The Effect of Rice Productivity on Farmers' Welfare and Food Crop Investment in Indonesia

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Abstract: *Rice is a fundamental staple in Indonesia, playing a vital role in both the diet of the population and the agricultural economy. As rice productivity influences not only food security but also the economic well-being of farmers, understanding this relationship is crucial for developing effective agricultural policies. Enhanced productivity can lead to increased income for farmers, which in turn can foster greater investment in food crop production and improve overall agricultural sustainability. The study aims to determine how improvements in rice productivity influence the economic well-being of farmers and their investment decisions in food crops. Utilizing the Error Correction Model (ECM) for data analysis, the research examines both short-term and long-term relationships between rice productivity, farmers' welfare, and food crop investment. The findings reveal that increased rice productivity significantly enhances farmers' welfare, leading to higher levels of investment in food crops. These results highlight the importance of improving rice productivity as a strategy to promote agricultural development and improve the livelihoods of farmers in Indonesia.*
Keywords: *Rice Productivity, Farmers Welfare, Investment*
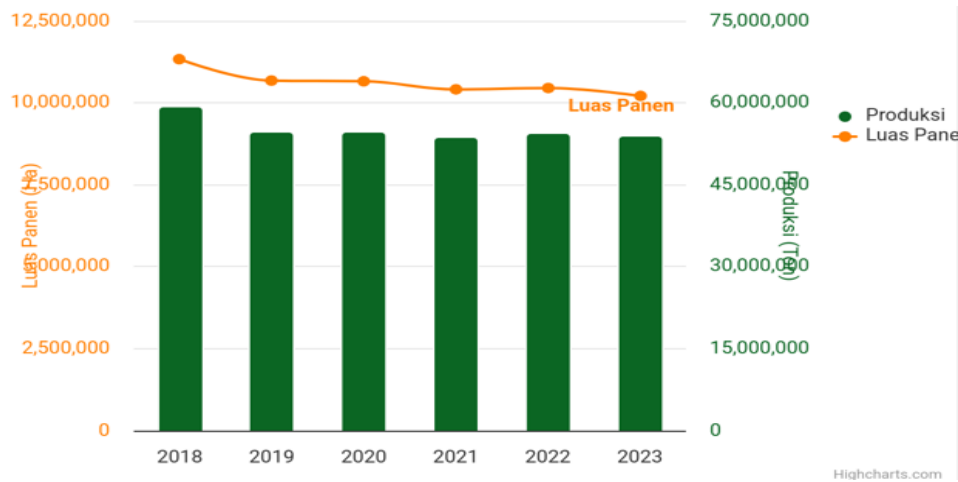
INTRODUCTION

One of the key pillars supporting Indonesia's economy is the agricultural industry. Since rice is a staple food for a substantial portion of the population, increasing rice output is crucial to ensuring food security. Government policy, climate change, and agricultural technology have all had an impact on the agricultural industry during the past 10 years, particularly on rice. A substantial portion of Indonesia's GDP comes from the agricultural sector. Agriculture continues to be a major source of income for many people, particularly in rural areas, even though its share is decreasing as the industrial and service sectors grow.

In an attempt to promote national food security, the Indonesian government has increased rice output through a number of calculated measures. Superior rice varieties and sound agronomic techniques can boost rice yield, according to Norman Borlaug, an agricultural expert dubbed the "father of the green revolution." (Evans & Lawson, 2020) According to Vergauwen and De Smet (2017), he underlined the significance of innovation in raising crop yields (Vergauwen & De Smet, 2017). The effective use of resources, such as land, water, and other agricultural inputs, to generate the highest possible yield is what Seetharam refers to as rice productivity. According to Hossain, rice productivity is the yield produced per hectare, which is impacted by variables including technology, climate, and agricultural policy. In this

context, productivity is not just about quantity but also sustainability (Mulati et al., 2022). In order to achieve greater productivity, he underlined the significance of social and economic aspects (Wahyudi Manurung et al., 2020)

Source : BDSP Kementerian Pertanian, 2024
Figure 1. Rice Production and Harvest Area 2018 – 2023

The pattern of Indonesia's rice productivity from 2018 to 2023 is erratic, with a decline in production in 2023. Indonesia produced 59.20 million tons of rice in 2018. Indonesia produced 53.98 million tons of rice in 2023, a 1.4% decrease from 2022. Reduced harvest areas and drought brought on by El Nino were the main causes of the 2023 production drop. Indonesia produced 5.24 tons of rice per hectare in 2022. Indonesia's rice yield increased by 0.9 percent from 2022 to 5.29 tons per hectare in 2023. 10.21 million hectares of rice were harvested in Indonesia in 2023, a 2.29 percent decrease from 2022. Since 2018, BPS has determined the size of rice harvest areas using the Area Sampling Framework (ASF) approach. Compared to the earlier approach, this one is thought to be more accurate. From 2018 to 2023, Indonesia's rice production contribution by province demonstrates dynamics impacted by governmental regulations, weather patterns, and technology advancements (Badan Pusat Statistik, 2024)
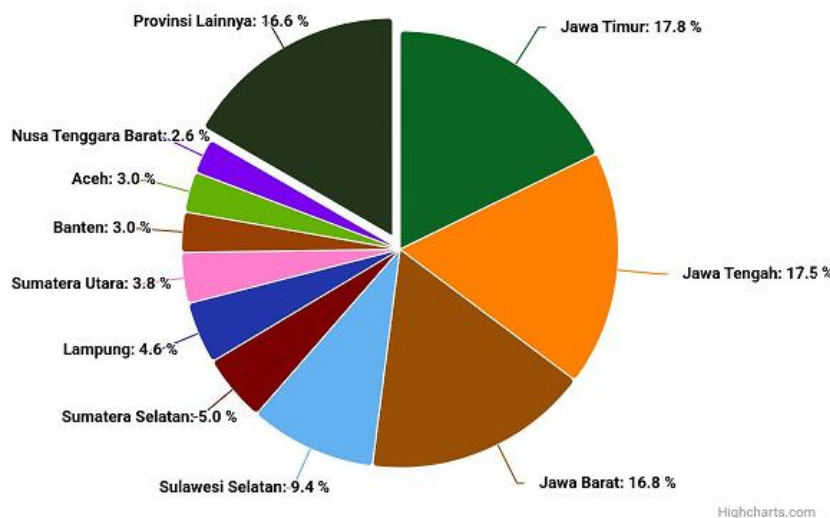
Source : BDSP Kementerian Pertanian, 2024
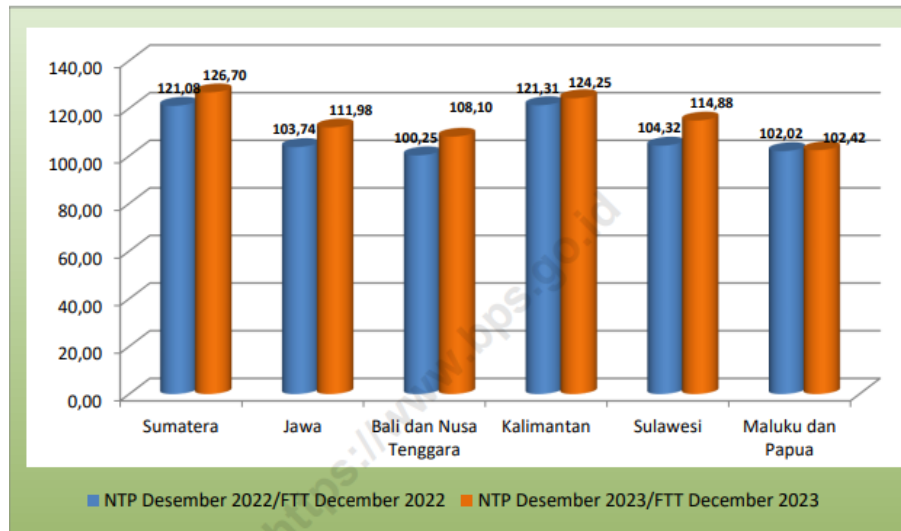**Figure 2. Rice Production Contribution, Average for 2018–2023**

With a five-year average contribution of 17.8% and a total output of 9.71 million tons of MDG in 2023, East Java continues to be Indonesia's leading producer of rice. East Java, the greatest rice-producing province, is renowned for its organized agricultural initiatives and has numerous well-irrigated regions. Here, rice output is comparatively steady and frequently rises. At 16.8% and 17.5%, respectively, West Java and Central Java also make major contributions to the country's rice production (Kementerian Pertanian, 2021)

In order to become a rice-self-sufficient nation and the largest exporting nation in the world, it is anticipated that the rise in rice productivity brought about by the aforementioned factors will improve farmer welfare, create an environment that is favorable for investment in the food crop sector, and lessen the amount of rice imports that have so far placed a strain on the government budget.

Farmers can produce more rice from the same amount of land if rice productivity rises. Farmers will be able to better meet their daily demands thanks to higher yields, which will immediately enhance their income. Better product quality frequently follows increased production. Farmers might obtain a higher price for their produce since premium paddy is more sought-after in the marketplace. Farmers can invest more money in improved agricultural technology, such as farm equipment and tools, when their revenue rises. This can further boost production. Similarly, increased wages enable farmers to set aside money for the medical and educational expenses of their kids. This can lead to a healthier and better-educated generation, which benefits society overall (Buletin Konsumsi Pangan, 2021)

The Farmer Exchange Rate (NTP) is frequently used to measure indicators of farmer welfare. A ratio known as the Farmer Exchange Rate (NTP) compares the price that farmers receive for their produce to the price they pay for the commodities and services they require. According to Keumala and Zainuddin (2018), NTP is a crucial metric for evaluating the competitiveness of the agricultural industry as well as the welfare of farmers (Keumala & Zainuddin, 2018) Amartya Sen stressed how crucial it is for farmers to have access to markets and financial tools. According to him, a low NTP could be a sign of unequal resource allocation and farmers' restricted access to high-quality agricultural inputs (Desvina & Meijer, 2018). Gary Becker considers economic behavior while analyzing farmer exchange rates. According to him, NTP influences farmers' decisions to produce and sell agricultural goods; a high NTP will incentivize farmers to boost investment and production (Nugrahaning Widi, 2021)

The Central Bureau of Statistics' 2023 agricultural exchange rate statistics show that the NTP grew by 8.03 percent in December 2023 as opposed to December 2022. The rise in It (11.72 percent) was higher than the increase in Ib (3.41 percent), which had an impact on this. The Food Crop Subsector saw the largest growth in NTP at 12.32 percent, followed by the Horticultural Crop Subsector at 11.72 percent and the Smallholder Plantation Crop Subsector at 5.18 percent. NTP has increased in a number of subsectors. In the meantime, the Fisheries Subsector saw the largest drop in NTP (1.95 percent), followed by the Livestock Subsector (0.64%) (Badan Pusat Statistik Indonesia, 2024)

**Figure 3. Average Farmer Exchange Rate by Region, December 2022
and December 2023**

Better agricultural potential is shown by higher rice productivity, which may draw investors to food crops. The distribution of resources (money, manpower, and technology) to boost food crop production is referred to as food crop investment. The agricultural sector's efficiency, productivity, and sustainability are intended to be enhanced by this investment (Lenggogeni, 2012). In the agricultural industry, Schultz underlined the value of investing in both people and physical capital. Food crop production may be made more productive and efficient by investing in research, education, and agricultural infrastructure (Ilmi, 2019). According to Keynes, investment in the agricultural sector, including food crops, is crucial for promoting economic growth. He emphasized that the right investment can increase production capacity and create jobs, which in turn will increase farmers' income and community welfare (Sari et al., 2023)

Investors are more inclined to make larger investments in infrastructure, technology, and the development of agricultural products when crop yields are successfully increased. Projects with strong prospective returns are typically the ones that attract investors. The flow of capital into the agriculture sector rises as a result of investors seeing good opportunities as rice productivity rises. Improved seed types, sustainable agricultural methods, and effective irrigation systems are examples of innovative technology that are frequently used in conjunction with increased production. These developments draw funding for research and development in addition to raising yields. Farmers may boost their yields with improved technology, which in turn stimulates further investment in agricultural product development and innovation.

Primary sector investments (agricultural cultivation businesses) and secondary sector investments (processing industries) make up the agriculture sector's investment portfolio. It is interesting to note the pattern of investment development in primary agricultural businesses during the 2014–2022 period because, while average growth is still positive (18.29 percent annually for domestic investment and 3.27 percent annually for foreign investment), domestic investment tends to rise while foreign investment tends to fall during the 2014–2019 period.

The study "The Impact of Rice Productivity on Farmers' Income in Indonesia: Perspectives from Sustainable Agriculture" by Susilo, A., & Yusuf, M. (2023) is one of the earlier studies that is pertinent to this one. This study demonstrates that raising rice productivity considerably raises farmers' incomes, improving their welfare in the process (Finger et al.,

2023). The significance of sustainable farming techniques in raising production yields is also highlighted by this study. The following study, "Investment in Agricultural Technology and Its Effects on Rice Productivity and Farmers' Welfare in Indonesia," was carried out by Novita, D., & Pratiwi, R. (2022). According to this study, rice productivity significantly increased as a result of investments in agricultural technology, such as better rice varieties and effective irrigation. In addition to showing a positive return on investment in the food crop sector, this helps to increase farmer welfare (Villacis et al., 2023). Lastly, the study "Rice Production and Its Socioeconomic Impacts on Rural Farmers in Indonesia: A Study of the Java Region" by Rahman, I. A., & Hidayat, R. (2023). The social and economic effects of rice cultivation on the well-being of farmers in rural Java, Indonesia, are investigated in this study. The findings indicate that greater access to health and education services for farmers is positively connected with higher rice yield (Aprillya et al., 2019)

Based on the three references above, some research gaps that can be identified are:
1. Geographical Context Limitations:
   The majority of research tends to concentrate on particular areas, such Java. Investigating the effects of rice productivity in other Indonesian regions with distinct agricultural and economic circumstances is also necessary.
2. Environmental and Sustainable Aspects:
   Research that thoroughly examines the connection between rice productivity, sustainability, and its effect on long-term farmer wellbeing is lacking, despite the fact that numerous studies have emphasized the significance of sustainable methods. In the context of productivity, this study may use social and environmental-based methodologies.
3. Investment vs. Long-term Results:
   There is little data on how technology investments affect long-term results and how they affect farmer welfare. There is a chance to carry out longitudinal research that can shed light on how farmer welfare evolves over time in response to shifts in productivity.

By recognizing this research gap, the study can significantly advance our knowledge of the effects of rice productivity in Indonesia and provide suggestions for crop sector investment and agricultural policy. To support the claims and methodology of this study, make sure to look for and evaluate further material.

RESEARCH METHODS

Error correction model analysis, or ECM (Error Correction Model), is a quantitative data analysis method that was employed to address the issues in this study. An econometric technique called the Error Correction Model (ECM) is used to examine both short-term and long-term correlations between cointegrated (long-term equilibrium) economic variables. The Engle-Granger model served as the basis for the ECM, which is frequently employed in the analysis of time series data (Gujarati et al., 2015)

RESULTS AND DISCUSSION
Results of the Stationarity Test

The unit root test, also known as data stationarity, should be performed on each variable that will be used in the study before utilizing regression. The Augmented Dickey-Fuller (ADF) test method, a data stationarity test, is used in the author's research. With the exception of short-term residuals, which demand that variables be stationary at the Level level, all variables have not been stationary at the Level level, necessitating a retest to determine the degree of stationarity. The findings of the stationary test are as follows:

Table 1. Results of the Stationarity Test

Variabel	At Level		At 1ˢᵗ Difference	
	ADF Prob	Explanation	ADF Prob	Explanation
Rice Productivity	0,6335	Not Stationary	0,0005	Stationary
Farmers' Welfare	0,3847	Not Stationary	0,0000	Stationary
Investment	0,2486	Not Stationary	0,0000	Stationary
Residual short time	0,0000	Stasioner	-	-

Source: Data processed by Eviews 12

The ADF statistical test findings for the first difference are displayed in Table 1, indicating that the null hypothesis is rejected. In other words, the data on all variables is reduced once the data becomes stationary. has a likelihood value below 0,05. This indicates that all of these variables match the criteria for employing Error Correction Model (ECM) analysis, have stationary data circumstances at the first difference level, and are free of unit root issues.

Cointegration Test

Cointegration testing using the Johansen technique approach is used to assess the cointegration between the variables of rice productivity, farmer welfare, and food crop investment. The following are the outcomes of this method:

Table 2. Results of the Johansen Cointegration Test

Trace Statistic	0.05 Critical Value	Probability	Explanation
48,27685	15,49471	0,0000	Terkointegrasi
Max Eigen Statistik	**0.05 Critical Value**	**Probability**	**Explanation**
46,29029	14,26460	0,0000	Terkointegrasi

Source: Data processed by Eviews 12

The test results above are shown in Table 2. The Trace Statistic value (48,27685) > Critical Value (15,49471) and Probability value 0,0000 < 0,05, as well as the Max Eigen Statistic value (46.29029) > Critical Value (14.26460) and Probability value 0,0000 < 0,05, indicate that there is cointegration in the equation model for rice productivity, farmer welfare, and food crop investment over the long term, which satisfies the ECM analysis requirements.

Error Correction Model Estimation
1. **Effect of rice productivity on farmer welfare**

Since there is a long-term balance, the analysis employed in model 1 is the Error Correction Model (ECM), according to the results of the stationarity and cointegration tests that were conducted. The following are the regression results that demonstrate the causal relationship between the independent and dependent variables:

Table 3. ECM Short-term and Long-term Estimates Model 1

SHORT-TERM ESTIMATION

Dependen Variable : FARMER WELFARE				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0,016236	0,004866	3,336848	0,0018
D(Ln_PRODUCTIVITY)	0,974850	0,024489	39,80837	**0,0000**
RES(-1)	-0,224616	0,109929	-2,043286	0,0386
R-squared	**0,783042**	**Prob(F-statistic)**	0,000000	
Adjusted R-squared	0,782100	**Durbin-Watson stat**	1,804076	
LONG TERM ESTIMATION				
Dependen Variable : FARMER WELFARE				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	6,084423	0,449366	13,54002	0,0000
Ln_PRODUCTIVITY	0,701610	0,063085	11,12162	**0,0000**
R-squared	**0,764983**	**Prob(F-statistic)**	0,000000	
Adjusted R-squared	0,758798	**Durbin-Watson stat**	1,901424	

Source: Data processed by Eviews 12

With the coefficient of determination showing a short-term R-Squared value of 78,30 percent and a long-term R-Squared value of 76,49 percent, Table 3's results indicate that the impact of rice productivity on farmers' welfare is both short- and long-term. The estimation results table contains calculation results that statistically show significant results on the probability value of rice productivity is smaller = than α (0,0000 ≤ 0,05).

The findings demonstrated that:

1) Farmers' incomes are immediately increased by higher yields, allowing them to satisfy their basic demands and enhance their standard of living.
2) Improved agricultural technologies and techniques are made available to farmers by high productivity, which boosts yields and efficiency.
3) By lowering the chance of losses from unfavorable weather or changes in prices, increased production helps farmers achieve financial security.
4) Over time, higher output may persuade farmers to make investments in improved experience, education, and infrastructure—all of which enhance well-being.
5) The entire agricultural industry may grow with higher production, generating jobs and enhancing community well-being.

When taken as a whole, these elements demonstrate how rice productivity can be the key to greatly enhancing farmers' wellbeing.

2. Effect of Rice Productivity on Food Crop Investment

Because of the long-term balance, the analysis employed in model 2 is the Error Correction Model (ECM), which is based on the results of the stationarity and cointegration tests. The following regression findings demonstrate the causal relationship between the independent and dependent variables:

Table 4. ECM Short-term and Long-term Estimates Model 2

SHORT-TERM ESTIMATION				
Dependen Variable : FOOD CROP INVESTMENT				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	2,630205	0,356079	7,386578	0,0000
D(Ln_PRODUCTIVITY)	0,635390	0,065653	9,677961	**0,0000**
RES(-1)	-0,346503	0,120368	-2,878702	0,0071
R-squared	**0,806999**	**Prob(F-statistic)**	0,000000	
Adjusted R-squared	0,790851	**Durbin-Watson stat**	1,928270	
LONG TERM ESTIMATION				
Dependen Variable : FOOD CROP INVESTMENT				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	5,807213	2,148080	-2,703444	0,0102
Ln_PRODUCTIVITY	0,596129	0,131048	4,548939	**0,0001**
R-squared	**0,752562**	**Prob(F-statistic)**	0,000054	
Adjusted R-squared	0,735524	**Durbin-Watson stat**	1,964803	

Source: Data processed by Eviews 12

With a coefficient of determination with a short-term R-Squared value of 80,69 percent and a long-term R-Squared value of 75,25 percent, it can be concluded that the rice productivity variable has a significant and positive effect on food crop investment in Indonesia. This conclusion is based on the results of Table 4, which shows the effect of rice productivity on food crop investment over the short and long term. The estimation results table's calculation results statistically show significant results on the probability value of rice productivity smaller = α (0,0000 ≤ 0,05).

The results showed that :

1) Economic Benefits: Farmers who produce more rice earn more money, which motivates them to make further investments in improved farming methods and technologies.
2) Farmer Confidence: Successful outcomes boost farmers' confidence to invest more in infrastructure upgrades and agricultural inputs.
3) Financial Access: Farmers that are more productive have easier access to loans and funding, which encourages them to invest in other food crops.
4) Business Diversification: Farmers are more inclined to plant a variety of crops when yields are steady, which raises overall investment in the agriculture industry.
5) Long-Term Impact: Over time, higher rice productivity improves the agricultural economy and food security by fostering more favorable conditions for sustainable investment..

These interconnected elements demonstrate how increased investment in food crops can be fueled by rice yield.

CONCLUSION

The following conclusions can be drawn from the research findings: 1) In both short- and long-term estimations, rice productivity significantly and favorably affects farmers' welfare. This suggests that raising rice productivity can enhance farmers' income and standard of living, therefore it's critical to keep promoting farming methods that boost yields and guarantee the long-term sustainability of their well-being. 2) Both short- and long-term estimations show that

rice productivity significantly and favorably affects food crop investment. This suggests that raising rice productivity motivates farmers to make greater investments in the development of food crops, which can boost agricultural output generally and promote food security.

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