Risk Preference of Farmers and Technical Efficiency of Rice Farming in Flood-Prone Areas of East Java, Indonesia

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Abstract

Although there is an increase in studies about the research on the farmers' preference against production risks and the technical efficiency of the rice farming business, the issue of natural disaster-prone areas in agricultural areas is not yet widely discussed. The agricultural sector's dependence on nature is still high, so the study about the production risks and the technical efficiency of rice farming business is still interesting to discuss. This research aims to analyze the rice farmers' risk preference and the technical efficiency level of rice production in the flood-prone areas. The Just and Pope approach is used to analyze the farmer's preference towards the production risks, and the stochastic frontier analysis is used to study the technical efficiency level of rice farming. This research involved 240 farmers as the respondents in three regencies in East Java, namely Ngawi, Bojonegoro, and Pasuruan regencies. Interviews and questionnaires became the instruments used to collect the primary data. This research found that in Ngawi Regency, the farmers tend to have a risk-seeking behavior and are more efficient in production. This shows that the risk-seeker farmers tend to be efficient in doing the farming business. Based on the findings, it's expected to be used as a consideration by the local government in offering incentive programs and increasing the farmers' skills, focusing on technology and increasing the farmers' managerial capacity.

Keywords

Risk preference, Technical efficiency, Rice farming, Flood-Prone, East Java

Introduction

Rice is the main food crop commodity that has become the heart of the farmers in Indonesia and is deemed to be important and strategic in supporting the economy of Indonesia. Based on the data from the Food and Agriculture Organization (FAO), it is stated that the rice commodity has become a superior commodity compared to others. Therefore, it is hoped that the farmers are able to produce rice with a high level of productivity without having to increase the land areas. However,

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a lot of farmers are still facing problems, including the change of climate that causes changes in the duration of the rainy and dry seasons, natural disasters like floods and landslides, pest and disease attacks, and the low price of rice in the harvesting season. This causes the risk of the rice farming business, which farmers have to face, so that the farmers have to have the ability to manage their farming business with the changes that are happening (Rizwan et al., 2020; Saeri et al., 2024).

East Java is one of the provinces that has become the national granary. Based on the data from the Central Bureau of Statistics of Indonesia (Statistik & Timur, 2023), East Java Province achieved the highest production of rice in Indonesia, valued at 9.71 million tonnes of dry milled rice in 2023. The rice-producing areas in East Java include Pasuruan, Ngawi, and Bojonegoro Regencies. Those three regencies are flood-prone areas. The three regencies are the rice centers and are located in the river basin, with the consequence that the area will experience flooding during high rainfall. The floods experienced by the rice farmers in those areas are certainly contributing to the decrease in production and income. It is important to research how the farmers' behaviour in facing the flooding risk affects the production and the income, so that their farming business continues.

Floods that often strike cause farmers to have to be able to manage their farming business properly to achieve optimal production and income. This includes managing the production input to be on time and in the right amount to keep the production and cost efficiencies in optimal condition. Inputs like the land, seeds, fertilizer, pesticides, labor, and management generally determine the rice farming business. The accurate utilization of inputs can increasing the productivity as well as technical efficiency, yet not causing risks if managed properly, such as the use of a certain variety of seeds that are vulnerable to climate change, can causing in crop failure especially during flooding, the excessive usage of urea fertilizer that vulnerable to the water (Azis & Shafriani, 2024;Zarliyanti et al, 2021). The availability and quality of inputs also determine the size of risks that are faced by the farmers, as the delay of food supply or the high price of the pesticides will affect the production decision and the efficiency potential. Therefore, the balance in the utilization of input is important to achieve high technical efficiency as well as minimize the production risks and the economic risks in the rice farming business (Hakim et al., 2021; Mon et al., 2021).

The studies in several areas show a correlation between the risk preference and technical efficiency; farmers who are braver to take risks tend to implement intensive performance that increases the maximum productivity, but not balanced with the high risk of failure (Apriana & Fariyanti, 2017; da Silveira et al., 2023; Duong et al., 2019; Rizwan et al., 2020). The farmer's behavior toward the production risks, including the risk preference tightly tied to the production efficiency, as it played a direct role in technical decisions, including the selection of seeds, fertilizer dosage, and the planting schedule. These decisions affect the harvesting result and the input utilization efficiency.

Based on the explanation above, the rice farmers are faced with the uncertainty of production due to climate change and natural disasters that cause production risks, and an achieved technical efficiency level that is not optimal. It's estimated that the technical efficiency of the farmers in several locations, especially in the research location, can still be increased because of the farmers' behavior, which allows they to take risks. The main problem in this research is "how the rice farmers' behavior in a flood-prone area faces the production risks and the technical efficiency level in rice production." This research aimed to analyze the risk preference of the rice farmers and the level of rice farming's technical efficiency in the flood-prone area. It's expected that this research will result in findings that are relevant academically and strategically to the decision makers. The

result of this research will inform the design of subsidy policy, insurance program, and targeted consultation intervention to increase the efficiency and rice farming resilience.

Methodology

- **Location and time of the research**

The research location is selected in East Java Province, considering that East Java is included as the biggest producer of rice in Indonesia. The location is in three regencies that become the rice central in East Java, including Ngawi, Bojonegoro, and Pasuruan regencies. These three regencies are included as the areas that are affected by floods annually, as they are located near the river. Rice is the main crop that was planted by the farmers in those three areas throughout the year, so the sample chosen gives a good representation in the research. The research was conducted from June to August 2025, and the data were obtained from the first rice planting season that was conducted between December 2024 and May 2025. Figure 1 shows the map of the research location.

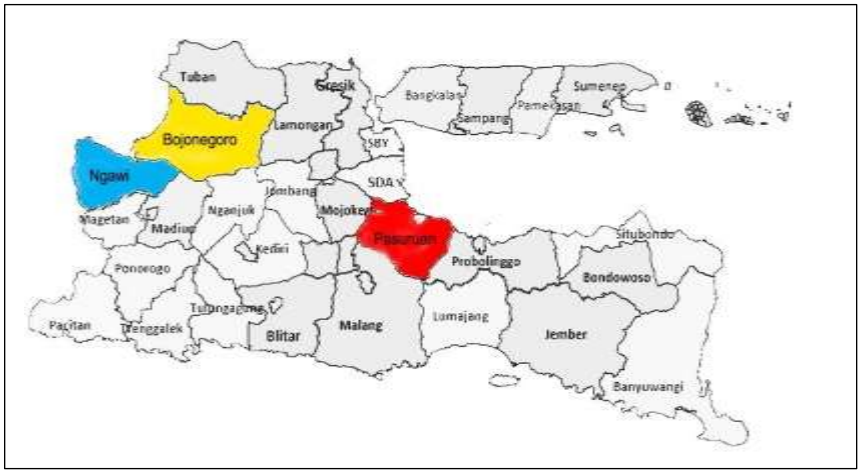

Figure 1. Map of research location

- **The Sampling and Data Collection Technique**

Samples in this research are the rice farmers who have their land flooded more than once. The sampling technique that is used is the multi-stage cluster sampling. Four steps were used, namely: selecting the regency, selecting the district, selecting the village, and selecting the sample by random sampling. The target number of the sample in this research is 80 persons in one location, considering the research period, so that the total sample is 240 farmers. The research is using the primary data, which was collected through interviews, questionnaires, field observation, and documentation (Qonita et al., 2025). Whereas the secondary data includes the supplementary information, including the profile of the village, the farmers' group, and the farmers, which was obtained from the local government.

- **Data analysis**

The approach used to measure the farmer's risk preference is the Just and Pope risk function (Asmara et al., 2022; Mamilianti et al., 2019). This model explains that production is not

only determined by the production function, but also by paying attention to the risk function. The model is:

$$y = f(x,z) + u = f(x,z) + g(x,z)\varepsilon$$

Where: y is production; f(x,z) is the production function; g(x, z) is the risk function; x is the production input, and z is the amount of fixed input; and ε is the error term.

The steps of estimating the risk production are done in two steps. The first step is estimating the production function f(x, z). The second step is calculating the absolute value of the rest of the production function, dependent variable, in estimating the production risks function g(x, z). Here, the independent variables of the risk function are equal to the independent variables of the production function. Then, to determine the farmer's behavior toward risk, the utility function is used:

$$\pi^e = py - w'x = pf(x,z) - w'x + pg(x,z)\varepsilon$$

Where: π^e is the expected profit; p is the price of the output; y is the production; w is the vector of the price of the input variables; x is the amount of input used.

At the same time, to measure the level of technical efficiency of the rice production in the three research locations using the stochastic frontier production function, following the estimator model of the production function by Coelli et al (2005). The goal of the analysis is to determine the farmers' production and the technical efficiency value of the rice farmers. The hypothesis used is that rice production is affected by the land area, the seeds, the urea and ponska (NPK) fertilizer, pesticides, and labor (Abdul-rahaman et al., 2021; Chandel et al., 2022; Rahim et al., 2020; Saeri et al., 2024). The estimator model using the stochastic frontier production function is formulated in the following equation:

$$ln\, Y = \beta_0 + \beta_1\, ln\, X_1 + \beta_2\, lnX_2 + \beta_3\, lnX_3 + \beta_4\, lnX_4 + \beta_5\, lnX_5 + \beta_6\, lnX_6 + (V_i - U_i)$$

Where: Y is the rice production in kg; X_1 is the land areas in m^2; X_2 is the amount of the rice seeds used (kg); X_3 is the amount of urea fertilizer used; X_4 is the amount of ponska (NPK) fertilizer used in kg; X_5 is the amount of pesticide used in liter; X_6 is the number of labors used in workdays; and (vi – ui) is the error term.

The measurement of technical efficiency of the rice production is measured with the following formula (Coelli *et al,* 2005):

$$TE = \frac{y_i}{y_i^*} = \frac{\exp(x_i\beta + v_i - u_i)}{\exp(x_i\beta + v_i)} = \exp(-u_i)$$

Where: y_i is the actual production based on the observation; y_i^* is the estimation of production potential from the Scholastic Frontier Function. The technical efficiency for a farmer ranged between 0 and 1. That technical efficiency has values that are opposite to the effect of the technical inefficiency effect.

Results and Discussion

- **Farmer's Preference towards the Risk in Rice Production**

Table 1 shows the result of the analysis of the farmers' preference towards the production risks using the Just and Pope approach. Based on the result, it is known that the respondent farmers in the Ngawi Regency tend to be risk seekers or dare to take risks at 86,25%, whereas in Bojonegoro at 60% farmers and in Pasuruan at 56,25% farmers. This result is surely influenced by the farmers' behavior in the input allocation during flooding or not. The risk-seeker farmers tend to accept risks; flooding didn't reduce the farmers' motivation to keep doing the production. This is proven by the fact that during flooding, the farmers keep continuing the production process even though they are experiencing loss due to the floods. However, in contrast to the farmers in Pasuruan, they only farm rice once a year, as every year, floods the land for more than a week, and it can't be planted. There is a small percentage of risk-averse farmers or farmers who don't want to take risks in the three regencies. The risk-averse farmers are inclined to use the input carefully and tend to use less than the recommended dose, and are less interested in the use of the newest technology that requires a high capital investment. This is because the farmers are afraid of failure. The risk-seeking farmers dare to use the technology and focus on increasing productivity (Apriana & Fariyanti, 2017; Asmara et al., 2022; Asravor, 2019; Mamilianti, 2020; Paulson et al., 2021).

Table 1. The Respondent Farmer's Behavior towards Production Risks

Farmer's behavior toward risks	Ngawi		Bojonegoro		Pasuruan	
	Farmer (person)	Percentage (%)	Farmer (person)	Percentage (%)	Farmer (person)	Percentage (%)
Risk seeker	69	86,25	60	75	45	56,25
Risk averse	11	13,75	20	25	35	43,75
Risk neutral	0	0	0	0	0	0
Total	80	100	80	100	80	100

Source: Primary data analysis, 2025

- **Technical Efficiency in the Rice Farming Business**

The distribution of technical efficiency of rice farmers in the three regencies where this research is conducted can be seen in Table 2 and Figure 2. The technical efficiency analysis with the Frontier Stochastic approach estimated the level of technical efficiency achieved by each farmer. This technical efficiency level mirrored the utilization of production input by the farmers towards their production. The farmers are deemed to be efficient if they can utilize the input that results in maximum production (Anam et al., 2025; Novitaningrum et al., 2019; Obianefo et al., 2023; Sun & Li, 2021). Based on the analysis of the technical efficiency level in the three research locations in Table 2, it shows that the Ngawi Regency has the highest average at 0.860 compared to the other two regencies. This shows that the Ngawi Regency can still increase its technical efficiency by 24% to achieve maximum production. Smaller than the other two regencies, Pasuruan Regency has the lowest technical efficiency at 0.643. Seeing this, the respondent farmers in Pasuruan Regency have not yet achieved the optimum efficiency level. The farmers have to be able to manage their farming business so that the land productivity will be increased.

The production efficiency level of the farmers is low, and this was influenced by the utilization of production input that is not optimal, such as the seeds, fertilizer, and pesticides, that is not according to the recommendation. Moreover, the capital constraints cause the farmers to find it hard to access modern technology, such as farming machinery, that can actually increase productivity. Other factors that can also play a role is the social-economy factor of the farmer which has been widely researched by several researchers about the technical efficiency, such as the experience in the farming business, the education, the knowledge and skill level of the farmers in implementiing the efficient farming technique, access to the market and weather information, and the limitation in the agricultural counseling (Bozoğlu & Ceyhan, 2007; Delay et al., 2021; Le et al., 2019; Min et al., 2021; Ngango & Hong, 2021).

Table 2. The Distribution of Technical Efficiency during the Rainy Season

The Level of Technical Efficiency	Ngawi		Bojonegoro		Ngawi	
	Farmer (person)	Percentage (%)	Farmer (person)	Percentage (%)	Farmer (person)	Percentage (%)
0 - 0,25	0	0	0	0	0	0
0,26 - 0,5	12	15	19	23,75	29	36,25
0,51 - 0,7	8	10	10	12,5	15	12,5
0,71 – 0,85	11	13,75	9	11,25	17	21,25
0,86 - 1	49	61,25	42	52,5	19	23,75
TOTAL	**80**	**100**	**80**	**100**	**80**	**100**
Min		0.427		0.419		0.307
Max		0.999		0.999		0.952
Average		0.860		0.824		0.643

Source: Primary data analysis, 2025

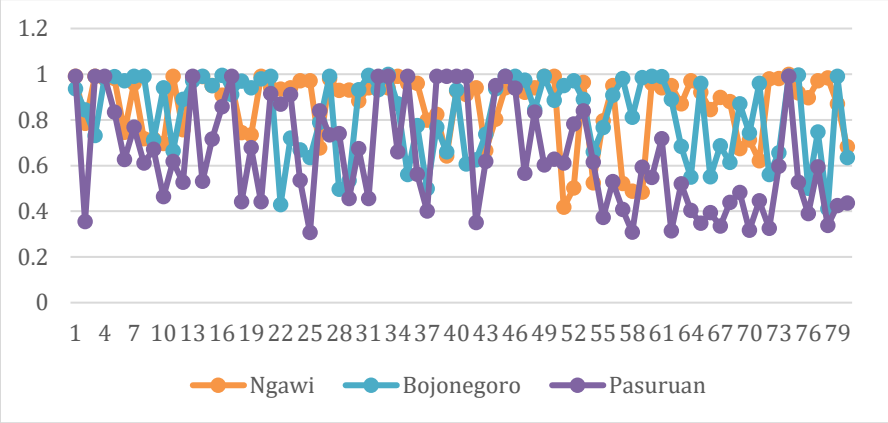

Figure 2. The Distribution of Respondent Farmers' Technical Efficiency

This research is limited to the explanation of the farmers' preference towards the production risks and the technical efficiency level, finding that the majority of farmers in the Ngawi Regency have a risk-seeker behavior towards the risks and are efficient in production. The future research is interesting to raise this topic, namely, the correlation and the effect of the production risk preference and the farmer's technical efficiency. The future research can be

widened by explaining the effect of the farmers' risk preference on the technical efficiency by choosing a wider research location so that the findings of the research are more generally applicable.

Conclusion

The analysis of technical efficiency utilizing the stochastic frontier production function showed an average technical efficiency value of rice production in the three regencies, which are classified as the flood-prone areas in East Java, is 0.860 in Ngawi Regency, 0.824 in Bojonegoro Regency, and 0.643 in Pasuruan Regency. The farmers' behavior toward risk-seeking in Ngawi is 89%, in Bojonegoro is 80%, and in Pasuruan is 65%. Meanwhile, the farmers who have a risk-averse behavior are 11% in Ngawi, 20% in Bojonegoro, and 35% in Pasuruan. Based on the result, it was found that the rice farmers in Ngawi have a risk-seeker behavior or are daring to take risks and efficient towards the input allocation. These findings imply that the farmers in flood-prone areas need support from all related institutions, especially in the utilization of technology and the increase in managerial capacity.

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