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Impact of Rice Price Fluctuations on the Welfare of Paddy Farmers

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ABSTRACT

Rice is a staple food for Indonesia and should be available at an affordable price. This study aims to analyze the factors causing fluctuations in rice prices, and analyze the effect of changing prices on the livelihoods of rice farmers. The farmers' welfare was calculated using Farmer Exchange Rate (FER). The analysis was conducted using a simultaneous equation model, utilizing time series data from 2009 to 2023. This study employed Two-Stage Least Squares (2SLS) and Multiple Linear Regression techniques. The findings reveal that rice production is significantly influenced by the previous year's rice prices and the size of the harvested area. Meanwhile, the factors affecting consumption are the rice price variable and income levels, as well as the factors influencing rice prices, which include the price of unmilled dry grain, rice production, and the highest retail price. Meanwhile, regarding the welfare of rice farmers measured by the FER, it is known that the FER in East Java has fluctuated from 2009 to 2023. The highest contributor to the rice FER occurred in 2023, reaching 115.64%, with an average FER for East Java from 2009 to 2023 of 102.86%. This indicates that the Rice FER is in a surplus state, suggesting that rice farmers are prosperous.

1. INTRODUCTION

From both social and economic perspectives, as an agrarian-based country, Indonesia relies heavily on its population working in the agricultural sector. One of the agricultural commodities is rice, which is consumed by the greater part of Indonesia's citizens work as a staple food because it is the most easily found staple food and contains carbohydrates and energy (Widayanti *et al*., 2020). A large portion of the population continues to reside in rural regions and relies on agriculture for their livelihood, particularly rice, as their main source of livelihood. Rice as a source of income for farmers can also be used to improve farmers' welfare and maintain environmental balance (Ningrat *et al*., 2021). Several top rice-producing regions in Indonesia are East Java, West Java, Central Java, South Sumatra, Lampung, South Sulawesi, Bali, West Nusa Tenggara, and North Sumatra. According to BPS (2023), the harvested rice area is projected to cover approximately 10.20 million hectares, yielding around 53.63 million tons of dry unhusked rice (GKG). For the year 2023, rice output is estimated to reach 30.90 million tons of milled white rice intended for public consumption.

East Java is the largest rice producer among several provinces in Indonesia. In 2023, the production of rice and paddy in East Java Province ranked highest as the largest rice producer nationally, with a harvest area of approximately 1.685 million hectares. The production reached 9.591 million tons DUR, or 5.538 million tons of rice in second place is West Java, followed by Central Java in third place. Based on data from the BPS (2023) in 2023 the three regencies in East Java with the top producers in terms of total GKG rice production include Lamongan, Ngawi, and Bojonegoro. The bottom three cities in terms of rice production include Surabaya, Pasuruan, and Kediri.

The fluctuations in rice production can affect the prices of both medium and premium rice in the market. The important characteristic or nature of rice as one of the seasonal agricultural products means that not all agricultural products can be found every year. This season is influenced by climate and weather, which directly impacts crop production. This seasonal characteristic causes prices to be high when supply is low but low when supply is abundant, allowing farmers to receive lower prices for their products (Daryanto *et al*., 2021). In addition to being easy to find, the price of rice per kilogram also varies. If the production quantity is low, the amount of goods offered or available in the market will decrease, leading to a price increase, and vice versa. If the amount of rice available in the market decreases due to reduced production, the price will increase; consequently, if there is a bumper harvest, the prices of both medium and premium rice will decrease. Based on the graph regarding rice prices by the BPS (2023), the prices of both premium and medium quality rice are not always stable each year, with fluctuations in both increases and decreases. From the ten-year graph, the lowest rice price occurred in 2013 and the highest rice price in 2023. BPN (2023) recorded the average rice price in the week of October 2023 at 13,216 IDR/kg, down 0.18 percent from the average of the previous week at 13,240 IDR/kg. The highest price was recorded in Papua at 15,975 IDR/kg, and the lowest was in South Kalimantan at 12,079 IDR/kg.

The prices of medium and premium quality rice in East Java Province have been increasing since August 2023. According to the SISKAPERBAPO (2025), the mean price of medium-quality rice in East Java Province at the end of first week of May 2025 was 12,782 IDR/kg. Sumenep Regency recorded the highest average price for medium-grade rice at IDR 13,000/kg, whereas Malang City had the lowest at IDR 10,783. Meanwhile, the average price of premium rice rose by 25 points, reaching IDR 13,776/kg. Among all regions, Bangkalan Regency reported the highest average premium rice price at IDR 15,666, while the lowest was in Mojokerto Regency at IDR 12,375/kg. Addressing rice price volatility is crucial, as it directly impacts the livelihood and welfare of rice farmers. The farming industry, as an economic driver, plays a part in enhancing the well-being of farmers, who serve as the primary stakeholders in the sector, providing food, shelter, and clothing, and also serving as an input market for the development of the agricultural product industry in the form of raw materials. The welfare of farmers can improve if their income exceeds the costs incurred, but this is balanced by high production levels and good prices. Besides price, income is also influenced by the amount of rice produced (Hartati *et al*., 2017).

The condition in which a farmer can live decently and have access to resources, education, health, and other basic facilities is called farmer welfare. The welfare of farmers can play a crucial contribution to ensuring a nation's sustainability food and agricultural system. Improving farmers' welfare is expected to contribute positively on food security, economic development, food sovereignty, and efforts to reduce poverty. However, improving farmers' welfare is not easy and there are many challenges that must be faced. Many farmers face dependence on certain markets that are unstable and fluctuating, as well as a lack of access to resources.

The Farmer Exchange Rate (FER) serves as a key indicator in assessing the welfare of farmers. In practice, FER evaluates the purchasing power of farmers by comparing the value of agricultural outputs they produce to the cost of goods and services consumed by farming households, as well as inputs needed for agricultural production (Bima, 2022). Ekaria & Hassyati(2014), suggest that farmer welfare in Indonesia can be assessed through this exchange rate, which is calculated by comparing the percentage of what farmers pay against what they earn (Aulia *et al*., 2021). Based on this contextual background, the current study seeks to examine the factors driving fluctuations in rice prices and to assess how these price shifts affect the well-being of rice farmers. The findings are expected to provide a fair basis for evaluating farmers' prosperity.

2. MATERIALS AND METHODS

This research used secondary data series over the period from 2009 to 2023, included data and information on rice prices, consumption, and production that influence price fluctuations. Production, consumption, and rice prices are the factors studied, along with welfare using the FER in East Java region along with its contributing factors, namely harvest area, selling price, fertilizer price, and farm labor wages. Data analysis was conducted using two stages least square, which involved both simultaneous testing and multiple linear regression analysis through SPSS version 29. The reason for using simultaneous analysis of two stages least square is because based on the theory from Kristian (2013) the factors that affect price fluctuations are production, consumption, and price variables. In the equation, there are influencing factors, such as the production equation with variables of the price of rice, harvest area and price of Urea fertilizer.

2.1. Simultaneous Analysis

Simultaneous analysis was used to answer the first objective, namely analyze the factors causing fluctuations in rice prices. Simultaneous is a model consisting of more than one regression equation, where the regression equations of one regression equation and the other regression equations are interdependent. According to Gujarati & Porter (2012), each simultaneous equation contains three types of variables, namely endogenous variables, predetermine variables, and error variables. To determine the method of estimating parameters for each company, the model is identified based on the order condition as follows:

$$(K\text{-}M) \left| \begin{array}{lll} > (G\text{-}1) & \rightarrow & \text{the equation is over identified} \\ = (G\text{-}1) & \rightarrow & \text{the equation is exactly identified} \\ < (G\text{-}1) & \rightarrow & \text{the equation is under identified} \end{array} \right. \quad (1)$$

where K represents the total number of variables in the model, M indicates the combined total of endogenous and exogenous variables within the identified equation, and G refers to the total number of equations in the system. The main focus of this first research objective is to examine the determinants influencing the production, consumption, and retail price of white rice in East Java Province.

2.2. Multiple Linear Regression Analysis

(a) Rice Production

White rice production in East Java Province is allegedly influenced by white rice prices, fertilizer prices and harvest area. The multiple linear equation for rice production (QR) was formulated as the following:

$$QR = a_{i0} + a_{i1}\,PR_{t-1} + a_{i2}\,HA_i + a_{i3}\,PF + e_1 \quad (2)$$

where QR = white rice production (ton/ha), PR_{t-1} = price of white rice in the previous year (IDR/ton), HA = harvest area (ha), PF = fertilizer price (IDR/ton), and e = error. Expected parameters are that $a_1 > 0$, $a_2 > 0$, and $a_3 < 0$.

(b) Rice Consumption

White rice consumption in East Java Province is supposedly influenced by rice prices, income, and population. The multiple linear equation for consumption (C) was formulated as follows:

$$CR = b_1 + b_2\,PR + b_3\,In + b_4\,P + e_2 \quad (3)$$

where CR = white rice consumption (ton/year), In = total income (IDR/year), P = number of population (people/year), and e = error. Expected parameters are $b_1 > 0$, $b_2 > 0$, and $b_3 < 0$

(c) Retail Price of White Rice

The retail price (RP) of white rice in East Java Province is allegedly influenced by rice production, consumption and prices. The multiple linear regression equation for the retail price (RP) of white rice was formulated as follows:

$$RP = c_0 + c_1\,PG + c_2\,QR + c_3\,MP + e_3 \quad (4)$$

where PG = price of GKG (dry unhusked rice grains) (IDR/ton), MP = highest retail price of white rice (IDR/ton), e = error. Expected parameters are $c_1 > 0$, $c_2 > 0$, and $c_3 < 0$.

2.2. Farmer Exchange Rate

The Farmer Exchange Rate (FER) is calculated by comparing the price index received by farmers (IT) with the price index they pay (IB), expressed as a percentage. A higher FER indicates greater purchasing power among farmers. The FER is the result of the formulation of the Laspeyres price index as developed by the BPS (Badan Pusat Statistik). The FER was formulated into the following formula:

$$\text{FER} = \frac{IT}{IB} \times 100\ \% \quad (5)$$

The FER value serves as an indicator for assessing the welfare level of rice farmers based on the following benchmarks Rahmat (2013):

a. FER > 100: farmers have a surplus. Farmers' income is greater than their expenses. Thus, farmers are prosperous.
b. FER = 100: Farmers reach a break-even point when the rise or fall in production prices matches the percentage change in the cost of consumer goods and production inputs. In this condition, the welfare level of farmers remains unchanged.
c. FER < 100: farmers are deficit. Farmers' income is smaller than expenditure. Thus farmers are unprosperous.

2.3. Multiple Linear Regression for FER

Several statistical analyses were conducted, including the t-test, F-test, and the coefficient of determination (R^2). As noted by Sugiyono (2012), multiple linear regression serves as a forecasting method to estimate the effect of two or more independent variables on a dependent variable, and to determine whether a functional relationship exists among them. This method is utilized to identify whether such relationships between the predictors and the outcome variable are statistically significant. In this research, multiple linear regression analysis for FER was mathematically expressed through the following equation:

$$FER = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + e \quad (6)$$

where X_1 = harvested area (ha), X_2 = total production of white rice (ton), X_3 = selling price of white rice (IDR/ton), X_4 = fertilizer price (IDR/ton), X_5 = labor wages (IDR/day), a = constant, $b_1 – b_5$ = regression coefficients, and e = error.

3. RESULTS AND DISCUSSION

Table 1 summarizes the productivity of rice farming in East Java Province for 15 years period from 2009 to 2023. Important variables listed in the table include white rice production, white rice consumption, white rice prices, harvest area, white rice selling price, fertilizer price, farm labor wages, and FER (Farmer Exchange Rate).

3.1. Factors Causing Fluctuations in Rice Price

In the consumption equation there are variables in the price of rice, the amount of income and the number of population while in the price equation there are variables in the price of dry milled grain, production and the highest retail price. Based on all these variables affecting each other or there are exogenous and endogenous variables.

3.1.1. Factors Affecting Rice Production in East Java Province

Table 2 summarize results of analysis of variance (ANOVA) on the rice production. The findings indicate that the R^2 coefficient of determination value of the rice production model is 0.834 meaning that 83.40% of rice production is attributed to the variation among exogenous variables within the model, namely rice price lag, harvested area, and urea fertilizer price. Meanwhile, the remaining variance is influenced by factors not included in the model. Based on the ANOVA (Analysis of Variance) results, the calculated F-value is 23.767, while the F-table value at a 95% confidence level is 2.62 (F-calculated > F-table). Therefore, the null hypothesis (H_0) is rejected and the alternative hypothesis (H_1) is accepted, indicating that the independent variables significantly affect the dependent variable (rice price, harvest area, and urea fertilizer price) together have a significant effect on rice production. Statistical analysis reveals that white rice production in East Java can be estimated according to the following equation:

$$QR = – 1.930 + 0.606\ PR_{t-1} + 0.581\ HA + 0.026\ PF + e_1 \quad (7)$$

The price of rice in the previous year had a positive effect on rice production. Every unit increment in white rice price (PR) in the previous year resulted in the increase of white rice production (QR) in East Java by 0.606 ton. The rice price variable (PR_{t-1}) obtained a p-value of 0.012, which falls below $\alpha = 0.05$, indicating that the rice production is significantly affected by the rice price variable. When viewed partially, the variable of rice price in previous year (PR_{t-1}) obtained a t-count value of 3.862 while t-table at a 95% confidence level is 1.96. In other words, t-count > t-table. Thus, H0 was not accepted. This indicates that the previous year's rice price, as an independent variable, significantly influences rice production in the subsequent year. This finding is consistent with the study carried out by Aldi *et al.* (2020) who reported that the rice price variable significantly affected rice production, with a significance value of p-

Table 1. Performance of rice production in East Java Province in the period of 2009-2023

Year	QR (t)	PR (IDR/t)	HA (ha)	PF (IDR/t)	CR (t/year)	In (10^9 IDR)	Popl. (people)	PG (IDR/t)	RP (IDR/t)	FER (%)	WF (IDR/d)	IB				IT
												HH	BPPBM	Sum.	Avg.	
2009	5,079,978	6,000,000	1,787,354	1,200,000	3,238,171	30,480	37,271,775	2,900,000	5,578,000	93.25	19906.75	119.93	116.83	236.78	118.39	110.4
2010	4,976,503	7,413,000	1,842,445	1,200,000	3,263,708	36,891	37,565,706	3,761,870	6,673,000	94.49	21427.38	131.86	121.1	252.96	126.48	119.52
2011	4,484,487	7,700,000	1,807,393	1,600,000	3,395,654	34,531	37,840,657	4,158,420	6,493,000	106.07	22846.13	140.16	129.98	270.14	135.07	143.27
2012	5,268,569	7,546,000	1,838,381	1,800,000	3,350,161	39,757	38,106,590	4,513,610	8,335,000	**109.2**	24216.38	148.13	136.39	284.52	142.26	155.36
2013	5,263,444	7,799,000	1,897,816	1,800,000	3,395,045	41,050	38,363,195	4,130,790	8,794,000	100.44	25614.25	107.02	105.25	212.27	106.135	106.61
2014	5,608,026	8,076,000	1,934,293	1,800,000	3,450,594	45,290	38,610,202	4,684,620	8,761,000	99.35	27729.88	115.45	110.72	226.17	113.08	112.35
2015	5,888,453	8,955,000	2,021,766	1,800,000	3,472,975	52,731	38,847,561	5,230,130	8,943,000	100.64	30486.88	124.43	117.39	241.82	120.91	121.69
2016	6,105,017	9,006,000	2,112,563	1,800,000	3,566,916	54,982	39,075,152	4,934,900	9,659,000	100.17	32620.63	132.91	120.92	253.83	126.91	127.13
2017	6,282,713	8,919,000	2,136,412	1,800,000	3,601,324	56,036	39,292,971	5,231,780	9,450,000	100.17	33784.5	137.30	125.64	262.94	131.47	131.70
2018	5,861,191	9,759,000	1,828,700	1,800,000	4,200,000	57,199	39,500,851	5,481,570	9,450,000	107.64	38041.13	142.70	131.37	274.07	137.03	147.50
2019	5,503,725	9,548,000	1,702,426	2,250,000	4,323,181	52,550	39,698,631	5,380,380	9,450,000	102.55	42947.38	103.58	103.9	207.48	103.74	106.39
2020	5,742,176	9,752,000	1,702,426	2,250,000	4,301,639	55,998	40,665,696	5,505,000	9,450,000	104.14	46036.75	106.78	106.48	213.24	106.62	111.04
2021	5,652,705	9,371,000	1,747,481	2,250,000	4,260,000	52,971	40,878,789	4,978,450	9,450,000	101.37	55500.50	108.41	109.69	218.01	108.79	110.29
2022	5,500,801	9,647,000	1,704,759	2,250,000	4,378,652	53,066	41,149,974	5,476,890	10,900,000	107.8	61338.63	116.61	115.44	116.26	116.26	125.34
2023	5,607,131	10,709,000	1,698,083	2,250,000	5,612,985	60,047	41,416,407	7,010,590	12,500,000	**115.64**	62974.38	119.97	116.93	236.90	119.09	137.72

Note:
QR : White rice production
PR : Price of white rice
HA : Harvested area
PF : Price of Urea fertilizer
CR : White rice consumption
In : Total income or revenue
Popl. : Number of population
PG : Price of dry unhusked rice (GKG)
RP : retail price of white rice
FER : Farmer Exchange Rate
WF : Wage of farmer worker
IB : Farmer-paid price index
IT : Farmer-received price index
HH : Household
BPPBM : Production Costs and Additional Capital Goods
Sum. : Summation of HH and BPPBM
Avg. : Average of HH and BPPBM

value = 0.001 and a *F*-calculated value of 12.329. However, this contradicts the findings of Rahim *et al*. (2024), who reported that rice prices had a negative and statistically insignificant effect on rice production, with a p-value of 0.091 > 0.05. This suggests that rice prices did not have a meaningful impact on rice production in the nine main rice-producing provinces in Indonesia during the 2017–2021 period.

Table 2. Results of analysis of rice production factors in East Java Province

Variable	Coefficient *a*	Standard Error	*t*-value	Sig
(Constant)	–1.930	5.369	–0.359	0.734
PR_{t-1} (white rice price of the previous year)	0.606	0.157	3.862	0.012*
HA (Harvest area)	0.581	0.178	3.263	0.022*
PF (Urea fertilizer price)	0.026	0.284	0.093	0.930
R-squared = 0.834; Adjusted R-squared = 0.895; *F*-value = 23.767				

Note: * significant at α 5%

The harvest area affects rice production positively and significantly. When the harvest area (*HA*) increases by 1 ha, then rice production (*QR*) will increase 0.581 ton. Given a *p*-value of 0.022, which is below the significance threshold of α = 0.05, the harvest area (*HA*) variable demonstrates a statistically significant influence on rice production. When viewed partially, the variable of harvest area (*HA*) obtained a *t*-count value of 3.263 with a critical *t*-value of 1.96 at the 95% confidence level. Therefore, since the *t*-calculated value exceeds the *t*-table value, the null hypothesis (H_0) is rejected. This indicates that the harvest area, as an independent variable, significantly influences rice production. These findings are consistent with the study conducted by Asriadi (2023) reported that their study results highlight the impact of harvest area on rice production. A similar conclusion was also presented in the research of Susilawati & Halim (2024), finding a *t*-statistical value for the variable rice harvested land area of 30.47, greater than the *t*-table (2.201) which implying that the harvested area of rice paddy during the period 2010-2022 has a significant effect on the increase of rice production in Jambi Province.

The cost of urea fertilizer shows no statistically significant impact on rice production. An increase in urea fertilizer prices (*PF*) increases by one unit, rice production (*QR*) will decrease by 0.026 ton. The variable of Urea fertilizer price (*PF*) did not have a significant impact on the rice production variable, as indicated by its significant value of 0.930, which is greater than α = 0.05. If the urea fertilizer (*PF*) price variable is seen partially, a *t*-count value of 0.093 is obtained and a *t*-table at a 95% confidence level of 1.96 with another word *t*-count < *t*-table. As a result, the null hypothesis (H_0) was accepted, indicating that the urea fertilizer price variable does not have a statistically significant influence on rice production. This outcome aligns with the findings of Hapsari *et al*. (2009), who concluded that urea fertilizer prices were not a determining factor in rice yield variation. Likewise, this study supports the results of Putri *et al*. (2020), who found that the ratio of urea fertilizer price to rice price, with a value of 0.177, did not exhibit a significant relationship with rice production levels.

3.1.2. Factors Affecting Rice Consumption in East Java Province

Table 2 summarize results of ANOVA on the rice consumption. The analysis indicates that the R^2 value of the rice production model is 0.999, this indicates that 99.99% of the variation in rice consumption can be attributed to the combined influence of the independent variables in the model, namely rice price, total income, and population size. The remaining percentage is explained by other factors not included in the model. Based on the analysis of variance (ANOVA), the F-statistic value was found to be 5.006, exceeding the critical F-value of 2.62 at the 95% confidence level. As a result, the null hypothesis (H_0) is rejected, and the alternative hypothesis (H_1) is accepted. This means that the independent variables consisting of rice prices, the amount of income, and the number of population together have a significant effect on rice consumption. Statistical analysis reveals that rice consumption in East Java can be predicted according to the following equation:

$$CR = -7.792 + 3.090\, PR - 1.237\, In + 0.612\, P + e_2 \tag{8}$$

Table 2. Results of rice consumption factor analysis in East Java Province

Variable	Coefficient *b*	Standard Error	*t*	Sig
(Constant)	– 7.792	22.168	– 0.351	0.740
PR (Rice prices)	3.090	1.070	2.888	0.034*
I (Income)	– 1.237	0.510	– 2.426	0.040*
P (Population)	0.612	1.470	0.416	0.695
R-square = 0.750; Adj R-square = 0.600; *F*-value = 5.006				

Note: * significant at α 5%

The statistical analysis results using the simultaneous approach reveal that rice price (PR) significantly influences the level of rice consumption (CR), where when the price of rice increases by one unit, rice consumption in East Java will increase by 3.090 ton. The rice price variable (PR_{t-1}) had a significant influence on the rice consumption variable, as shown by a significant *p*-value= 0.034, which was smaller than α = 0.05. When analyzed partially, the variable of the amount of income obtained a *t*-count value of 2.888 and *t*-table at 95% confidence level of 1.96, in other words, the t-statistic exceeds the critical t-value, leading to the rejection of the null hypothesis (H_0) and the acceptance of the alternative hypothesis (H_1). This indicates that the rice price variable has a statistically significant influence on rice consumption. These findings are consistent with the results of a study by Qomariyati *et al.* (2022). Their study shows that rice price variables affect rice consumption in West Sumatra Province, with a significance value of 0.000.

The study found that income (*In*) significantly affects rice consumption, with a *p*-value of 0.040, which is less than the significance level of α = 0.05. This confirms that the income variable has a meaningful impact on the level of rice consumption. When income increases by one unit, rice consumption in East Java decreases by 1.237 ton. When analyzed partially, the variable of the amount of income obtained a *t*-count value of -2.426 and *t*-table at a 95% confidence level of 1.96, in other words the *t*-statistic is higher than the *t*-table value. Thus, H_0 is not accepted, indicating that H_1 holds true. This research is in line with Am & Ansar (2014). The findings indicate that income levels influence household consumption patterns in Bontonompo District, Gowa Regency, suggesting that income is a key factor affecting rice consumption. This is consistent with the study by Sitanggang (2017). The significance test produced a *p*-value of 0.035, which is below the 0.05 threshold, confirming that income has a statistically significant impact on rice consumption.

The number of population (*P*) positively affects rice consumption (*CR*) but the impact is not significant. When the population increases by one person, the level of rice consumption in East Java will increase by as much 0.612 ton. The ANOVA results indicate a *p*-value of 0.695, which exceeds the α level of 0.05, suggesting that population variation does not significantly impact rice consumption. When analyzed individually, the population variable yielded a t-statistic of 0.416, which is below the critical value of 1.96 at the 95% confidence level. This implies that H_0 is accepted and H_1 is rejected, confirming that population size, as an independent variable, does not significantly influence rice consumption. These findings are consistent with Yenny & Anwar (2020), who reported a non-significant relationship between population size and rice consumption, with a *p*-value of 0.216. On the contrary, the results differ from Putra & Wardana (2018), whose study found a positive and statistically significant effect of population size on rice consumption. Their analysis reported a *t*-value of 4.069 and a *p*-value of 0.000, which is well below the 0.05 threshold, indicating a meaningful influence of population size on rice consumption.

3.1.3. Factors Affecting Rice Price Fluctuations

Table 3 presents findings indicating that the value of the R^2 determination coefficient of the rice price model is 0.954, meaning that 95.40% of rice prices is attributable to the variation among the exogenous variables in the model, namely the price of dry milled grain, rice production, and the highest retail price, the remaining variation is caused by factors outside the scope of this study. According to the ANOVA results, the F-count is 16.887, which exceeds the F-table value of 2.62 at the 95 percent confidence level. In other words, the F-count is greater than the F-table. Therefore, the null hypothesis is rejected and the alternative hypothesis is accepted. This suggests that the independent variables, including the price of dry milled grain, rice production, and the highest retail price, have a statistically significant impact on rice prices. Referring to the parameters listed in Table 3, the rice price in East Java Province can be estimated according to the following equation:

$$PR = -3.231 + 0.772\, PG - 0.553\, QR + 1.078\, MP + e_3 \quad (9)$$

Table 3. Results of Rice Price Factor Analysis in East Java Province

Variable	Coefficient *c*	Standard Error	*t*	Sig.
(Constant)	–3.231	3.005	–1.075	0.331
PG (Price of Milled Dry Grain)	0.772	0.113	6.832	0.001*
QR (Rice Production)	–0.553	0.183	–3.026	0.029*
MP (Highest Retail Price)	1.078	0.338	3.186	0.024*
R-squared = 0.954; Adj R-squared = 0.910; *F*-value = 16.887				

Note: * significant at α 5%

The findings indicate that a rise of IDR 1,000 in the price of dry unhusked rice (PG) leads to an increase in the rice price (PR) by IDR 0.772. The variable of price of dry unhusked rice grains (*PG*) has a significant influence on the rice price variable, with a *p*-value of 0.001, which is lower than the standard alpha of 0.05, the result is considered statistically significant. When viewed partially, the price variable of dry unhusked rice grains obtained a calculated *t* value of 6.832, and *t*-table at a 95% confidence level of 1.96, in other words, the calculated t-value exceeds the critical t-value. Therefore, the null hypothesis is rejected. This indicates that the independent variable, which is the price of dry unhusked rice, significantly influences rice prices. This research is in line with research from Kusumawardhani & Octavia (2023). The results showed that, supported by a *p*-value equal to 0.018, the Dry Milled Grain variable had a significant influence on rice prices. The outcome of this research is consistent with the work of Fathia (2018), which highlights that both rice production and the price of milled dry grain have a significant positive effect on rice prices.

Based on the statistical evaluation through the simultaneous method show that an increase in rice production (*QR*) by 1.0 ton causes a decrease in white rice prices (*PR*) by 0.553. The rice production variable (*QR*) significantly affects the rice price variable, as indicated by its significant value of *p*-value = 0.029 which is less than α = 0.05. The analysis shows that rice production has a statistically significant impact on rice prices, which supports previous studies conducted by Batubara & Rozaini (2023). According to the study, rice production factors affect rice prices. This is also in line with a study from Israwati *et al*. (2017) indicating that higher rice production contributes positively to the selling price of local rice. These analytical results are consistent with the conditions in the field that if there is a big harvest, rice production increases can reduce rice prices and if during the famine season, rice prices increase because rice production or rice availability decreases.

The highest retail price set by the government contribute to the rise in market rice prices. An increase of IDR 1.0 in the maximum retail price (*MP*) results in a rise of IDR 1,078 in the rice price (*PR*). The *MP* variable significantly affects the rice price variable, as shown by its significant value of 0.024 which is smaller than α 0.05. When viewed partially, the Highest retail price variable of rice obtained a *t*-calculated value of 3.186 and *t*-table at a 95% confidence level of 1.96, in other words, since the t-count exceeds the t-table, the null hypothesis is rejected. This indicates that the highest retail price (*MP*) variable significantly influences rice prices. These findings are consistent with the study by Nopiyanti (2022), which demonstrated that the *MP* variable had a meaningful effect on rice pricing. Similar results were also reported by Nelly *et al*. (2018), who found that the highest retail price of rice had a significant impact, with a *p*-value of 0.0001—further confirming the influence of *MP* on rice prices.

3.2. Rice Farmer Exchange Rate

The Farmer Exchange Rate (FER) serves as one of the key indicators used to assess the economic well-being of farmers. It is calculated by comparing the price index earned by farmers (*IT*) with the price index they spend (*IB*). Referring to Table 1, the FER for rice farmers in 2009 – 2023 has an average of 102.86% where the FER > 100% means that paddy farmers residing in East Java Province are at the level of welfare. The exchange index for paddy farmers varies and is at various levels of welfare, such as the condition in 2016 and 2017 where the FER of rice is 100%. This condition reflects a breakeven point, indicating that farmers' welfare remains stable as the price index paid equals the index received. In 2023 and 2012, the largest contributor to rice FER occurred. In these two years, the condition of rice FER is considerably high, shows that rice farmers are in a high prosperous state.

Overall, the value of rice FER in 2009, 2010 and 2014 experienced a deficit with values < 100%. In other words farmers in that year were not prosperous namely 93.25; 94.49; and 99.35%. In addition, this deficit is also due to the high inflation of several consumer goods in that year. As a result of soaring inflation, the prices of consumer goods are getting more expensive. If the price of consumer goods is getting more expensive, the index representing farmers' expenditures exceeds the index reflecting their earnings, causing the FER of agricultural commodities to become a deficit.

The development of the *IB* value in East Java Province from 2009 to 2023 has fluctuated over the years. Where in 2019 it had the lowest *IB* amount of 103.74, which then increased in the following year by 106.62. Meanwhile, the largest *IB* was owned by 2018 at 142.26. On the other hand, it shows that the value of it is also not constant, that is it in fluctuations in the amount of value. The lowest *IT* value was in 2019 at 106.39 which then increased the following year at 111.04. Meanwhile, the largest *IT* value was in 2012 at 155.36.

The price index paid which has increased continuously means that this is due to the increasing price of basic necessities, although the price has decreased but is not seen significantly. After the monetary crisis in Indonesia, almost all basic necessities experienced an increase in price. This may lead to a rise in the price index paid by farmers, which in turn can impact their overall welfare.

3.3. Factors Affecting the Farmer Exchange Rate

This computation has undergone several classical assumption tests, including assessments for normality, multicollinearity, heteroscedasticity, and autocorrelation. All tests met the necessary criteria. Conducting classical assumption testing is essential before proceeding to further data analysis, as it ensures the resulting regression model adheres to the BLUE (Best Linear Unbiased Estimator) standard. Regression models that meet the BLUE criteria can be used as reliable and reliable. Estimators where the Estimator is stated to be unbiased, consistent, normally distributed and also efficient (Juliandi *et al*., 2014). Classical assumption tests to ensure that the regression equations are functional are precise and valid. Prior to performing multiple regression and hypothesis testing, a series of classical assumption tests were conducted to ensure that the regression model was free from violations and fulfilled the criteria for proper linearity. The following table presents an overview of the linear regression testing process.

$$Y = -0.530 - 0.158X1 - 0.321X2 + 0.99X3 + 0.149X4 - 0.084X5 \quad (10)$$

The outcomes of the multiple linear regression analysis reveal that the constant value is –0.530 which means that if it is assumed that the land area ($X1$), the amount of production ($X2$), the selling price ($X3$), the price of fertilizer ($X4$), and the wages of farm workers ($X5$) then rice farmers' terms of trade (Y) decrease by 0.530 %. Table 5 reveals the results of the FER from the calculation of Multiple Linear Regression:

Table 5. Multiple regression approach for FER

Model	Unstandardized Coefficient	*t*	Sig.
Constant	–0.530	–0.837	0.424
Ln_X1 (Harvest Area)	0.158	1.574	0.150
Ln_X2 (Production)	–0.321	–3.339	0.009*
Ln_X3 (Selling Price)	0.099	1.338	0.014*
Ln_X4 (Fertilizer Prices)	0.194	4.557	0.001*
Ln_X5 (Farm Labor Wages)	–0.084	–2.299	0.047*
R^2 = 0.829; F-count = 8.701; F-table = 3.482; *t*-table = 2.2621. * = significant on α 5%			

1. Effect of Harvest Area on Farmer Exchange Rate.

According to the analysis results, the coefficient for the harvest area variable shows a significance value of 0.150, which exceeds the threshold of $\alpha = 0.05$. This indicates that the land area variable does not have a statistically significant influence on the Farmer Exchange Rate. This is because the high area of rice land does not determine the high productivity of rice, due to the low and inefficient rice yield, there is no noticeable effect on the exchange rate of farmers in the food crops segment. Although the high area of rice land is accompanied by high rice productivity, it only applies to that year, meaning that there is no effect or impact in the long te.rm that guarantees an increase in future trends in farmers' terms of trade in the food crop segment. Similar conclusions were also reached by Hendrarini *et al*. (2023). The results showed that the area of paid land did not affect the exchange rate of farmers in the food crop subsector. This is also in line with research from Wahyudi & Ulum (2024) who states that the t-value of the table at a significant level α = 0.05 is 1.812 (1.812 > 1.3597), these findings suggest a meaningful relationship between land area and the exchange rate of farmers.

2. Effect of Production on Farmer Exchange Rate

The analysis shows that the rice production coefficient has a significance value of 0.009, which is less than α = 0.05, indicating that rice production significantly influences the Farmer Exchange Rate. This can happen and will have a good impact on Farmers, because the decrease in production will increase. Farmers' income, which will then improve the welfare of Farmers' lives. This study aligns with the findings of Pramesti (2024), which demonstrated that the production volume variable significantly influences the Farmer Exchange Rate. Similarly, Andriyani & Ananda (2023) also found that, based on partial testing, agricultural production levels in Indonesian provinces have a significant and negative impact on the Farmer Exchange Rate in those regions.

3. The Effect of Selling Prices on Farmers' Exchange Rates

According to the findings, the coefficient for the selling price in the multiple regression analysis shows a significance value of 0.014, which is below the threshold of α = 0.05. This suggests that the selling price variable significantly impacts the Farmer Exchange Rate. This result supports the theory that higher selling prices lead to an improved Farmer Exchange Rate, thereby indicating enhanced farmer welfare. This happens because an increase in selling prices will increase. Farmers' production, which will directly increase farmers' income. An increase in farmers' income means that there is an increase in fixed *IT* and *IB*, so that farmers experience a surplus. This research is in line with Khayatun (2018). Findings indicate that the selling price positively and significantly affects the Exchange Rate value in the food crop sub-sector. This outcome is consistent with previous studies Pettalolo *et al*. (2019), contains that the t-value of the variable selling price is 13.581 at a significant level of 0.001. Therefore, the selling price variable has a tangible and statistically significant impact on the expansion of paddy fields in Sidondo Village.

4. The Effect of Fertilizer Prices on Farmers' Exchange Rates

From the table of multiple linear regression results, the fertilizer price has a significance value of 0.001, which is less than the α level of 0.05, indicating that the subsidized urea fertilizer price variable significantly influences the Farmer Exchange Rate. This finding implies that fertilizer costs, when considered independently, have a real and statistically significant effect on the Farmer Exchange Rate, because the increasing cost of fertilizer will certainly increase farmer production and revenue will also increase because with high fertilizer costs will make farming productivity increase so that the farmers' purchasing power index will also experience an increase. This finding aligns with a previous study by Kurniawan (2019), which revealed that the purchasing power of rice farmers is influenced by the price variable of urea fertilizer. Similar results were reported by Marsudi *et al*. (2019). The analysis produced a significance value of 0.022, which is smaller than the alpha level of 0.05, indicating that the subsidized urea fertilizer price has a statistically significant effect on the farmers' purchasing power index.

5. The Effect of Farm Labor Wages on the Farmer Exchange Rate

The data outlined in the table above shows that multiple regression of the farm worker wage variable have a significant value of 0.047 which is lower than α = 0.05 which shows that the farm worker wage variable have a notable influence on the farmers' purchasing power index. This indicates that wages received by agricultural laborers contribute partially and significantly to the fluctuations in farmers' economic standing, because an increase in farm workers' wages will certainly increase the farmers' exchange rate and farmers will get welfare. This research is in line with Irawan (2021). The findings indicate that the farmers' purchasing power is significantly affected by the variable of farm labor wages. However, this outcome contrasts with the study by Yuniar (2024), which reported that wages for agricultural workers negatively impact the economic exchange position of food crop farmers in. South Sulawesi Province where every one unit increase in farm labor wages will reduce the FER by 28.5%.

4. CONCLUSION

From the outcomes of this research, it can be concluded that the factors that cause fluctuations in rice prices in the production equation are the variables of rice prices and harvest area, in the consumption model, the determining variables include the price of rice and the level of household income as primary contributors, whereas in the price determination model, the significant influencing factor is the cost of dry milled grain, production and the highest retail price The average FER of East Java Province was obtained at 102.86%, which means that rice farmers in East Java Province are classified as prosperous. The variables that significantly influence the Farmer Exchange Rate (FER) include production amount, selling price, fertilizer price and farm labor wages, while the variable of harvest area is not significant. Fluctuations in rice prices greatly affect the welfare of farmers. Rising production costs, such as fertilizers and pesticides, as well as external factors such as climate change, can make farmers' incomes low and unstable.

Based on the overall research that has been conducted, the author recommends that the government take an active role in enhancing the stability of agricultural commodity prices by establishing standardized agricultural production costs, along with maintaining price stability in the agricultural trade sector, with the expectation that farmers will be encouraged to boost their production levels and productivity so as to increase farmers' income and maintain farmers' welfare.

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