The Influence of Production Factors and Fertilizer Subsidies on GRDP in the Agricultural Sector in Indonesia

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Abstract. The agricultural sector is one of the sectors that supports economic growth. The agricultural sector still plays an important and strategic role in the national economy. This research aims to see the influence of Production Factors and Fertilizer Subsidies on GRDP in the Agricultural Sector in Indonesia in 2019-2023. This research covers 34 provinces in Indonesia and uses panel data methods with a Fixed Effect Model approach. The results show that investment, labor, land area, farmer exchange rate (FER), and fertilizer subsidies have a positive and significant effect on GRDP in the agricultural sector. The government is expected to increase attention to improving the quality of the workforce, proper land management, increasing investment through technology, and improving the fertilizer subsidy mechanism so that it is more targeted at farmers' welfare.

Keywords: GRDP Agriculture Sector, Production Faktor, Farmer Exchange Rate, Subsidies Fertilizer, Panel Data.

1. Introduction

The agricultural sector in Indonesia plays a crucial role in economic growth, significantly contributing to the national GDP and providing employment [1]. In 2023, the sector's labor absorption percentage was notably high compared to other sectors, highlighting its importance in the national economy. Agriculture remains a key economic sector across Indonesian provinces, contributing to both national GDP and provincial GRDP [2]. Regional growth in agriculture depends on factors such as competitiveness, regional uniqueness, and agricultural potential. To maximize the sector's impact, it is essential to prioritize the management and development of high-value agricultural potential, which supports broader regional economic growth [3]. In Indonesia, the area of agricultural land has been decreasing due to increasing demand for land for non-agricultural purposes, driven by population growth and infrastructure needs [4]. This competition between agricultural and non-agricultural uses has led to the conversion of agricultural land, particularly rice fields, into non- agricultural uses, impacting agricultural GDP [5]. Despite this reduction in land area, agricultural productivity, as indicated by agricultural GRDP, has continued to rise. Technological innovations in agriculture have played a significant role in boosting GRDP, showing that land area is no longer the sole determinant of agricultural production success [6]. In addition to agricultural land area, labor is a crucial factor in boosting the agricultural sector's GDP. According to [7], both population and labor force growth drive economic growth by increasing production levels and expanding

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the domestic market. While the impact of rapid population growth on economic development remains debated, a growing workforce, especially in agriculture, is generally seen as a positive contributor to increasing agricultural GDP. Labor, along with advancements in science and technology, natural resources, and production capacity, plays a significant role in long-term economic development [8].

Agricultural investment is a critical factor in boosting agricultural production.[9] defines investment as the acquisition of capital goods and production equipment to enhance production capacity. Agricultural investment declined between 2019 and 2021 due to reduced agricultural commodity output but increased again in 2022-2023. This aligns with Harrod-Domar theory, which posits that higher investment enhances production capacity and economic growth, driven by increased savings and investment. Investment creates new job opportunities, benefiting the community and supporting agricultural efforts. Thus, reviewing the impact of investment on agricultural GDP is essential for understanding its contribution to the sector's growth. Another factor that affects agricultural production is the Farmer's Exchange Rate (NTP) NTP is one of the indicators that can be used as a reference in determining the direction of agricultural policy [10]. The farmer's exchange rate is a measure of the exchange ability of agricultural products produced by farmers with goods or services consumed by farming households and goods or services needed in producing agricultural products [11].

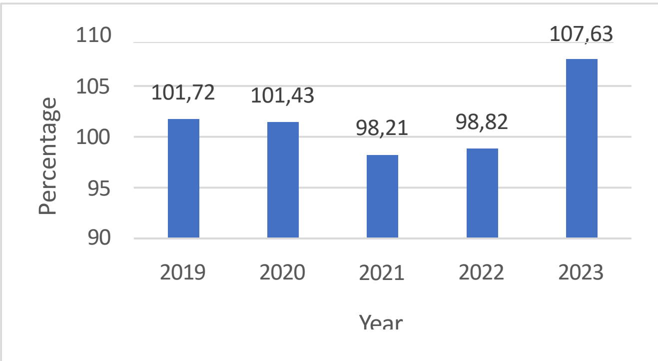

Fig. 1. Indonesian Farmer Exchange Rate 2019 – 2023

Fig 1 from 2019 to 2022, the Farmer Exchange Rate (NTP) decreased due to low farmer income and purchasing power. However, in 2023, NTP rose significantly as farmers' incomes and purchasing power improved. NTP, which reflects farmer welfare, is the primary indicator used by agricultural development observers to assess welfare levels in an area [12]. An increase in NTP positively affects agricultural GDP by enhancing farmer welfare and economic growth. This study aims to analyze whether NTP significantly influences agricultural productivity in Indonesia over time [13]. Fertilizer subsidies are a key government measure to enhance national food sovereignty and are continually increased each year [14]. These subsidies aim to improve farmers' ability to purchase the recommended amount of fertilizer for balanced fertilization based on location. By supporting farmers in this way, the government helps achieve higher agricultural production targets and facilitates the development of agricultural infrastructure and facilities [15].

Data from the Ministry of Agriculture indicates that fertilizer subsidy allocations in Indonesia generally increased from 2019 to 2023, although there was a decrease in 2022 due to budget cuts and concerns about the effectiveness of the subsidy program. Issues such as overspending and inefficiencies in distribution have been noted. The effectiveness of the fertilizer subsidy policy, measured by indicators like the right place, price, time, and amount, remains problematic, impacting the GRDP of the agricultural sector [16].

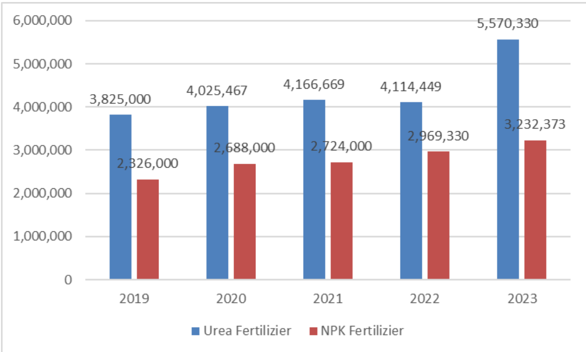

Fig. 2. Indonesian Fertilizer Subsidies 2019 – 2023

Figure 2 Subsidies for urea and NPK fertilizers are commonly used in agriculture, with urea fertilizer being preferred due to its ease of use [15]. From 2019 to 2021, the Gross Domestic Product (GRDP) of the agricultural sector increased, although there is interest in confirming the impact of agricultural production factors on GRDP. Urea fertilizer, rich in nitrogen, is essential for plant protein production, chlorophyll maintenance, and overall plant growth, making it effective for increasing plant production [18]. NPK fertilizer, which supports vegetative growth and nutrient efficiency, is also valuable. Despite the benefits, the fertilizer subsidy policy faces challenges such as fertilizer shortages, smuggling, price increases, and leakage into non-subsidized markets [17]. Maintaining the effectiveness of these subsidies is crucial for sustaining agricultural productivity. Based on the background and problem formulation above, the objectives to be achieved in This study is to analyze the influence of agricultural production factors and subsidies on agricultural GRDP in Indonesia. this research is expected to provide useful information in understanding the production factors that influence GRDP in the agricultural sector.

2. Literature Review

2.1 Empirical Reviews

This research is based on several studies that have been conducted previously. Research by [19], is a reference used by the author to see the influence of land area and labor variables. Based on the results of the study, it shows that land area has a negative and significant effect on GRDP, then the labor variable shows a negative but insignificant effect on GRDP. Then, research conducted by [20] to see the effect of the effectiveness of fertilizer subsidies on rice productivity. The results of the study showed the positive effect of fertilizer subsidies on rice productivity. But, researched by [27] shows that fertilizer have negative impact on agricultural GRDP so with this different, this study wants to see the effect in Indonesia and research conducted by [21] to see the effect of farmer exchange rates on economic growth. The results found that farmer exchange rates had a negative effect on economic growth. While research conducted by [22] to see the effect of investment variables on GRDP in the agricultural sector. The results found that investment had a positive and significant effect on economic growth.

2.2 Production Theory

Production is the process of changing input (production factors) into output (production results) [23]. This production activity can increase the usefulness (utility value) of an item by providing new benefits or benefits that are greater than the original [24]. Cobb-Douglas Production Theory Economic growth is largely determined by the output produced. The output of goods and services of an economy (GDP) depends on (1) the amount of input or production factors and (2) the ability to convert input into output [25].

$$Y = AF\,(K\,, L, H) \tag{1}$$

Where:

Y = GRDP of agricultural sector

A = Technology

K= Capital

L = Labor Force

H = Land Area

Gross Domestic Product (GDP) in the agricultural sector represents the total added value of goods and services produced across all regions within a year. There are three main approaches to calculating GDP: the production approach, the expenditure approach, and the income approach [26]. Key factors influencing GDP include land, investment, and labor. Land encompasses all components of the Earth's surface, including the atmosphere, soil, topography, and the impacts of human activities [5]. These elements affect land use today and in the future. Labor, defined as the working-age population capable of producing goods and services, also plays a crucial role in determining agricultural GDP [9].

2.3 Farmers Exchange Value

The Farmer Exchange Rate (NTP) is a ratio that compares the price index received by farmers (It) to the price index paid by farmers (Ib), expressed as a percentage. The price index received by farmers reflects the prices of their production outputs, while the price index paid by farmers indicates the prices of goods and services they purchase, including those for agricultural production. An NTP above 100 suggests that farmers are experiencing a surplus and are more prosperous, as their production prices exceed their consumption costs. Conversely, an NTP below 100 indicates a deficit, where farmers' production prices are less than their consumption costs. An NTP of 100 means farmers are breaking even, with production and consumption prices rising or falling at the same rate [10].

2.4 Fertilizer Subsidies

Subsidies are government payments to businesses or households aimed at improving conditions [29]. These can be direct, like cash or interest-free loans, or indirect, such as rent reductions or fee exemptions. Fertilizer, a key input for boosting agricultural production and competitiveness across various sectors like food crops, horticulture, livestock, and fisheries, has historically been subsidized. Since 1969, the fertilizer subsidy policy has aimed to increase productivity and improve farmer welfare. Subsidies are provided by covering the difference between the production cost and the government-set highest retail price (HET) [16]. The policy focuses on two goals: enabling farmers to afford the recommended fertilizer amounts and ultimately increasing agricultural productivity to support national food security.

Based on a literature study of previous research, the author constructs The hypothesis is that production factor variables such as labor, investment, land area and farmer exchange rates and fertilizer subsidies have a significant effect on the GRDP of the agricultural sector.

3. Method

3.1 Data and source of data

This study utilizes annual secondary data from 2019 to 2023, sourced from the Statistical Indonesia, Ministry of Agriculture, and CEIC. The data includes GRDP by business field, agricultural land area, agricultural labor, farmer exchange rates, fertilizer subsidies, and agricultural investment. The aim of the study is to analyze factors influencing agricultural production using quantitative data. Data processing for the study is conducted using STATA software.

3.2 Analysis Method

This study uses a quantitative method with panel data regression, which combines cross-section data from 34 Indonesian provinces and time series data from 2019-2023. The method aims to determine the effect of independent variables on the dependent variable. The dependent variable is the percentage of GRDP in the agricultural sector, while the independent variables include agricultural land area, labor, investment, farmer exchange rates, and fertilizer subsidies. After data processing, model suitability and classical assumption tests are conducted to select the most efficient model, followed by statistical interpretation of the models.

Panel Data Regression Model: Panel data combines cross-section and time-series data, offering several advantages in research. According to [30], it provides more data, increasing the degrees of freedom, and helps address issues related to omitted variables. Panel data consists of observations from several individuals over time. If each individual is observed for the same period, the data is considered a balanced panel; if the observation periods differ, it is called an unbalanced panel. Panel data regression models are typically formulated to analyze these combined datasets.

Common Effect Model (CEM) combines time series and cross-section data without accounting for time or individual differences, assuming that regional data behavior remains constant over time. It is the simplest panel data approach and uses the Ordinary Least Square (OLS) method for estimation. In OLS, it is assumed that the intercept (y_o) and the slope (the coefficient of the independent variable's effect on the dependent variable) remain consistent across all time periods and cross-sections. This model assumes uniform behavior in the data over time [32].

The Fixed Effect Model (FEM) assumes that differences between individuals are reflected in varying intercepts, while the slope remains constant across individuals and over time. The model uses the Least Square Dummy Variable (LSDV) technique to capture intercept variations between regions in panel data. However, a drawback of this model is that with a large number of cross-section data, introducing multiple dummy variables can reduce the degrees of freedom [32].

Random Effect Model (REM) This model evaluates the disturbances of variables that are interrelated across time and individuals in panel data. This model is also known as the Error Component Model (ECM) or using the technique Hausman test Generalized Least Square (GLS) [30]. The advantage of using this model is that it can eliminate heteroscedasticity. This random effect model assumes that each intercept is random with a constant mean value.

To determine the best model, tests like the Chow test, Hausman test, and Lagrange Multiplier test are conducted. The classical assumption test is used to ensure the regression model meets the BLUE (Best, Linear, Unbiased Estimator) criteria. In the Ordinary Least Square (OLS) approach, these tests include linearity, autocorrelation, heteroscedasticity, multicollinearity, and normality. However, not all are required. Linearity is assumed, and normality is not mandatory for BLUE. The multicollinearity test is needed when there are multiple independent variables, heteroscedasticity is relevant for cross-section data, and an autocorrelation test is specific to time series data.

3.3 Research Model

The model formed in this study is to determine and analyze the influence of independent variables on dependent variables. This study uses a type of panel data which is a combination of time series and cross section data. Panel data analysis in this study is used to determine how much influence production factors and fertilizer subsidies have on agricultural production in Indonesia. The author uses natural logarithms on the independent variables in the model. This is done because there are several considerations according to Wooldridge [33], namely: Changing the interpretation of the variable coefficient units to percentages, but this has no effect on the variable coefficient, Natural logarithms are often used for variables that are always positive, especially when there are many variations, for example the rupiah and population, and Models using natural logarithms on their dependent variables (log(y)) often better meet the assumptions of classical linear models such as having the opportunity to be linear, preventing heteroscedasticity, and normality often makes more sense. The econometric equation model in this study can be seen as follows [30]:

$$LNGRDP_{it} = \beta_0 + \beta_1 LNInv_{it} + \beta_2 LNLB_{it} + \beta_3 LNLand_{it} + \beta_4 FER_{it} + \beta_5 LNUrea_{it} + \beta_6 LNNPK_{it} \ldots e_{it} \quad (3)$$

In which: GRD represents gross domestic region sector agriculture, INV represents investment sector agriculture, LB represents Labor Force of agriculture, Land represents land area of agriculture, FER represent farmer exchange rate, Urea represent fertilizer urea, NPK represent fertilizer NPK.

Table 1. Measurement of Variables

Variable	Variable Name	Labels	Measurement
Dependent	Gross Regional Domestic Product	LNGRDP	Percentage
Independent	Investment	LNInv	Percentage
	Labor Force Agriculture	LNLB	Percentage
	Land Area Agriculture	LNLand	Percentage
	Farmer Exchange Rate	FER	Percentage
	Urea Fertilizer	LNUrea	Percentage
	NPK Fertilizer	LNNPK	Percentage

4. Results and Discussion

4.1 Data Estimation Results

To identify the best model, several tests were conducted, including the Chow test and the Hausman test, involving Pooled Least Squares (PLS), Fixed Effect Model (FEM), and Random Effect Model (REM) estimations. The Chow test determined that FEM was the preferred model, as the probability value of 0.0000 was lower than the 5% significance level, leading to the rejection of H_0. The Hausman test further confirmed FEM as the best model, with a probability value of 0.0000, also below the 5% significance level, resulting in the rejection of H_0. Thus, FEM was chosen as the most suitable estimation model for this study.

Table 2. Model Suitability Test Results

Model Fits Test	**Probability Chi-Square**	**Model**
Chow Test	0,0000	FEM
Hausman Test	0,0000	FEM

Classical Assumption Test

Multicollinearity Test: This test is conducted to see if there is a relationship between independent variables in the model. Multicollinearity can occur when the variables in the model are correlated [31]. To see multicollinearity can be done with the Variance Inflation Error (VIF) value, the value that determines the problem of multicollinearity is if the VIF value is more than 10. In this study, there is an indication of a multicollinearity problem.

Table 3. Multicollinearity Table

Variable	VIF
Labor Force	91.73
Urea Fertilizer	45.38
NPK Fertilizer	34.84
Land Area	45.35
Farmer's Exchange Rate	34.20
Investment	29.80

Heteroscedasticity Test: This test aims to identify heteroscedasticity, which occurs when a regression model exhibits varying residual variance across observations, rather than a consistent variance (homoscedasticity). In this study, the modified Wald test for groupwise heteroscedasticity in the fixed effects regression model was employed. The test returned a probability value of 0.000, which is below the 5% significance level, indicating the presence of heteroscedasticity in the model. Consequently, improvements are needed to address this issue.

Autocorrelation Test: The Autocorrelation Test assesses whether there is a correlation between errors in the current period and those in the previous period. In this study, the Wooldridge Test was used to address multicollinearity issues, which were resolved as indicated by the results. However, the autocorrelation test yielded a probability value of 0.0004, which is below the 5% significance level, suggesting the presence of autocorrelation in the model. Consequently, the null hypothesis is rejected, indicating that the model is affected by autocorrelation.

4.2 Improvements to the Classical Assumption Test

The model suitability test identified the Fixed Effect Model (FEM) as the best model for this study. Subsequent classical assumption tests revealed issues with heteroscedasticity, autocorrelation, and multicollinearity. To address these problems, the model was improved using orthogonalization, robust regression, and General Least Squares (GLS) clustering. Orthogonalization was applied to correct multicollinearity by transforming variables, so they become uncorrelated. After orthogonalization, GLS clustering was used to address heteroscedasticity and autocorrelation, ensuring a more robust model.

Table 4. Results of Improvement of Classical Assumption Test

Variable	Coefficient	Prob
oln_Investment	0,3247662	0,000***
oln_Labor Force	0,8284784	0,000***
oln_Land Area	0,4013254	0,000***
oFarmer Exchange Rate	0,0890711	0,000***
oln_Urea Fertilizer	0,0520616	0,000***
oln_NPK Fertilizer	0,009719	0,087**

Constanta	8,425,525	0,000***
Prob>F		0,000
R^2		0,7818

4.3 Statistical Tests

After improving the model, statistical tests were conducted, including the simultaneous significance test (F-test), partial test (t-test), and determination coefficient test (R^2). The F-test showed a probability value of 0.0000, indicating that the independent variables collectively have a significant effect on the dependent variable. The t-test results revealed that five out of six independent variables—investment, labor, land area, NTP, and urea fertilizer—had significant effects on the dependent variable, with probability values of 0.000 or 0.027. The determination coefficient (R^2) was 0.7818, meaning that 78.18% of the variation in the dependent variable can be explained by the independent variables in the model, while 21.82% is attributed to other factors not included in the model.

4.4 The Influence of Agricultural Investment on the GRDP of the Indonesian Agricultural Sector

The regression analysis reveals that agricultural investment has a positive and significant impact on the GRDP of the agricultural sector, the positive coefficient signifies a direct relationship between agricultural investment and GRDP, meaning that higher investment in the agricultural sector leads to a higher GRDP. This finding aligns with the theoretical framework used in the study. According to the Cobb-Douglas production theory, output growth depends on capital and workers [25]. So, an increase in investment in the agricultural sector will increase the GRDP of the agricultural sector. This finding is consistent with the research by [22], which confirms that investment positively and significantly affects the GRDP of the agricultural sector. This result supports the Harrod-Domar theory, which posits that an increase in investment enhances a community's production capacity and economic growth. According to this theory, higher investment leads to more job creation, benefiting the community and contributing to agricultural development and prosperity.

4.5 The Influence of Agricultural Labor on the GRDP of the Indonesian Agricultural Sector

The best estimation results indicate that agricultural labor positively and significantly impacts the GRDP of the agricultural sector, this finding contrasts with research by [19] which found a negative impact of labor on GRDP. However, it aligns with other studies and Adam Smith's classical theory, which views human resources as a crucial factor in economic growth and national prosperity. According to Smith's theory, effective allocation of labor is fundamental to economic development [8].

4.6 The Influence of Agricultural Land Area on the GRDP of the Indonesian Agricultural Sector

The regression results indicate that the area of agricultural land has a positive and significant effect on the GRDP of the agricultural sector. This finding contrasts with research, which reported a negative effect of land area on GRDP [19], but aligns with other studies, including [35] and [36] which found a positive influence. The results underscore the importance of properly utilizing agricultural land to prevent its erosion due to infrastructure development and ensure continued agricultural productivity to meet community needs.

4.7 The Influence of NTP on the GRDP of the Indonesian Agricultural Sector

The regression analysis reveals that the farmer's exchange rate has a positive and significant effect on the GRDP of the agricultural sector, this finding contrasts with research, which reported a negative effect of the farmer's exchange rate on GRDP [23]. However, it aligns with research, which demonstrated a positive relationship between the farmer's exchange rate and GRDP. The positive effect suggests that as farmer welfare improves, reflected by a higher farmer's exchange rate, the GRDP of the agricultural sector also increases, indicating a boost in farmers' purchasing power and overall economic contribution [37].

4.8 The Influence of Urea and NPK Fertilizers on the GRDP of the Indonesian agricultural sector

The study findings indicate that both urea and NPK fertilizers have a positive and significant impact on the GRDP of the agricultural sector. These results are consistent with previous research by [20] which found that both types of fertilizer positively affect agricultural GRDP. However, the study also notes criticism regarding the targeting and effectiveness of fertilizer subsidy policies, as they are often deemed to benefit producers more than the intended farmers [15]. This ineffectiveness in subsidy distribution negatively impacts the GRDP of the agricultural sector [16].

5. Conclusion

The study titled "The Influence of Production Factors and Fertilizer Subsidies on Agricultural GRDP in Indonesia" concludes that production factors, such as investment, labor, agricultural land, exchange rates, and fertilizer subsidies (urea and NPK), have a positive and significant impact on increasing agricultural GRDP. Labor was found to have the largest influence, suggesting that improving the skills and quality of agricultural workers, especially in food crops, can maximize output and increase agricultural GRDP. While other factors have smaller coefficients, they are expected to contribute more in the future. Fertilizer subsidies should also be made more affordable to improve access and support agricultural growth.

Based on the research findings, several suggestions are offered to address issues related to agricultural production factors and fertilizer subsidies on agricultural GRDP. The government should focus on improving the education, skills, and quality of agricultural workers through training, as the workforce significantly impacts agricultural GRDP. Additionally, better management of agricultural land is crucial to ensure it is used efficiently for farming, preventing its conversion to non-agricultural purposes. Agricultural investment also needs attention, as it remains limited, and increasing investment, especially in technology like tractors, could improve production efficiency. Furthermore, the current fertilizer subsidy mechanism is seen as poorly targeted, with more benefits going to producers rather than farmers, the intended recipients.

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