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Economic Efficiency of Rice Farming: A Performance Difference among Agricultural Insurance Participant and Non-participant Farmer

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ABSTRACT

Agricultural insurance is a risk-sharing business arrangement to protect farmers who encounter problems with adverse selection and moral hazards caused by asymmetric information. This situation leads to market inefficiencies since people with more information commonly take advantage of less informed people. This study aimed to compare the performance difference in the economic efficiency of rice farming between Rice Farming Insurance (RFI) participants and non-participant farmers. Primary data were collected from 202 farmers in Tangerang Regency. The marginal value product–marginal factor cost (MVP-MFC) approach was utilized to estimate resource use efficiency in rice production. The t-test was applied to determine differences in input allocation. The MVP-MFC discovered that the use of seeds was efficient for RFI participant farmers. Meanwhile, land, organic fertilizer, and pesticide had not been efficient, and inputs of inorganic fertilizer and labor were inefficient. Conversly, non-participant farmers indicated that the use of land, seeds, organic fertilizers, and pesticides had not been efficient, but the use of inorganic fertilizers and labor was inefficient. However, the comparison test revealed no difference in the input allocation efficiency between RFI participants and non-participant farmers. Hence, innovation in media and extension methods were required to change farmers' behavior. Government policies were also necessary to ensure the availability of inputs. In addition, avoiding adverse selection and moral hazards in agricultural insurance was required to identify hazardous groups.

Keywords: Economic efficiency; Input; Rice farming; Agricultural insurance

INTRODUCTION

Climate change is a phenomenon that impacts high uncertainty on the agricultural sector (Varela-Ortega et al., 2016). Many studies in many countries have demonstrated that climate change considerably alters productivity. A highly productive areas may become less productive, even though some currently marginal areas may benefit substantially (Reilly, 1996). The increase in temperature affects the crop yields and initiates the harvest not being as desired. It also encourages the growth of weeds and pests that may reduce crop yields. Opportunities for crop failure are also due to the changes in precipitation patterns. Hence, the agricultural sector is the most vulnerable to climate change impacts (Aziz, Aziz, Aris, & Aziz, 2015; Chandio, Jiang, Rehman, & Rauf, 2020; Howden et al., 2007; Nelson et al., 2009; Zhai & Zhuang, 2009). Climate change is considered to endanger the sustainability of the agricultural sector as the livelihood and income of small farmers. Therefore, it is estimated to be harmful as it threatens global food security (Reddy, 2015).

Insurance has become strategic in overcoming poverty and improving farmers' welfare (The World Bank, 2020). Agricultural insurance is considered a risk transfer instrument to build a resilient pathway (Ramm, Balogun, Range, & Souvignet, 2018). The importance of crop insurance has been recognized. Some crop insurance literature asserts that increasing risk has enhanced the use of inputs, such as fertilizers and pesticides (Chakir & Hardelin, 2010; Horowitz & Lichtenberg, 1993; Wu, 1999). Crop insurance is also deemed to advance planting (Dismukes, Coble, Miller, & O'Donoghue, 2013; Goodwin, Vandeveer, & Deal, 2004; Supriyati, Tjahjono, & Effendy, 2018; Young, Vandeveer, & Schnepf, 2001). Others have disclosed that the planting structure could be modified by crop insurance (Wu, 1999; Young et al., 2001).

Climate change has a significant impact on the agricultural sector, especially food crops, in various areas of Indonesia, including the Tangerang Regency. Food crop production and productivity have decreased due to lower air temperatures, droughts, floods, and increasing pest and disease attacks. In response, the Indonesian government launched the Rice Farming Insurance (RFI) program in 2014 to reduce the harmful impact. RFI is driven by the high risk of farming uncertainty due to disasters and attacks by plant-disturbing organisms, especially after being affected by climate change impacting to achieve food self-sufficiency. Thus, RFI is expected to be a risk transfer instrument to minimize the impact (Pasaribu, 2010). Farmers are able to apply for agricultural insurance if the land planted does not exceed two hectares. They must also be active members of farmer groups. Indeed, farmers who receive premium subsidies must manage their farming or livestock business properly and seriously (International Association of Students in Agricultural and Related Sciences [IAAS], 2021).

Nevertheless, insurance companies face adverse selection and moral hazards due to asymmetric information. These problems are highly possible to occur. With the spread of the agricultural sector in various regions, it will not be easy to obtain complete information regarding the characteristics of farmers. In other words, it is a case in which asymmetric information occurs. In insurance, adverse selection is the tendency of those at high-risk to purchase the product (Hayes, 2022). In such a case, it is the farmers who possess more knowledge. Meanwhile, moral hazards occur when asymmetric information exists between two parties; however, a change in the behavior of one party is exposed after a deal is struck. A moral hazard is a risk that one party has not entered into the contract in good faith (Hayes, 2022). In this case, insured farmers reduce their efforts to prevent losses after purchasing insurance. It is thought to cause inefficiency in allocating production factors in rice farming. Accordingly, it is crucial to identify whether differences exist in the efficiency of production factor allocation between RFI participants and non-participant farmers. Many studies compared the efficiency of the use of inputs for rice farming. However, only a few compared the overall inputs between RFI participants and non-participant farmers. An actual depiction of whether differences exist in the efficiency of input use between RFI participants and non-participants in Indonesia can be obtained from this study, considering that production risks due to climate change are also encountered throughout Indonesia. Likewise, the terms and conditions of RFI apply nationally.

RESEARCH METHOD

Study Area

Tangerang Regency is one of the rice production centers in Banten Province, as supported by its above-average rice production (as seen in Figure 1). In addition, rice farmers in this regency have participated in the RFI program. Therefore, Tangerang Regency was determined as the research location.

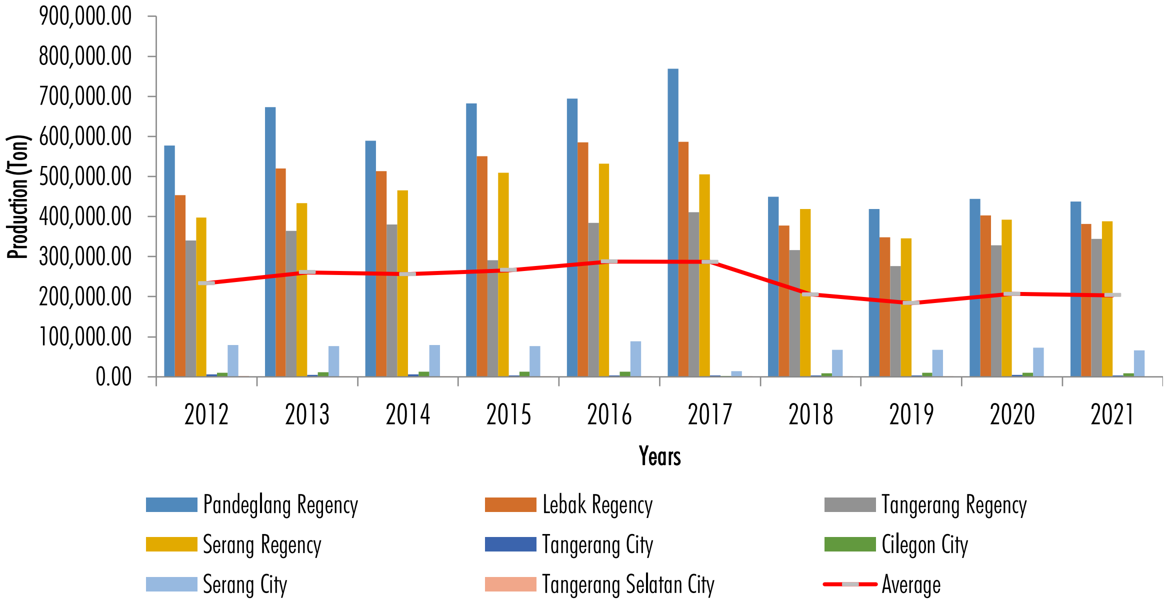

FIGURE 1. RICE PRODUCTION IN BANTEN PROVINCE IN 2012-2021

Sampling Procedure and Data Collection

This study utilized primary data obtained through questionnaires and secondary data collected from the Department of Agriculture and Food Security of Tangerang Regency and Statistics Indonesia. The variables measured comprised rice production and its inputs encompassing land, seeds, organic fertilizer, inorganic fertilizer, pesticide, and labor.

The selection of respondents was accomplished through several steps. The first step was to sort the rice planting area in all districts in Tangerang Regency, and the Sepatan and Legok were selected randomly. Subsequently, the villages of Sepatan and Sarakan (Sepatan District) and Ciangir and Bojongkamal Villages (Legok District) were selected randomly with the same method. Farmers participating in the RFI were only discovered in Sepatan and Sarakan. Meanwhile, farmers in Ciangir and Bojongkamal Villages were unable to participate in the RFI due to constraints on the requirements. The last step was to determine the respondents selected utilizing proportional simple random sampling. Table 1 describes the sample size for each village.

TABLE 1. SAMPLE SIZE RFI PARTICIPANT AND NON-PARTICIPANY FARMER ON TANGERANG REGENCY

No	District	Village	RFI Participant	Non-participant	Total
1	Sepatan	1. Sepatan	3	32	35
		2. Sarakan	25	40	65
2	Legok	1. Ciangir	0	45	45
		2. Bojong Kamal	0	57	57
Total			28	174	202

Analytical Technique

Data obtained were analyzed through descriptive analysis and the Cobb-Douglas production function model, followed by an analysis of price efficiency. The analysis of the Cobb-Douglas production function model could explain the impact of using production factors. The equation model was as Formula 1 (Sumodiningrat, 2001).

$$Y=aX_1^{b1} . X_2^{b2} . X_3^{b3} . X_4^{b4} . X_5^{b5} .X_6^{b6} . e^u \quad (1)$$

The equation was then converted into the Formula 2 linear equation.

$$LnY = Lna + b_1 LnX_1 + b_2 LnX_2 + b_3 LnX_3 + b_4 LnX_4 + b_5 LnX_5 + b_6 LnX_6 \quad (2)$$

while, Y was rice production (kg); a was constant; $b_1...b_6$ was regression coefficient $X_1...X_6$; X_1 was land (hectare); X_2 was seeds (kg); X_3 was organic fertilizers (kg); X_4 was inorganic fertilizers (kg); X_5 was pesticides (liter); X_6 was labor (man-day); e was natural logarithm (e = 2.71828); and u was error.

The data obtained were tested for classical assumptions. The Kolmogorov-Smirnov (K-S) test was run to determine the normality, with the criteria being normally distributed if the significance is 0.05 and not normally distributed if the significance score is < 0.05 (Ghasemi & Zahediasl, 2012). The heteroscedasticity test examined the regression model, defined by examining the pattern on the scatterplot graph. Additionally, the multicollinearity test was performed to identify the correlation between variables by examining at score of the Variance Inflation Factor (VIF). A VIF score of < 10 indicates no multicollinearity (Field, 2015).

The simultaneous impacts of production factors of land, seed, organic fertilizer, inorganic fertilizer, pesticide, and labor were tested by the F-test. If the significance score is ≤ 0.05, H_1 is accepted (H_0 is rejected), meaning that the independent variables simultaneously affect the dependent variable. In contrast, if the significance score is > 0.05, H_1 is rejected (H_0 is accepted), indicating that the independent variables simultaneously do not affect the dependent variable.

T-test was employed to examine the effects of land, seed, organic fertilizer, inorganic fertilizer, pesticide, and labor partially on production. H_1 is accepted if the significance score is ≤ 0.05, signifying that each independent variable affects the dependent variable. Conversely, H_1 is rejected if the significance score is > 0.05, implying that each independent variable does not affect the dependent variable.

Allocative efficiency was achieved when the optimal use of the input proportion follows marginal productivity. When the production function was linearized and differentiated concerning the input (Xi), the following Marginal Physical Productivity (MPP) occurs (Wijaya, Rifin, & Hartoyo, 2022):

$$APP_i = \frac{Y_i}{X_i} \quad (3)$$

$$MPP_i = \frac{d \ln Y_i}{d \ln X_i} = \frac{\partial Y_i}{\partial X_i} x = \beta_i \left(\frac{Y_i}{X_i}\right) = \beta_i x \, APP_i \quad (4)$$

Furthermore, the Marginal Product Value (MVP) was obtained from the Formula 5.

$$MVP_i = \beta_i \left(\frac{Y_i}{X_i}\right) x P_{yi} = MPP_i x \, P_{yi} \quad (5)$$

The development of input-use-efficiency or resource-use-efficiency (RUE) began with assumptions regarding producer goals(Houngue & Nonvide, 2020). The farmers' ability to utilize inputs efficiently determines the RUE score.

$$AE_i = \frac{MVP_i}{P_{xi}} \;\; / \;\; RUE_i = \frac{MVP_i}{MFC_i} \quad (6)$$

The decision-making criteria were (i) if the RUE score = 1, the input has been processed efficiently; (ii) if the RUE score > 1, the input is underutilized, and it is recommended to increase the input use; (iii) if the RUE score < 1, the input used is excessive; thus, its use should be reduced. Subsequently, the t-test was applied to determine whether differences exist in the input allocation of rice farming among RFI participants and non-participant farmers (Field, 2015).

RESULTS AND DISCUSSION

Respondent Identity

The respondents' identity illustrated their characteristics. Table 2 portrays that the respondent farmers were old, poorly educated, and had long farming experience. The RFI participant and non-participant farmers selected as the respondents were still in productive age despite being over 50. Age could affect the physical fitness of farmers engaged in agricultural activities and their behavior toward decision-making in farming. It follows the discovery of (Alassaf, Majdalwai, & Nawash, 2011) that farmers' age as one of the socioeconomic factors posed a positive relationship with their decision to continue farming. Productive-age farmers performed better than non-productive-age ones. In addition, age could serve as a benchmark to determine farmers' activity.

The average education level of respondents was elementary school. Farmers' education level influenced their behavior and the application of techniques. Poorly educated farmers could limit their ability to apply the techniques. Education has been proven to improve the productivity of agriculture for users of modern technology (Fatmawati, Lahming, Asrib, Pertiwi, & Dirawan, 2018; Paltasingh & Goyari, 2018).

TABLE 2. IDENTITY OF RICE FARMER RESPONDENTS IN TANGERANG REGENCY

Characteristic	Category	RFI Participant		RFI Non-participant		Total	
		Number of Farmers (Person)	Percentage (%)	Number of Farmers (Person)	Percentage (%)	Number of Farmers (Person)	Percentage (%)
Age (years)	< 36	3	10.71	12	6.90	15	7.43
	36 – 50	5	17.86	55	31.60	60	29.70
	51 – 65	19	67.86	76	43.68	95	47.03
	> 65	1	3.57	31	17.82	32	15.84
Education	No education	2	7.14	11	6.32	13	6.44
	Elementary	6	21.43	98	56.32	104	51.49
	Junior high school	16	57.14	50	28.74	66	32.67
	Senior high school	3	10.71	15	8.62	18	8.91
	Higher education	1	3.57	0	0.00	1	0.49
Family member (person)	≤ 2	8	28.57	92	52.87	100	49.50
	3 – 4	18	64.29	80	45.98	98	48.52
	≥ 5	2	7.14	2	1.15	4	1.98
Land size (hectare)	< 0.2	0	0.00	37	21.26	37	18.32
	0.2 – 0.5	11	39.29	75	43.10	86	42.57
	> 0.5 – 1	8	28.57	40	22.99	48	23.76
	> 1	9	32.14	22	12.64	31	15.35
Experience (year)	≤ 10	4	14.29	40	22.99	44	21.78
	11 – 20	10	35.71	37	21.26	47	23.27
	21 – 30	5	17.86	40	22.99	45	22.28
	31 – 40	8	28.57	46	26.44	54	26.73
	> 40	1	3.57	11	6.32	12	5.94

The average of family members of RFI participant farmers was three people and greater than those non-participants of solely two people. Furthermore, the average experience of RFI participant farmers was 23 years, less than non-participant farmers, which was 24 years. It is a rational decision; as long as farming provides work opportunities and a higher income share, the family will continue farming (Alassaf et al., 2011).

The average land cultivated by RFI participant farmers was 0.83 hectares, wider than non-participant farmers, solely occupying 0.51 hectares. The land influenced not only the level of farming efficiency but also efforts to transfer and apply technology in agricultural development. There has been an alarming fact about converting agricultural land to non-agro uses. In Java Island, the conversion rate of agricultural land has reached approximately 100,000 hectares per annum (Winoto & Siregar, 2008). Due to the relatively low agricultural production (or productivity), such changes are crucial in explaining Indonesia's relatively slow agricultural production growth.

Input Allocation

Inputs that do not suit the land characteristics will be ineffective and wasteful, both in capital input and land resources (Widiatmaka et al., 2016). As displayed in Table 3, the inputs in this study encompassed land, seed, organic fertilizer, inorganic fertilizer, pesticide, and labor.

TABLE 3. THE ALLOCATION OF RICE FARMING INPUTS IN TANGERANG REGENCY

No.	Input	RFI Participant		Non-participant	
		Average	Average per hectare	Average	Average per hectare
1.	Land (hectare)	0.83	-	0.51	-
2.	Seed (kg)	23.50	28.31	17.51	34.33
3.	Organic fertilizer (kg)	123.57	148.88	141.09	276.65
4.	Inorganic fertilizer (kg)	172.36	207.66	213.75	419.12
5.	Pesticides (L)	1.95	2.35	1.15	2.25
6.	Labor (man-day)	163.57	197.07	96.96	190.12
7.	Production (kg)	4,414.11	5,318.20	2,706.48	5,306.82

Land Allocation

The smallest land cultivated by RFI non-participant farmers was 0.05 hectares, while the widest was 1.80 hectares. Meanwhile, among RFI participant farmers, the smallest cultivated land was 0.20 hectares, and the widest was the same as non-participant ones, 1.80 hectares. However, it does not mean that farmers owned the land. Land tenure has been classified into three types: (1) owned land, (2) leased land or profit sharing, and (3) owned land and leased land or profit sharing. Figure 2 illustrates the survey results, revealing that leased land or profit sharing dominated the land tenure.

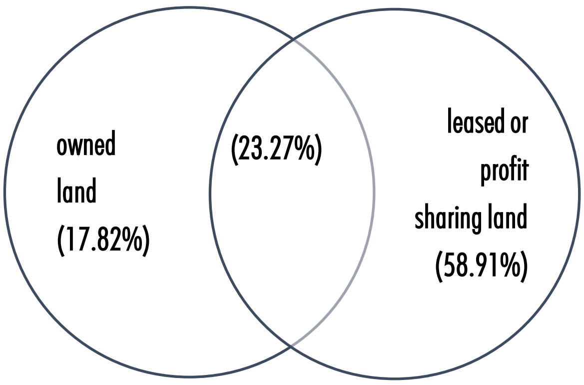

FIGURE 2. LAND TENURE OF RESPONDENT FARMERS ON TANGERANG REGENCY

However, the interviews unveiled that farmers did not differentiate their farming management on their land and arable land. Hence, the application of technology demonstrated the same treatment. Nevertheless, the cost of land rent resulted in different farming incomes.

Seed Allocation

Most farmers in Tangerang Regency utilized Ciherang, which was produced by crossing local superior rice varieties. Ciherang is suitable for planting in both rainy and dry seasons with an altitude below 500 meters above sea level; therefore, it was suitable to be planted in Tangerang Regency. Ciherang has offered several benefits, comprising productivity of 6.0 to 8.5 tons/hectare, relatively short plant life of 116 to 125 days, resistance to pests and harmful diseases of rice plants (such as brown leafhoppers and bacterial leaf blight), fluffier and fragrant rice. In addition to the affordable price of rice seed, Ciherang could still be applied as a replanting material.

Following Table 3, the average number of seeds used by RFI participant farmers reached 23.5 kg. Meanwhile, the RFI non-participant farmers utilized solely 17.5 kg. The interviews revealed that farmers deliberately sowed rice with more than required to anticipate not growing seeds. Hence, they could be employed for embroidery. Nevertheless, the rest was frequently left alone, even thrown away. In short, the use of excessive inputs caused inefficiency.

Organic Fertilizer Allocation

The organic fertilizer in Tangerang Regency was mostly animal manure, while only a few utilized straws. The average use of organic fertilizer by both RFI participants and non-participant farmers was still under the recommendation (1,000 kg per hectare) due to the lack of available animal manure and the pungent smell.

Furthermore, organic fertilizer is one of the most efficient critical elements of organic and sustainable agricultural development (Hou et al., 2023; Salam, Sarker, & Sharmin, 2021; Yue et al., 2022). It plays an essential role in better production and is an alternative source of essential phytonutrients. Therefore, organic fertilizers have been recommended to increase crop yields (Pangnakorn, 2006).

Inorganic Fertilizer Allocation

The recommended dosage for using urea was 250-300 kg per hectare (L. R. Widowati et al., 2020). Meanwhile, the RFI participant farmers' use of inorganic fertilizer (urea) reached 207.12 kg per hectare, less than non-participant farmers' (417.8 kg per hectare, as seen in Table 3). These findings depicted that the dosage applied by RFI participant farmers was less than the recommendation, while the RFI non-participant farmers utilized a greater dosage than the recommendation.

The high use of inorganic fertilizer continuously without returning organic matter would disrupt the nutrient balance in the soil, reduce fertilizer efficiency, and negatively impact the soil and the environment. It is believed to be one of the causes of the decline in rice productivity (L. R. Widowati et al., 2020).

Pesticide Allocation

Generally, farmers apply pesticides to protect crops from pests. Plant Pest Organisms (PPO) attacking rice plantations in Tangerang Regency were dominated by stem borers, brown planthoppers, and rats. Hence, farmers there frequently utilized pesticides to control these pests. The average pesticide use by RFI participants farmers was 2.30 liters per hectare, slightly higher than non-participant ones of 2.24 liters per hectare. It was a little more than the recommended dosage of 2.00 liters per hectare.

Pesticides are substances or mixtures mainly utilized in agriculture or public health protection programs to protect plants from pests, weeds, or diseases (Nicolopoulou-Stamati, Maipas, Kotampasi, Stamatis, & Hens, 2016). The benefits of chemical pesticides have led to their widespread application. Unfortunately, farmers frequently violate regulations by using chemical pesticides. The interview made it clear that large-scale application was easy, and the tangible results could be realized rapidly.

There has been overwhelming evidence that some of these chemicals pose a potential risk to humans and other life forms and unwanted side effects on the environment (Aktar, Sengupta, & Chowdhury, 2009; Tu et al., 2021). Pesticide use could be minimized by observing the pests.

Labor Allocation

Worker days (man-day) were employed to measure the number of workers in rice farming. Rice farming activities included plowing land, seedling, planting, fertilizing, maintaining (consisting of weeding, irrigation, and pest and disease control), as well as harvesting and post-harvesting. Table 4 exhibits the labor allocation assigned to each agricultural activity.

TABLE 4. AVERAGE LABOR ALLOCATION FOR RFI PARTICIPANT AND NON-PARTICIPANT FARMERS IN TANGERANG REGENCY

Activity	Average Labor Allocation (man-day/hectare)	
	RFI Participant	RFI Non-participant
Plowing land	35	25
Seedling	7	6
Planting	39	38
Fertilizing	11	17
Maintaining	21	24
Harvesting and post-harvesting	84	80
Total	197	190

Cultivation began with fences and the irrigation system cleaned up. The fields were then submerged for one week. Subsequently, plowing could be performed using tractors. Farmers in Tangerang Regency conducted it twice. The tractors were rented from the farmer groups. Since the Rice, Corn, and Soybean Program (in Indonesia, it is called *Pajale* program), farming has increasingly emphasized mechanization efforts. The rental rates were scaled to the area of land to work. The larger the land, the greater the costs to be incurred.

The plowing necessitated 35 man-days per hectare for RFI participant farmers and 25 man-days per hectare for non-participant ones. The interview unveiled that it was due to the hard ground. The excessive and continuous use of pesticides would generate a hard land. It is in line with (Food and Agriculture Organization [FAO], 2020), asserting that using fertilizers and pesticides initially enhances crop development and, thus, the production of biomass (especially crucial on depleted soils). However, using some fertilizers, especially N fertilizer and pesticides, could promote microbial activity and the decomposition of organic matter. Chemicals provide N components that are easy for microorganisms to handle. It is especially essential when the C:N ratio of soil organic matter is high, and N deficiency slows down degradation.

Moreover, the average time for seedlings could be more than 17 days. It was carried out in the same area as the rice field to be planted. Seven man-days per hectare were invested in seedlings by RFI participant farmers, but non-participant ones required only six man-days per hectare. In other words, similar respective activities led to the seedling labor allocation being almost the same between RFI participants and non-participant farmers.

Most Tangerang Regency farmers implemented the "*ceblokan*" farming system. Farmers increasingly adopted commercial thinking as a result of using new technology. In the "*ceblokan*" system, harvesters are obliged to participate in planting rice and weeding. The labor allocation in planting was 39 man-days per hectare (RFI participant farmers) and 38 man-days per hectare (RFI non-participant farmers). It happened because the planting activities in both groups utilized the same system.

Fertilizing was carried out twice when the plants were less than seven days after planting (DAP), and follow-up fertilization was conducted between the ages of 25 to 35 DAP. Fertilizing required a total labor allocation of 11 man-days per hectare for RFI participant farmers and 17 man-days per hectare for non-participant ones. Applying more fertilizers, the RFI non-participant farmers required more time to fertilize than the participants.

Table 4 displays that labor allocation for maintainance was not significantly different between RFI participant farmers (21 man-days per hectare) and non-participant ones (24 man-days per hectare) due to similar activities in both groups.

Harvesting was performed between 90 to 120 DAP. A thresher machine was applied, resulting in lower yield loss than with simple tools. Following harvest, the rice was sun-dried for two to four days to reduce the moisture content. The total labor allocation in harvesting and post-harvest activities was nearly the same for both RFI participant farmers (84 man-days per hectare) and non-participant ones (80 man-days per hectare). The harvest and post-harvest activities in both groups implemented the same system. Hence, it makes sense. The labor allocation in harvesting was quite large because of the "*ceblokan*" system.

Analysis of Rice Production Function in Tangerang Regency

The Cobb-Douglass production function analysis determined the relationship between inputs and production. This relationship was identified by looking at the regression coefficient by changing the Cobb-Douglass production function model into a natural logarithm.

Following the regression evaluation, the equation model for RFI participant farmers is as follows.

TABLE 5. RESULTS OF REGRESSION ANALYSIS OF RICE PODUCTION FUNCTION IN TANGERANG REGENCY

Variable	RFI Participant		RFI Non-participant	
	B	t_{count}	B	t_{count}
Constant	0.445	0.522	2.103	7.371
Land (lnX_1)	0.824	5.367	0.345	7.815
Seed (lnX_2)	0.015	0.118	0.132	3.613
Organic fertilizer (lnX_3)	0.117	2.458	0.102	3.389
Inorganic fertilizer (lnX_4)	-0.014	-0.174	0.039	3.164
Pesticides (lnX_5)	0.029	0.442	0.113	3.009
Labor (lnX_6)	-0.028	-0.626	0.379	7.906
R-square	0.937		0.975	
F_{count}	48.092		889.351	

The regression analysis on RFI participant farmers obtained an adjusted r-square score of 0.937 (93.7%) (Table 5). Meanwhile, non-participant farmers acquired 0.975 (97.5%), indicating the high capability of the unbiased variable to offer statistics to explain the variety of the structured variable. In short, the variables of land, seeds, organic fertilizers, inorganic fertilizers, pesticides, and labor significantly influenced the increase or decrease in rice farming production.

F-test on RFI participant farmers disclosed the score of F_{count} (48.09) > F_{table} (2.92). Likewise, non-participant farmers discovered the score of F_{count} (889.35) > F_{table} (2.17). Hence, all independent variables (land, seeds, organic fertilizers, inorganic fertilizers, pesticides, and labor) in the two groups of farmers simultaneously affected the dependent variable (rice production).

The t-test in both groups generated different results. For RFI participant farmers, only land and organic fertilizer variables posed $t_{count} > t_{table}$. Hence, only land and organic fertilizer inputs significantly affected rice production. As for RFI non-participant farmers, all variables possessed $t_{count} > t_{table}$, meaning that all inputs significantly influenced rice production.

These findings signified the inefficiency of inputs in rice farming by RFI participant farmers. It further strengthened the suspicion of moral hazards. When feeling safe because of insurance, policy buyers would behave unprofitably.

Economic Efficiency of Rice Farming Input Allocation in Tangerang Regency

Economic analysis is a traditional yet effective tool to reveal different production inputs and outputs (Yong et al., 2022). Table 6 exhibits the economic efficiency of rice farming input allocation by RFI participants and non-participant farmers.

The economic efficiency analysis revealed that both RFI participants and non-participant farmers had inefficient land allocation. Hence, the allocation of 0.83 hectares (RFI participant farmers) and 0.51 hectares (RFI non-participant farmers) has not been efficient, requiring more land to meet production goals. In terms of efficiency, the wider the land cultivated, the higher the production and income per unit area. According to (Bojnec &

Latruffe, 2013), larger economic benefits could be obtained under a large scale of management. Therefore, farmers should expand the land used in rice farming and increase productivity. Nevertheless, along with the increase in population, the land has changed its function as housing and industry. Thus, expanding the land area in Tangerang Regency was no longer an option. Increased planting densities, additional irrigation canals in rain-fed rice fields, and enhanced rice field quality were all viable options for expanding agricultural land.

TABLE 6. THE ALLOCATIVE EFFICIENCY ANALYSIS OF RICE FARMING INPUTS IN TANGERANG REGENCY

Variable	RFI Participant				RFI Non-participant			
	x_i	B_i	$NPMx_i$	$NPMx_i$ / Px	x_i	B_i	$NPMx_i$	$NPMx_i$ / Px
Land	0.83	0.82	18358793.00	21.60	0.51	0.34	7665538.55	9.02
Seed	23.50	0.02	11833.57	1.08	17.51	0.13	85741.29	7.79
Organic fertilizer	123.57	0.12	17553.56	17.55	141.09	0.10	8217.85	8.22
Inorganic fertilizer	172.36	-0.01	-1505.86	-0.67	213.75	0.04	2074.02	0.92
Pesticides	1.95	0.03	268819.30	3.36	1.15	0.11	1116952.53	13.96
Labor	163.57	-0.03	-3165.24	-0.06	96.96	0.38	44414.17	0.89

RFI participant farmers attained maximum seed efficiency. By comparing the marginal product value to the market price, there was only one production factor (1.07). On the other hand, RFI non-participant farmers had contrasting results, where seeds were declared inefficient. In other words, seedlings should be added to increase production.

Both sets of farmers demonstrated inefficient input allocation of organic fertilizer. Since the application rate of organic fertilizer was below the government-recommended dosage of 1,000 kg per hectare, an increase has been advised. Olson & Berry (2015) reported that erosion and decreased productivity have been revealed since the 1860s. Erosion is seen as a major hazard. This fear continues to be exacerbated due to the rapidly growing population and increasingly intensive cultivation.

Likewise, the inorganic fertilizer allocation of the two farmer groups also depicted inefficiency. The allocation of inorganic fertilizer (in this case, urea) was much higher than the recommended dosage (200 kg per hectare). The excessive application of inorganic fertilizer hastened the decline in soil fertility (FAO, 2020). It posed a critical effect on agricultural land and poor soil nutrients. It ultimately impacted low plant productivity and weakened plant immunity, resulting in many plant pests attacking plants.

Due to the inefficient pesticide allocation, both RFI participants and non-participant farmers should apply more pesticides to achieve their production goals. However, excessive use of pesticides could also be harmful because the vital microorganisms required to maintain soil fertility could die. Likewise, pests and diseases could develop resistance. More importantly, long-term excessive use of pesticides would create environmental harm and imbalances. There has been sufficient evidence that some of these chemicals pose potential risks to humans and other life forms, as well as undesirable environmental side effects (Aktar et al., 2009; FAO, 2020). Plant-based pesticides have become a viable alternative that farmers should utilize more frequently. To top it all off, botanical pesticides provide a double advantage; in addition to producing safe products, the environment is not polluted. Another advantage of using plant-based pesticides is that they are biodegradable.

Furthermore, the labor allocation for RFI participant farmers was inefficient. Meanwhile, non-participant farmers have not been efficient in labor allocation. Labor efficiency could be realized with agricultural mechanization. Currently, agricultural machine tool technology has developed. Agricultural machinery could reduce labor and even cut the time required to cultivate. It is consistent with previous studies discovering that the use of tractors would reduce the use of human resources and promote land preparation and planting activities (Suyatno, Imelda, & Komariyati, 2018). Mechanization in rice production could lessen the need for agricultural labor (Yang et al., 2022). The government has facilitated agricultural machinery tools in three types: pre-harvest, post-harvest, and yield processing. Pre-harvest agricultural machinery has the function of carrying out the production at the cultivation stage until near harvest. Suppressing input costs came up as one of the results of using agricultural machinery. Harvesting and post-harvest production were two of the many uses for post-harvest agricultural machinery. Agricultural machinery could reduce harvest and post-harvest costs and decrease yield loss. Harvest and post-harvest losses could be minimized using agricultural machinery, increasing value and enhancing revenue (E. H. Widowati, 2018). This manifest of government attention should be utilized by farmers properly to achieve efficiency in farming. Through agricultural extension, a substantial efficiency increase could be achieved by adopting modern agricultural technology and diffusion processes and improving farmers' abilities (Biswas, Mallick, Roy, & Sultana, 2021).

Table 7 displays the t-test results, revealing no difference in the efficiency of input allocation between RFI participant and non-participant farmers. The F-test exhibited a significant (Sig. F > 0.05) only on the variables of seeds and organic fertilizers, indicating the homogenous data variance on these variables in the two groups (RFI participant and non-participant farmers). Furthermore, there was no difference between the use of seeds for RFI participant and non-participant farmers, as indicated by a t-test conducted on the variables of seeds and organic fertilizers, acquiring a significance value of > 0.05. The negative sign on organic fertilizers signifies that the average organic fertilizer allocation for RFI participant farmers was lower than for non-participant farmers.

TABLE 7. INDEPENDENT SAMPLE TEST

Equal variances assumed	t-test for Equality of Means		
	T	Sig. (2-tailed)	Mean Difference
Land	3.229	.000	.32053
Seed	2.338	.020	5.99425
Organic fertilizer	-.533	.594	-17.52053
Inorganic fertilizer	-.860	.391	-41.38998
Pesticides	3.872	.000	.85402
Labor	4.464	.000	66.61166

Reduced yields were possible due to inefficient and less efficient inputs in rice farming. The excessive use of pesticides in both groups of farmers further evidenced the prevalence of pests endangering rice production. This information was certainly owned by the farmers but not necessarily possessed by the insurers. Hence, asymmetric information tended to cause adverse selection.

CONCLUSION

The analysis unveiled that land and organic fertilizer affected rice production for RFI participant farmers. In contrast, land, seed, organic fertilizer, inorganic fertilizer, pesticide, and labor, affected rice production for non-participant farmers. Non-participant farmers utilized inputs due to there was no guarantee of crop failure. Contrary, RFI participant farmers who more secure because of insurance coverage. This study revealed that the input allocation of seed for RFI participant farmers was efficient, while soil, organic fertilizer, and pesticide were declared inefficient, and inorganic fertilizer and labor were inefficient. Additionally, the analysis for non-participant farmers disclosed that the input allocation of land, seed, organic fertilizer and pesticide had not been efficient. Meanwhile, the input allocation of inorganic fertilizer and labor was declared inefficient. However, the study showed no difference in the efficiency of input allocation between RFI participants and non-participant farmers.

Considering these results, the authors suggest utilizing good agricultural practices (GAP) to achieve the economic efficiency of rice farming by increasing farmers' knowledge, attitudes, and skills. Changes in farmers' behavior to implement GAP required innovation in media and extension methods to access information and accelerate technology adoption. Government policies were also necessary to encourage the sustainability of farming by continuing to develop superior seed varieties, providing subsidized fertilizer, and ensuring fertilizer availability. In the case of agricultural insurance, avoiding adverse selection and moral hazards required identifying vulnerable groups.

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