Journal of Economics, Finance and Management Studies

ISSN (print): 2644-0490, ISSN (online): 2644-0504

Volume 08 Issue 03 March 2025

Article DOI: 10.47191/jefms/v8-i3-22, Impact Factor: 8.317

Page No: 1643-1650

Analysis of the Determinants of Rice Harvest Area, Rice Productivity, Rice Production, and Consumer Price Index on Gross Domestic Product: An Analysis of the Last 10 Years in Indonesia

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ABSTRACT: This study analyses the effect of harvest area, productivity, rice production, and the consumer price index (CPI) on the Gross Domestic Product (GDP) in Indonesia over the last 10 years. By using multiple linear regression method, results show that harvest area (X1) and rice paddy production (X3) have a positive significant effect on GDP, while harvest area (X3) has a positive significant effect on GDP, significant positive effect on GDP, while productivity (X2) and CPI (X4) are insignificant (X4) are not significant. These findings highlight the importance of increasing the size of harvest areas and production to support the growth of the agricultural sector, which is one of the largest contributors to GDP. one of the largest contributors to GDP. Key challenges include climate change and price fluctuations, which require adaptive policies as well as technological support. This research provides insights for the development of strategies that focus on on the sustainability of the agricultural sector to strengthen national food security.

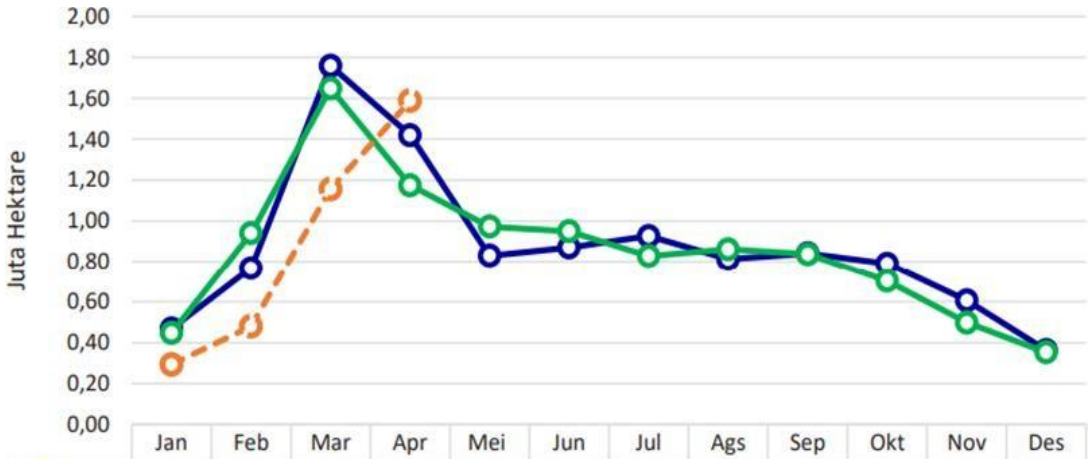
KEYWORDS: Harvest area, Productivity, Rice production, GDP, Consumer price index.

I. INTRODUCTION

The development of the agricultural sector is one of the government's policy commitments, both at the central and regional levels, in improving the standard of living of farmers by considering the majority of the population living in rural areas in Indonesia. In other words, NTP is a measure of the exchange ability of agricultural goods (products) produced by farmers with the production of goods or services needed for consumption of farm households and various factors needed in producing agricultural goods (Hendayana, 2001).

In Indonesia, the role of the agricultural sector is increasingly crucial due to its contribution as the third largest contributor to Gross Domestic Product (GDP), which plays a key role in national economic growth. Although Indonesia's economy contracted during the Covid-19 pandemic, the agricultural sector managed to record positive growth. Over the past three years, the sector has continued to grow with an average growth of around 1.77 per cent in 2020, 1.87 per cent in 2021, and reached around 2.25 per cent in 2022 according to BPS data in 2023.

Based on the BPS Survey results, the realisation of the rice harvest area from January to December 2023 reached around 10.21 million hectares, or decreased by 238.97 thousand hectares (2.29 per cent) compared to 2022 which amounted to 10.45 million hectares. The peak of rice harvest in 2023 was in line with 2022, which occurred in March. The rice harvest area in March 2023 was 1.65 million hectares, while in March 2022 the rice harvest area reached 1.76 million hectares.



	Jan	Feb	Mar	Apr	Mei	Jun	Jul	Ags	Sep	Okt	Nov	Des
2022	0,47	0,77	1,76	1,42	0,83	0,87	0,93	0,81	0,84	0,79	0,61	0,36
2023	0,45	0,94	1,65	1,17	0,97	0,95	0,83	0,86	0,84	0,70	0,50	0,35
2024	0,29	0,48	1,16	1,59								

Figure 1. The rice harvest area from January to December in 3-years
Source: Badan Pusat Statistik, 2024

Some of the variables that affect GDP include Harvested Area, Productivity, Production, and Government Purchase Price. A larger harvested area usually contributes increased production, which in turn can increase GDP. In other words, GDP is a measure of the exchangeability of agricultural goods (products) produced by farmers with goods or services required for consumption by farming households and for the purposes of producing agricultural goods (Hendayana, 2001). The main requirement to realise food security is the availability subsystem where food production comes from (Suryana, 2014; Hermanto, 2015).

If the rice harvest area increases, it is expected that rice production will also increase, which can contribute to an increase in GDP. In addition, favourable government purchase prices can also provide an incentive for farmers to increase their production. This research focuses on the problem of variables that affect the farmer exchange rate. The problem to be solved is about the issue of agricultural variables on the farmer exchange rate which will be proven by regression analysis.

II. LITERATURE REVIEW

(According to research from Ali and Khan et al (2020) entitled "Does Cereal crops asymmetrically affect Agriculture gross domestic product in Pakistan? Using NARDL model approach" the long-run result of rice production P-value is 0.1683 has a neutral effect on agricultural GDP while the null hypothesis is accepted. So the solution given by the author is that the government should provide subsidies in inputs, facilitate rice farmers when they experience problems. In the long run maize production test value is 0.0015 which has a unidirectional effect.

Research conducted from 2016 to 2018 in Kherson, Ukraine, titled "Soybean Productivity in Rice Crop Rotation Depending on the Impact of Biodestructor on Post-Harvest Rice Residues" Dudchenko, V., Markovska, O., & Sydiakina, O. (2021) explored soybean yields: The study reported a 17.9% increase in soybean yield compared to the control group. This increase was due to better seed germination conditions and reduced disease risk. Sustainable Agriculture: These findings underscore the potential of biodestructors in promoting sustainable agricultural practices by improving soil health and crop yields.

Limited Focus on Productivity Factors: While the study on sugarcane farmers identified productivity as a negative factor affecting well-being, it did not explore the underlying reasons for the negative impact. Further research could investigate the specific challenges causing the decline in productivity and how to overcome them (Abidin M.Z., 2021). Integration of COVID- 19 Impacts: The impact of the COVID-19 pandemic on agriculture and farmers' welfare is not addressed in existing studies. Given the significant disruptions caused by the pandemic, research is needed that examines its impact on agricultural productivity and farmer welfare in Indonesia (Abidin M.Z., 2021).

Based on the excerpts below is a summary and comparison of the articles:

- Cointegration and Stationarity Test:

All articles discuss the importance of stationarity and cointegration testing on time series data. The first document emphasises the use of the Augmented Dickey-Fuller (ADF) test to determine stationarity and the need for differencing the data if the data is not stationary (Abidin, 2021; Purnomo & Savikri, 2021) . The second document also mentions the use of the ADF test and highlights

the Durbin-Watson (D-W) statistic to evaluate cointegration, which indicates that cointegration exists in all analysed behavioural equations (Malian et al., 2016) .

- Error Correction Model (ECM):

The first document describes ECM as a method to analyse long-run and short-run relationships between variables, especially when dealing with non-stationary data (Purnomo & Savikri, 2021)). The second document also refers to ECM, noting its role in addressing short-run imbalances in the context of long-run cointegration (Malian et al., 2016) . The third document mentions the use of Ordinary Least Squares (OLS) regression to analyse the impact of various factors on agricultural productivity, but does not explicitly mention ECM (Purnomo & Savikri, 2021) .

- Error Correction Model (ECM):

The first document describes ECM as a method for analysing long-run and short-run relationships between variables, especially when dealing with non-stationary data (Syifa Aulia et al., 2021) . The second document also refers to the ECM, noting its role in addressing short- run imbalances in the context of long-run cointegration (Syifa Aulia et al., 2021) . The third document mentions the use of Ordinary Least Squares (OLS) regression to analyse the impact of various factors on agricultural productivity, but does not explicitly mention ECM (Sutrisno, Gatiningsih, 2017) .

- Data Characteristics:

The first document uses quarterly time series data and focuses on the relationship between dependent and independent variables through regression analysis (Purnomo & Savikri, 2021) . The second document does not mention the frequency of the data but indicates that the data is suitable for cointegration analysis (Malian et al., 2016) . The third document uses annual time series data and focuses on agricultural factors that affect the welfare of sugarcane farmers (Purnomo & Savikri, 2021) .

- Results and Findings:

The first document presents results indicating that all tested variables are not stationary at the level but become stationary after differencing (Syifa Aulia et al., 2021) . The second document confirms cointegration in all analysed equations, indicating the existence of a long-run relationship among the variables (Malian et al., 2016) . The third document provides results from OLS regressions, focusing on the impact of land area, productivity, and price on farmers' welfare, but does not address stationarity or cointegration (Purnomo & Savikri, 2021) .

In summary, while all the articles discuss time series data analysis, they differ in terms of the specific methodology (e.g., ADF vs OLS), the type of data used (quarterly vs annual), and the focus of the analysis (general economic linkages vs agricultural productivity).

III. RESEARCH METHODS

The type of research used in this study is quantitative research with this type of research which aims to determine the effect or relationship between two or more variables (Sugiyono, 2022).

The data collection techniques used in this research are documentation, and literature review by searching for data that has been published in the Indonesian Central Bureau of Statistics for the period of 2014-2023, namely in the form of annual reports on Gross Domestic Product at Current Prices (Y), Rice Harvest Area (X1), Rice Productivity (X2), and Production (X3), Consumer Price Index (X4). The data is obtained from the website www.indonesia.bps.go.id.

Multiple regression analysis is the regression of a dependent variable (Y) associated with one or more independent variables (X). It can also be used to predict or estimate the value of one variable against another.

In this study, the variable (Y) is gross domestic product which is then associated with four independent variables, namely X1= Rice Harvest Area, X2= Rice Productivity, X3= Rice Production, and X4= Prevailing Price Index. The form of the Regression Line Equation is:

$$\mathbf{Y= a + \beta1X1+ \beta2X2 + \beta3X3+ \beta3X4 + \varepsilon} \quad \mathbf{(1)}$$

Where:

Y= Indonesia's Gross Domestic Product at Current Prices (Billions) a = Constant

X1= Rice Harvested Area (ha) X2= Rice Productivity (ku/ha) X3= Rice Production (tonnes) X4= Current Price Index (Percent) β1= regression coefficient X1

β2 = regression coefficient X2 β3= regression coefficient X3 β4= regression coefficient X4 ε = Standard Error

Parametric statistical models are used so that before data analysis, classical assumption tests are required to obtain estimates. The assumption test includes normality, multicollinearity, autocorrelation and heteroscedasticity.

Statistical Test

A. Test t (Partial)

This test is conducted to determine the significance of the partial influence between variable X on Y with the assumption that other variables are considered constant.

- If the significance level < α (0.05), then variable X individually affects variable Y.
- If the significance level > α (0.05), then variable X individually has no effect on variable Y.

B. F Test (Simultaneous)

This test aims to show whether all X variables entered into the model simultaneously or together have an influence on the Y variable.

- If the probability level of F < α (0.05), then all X variables simultaneously affect the Y variable.
- If the probability level of F> α (0.05), then all variables X simultaneously have no effect on variable Y.

C. Coefficient of Determination (R2)

The coefficient of determination in this study uses Adjusted R Square (R2) which is used to measure how far the ability of variable X to influence variable Y

IV. RESULT AND DISCUSSION

Research results

This study aims to determine and analyse the effect of GDP on harvest area, productivity, production, and IHK. This research uses the Ordinary Least Square (OLS) regression analysis method. The results of the model estimation used to determine the relationship are described below along with the complementary tests.

Table 1. Econometric Model Estimation Result

Y^t= -6.602226 $X1^{(t)}$ -2.922900 $X2^t$ -0.716334 $X3^{(t)}$+ 2.175843 $X4^{(t)}$ (0.0012) (0.0329) (0.5058) (0.0815)
R2 = 0.913759; DW-Stat = 2.370757; F-Stat = 13.24431; Sig. F-Stat = 0.007174
Diagnosis Test Multicollinearity (VIF test) X1 = 1.804272; X2= 1.504865 ; X3 = 1.214298 ; X4 = 1.327811 Autocorrelation (Breusch Godfrey test) Obs*R-squared= 4.738931; Prob. Chi-Square(2)= 0. Normality (Jarque Bera test) Jarque-bera = 0.436711; probability = 0. Heteroscedasticity (ARCH) Obs*R-squared= 0.576055; Prob. Chi-Square(1)= 0.4479
Notes: *Significant at □ = 0.01; **Significant at □ = 0.05; ***Significant at □ = 0.10; Numbers in parentheses are empirical probability (p value) t-statistics.

A. Model goodness test

It can be seen that the probability value, or empirical significance of the F statistic in the estimated model has a value of 0.007174 which means <0.01; so H0 is rejected. Based on the results of testing the goodness of the model, it is known that the value of R2 is 0.913759, which means that the variables of harvest area, productivity, production, and IHK jointly affect GDP by 91.37% while the remaining 8.63% is explained by variations in other variables or factors outside the model studied.

B. Validity Test of Influence

The results of the effect validity test for all independent variables are summarised in Table 1.

Table 2. Validity test results Influence

Variables	Sig.t	Criteria	Conclusion
Harvested Area (X1)	0.9409	>0,10	Significant at α = 0.05
Productivity (X2)	0.1928	>0,10	Significant at α = 0.05
Production (X3)	0.3073	>0,10	Significant at α = 0.05
IHK (X4)	0.9470	>0,10	Significant at α = 0.05

C. DISCUSSION

Intepretation of the Influence of Independent Variables From the influence validity test, it can be seen that all independent variables, namely harvest area (X1), productivity (X2), production (X3), and IHK (X4) have a significant influence on GDP.

Variable Area of Harvest (X1) has a probability from the regression results with OLS method of 0.0012 significant at alpha 0.05. The pattern of the relationship between these two variables is logarithm-linear with GDP, meaning that if the harvest area increases by 1 per cent, gross domestic product will increase by 0.0012 per cent. Conversely, if the harvest area decreases by 1 per cent, the gross domestic product will decrease by 0.0012 per cent.

Variable productivity (X2) has a probability of regression results with OLS method of 0.0815 significant at alpha 0.05. The pattern of the relationship between these two variables is a logarithmic-linear variable with GDP, meaning that if productivity increases by 1 per cent, gross domestic income will increase by 0.0815 per cent. Conversely, if productivity falls by 1 per cent, gross domestic income will fall by 0.0815 per cent.

Variable Production Area (X3) has a probability of regression results with OLS method of 0.0329 significant at alpha 0.05. The pattern of the relationship between these two variables is a logarithmic- linear variable with GDP, meaning that if production increases by 1 per cent, gross domestic income will increase by 0.0329 per cent. Conversely, if production decreases by 1 per cent, gross domestic income decreases by 0.0329 per cent.

The consumer price index variable (X4) has a probability from the regression results with the OLS method of 0.5058 significant at alpha 0.05. The pattern of the relationship between these two variables is logarithm-linear with GDP, meaning that if the consumer price index increases by 1 per cent, gross domestic income will increase by 0.5058 per cent. Conversely, if the consumer price index falls by 1 per cent, gross domestic product will fall by 0.5058 per cent.

Based on regression analysis using the Ordinary Least Squares (OLS) method, it can be concluded that harvest area, productivity, and production area have a significant influence on Gross Domestic Product (GDP), with probabilities of 0.0012, 0.0815, and 0.0329, respectively. A 1% increase in harvest area, productivity, and production will increase GDP by 0.0012%, 0.0815%, and 0.0329% respectively. Conversely, a decrease in all three variables will decrease GDP in the same proportion. However, the consumer price index shows no significant effect on GDP with a probability of 0.5058. This finding confirms the importance of agricultural sector management and productivity in driving economic growth.

D. Economic Interpretation

- Growth of Agriculture Sector in ADHK GDP

The agricultural sector, particularly food crops, plays a significant role in Indonesia's IHK GDP. The size of harvest areas and the amount of production of key commodities such as rice, corn, and soybeans can be a key indicator of economic stability in this business sector. If harvested area and production increase, then the contribution of the agricultural sector to GDP tends to grow, given that agriculture supports food needs and affects people's purchasing power and welfare.

- Effect of Harvested Area on GDP

An increase in harvested area is usually accompanied by an increase in production volume, which drives up the sector's value-added in the ADHK calculation. However, an increase in harvested area is not always directly correlated with an increase in production. Other factors such as productivity per hectare, climate change, technology use, and agricultural practices greatly affect yields. If productivity per hectare is low, then even if the harvested area increases, production does not increase significantly and hence the impact on GDP may be limited.

- Effect of Productivity on GDP

Rice productivity is influenced by the amount of production that occurs in a certain period, so that the calculated output of production has an influence on the income of the agricultural sector. Therefore, every time there is an increase in rice productivity that directly affects the agricultural sector, the changes that occur automatically affect the gross domestic product.

- Effect of Production on GDP

An increase in rice production can affect the output of the agricultural sector. In this study, it was found that there was no significant effect of rice paddy production on the agricultural sector which in turn could also affect GDP.

- Effect of Overall Price Index on GDP

The price of rice will always follow the development of the price of production needs, so that the inflation that occurs can affect the price of rice production, which is seen through the IHK indicator. With an increase in rice price inflation as an indicator of the IHK, the price of rice will also increase, which has an impact on GDP.

- Climate Variability and Productivity Challenges

From 2014 to 2023, Indonesia experiences climate variations that affect food production. Years with El Niño or La Niña

phenomena often cause production uncertainty. El Niño, for example, often reduces rainfall and affects soil fertility, reducing crop yields. This leads to a decline in the agricultural sector's contribution to GDP. In this situation, government policies focusing on food security are important to stabilise the sector.

- Economic Trends and Dependence on the Agricultural Sector

Based on historical trends from 2014 to 2023 data, the agricultural sector is gradually transforming towards efficiency with the use of technology. However, the economic dependence of some regions in Indonesia, especially the agricultural regions, is still high on harvested area and production. Therefore, variability in these two aspects directly affects local and national GDP. Food security is also a strategic issue, where stable production and sufficient domestic demand can increase the economy's resilience to global food price fluctuations.

- Latest Data and Policy Recommendations

Based on the latest data, crop diversification efforts and increased productivity by adopting agricultural technology are solutions to optimise crop yields and increase the agricultural sector's contribution to GDP. The government can also strengthen the agricultural insurance system to reduce farmers' economic risks due to crop failure. Data for 2023 shows an increase in productivity per hectare in several commodities due to these interventions, which can strengthen the agricultural sector in Indonesia's economic structure.

In the overall analysis, it can be seen that harvested area and production not only affect the economic volume of the agricultural sector but also have a domino effect on food security, economic stability, and community welfare. Therefore, planning and policies that support the development of sustainable harvest areas and increased agricultural productivity will play an important role in maintaining the sector's positive contribution to Indonesia's GDP.

V. CONCLUSIONS

In Indonesia, the role of the agricultural sector is increasingly crucial due to its contribution as the third largest contributor to Gross Domestic Product (GDP), which plays a key role in national economic growth. Although Indonesia's economy contracted during the Covid-19 pandemic, the agricultural sector managed to record positive growth. Over the past three years, the sector has continued to grow with an average growth of around 1.77 per cent in 2020, 1.87 per cent in 2021, and reached around 2.25 per cent in 2022 according to BPS data in 2023.

Based on the results of the analysis in this study, it was found that the variables X1 (harvest area) and X3 (production) have a positive influence on Y (GDP), which is significant at alpa 0.05. However, there are two independent variables that are not significant in this study, these variables are X2 (productivity) and X4 (IHK).

The results of this study can be explained by various economic conditions that have occurred in Indonesia. As described in the explanation below:

The agricultural sector is the backbone of the Indonesian economy. The sector's contribution to Gross Domestic Product (GDP) is significant, especially for rural areas. The growth of the agricultural sector is not only influenced by the area of land planted, but also by productivity factors, technology, and government policies. Increasing productivity per hectare is key to increasing the added value of agricultural production and farmers' welfare.

Climate change poses a major challenge to the agricultural sector in Indonesia. Phenomena such as El Niño and La Niña can cause droughts or floods that negatively impact agricultural production. In addition, rising global temperatures can also lead to changes in cropping patterns and the emergence of new pests and diseases. To face these challenges, adaptation efforts are needed such as the development of crop varieties that are resistant to climate change, efficient irrigation systems, and the application of appropriate agricultural technologies.

The government has an important role to play in supporting the development of the agricultural sector. Appropriate policies, such as the provision of agricultural infrastructure, access to credit, and market development for agricultural products, can boost the growth of this sector. In addition, the government also needs to provide support to farmers in the form of agricultural extension, seed assistance, and subsidised fertilisers. With strong support from the government, the agricultural sector in Indonesia can become more productive, sustainable, and able to fulfil the food needs of the people.

The following are suggestions for research outlined in the given file, focusing on analysing the determinants of rice harvest area, rice productivity, rice production, and consumer price index on Gross Domestic Product (GDP) in Indonesia.

VI. ADVICE

Expanding the scope of the study is highly recommended and expected to be done by future researchers. Integrating additional variables that may affect GDP, such as government policies, access to agricultural technology, and the impact of climate change

may provide a more comprehensive picture of the factors at play in the agricultural sector.

Given the significant impact the COVID-19 pandemic has had on the agricultural sector, it is important to explore how the pandemic has affected farmers' productivity and welfare. This research could include interviews with farmers and data analysis before and after the pandemic to get a clear picture of the impact.

It is also beneficial to involve stakeholders such as farmers, local governments, and research institutions in the research process. By involving them, researchers can gain a broader and more relevant perspective on the challenges and opportunities in the agricultural sector.

ACKNOWLEDGMENT

Firstly, the author would like to express his gratitude to Allah SWT for giving his grace in the preparation of this article. The authors would like to thank all those who have contributed to the preparation of this journal in the preparation of this journal, especially to the second author, Mrs Eka Agustiani, S.E., M.M. as well as the lecturer who directed and taught the author so that it could be completed well, so that it can be completed properly.

Then thank you infinitely to my beloved mother, Sadiah. To the dearest father, Fendi Saleh. And the author's proudest younger brother, Naufal Azman Taufil. who always supports, prays, and directs the author to be able to complete this research well. And thanks to, Baiq Serenity Aquila Balqish, S.E. as the author's discussion partner while compiling this research. As well as reviewers, editors, and supporting institutions that have provided direction, input, and opportunities so that this journal can be completed properly.

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