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An investigation into the risk behavior of rice farmers in Lampung, Indonesia

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Abstract

Examining the variables that affect production risks, as well as how Lampung rice farmers respond to those risks, is the goal of this study. The data utilized was primary data obtained from three districts in Lampung Province, specifically South Lampung, Pesawaran, and Pringsewu. The data collection was conducted over the months of October and November in the year 2023. The research sample involved 161 rice farmers as respondents. The analysis employed the Just and Pope model, utilizing multiple linear regression, as well as the Moscardi and de Janvry model, to ascertain the preferences of farmers. The research findings indicate that the variables of land area, seeds, urea fertilizer, insecticides, and labor outside the family are factors that increase the risk. Rice farmers, in general, exhibit risk aversion and have a high tolerance for danger. Production hazards can be managed by applying precision agriculture, diversifying farming practices, and utilizing agricultural insurance.

Keywords: Farmers, Production risk, Rice, Risk-averse, Risk preference.

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1. Introduction

Rice is a major source of carbohydrates for most people worldwide. It also plays a global role in maintaining food security and contributes to the daily caloric intake in Asia [2, 3]. Rice in Indonesia is a crucial primary commodity that plays a vital role in providing food to support national food security [4]. In addition, rice serves as the primary source of calories for the global population, particularly in Indonesia [5]. The average rice consumption of the Indonesian population in 2023 reached 93.79 Kg/capita [6] which is higher compared to Thailand, Malaysia, China, Japan, and Korea [7].

The increase in population each year necessitates an increase in rice production to meet the food needs of the community [8]. The rice production in Indonesia in 2023, in the form of milled dry paddy, was 53.98 million tonnes, a decrease of 1.40 percent compared to the rice production in 2022, which was 54.75 million tonnes [9]. Efforts to enhance rice production and productivity are continuously being made to maintain the national supply [10, 11].

The activity of rice farming is greatly influenced by risks and uncertainties [12] that arise from various factors such as climate change [13, 14], pest and disease attacks [15, 16], market changes, and policy changes in the context of farming and trade [17]. The occurrence of climate change leads to fluctuations in production, a decrease in the quality of the output, crop losses, and a decline in productivity [18]. The decrease in rice production leads to unstable prices, food insecurity, economic instability, and social and political instability in a country [19-21], as well as negatively impacting farmers' income [22].

In 2023, the province of Lampung contributed 5.11% to the national rice production, making it one of the major hubs for rice production in the country. According to BPS-Statistics Indonesia [23]. The rice production in Lampung amounted to 2.76 million tonnes of milled dry paddy, cultivated across an area of 530.11 thousand hectares. According to BPS-Statistics Indonesia [23]. The rice output in Lampung Province between 2018 and 2023 exhibited a tendency to vary. The variability in rice output is impacted by factors such as seasonal planting, climate change, and the decreasing availability of agricultural land [24]. Climate change, which is marked by increasing temperatures and alterations in rainfall patterns, impacts the scheduling of rice farming [25] and presents a significant threat of reduced rice output in specific areas of Indonesia [26].

Farmers encounter several risks, including production risk, price risk, institutional risk, personal risk, and financial risk [27]. Farmers are exposed to production hazards that may arise from both external and internal variables [28]. External variables may arise from unpredictable meteorological conditions, infestations, and diseases, as well as other natural hazards like floods and landslides. Internal factors arise from the utilization of production components, including seeds, fertilizers, insecticides, and human resources [29, 30].

Production risk plays a crucial role in farmers' decision-making processes when it comes to determining how to allocate inputs, which in turn affects the output and the overall degree of technical efficiency in farming [31, 32]. Certain production parameters might either decrease or increase the level of risk. Augmenting the quantity of seeds and labor has the potential to amplify production hazards [33]. The inputs of urea fertilizer, Ponska fertilizer, insecticides, and land area are categorized as risk-reducing variables. Farmers are more diligent in regulating their farming practices to minimize risks when the cultivated land area increases [34]. Hence, it is imperative to take into account the elements that impact production risk in order to attain maximum production efficiency.

Farmers' risk preferences can be classified into three distinct categories: risk-averse farmers who consistently avoid risk, risk-neutral farmers who are indifferent to risk, and risk-seeker/risk-taker farmers who actively seek out risk. These preferences, as documented by Fauziyah et al. [32], Hong et al. [35], Jung and Houngbedji [36], Sasrido et al. [30], and Shinta [37]. It plays a crucial role in shaping farmers' decisions regarding the allocation of production inputs. The objective of this study is to examine the determinants of production risk and the risk preferences of rice farmers in Lampung Province.

2. Materials and Methodology

South Lampung Regency, Pesawaran, and Pringsewu Regency are the three districts in Lampung Province where the research was conducted. The location selection was deliberately decided based on the fact that the three districts are major hubs for rice production. The data collection was conducted throughout the period from October to November 2023. The research employed a survey methodology, utilizing a sample size of 161 samples determined through the application of the Slovin method. The population under study consisted of 15,657 farmers. The research employed the proportionate random sampling technique for the sampling approach.

Farmers' preferences for production risk are ascertained using the Moscardi and De Janvry [1] model, while the Just and Pope model with multiple linear regression is employed to examine the impact of production risk. The model utilizes the Cobb-Douglas production function expressed in the form of a natural logarithm. The identification of production risk is accomplished by utilizing the production variance value [38]. The production function and variance function for rice production can be expressed as follows:

Production function

$$LnY_i = \alpha_0 + \alpha_1 LnX_{1i} + \alpha_2 LnX_{2i} + \alpha_3 LnX_{3i} + \alpha_4 LnX_{4i} + \alpha_5 LnX_{5i} + \alpha_6 LnX_{6i} + \alpha_7 LnX_{7i} + \varepsilon i$$

Production Variance:

$$\sigma^2 Y_i = (Y_i - \hat{Y}_i)^2$$

Production variance function:

$$Ln\sigma^2 Y_i = \beta_0 + \beta_{1i} LnX + \beta_2 LnX_{2i} + \beta_3 LnX_{3i} + \beta_4 LnX_{4i} + \beta_5 LnX_{5i} + \beta_6 LnX_{6i} + \beta_7 LnX_{7i} + \varepsilon$$

Information:

Y = actual rice production (kg)
$\hat{Y}_i$ = average rice production (kg)
X_1 = Total land area (ha)
X_2 = Number of rice seeds (kg)
X_3 = Amount of Urea fertilizer (kg)
X_4 = Amount of NPK fertilizer (kg)
X_5 = Amount of insecticide (ml)
X_6 = Fungicides (kg)

X_7 = Number of workers in the family (HOK)
X_8 = Number of workers outside the family (HOK)
$\sigma^2 Y_i$ = Variance of rice production
ε = error
α1...α8 = Estimated average production parameter, coefficients $X_1, X_2,..., X_8$
β1... β8 = Estimated parameter coefficients of production, variances $X_1, X_2,..., X_8$

An examination of farmers' inclinations towards risks in rice production is conducted using the Moscardi and De Janvry [1] model, which is represented by the following equation:

$$K(s) = \frac{1}{\theta}\left(1-\frac{PxiXi}{Pyfi\mu y}\right)$$

Keterangan:
θ = Coefficient of variation of production ($\theta = \delta y/\mu y$) in which δy is the standard deviation of production and μy= average production
Pxi = Price of input i (for each respondent)
Xi = Number of inputs i (the number of inputs that are most significant and have the greatest contribution to each respondent)
Py = Price of rice products
fi = Elasticity of production of input i (elasticity of the most significant input and has the largest contribution)
μy = Average rice production
K(s)= Measurement of risk aversion parameters, S is a variable that represents the characteristics of farmers.

The risk aversion metric K(s) is utilized to categorize farmers into three distinct groups:

a. *Risk taker* (0<K(s)<0.4), low risk category
b. *Risk neutral* (0.4≤K(s)<1.2), medium risk category

risk averse (1.2≤K(s)<2.0), high risk category

3. Results and Discussion

The characteristics of the respondents according to age, education, rice field area, and farming experience are displayed in Table 1. The age distribution of the respondents indicates that the average age of rice farmers is 48.8 years. These farmers are in their productive years, which means they have the economic capacity to engage in farming operations.

The farmers' degree of education will impact their receptiveness to adopting new agricultural advances for farming development. The educational attainment of farmers significantly impacts their cognitive abilities, knowledge, and proficiency in generating innovative ideas [39]. Respondents most commonly pursued education levels of junior high school and senior high school, with each level accounting for 34 percent of respondents.

Table 1.
Respondent Characteristics.

No.	Variables	Number of respondents (people)	Proportion (%)
1.	Age		
	20-40 years	43	27
	41-60 years	104	65
	61-80 years	14	8
	Average (years)	48.8	
2.	Education level		
	Elementary school	41	26
	Junior high school	55	34
	Senior high school	55	34
	Bachelor	10	7
3.	Land size		
	0.10 - 0.50 (ha)	102	63
	0.51 - 1.00 (ha)	32	21
	1.10 - 1.50 (ha)	7	4
	1.51 - 3.00 (ha)	19	11.4
	≥ 3.00 (ha)	1	0.6
	Average (ha)	0.66	
4.	Farming experience		
	≤ 10 years	39	24
	10-25 years	48	30
	≥ 25 years	74	46
	Average (years)	17.8	

The mean size of rice fields cultivated by farmers is 0.68 hectares, with the majority falling within the range of 0.10 to 0.50 hectares, accounting for 63 percent of the total. Typically, farmers own the rice fields they cultivate, although some may be leased.

The average tenure of farmers in producing lowland rice is 17.8 years. According to Saputra [40], Farmers who have extensive farming experience are more likely to have a higher level of preparedness for different farming hazards. However, they may also face challenges in adopting innovations and technology, often preferring to stick to traditional farming ways.

4. Characteristics of Rice Farming

In order to prepare for rice plants that need to be replanted because they do not grow well or are attacked by pests and diseases, rice farmers in the research region typically sow more rice seeds than are required. The predominant cultivars chosen by farmers are Inpari 32 and Ciherang. The average seed sowing rate is 25 kg per hectare. Rice farmers commonly utilize both organic and inorganic fertilizers.

The organic fertilizer utilized is manure, with an average application rate of 200 kg per hectare. Commonly utilized inorganic fertilizers include urea, NPK Phonska, SP 36, and KCl. The mean application rate of urea fertilizer was 248.28 kg per hectare, NPK Phonska was 248.87 kg per hectare, SP 36 was 14 kg per hectare, and KCl was 3.7 kg per hectare. The application of fertilizer is often lower during GS 2 (dry season) compared to GS 1 (rainy season). Fungicides, insecticides, and herbicides are the most commonly utilized pesticides. The mean utilization of pesticides by farmers is 550.19 milliliters per hectare.

Labour encompasses both intrafamilial and extrafamilial work. The average labour utilization for rice cultivation in a single season amounts to 67.28 hours of labour per hectare. The most significant allocation of labour is dedicated to the tasks of planting and harvesting. A multitude of farmers have employed mechanized harvesting devices.

5. Factors Influencing Rice Production

Table 2 presents the estimation findings of the elements that impact rice production. The results of parameter estimation indicate that in GS 1, the variables of seeds, urea fertilizer, fungicide, and labor within the family have a positive sign and exert a significant effect on rice production at the $\alpha < 0.05$ level. Similarly, in GS 2, the variables of seeds, NPK fertilizer, fungicides, and labor from outside the family also have a positive sign and exert a significant effect on rice production at the $\alpha < 0.05$ level.

A positive coefficient value signifies that augmenting the input of seed production, fertilizer, fungicide, and labor will result in an increase in rice output. The findings are consistent with prior studies indicating that seeds have a tangible impact, as seen by a positive coefficient [41].

Table 2.
Results of estimating the parameters that influence rice production.

Variables	Growing Season (GS I)			Growing Season (GS II)		
	Regression coefficient		Standard error	Regression coefficient		Standard error
Constant (C)	23.840		276.308	121.051		313.267
Land area (X_1)	1.140		2.860	-.253		3.221
Seeds (X_2)	84.477	***	12.896	102.869	***	14.110
Urea fertilizers (X_3)	.006	***	.012	.011		.016
NPK fertilizers (X_4)	.071		.013	.057	***	0.16
Insecticides (X_5)	-.055		.134	-.164		1.076
Fungicides (X_6)	5.303	***	1.104	228.592	***	82.163
Family labor (X_7)	.130	**	.060	-.014		.063
Nonfamily labor (X_8)	.041		.041	.095	**	0.47
R^-Sq	0.847			0.799		
R-Sq(Adj)	0.702			0.619		
F-statistics	47.227			31.111		

Note: *** significant at level 0.01, ** significant at level 0.05, significant at level 0.10.

High-quality rice seeds will yield robust rice plants that exhibit optimal growth. High-quality rice plants that achieve optimal growth have the potential to significantly enhance output yields. As the number of seeds planted increases, the plant's nutritional requirements will also grow.

NPK fertilizer has a significant impact on promoting plant growth, increasing leaf count, enhancing the dry weight of the shoot, improving the dry weight of the roots, influencing the root-to-shoot ratio, and overall enhancing the total dry weight of the plants [42].

6. Factors Influencing the Risk of Rice Production

The analysis of factors influencing the risk of rice production can be elucidated by examining the outcomes of estimating the variance function of rice production. The model for estimating the risk function of rice production is derived by using the production variance as the dependent variable and the production components of land area, seeds, urea fertilizer, NPK fertilizer, pesticides, family labor, and non-family labor as independent variables, as shown in Table 3.

The estimation results demonstrate that the risk of rice production is positively impacted by the variables of land area, insecticides, and non-family labor in GS 1, and that this risk is significantly impacted by the variables of land area, seeds, urea fertilizer, insecticides, and non-family labor in GS 2. The positive coefficient value signifies that any increase in land size, seeds, urea fertilizer, pesticides, and non-family labor will result in an elevated risk of rice production.

One aspect that raises the risk of production is the land area. This finding aligns with the study conducted by Nainggolan and Harahap [43], which asserts that smaller land areas decrease production risk, whereas larger land areas increase production risk. The findings of Suharyanto et al. [44] contradict this result, as they suggest that expanding the land area can enhance company size, productivity, and farming efficiency, hence minimizing the risk associated with rice production.

Table 3.
Results of estimating the parameters of risk production.

Variables	Growing Season (GS I)			Growing Season (GS II)		
	Regression coefficient		Standard error	Regression coefficient		Standard error
Constant (C)	27.885		4.131	105568.830		3465.460
Land area (X_1)	0.353	***	0.051	11105.301	***	1325.672
Seeds (X_2)	-0.234		0.175	45.813	***	12.181
Urea fertilizers (X_3)	0.170		0.161	8.320	***	2.721
NPK fertilizers (X_4)	0.230		0.161	-0.052		1.545
Insecticides (X_5)	0.056	**	0.027	4.162	***	1.051
Fungicides (X_6)	0.141		0.015	1.158		1.874
Family labor (X_7)	0.022		0.045	5.077		6.123
Nonfamily labor (X_8)	0.214	**	0.085	17.175	**	7.141
R-Sq	0.818			0.765		
R-Sq(Adj)	0.775			0.755		
F-statistics	19.258	***		71.294	***	

Note: *** significant at level 0.01, ** significant at level 0.05, significant at level 0.10.

Seeds are an element of production that amplifies the risk of production. The findings of this study align with the research conducted by Suharyanto et al. [44], which asserts that higher utilization of seeds leads to an elevated risk in rice production. These results suggest that the seed variable is a contributing factor to increased risk [28]. Discovered that utilizing high-quality seeds in rainfed rice fields can lower the likelihood of reduced rice yield.

Urea fertilizer is a production input that amplifies the level of uncertainty in output. This finding aligns with the study conducted by Nura et al. [45], which asserts that higher utilization of Urea fertilizer is associated with an elevated production risk. The findings contradict the research conducted by Arifin et al. [28], which suggests that increasing the application of nitrogen fertilizer up to a specific threshold can mitigate the risk associated with rice production.

The use of insecticides in production can raise the hazards associated with them. Exceeding the optimal limit of insecticides can lead to resistance, environmental pollution, and human health issues [46]. Typically, farmers in the research region employ insecticides as a means to counteract brown planthopper infestations. Rice growers face the potential of brown planthopper infestations. The findings of this study contrast with those of Suharyanto et al. [44], indicating that pesticides have a substantial impact on production risks and contribute to the reduction of risk variables.

Non-familial labour is a contributing element that escalates the level of danger. The findings of this study align with the research conducted by Zakaria et al. [47] and Suharyanto et al. [44], indicating that the inclusion of labor has a notable impact on augmenting production risk. This is because when farmers who are already capable of cultivating their land receive additional labor, it might lead to an uneven and imprecise allocation of tasks, resulting in decreased productivity for the farmers. This can potentially exacerbate the danger of production inefficiencies.

7. Risk Preferences of Rice Farmers

Farmers' choices about the utilization of production inputs to create goods that aim to achieve efficiency in production activities are their way of responding to production hazards. Farmers want to achieve maximum production by effectively regulating the utilization of efficient production inputs [48]. Assessing the hazards associated with rice farming is valuable for overcoming barriers to reaching farming productivity, as it will be linked to farmers' inclinations in managing risk. The study's findings indicate that the average value of K(s) ≥ 1.2 signifies that rice farmers in GS 1 and GS 2 have risk-averse production risk preferences, falling into the high-risk category (Table 4). These findings align with the study conducted by Nainggolan and Harahap [43], which asserts that rice farmers' productivity regarding production inputs is characterized by risk aversion.

Three factors land acreage, pesticides, and non-family labor—determine the risk preferences of rice farmers' productivity in GS 1. Rice growers typically withhold the distribution of land and non-family labor inputs to mitigate output risks. Farmers are willing to incur the risk of using larger amounts of pesticide inputs to get higher productivity.

The variables of land area, seeds, urea fertilizer, pesticides, and non-family labor impact the risk preference of rice farmers' production in GS 2. Rice growers typically withhold the distribution of land, seedlings, and non-family labor inputs to mitigate production risks. However, when it comes to urea fertilizer and pesticide inputs, farmers' preferences tend to be more impartial.

Rice production has a risk-averse preference for land area. The findings of this study align with the research conducted by the Ministry of Agriculture [49], which indicates that farmers in Baso Regency, West Sumatra, exhibit risk-averse preferences when it comes to rice cultivation land. When it comes to the utilization of urea fertilizer input, rice farmers' production shows no risk preference. Farmers exhibit indifference towards the use of urea fertilizer input, irrespective of the resulting rice yield being either low or high. The rise in fertilizer prices will not impact farmers' risk behavior in terms of using urea input for production. The findings of Nainggiolan et al. [34] indicate that farmers exhibit risk aversion when it comes to utilizing urea fertilizer during the first and second growing seasons.

Rice farmers employ a greater quantity of pesticides during the first growth stage (GS 1) as opposed to the second growth stage (GS 2). This finding is consistent with the study conducted by Anggela et al. [50], which indicates that the primary factor contributing to production risk is climate variability. Specifically, unpredictable weather patterns and unclear climatic circumstances lead to a higher incidence of pest infestations during the rainy season as opposed to the dry season. Farmers can implement preventive measures such as performing regular maintenance and consistently managing pests and diseases. Rice farmers' productivity exhibits risk aversion towards the utilization of non-family labor input. This finding aligns with the study conducted by Asmara and Hanani [51] but contrasts with the research findings of Nainggiolan et al. [34], which indicate that rice farmers have a risk-taking attitude towards labor input.

Table 4.
Risk preferences in rice farmers' production.

Variables	Grow Season 1 (GS 1)		Grow Season 1 (GS 1)	
	K(s)	Risk Preference	K(s)	Risk Preference
Land area (X_1)	1.4283	risk averse	1.449	risk averse
Seeds (X_2)	-	-	1.333	risk averse
Urea fertilizers (X_3)	-	-	1.234	risk neutral
Insecticides (X_5)	0.3344	risk taker	0.714	risk neutral
Non-family labor (X_8)	1.2175	risk averse	1.282	risk averse
Rata-rata	1.2800	risk averse	1.200	risk averse

8. Conclusions with Recommendations

The land area, pesticides, and non-family labor inputs affect rice farmers' production risk in growing season 1, while seeds, urea fertilizer, land area, insecticides, and non-family labor influence producers' risk in growing season 2. Augmenting the utilization of land, seeds, urea fertilizer, pesticides, and non-family labor will amplify the level of output uncertainty. Rice farmers exhibit risk aversion in both growing seasons, with a tendency towards high-risk activities.

The research has implications for policy, and the following are suggested: (1) precision farming can be used to control the use of seed, fertilizer, and pesticide inputs; (2) farming businesses should be diversified; and (3) farmers should be encouraged to purchase farming insurance.

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