contribution varied with the average FDI of 7.2%, AL of 5.9%, FC of 4.7%, GD of 1.6% and DS of 0.013%. In the period up to the 10th (long-term), the internal variable, namely GDPAGR still dominated at 80%, followed by external variables namely FDI, FC, AL, GD and DS.

Technical variables such as land area and fertilizer consumption showed a relatively large contribution at the beginning of the period (short term), but in the long term the influence gradually decreased over time. The variables of financial social conditions, namely FDI, GD and DS, showed an increased contribution in the long term, although DS had the smallest contribution. The results of the variance decomposition analysis illustrate the long-term dynamics of the GDP of the Indonesian agricultural sector which is more influenced by external variables, namely investment, debt and debt costs. Therefore, policies that regulate the use of investment and the management of state finances are very important in strengthening agricultural GDP and its sustainability.

CONCLUSION

This study found that there is a long-term relationship between debt, debt service costs, foreign direct investment, fertilizer consumption and land area to agricultural GDP, and supports the view of growth theory that emphasizes capital accumulation and inputs in driving sectoral output. The results of the study show a positive relationship between debt to the agricultural sector in contributing to the growth of the sector and functioning as a supporting instrument if managed carefully. However, debt service costs have the potential to become a burden and pressure the contribution of the agricultural sector through principal and interest payments so that it can reduce the space allocated for financing in the productive sector. The effectiveness of debt policy is not only determined by the amount of debt, but also by the structure and ability to manage debt obligations.

Based on these conclusions, this study recommends the importance of prudent and productive-oriented debt management because debt can be an instrument that supports growth if it is directed to investments that generate long-term productivity and if it is not balanced with effective debt service cost management, the positive potential of debt can be reduced and even cause fiscal vulnerability. These findings strengthen the literature on the role of fiscal policy in agricultural development, especially in developing countries with high dependence on external financing, the government needs to direct debt allocation to productive activities such as the development of irrigation infrastructure, the provision of

production facilities, and the support of modern agricultural technology, so that the benefits of financing can directly improve the performance of the agricultural sector. The government needs to evaluate the amount of debt and debt service costs that will limit the country's fiscal space in financing strategic sectors, including agriculture in the future. However, this study still has limitations in the scope of variables and observation periods that are limited to macro data. The dependent variable i.e. agricultural GDP in this study represents the contribution and role in the economy compared to real output, but the results of this study still provide important implications regarding the relationship between debt policy and the agricultural sector.

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AUTHOR CONTRIBUTION

Muhammad Azizan conducted the research, collected and analyzed the data, interpreted the findings, and prepared the manuscript. **Dwi Rachmina** contributed to the development of the research background, introduction, and discussion of results, as well as provided academic supervision and critical review of the manuscript. **Novindra** contributed to the research methodology, interpretation of results, and manuscript improvement through academic guidance and review.

CONFLICT OF INTEREST STATEMENT

The author declares no conflict of interest regarding the publication of this paper.

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