Risk Analysis of Rice Farming at Volcano Semeru Area, Pronojiwo District, Lumajang Regency, Indonesia

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Abstract. This study aimed to analyze the production and financial risks of paddy rice farming in Pronojiwo district, Lumajang Regency, East Java, Indonesia. The research was conducted in March to May 2021, after the case of Semeru eruption in December 2020. The villages sample were Oro-Oro Ombo and Supiturang, the two most affected by the Mount Semeru lava flow. Primary data were obtained from the amount of 95 respondents chosen randomly. The risk of production and financial were analyzed by Coefficient of Variation (CV). Meanwhile, the factors affecting farm risk is analyzed by using regression method. The result of production risk on paddy rice farming in Pronojiwo, Lumajang Regency shows a low risk, namely indicated by CV of 35.38 %. However, the farm income risk is much higher, indicated by CV of 79.08 %. The factors affecting production risk is usage of chemical fertilizer. The increased number of chemical fertilizer will increase production risk of rice farming.

Keywords: Financial risk, paddy rice farming, production risk.

1 Introduction

Rice is the most consumed food source of carbohydrates in Indonesia. Therefore, rice is one of the strategic commodities programmed in an effort to be self-sufficient in food. Indonesia's population of 270 × 106 has encouraged the importance of rice farming to meet the needs of national rice consumption, in addition to food diversity programs to reduce rice needs. East Java Province is one of the important rice-producing areas. Planting sites include lowlands, medium lands, and highland. One of the rice producing locations with the characteristics of

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mountainous areas is Pronojiwo district in Lumajang Regency. Pronojiwo district has the characteristics of an agricultural area that is at risk of being affected by volcanic ash eruptions and the lava flow of Mount Semeru. Several volcanic eruptions of Mount Semeru in 2020 and previous years have had an impact on the destruction of land carried by cold lava flows, but on the other hand it has also been beneficial to the fertility of agricultural land. Therefore, rice farming in Pronojiwo district faces production risks that are very likely to occur.

Lumajang Regency is an important rice producer in East Java with a production of more than 400 × 10^3 t a year, and in January to June 2018 its production reached 261 331.7 t [1]. Pronojiwo district has a rice harvest area of 520 ha in January until June 2018 with a production of 3 279.7 t [1]. Rice productivity reached 6.31 t ha⁻¹ in that year, but rice productivity was disrupted by the eruption of Mount Semeru which occurred from 2018 to 2020. Thus, there has been a production risk in rice farming. The risk of rice farming production can be caused by internal and external factors. This study examines internal factors, which include the inputs of production of farming. In addition, the attitude of farmers in Pronojiwo district towards the risks of farming production has not been scientifically assessed.

Farmer's attitude towards risk is an important aspect in the success of rice farming. Most farmers are more risk averse [2, 3]. In particular, farmers were more sensitive to disaster-caused property loss than to disaster-caused crop loss [4]. Farmers tend to avoid production risk, because rice farming is the only one source of income [5]. The risk of rice production in farming businesses that get tertiary irrigation policies is lower than those who do not receive such irrigation [6]. Rice farming in rain fed paddy fields is vulnerable to production and income risks [7]. Farming communities are exposed to various types of risks, but production and environmental risks are the greatest [8]. The results of this study not only can be used for the development of risk-based farmers' decision models but can also be used as input for the development of government policies in resource sharing and development of agricultural insurance [9]. Land, seeds, fertilizers, and pesticides affect the risk of field rice production [10]. Farmers in Pronojiwo district have to deal with the changes in several factors such as weather, disaster, and market.

Various previous research results have examined risk analysis in farming. Production risks can result in reduced productivity and increased operating costs [11]. The results of the analysis of production risks in farming several types of crops are quite diverse. In Mainland South East Asia, for example, non-rice crops are important in improving rice farmer income, but they face production risks because of the soil constraints [12]. In apple plants, the combination of organic fertilizers with chemical fertilizers reduces production risk [13]. Factors affecting the risk of chrysanthemum flower production are chemical fertilizers [14].

Especially in rice farming, low production risks were found [2]. Farmers experience risks of hybrid rice production from moderate to serious [15]. In Zhejiang Province, China, the land market reform has increased production risk [16]. In field rice farming, risk production in the rainy season is lower than the dry season [10, 11]. Factors affecting the risk of rice production are unexpected production performance, germination failure, seed availability during sowing seasons, crop failure due to pests, and fertilizer usage [15, 17, 18]. Production factors that have a significant effect on production risk are Phonska fertilizer (KCl), organic fertilizer and labor, while liquid pesticides reduce the risk of rice production [2, 17].

Farmer families need financial power to fulfill their daily lives. Meanwhile, production risk influence profitability [3]. Production and financial risks are the most worrisome for farmers [16]. Production risks, particularly in terms of prices received and livelihoods, are faced by Organic Basmati Rice (OBR) farmers in India [19]. In Bangladesh farmers who are educated from high-income families, are innovative, experienced, and who sell rice through government procurement face lower risk of yields in hybrid rice production [15]. In Tanzania, it is still possible for rice farmers to increase food production and income through the
application of improved technologies, particularly SRI management practices, which have shown a promising future [20]. Therefore, studying production risk also needs to study the financial risk. Causes of financial risk include high production costs [21], and limited capital [22, 23], thus causing farm income. Financial risks on investing in tissue culture technology in bananas found that investment risks were low and profit opportunities were high [24].

The most complete results of the rice farming risk analysis are to analyze the level of production risk, the factors that affect production risk, and farmers' attitudes towards production risks. So far, no analysis of production risks as well as financial risks in rice farming has been found. In fact, financial risk information is quite important because the ultimate goal of farming is to obtain financial performance. The novelty of this study is to combine the analysis of production risk and financial risk in rice farming, the risk indicator used is farm income.

Referring to the importance of understanding rice farm risk, this research aimed to analyze the production and financial risk in Pronojiwo district of Lumajang Regency. This research is focused on farmers’ land with situation of disaster-prone of Volcano Semeru in Pronojiwo district, Lumajang Regency.

2 Methods

The research was conducted at Pronojiwo district, Lumajang Regency, East Java Province, Indonesia. The observation and collecting research data was done on March to May 2022, after the case of Semeru eruption on December 2020. At the time of data collection, rice farming has experienced one harvest since the last eruption of Mount Semeru. The villages sample were Oro-Oro Ombo and Supiturang, the two most affected by the Mount Semeru lava flow. The selection of the two villages was for the purpose of identifying the risk of farming in disaster-prone areas.

Primary data were obtained from the amount of 95 respondents chosen randomly. An interview with paddy rice farmers was done using semi open questionnaire. The risk of production and financial were analyzed by Coefficient of Variation (CV). CV is the size of relative risk, it is counted from the standard deviation divided by the expected average value. The value of CV can be written by the following Equation (1):

\[ CV = \frac{\sigma}{\bar{X}} \]  

Where,

- \( CV \) = Coefficient of variations
- \( \sigma \) = Standard deviation of the yield
- \( \bar{X} \) = Productivity of rice yield (kg ha\(^{-1}\))

This formula was also used to analyze the CV of farm income to find the financial risk of rice farm. Factors affecting farm risk were analyzed with two stages of regression analysis. The first stage analyzes the Cobb-Douglas non-linear regression function. The formulation of the regression model is in Equation (2):

\[ \ln Y = \ln b_0 + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + b_4 \ln X_4 + b_5 \ln X_5 + e_i \]  

Where,

- \( Y \) = Yield of rice (kg)
- \( X_1 \) = Land (ha)
- \( X_2 \) = Seed (kg)
- \( X_3 \) = Fertilizer (kg)
X4 = Pesticide (unit)
X5 = Labor (man day)
Ln = Natural logarithms as a form of empirical data transformation

The second stage is to analyze the influence of factors of production on the risks of farming. Farm risk is taken from the residual value of the first stage of regression analysis. The residual value is the difference between the value of estimated Y and actual Y. The significance decision of the influence on production risk uses the probability of error.

3 Results and discussion

3.1 Production risk of rice farming in Pronojiwo district

Production risk is measured from the Coefficient of Variation (CV) of rice farming production in the 2020 to 2021 rainy season. Data on average production per hectare, cost, receipts, and farm income are presented in Table 1. Each of the indicators is presented in average values and standard deviations. Rice farming in Pronojiwo district reaches an average of 5.5 t ha\(^{-1}\). This productivity is slightly lower than the rice productivity in East Java in 2021 of 5.6 t ha\(^{-1}\). The average income of rice farming per ha is IDR 5.56 \(\times\) 10\(^6\) but the standard deviation is very large. This shows that the range of farm income from the lowest and highest values is very far away. The very wide range or difference in rice farming income indicates a large income risk. Furthermore, the results of the risk analysis with CV are presented in Table 2.

Table 1. Average value of rice farming production, revenue, cost, and income per ha.

<table>
<thead>
<tr>
<th>Number</th>
<th>Description</th>
<th>Mean</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Yield (g)</td>
<td>5 528.6</td>
<td>2 070.8</td>
</tr>
<tr>
<td>2</td>
<td>Total revenue (IDR)</td>
<td>25 197 837.5</td>
<td>9 195 042.5</td>
</tr>
<tr>
<td>3</td>
<td>Total cost (IDR)</td>
<td>19 638 097.0</td>
<td>6 399 705.7</td>
</tr>
<tr>
<td>4</td>
<td>Farm income (IDR)</td>
<td>5 559 740.5</td>
<td>5 594 147.7</td>
</tr>
</tbody>
</table>

Source: Analysis of primary data, 2022.

Table 2 presents the results of the Coefficient of Variance (CV) calculation of rice farming production. The CV value obtained by 35.38 % indicates that the production risk of rice farming is low. This means that although the Pronojiwo district area is in the disaster-prone category, it does not result in a large enough risk of rice farming production. The risk level of rice farming production in Pronojiwo is lower than the risk of rice farming in Lampung CV of 0.68 and 0.69 [6], however the risk level is higher than Madiun Regency and in Bali with CV ranges from 5.8 % to 14.80 % [25, 2].

Table 2. Production risk of rice based on coefficient of variance (CV).

<table>
<thead>
<tr>
<th>Number</th>
<th>Categories</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Average expected yield (kg)</td>
<td>6 299.9</td>
</tr>
<tr>
<td>3</td>
<td>Standard deviation</td>
<td>2 228.9</td>
</tr>
<tr>
<td>4</td>
<td>Coefficient of variation (CV)</td>
<td>0.3538</td>
</tr>
<tr>
<td>5</td>
<td>CV (%)</td>
<td>35.38 %</td>
</tr>
</tbody>
</table>

Source: Analysis of primary data, 2022.
3.2 Financial risk of rice farming in Pronojiwo district

Financial risk is limited to the income risk of rice farming. Income risk is measured from the Coefficient of Variation (CV) of rice farming income for the 2020 to 2021 rainy season. Rice farming in Pronojiwo district achieved an average income of IDR 5.56 × 10^6 per ha. This revenue is much lower than the income of rice farming per ha in Lampung in 2022 of IDR 13 258 682 [26]. The average rice farming income per ha and its standard deviation show a very long range which results in high income risk. Furthermore, the results of the income risk analysis using CV are presented in Table 3.

Table 3. Financial risk of rice based on coefficient of variance.

<table>
<thead>
<tr>
<th>Number</th>
<th>Categories</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Average expected income ( IDR )</td>
<td>7.062 384.8</td>
</tr>
<tr>
<td>3</td>
<td>Standard deviation</td>
<td>5.506 815.6</td>
</tr>
<tr>
<td>4</td>
<td>Coefficient of variation (CV)</td>
<td>0.7908</td>
</tr>
<tr>
<td>5</td>
<td>CV (%)</td>
<td>79.08 %</td>
</tr>
</tbody>
</table>

Source: Analysis of primary data, 2022.

Table 3 shows the CV figure on the risk of rice farming income of 79.08 % or at a very high level of risk. The greater the value of the variation in farm income indicates a higher level of risk. The data of this study shows that the income risk level of 79.08 % (Table 3) is much higher than the production risk level of 35.38 % (Table 2). Rice farmers in Pronojiwo district face a financial risk, namely a very high income. Some farming risk analyses that found high income risk results include hybrid maize farming in Pakistan [27] and broiler farms in Minahasa [23]. Organic rice farmers in China, in addition to increasing profitability, are also expanding the market [28].

3.3 Factors affecting production risk of rice farming

Factors affecting the production of rice farming were analyzed by Cobb Douglass non-linear multiple regression. Furthermore, from the results of the Cobb Douglass analysis, a residual value was obtained which was used as a risk variable for rice farming production. Furthermore, production factors are tested for their effect on risk with a regression model. The results of the analysis of the two regression models are presented in Table 4.

Table 4. The factors affecting yield and risk of rice farm.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Regression coef. of yield* (2)</th>
<th>Significance of yield regression (3)</th>
<th>Regression coef. of risk** (4)</th>
<th>Significance of risk regression (5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>6.848</td>
<td>.000</td>
<td>3.180</td>
<td>.112</td>
</tr>
<tr>
<td>Ln X1</td>
<td>.429</td>
<td>.000</td>
<td>-.316</td>
<td>.379</td>
</tr>
<tr>
<td>Ln X2</td>
<td>.219</td>
<td>.024</td>
<td>-.273</td>
<td>.391</td>
</tr>
<tr>
<td>Ln X3</td>
<td>.043</td>
<td>.543</td>
<td>.480</td>
<td>.047</td>
</tr>
<tr>
<td>Ln X4</td>
<td>.359</td>
<td>.187</td>
<td>.254</td>
<td>.778</td>
</tr>
<tr>
<td>Ln X5</td>
<td>-.053</td>
<td>.729</td>
<td>.359</td>
<td>.478</td>
</tr>
</tbody>
</table>

*) The dependent variable is yield of rice farm (kg).
**) The dependent variable is risk which is measured by residual or regression.

Table 4 presents the results of two regression analyses, namely factors that affect rice farming production, and factors that affect production risk. Columns two and three each indicate the regression coefficient of the factors affecting production and the significance
value of each variable. Columns four and five each indicate the regression coefficient of the factors affecting the risk and the significance value of each variable.

Factors that significantly affect rice farming production are land area (X1) and seeds (X2), with significance values of 0.000 and 0.024, respectively. That is, the land area has a significant effect on production with an error rate of less than 1%. Meanwhile, seeds have a significant effect on production with an error rate of 2.4%.

The value of the land factor regression coefficient of 0.429 means that if the land area increases by 1% from the current average, rice production will increase by 0.429% from the current average production. The increase in land area can increase production, indicating that the average land tenure for rice farming is currently still within the scope of farmers' abilities in managing farming. The results of this study support several previous studies that show that increasing land area can increase farm production [29, 10, 25, 26].

The regression coefficient in seeds of 0.043 means that if the seeds increase by 1% from the current average use, rice production will increase by 0.043% from the current average production. The addition of rice seeds can increase production, indicating that the average use of rice seeds has not yet reached overcapacity which results in clumps of rice plants crowded to find nutrients and results in a decrease in production. The results of this study are in line with several previous studies that the addition of seeds can increase production [10, 25, 29]. However, there have been previous studies that have shown the results that the addition of seeds decreases rice production even though it is not significant [2]. In horticultural research on chrysanthemum flowers, there are also findings that seed addition decreases production although statistically insignificant [14].

The results of the risk factor analysis show that there is one factor that affects the risk of rice farming production, namely chemical fertilizers (X3). The results are indicated by the regression test value indicated by a significance value of 0.047 (Table 4 column 5). This means that chemical fertilizers contribute to increasing the risk of rice farming production. If the use of chemical fertilizers by rice farmers in Pronojiwo district is increased, it will increase the risk of rice farming production. Production risks are affected by the use of fertilizers because the use of fertilizers must be in accordance with the required dosage. According to Dewati and Waluyati [2] The use of chemical fertilizers will provide good benefits for crop production if given with the right dosage, but if the use is not appropriate the dosage will actually be risky. The results of this study are in line with Dewati and Waluyati [2] that the addition of Phonska fertilizer and other chemical fertilizers has a significant positive effect on the production risks of farming. In the farming of chrysanthemum plants, it was also found that the addition of chemical fertilizers increased production risks [14]. However, this result is different from several previous studies that found that the addition of chemical fertilizers did not significantly increase the risk of production. [25]. The use of chemicals must be wise, even gradually it needs to be reduced to produce organic products, because middle and upper segment consumers are willing to pay more for organic products [30].

4 Conclusion

The production risk on paddy rice farming in Pronojiwo district, Lumajang Regency, East Java, Indonesia shows a low risk, however the farm income risk is very high. The factors affecting production risk positively are usage of chemical fertilizer. The increased number of chemical fertilizers will increase production risk of rice farming. Further research needs to analyze more detail about what kind of fertilizer contribute the highest to the rice production risk.
References


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