RICE PRODUCTION RISK IN MAIN PRODUCING COUNTRIES 1961-2021

Aura Dhamira1*, Fadilla Ristya Aminda1)

1Agribusiness Department Faculty of Agriculture
Universitas Pembangunan Nasional Veteran Yogyakarta

*Corresponding author: aura.dhamira@upnyk.ac.id

To cite this article:

Received: October 23, 2023; Accepted: December 25, 2023; Published: December 31, 2023

ABSTRACT

Rice is an important food commodity to meet the high demand for food, especially in Asia. Most of the central producing countries of this commodity are located in Asia, and they play a significant role in supporting the availability of food for the people amidst the significant risks and uncertainties in carrying out rice farming, including the consequences of climate change and pests and diseases. This study aims to (1) find out the trend of rice production and production risks in the central producing countries over 61 years and (2) find out the risks of rice production in each of the central producing countries. This research was conducted using descriptive analysis using secondary data from 1961-2021, which was processed into tables and graphs. Meanwhile, the calculation of production risk is carried out using the coefficient of variation method. The results show that rice production in the central producing countries has a positive trend, where production increases from year to year. This is followed by a decrease in the risk of rice production every year. Vietnam is a country with the most significant rice production risk, while Cina and Brazil are countries with the lowest production risk. The application of programs proclaimed by the government, which are also adapted to the characteristics of farmers and actual conditions in the field, is expected to minimize production risks so that optimal production can be achieved.

Keywords: Asia; coefficient of variation; rice; production risk.

INTRODUCTION

Rice is one of the primary food sources for most Asian people. Rice consumption in Asia will be the highest in the world from 2018 to 2022. The average rice consumption of Asian people is 77.2 kg per person per year, which is projected to increase to 77.5 kilograms per person per year in 2030 (OECD, 2021). Rice production in the central producing countries is a concern in supporting food availability for the community, especially the Asian community. The availability of rice in the world is supported by the production of 10 central producing countries, most of which are countries in Asia. In contrast, the only country outside this region is Brazil. China and India have steadily become the main contributors to supporting world rice production. According to the data from FAO, in 2021, China contributed 21.4 percent of world production, while India contributed 19.51 percent. From 1961 to 2021, world rice production fluctuated with an increasing trend.

Farming activities are inseparable from risks and uncertainties. According to Debentin (1986), Risk and uncertainty have different definitions, where in situations full of risk, the possibility and impact of an event are known. Conversely, in situations full of uncertainty, the probability and impact of an event are unknown. Furthermore, risks in farming appear in various forms, with multiple sources. Production risk is influenced by controllable and uncontrollable production factors (Hasanah et al., 2018).

Climate change risks agriculture and food security (Aldoost et al., 2019). Rapid climate change impacts agroecosystems and agricultural productivity (Li, 2023; Tonnang et al., 2022). There is a significant relationship between drought and a decline in agricultural production over the past few decades (Leng & Hall, 2019). Furthermore, Leng & Hall (2019) studied that increasing the severity of
drought from moderate to extraordinary will increase the risk of losing rice production by 18% so in exceptional drought conditions, the risk of losing rice production reaches 68%. On the other hand, Tonnang et al. (2022) stated that rising temperatures and CO₂ concentrations in the atmosphere increase interactions between pests and plants.

Pests and diseases are a substantial source of risk to rice production. Not monitoring pests will cause low productivity and even total crop failure (Salazar & Rand, 2020). Pests influence the use of pesticides directly or indirectly in rice production. Drought conditions further exacerbate the spread of pests, increasing the risk of pests becoming resistant to insecticides and reducing pesticide performance (Khodaverdi et al., 2016; Salazar & Rand, 2020). Dong et al. (2010) found that rice diseases, insects, and weeds in Yunnan, China, caused rice production losses of 12.95%.

The use of seeds, fertilizer, land, and labor are production factors that can be controlled and influence production risk (Hasanah et al., 2018; Salam, 2022; Suharyanto et al., 2015). Furthermore, Suharyanto (2015) states that using organic fertilizer will reduce the risk of lowland rice productivity because the use of chemical fertilizers in high amounts in the long term will affect the quality and fertility of the soil. Land use will also reduce production risks; the larger the rice field area, the more technically efficient it will be (Hasanah et al., 2018; Salam, 2022). Meanwhile, increasing the use of labor reduces production risks (Salam, 2022). Graf & Oya (2021) found that the System Rice Intensification (SRI) method contributes to African labor absorption and can increase production and profitability for marginal farmers. This research focuses on knowing the development of rice production risk in the ten main rice-producing countries, namely Bangladesh, Brazil, China, India, Indonesia, Myanmar, Pakistan, Philippines, Thailand, and Vietnam, from year to year, as well as knowing the level of rice production risk in each country.

**MATERIALS AND METHODS**

This research was conducted using secondary data from rice production data from the world’s 10 largest rice producing countries: Bangladesh, Brazil, China, India, Indonesia, Myanmar, Pakistan, Philippines, Thailand, and Vietnam. The data used is rice production data for 61 years from 1961 to 2021, as there is a limitation to the data that we can find regarding rice production. Therefore we are only able to use this period. This research was conducted to determine the development of rice production risk in ten rice-producing countries from year to year and the level of rice production risk in each country. Rice production risk is calculated using Coefficient of Variation (CV) analysis. This coefficient shows the degree of production variability concerning the population average. The formula used to calculate the coefficient of variation can be seen in equation (1):

\[
CV = \frac{\sigma}{\mu}
\]

(1)

Where CV is the coefficient of variation, \( \sigma \) describes the standard deviation of rice production, and \( \mu \) represents the average output. The higher the CV value, the higher the production risk. Conversely, the lower the CV value, the lower the production risk.

The development of production risk in the ten largest rice-producing countries is carried out by calculating the average CV for all countries each year. The calculation results are then presented as a line diagram so that the trend can be seen. Meanwhile, the rice production risk for each country is calculated using the mean and standard deviation of each country’s rice production from 1961 to 2021. This calculation is then presented in the form of a bar chart.

**RESULTS AND DISCUSSION**

**Rice Production in 10 World Rice Producing Countries**

There are ten world rice-producing countries that contribute up to 83 percent of world rice consumption, namely Bangladesh, Brazil, China, India, Indonesia, Myanmar, Pakistan, the Philippines, Thailand, and Vietnam. Most of these rice producers are in the Asian region and have a tropical to subtropical climate, which makes it easy to carry out rice farming because these conditions make it possible to obtain high rice production. A statistical description of the data used in this research can be seen in Table 1.

Table 1 shows the country with the highest average production is China, with production reaching more than 100 million tons, where the most increased production was more than 214 million tons achieved in 2017, and the lowest production (56,217,596.00) was experienced in 1961. The average rice productivity in China from 1961 to 2021 reached 6.45 tons per hectare with a middle land
area of 31,684,032.23 hectares. On the other hand, India ranks second as the country with the highest rice production, with an average of 108,100,015.36 tons. The most increased production was achieved in 2021 and was lowest in 1966. The average rice productivity in this country is lower than in China, which is 2.57 tons per hectare. However, the area of rice land in India is more extensive, reaching 41,165,432.3 hectares. It can be concluded that the large rice production in China is caused by high productivity, while the increased output in India is the impact of the large harvest area.

Table 1. Statistical Description of Rice Production in 10 World Rice Producing Countries

<table>
<thead>
<tr>
<th>No</th>
<th>Country</th>
<th>Rice Production (ton)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Average</td>
</tr>
<tr>
<td>1</td>
<td>Bangladesh</td>
<td>30,487,924.25</td>
</tr>
<tr>
<td>2</td>
<td>Brazil</td>
<td>9,530,061.39</td>
</tr>
<tr>
<td>3</td>
<td>China</td>
<td>163,648,340.31</td>
</tr>
<tr>
<td>4</td>
<td>India</td>
<td>108,100,015.36</td>
</tr>
<tr>
<td>5</td>
<td>Indonesia</td>
<td>39,924,796.32</td>
</tr>
<tr>
<td>6</td>
<td>Myanmar</td>
<td>17,208,247.89</td>
</tr>
<tr>
<td>7</td>
<td>Pakistan</td>
<td>6,071,798.76</td>
</tr>
<tr>
<td>8</td>
<td>Philippines</td>
<td>10,683,944.29</td>
</tr>
<tr>
<td>9</td>
<td>Thailand</td>
<td>22,192,586.70</td>
</tr>
<tr>
<td>10</td>
<td>Vietnam</td>
<td>23,987,042.73</td>
</tr>
</tbody>
</table>

Source: Secondary Data Analysis (FAOSTAT, 2023)

Indonesia is in third place with the highest average rice production. The highest and lowest production rates were experienced in 2015 and 1963, respectively. This country has an average productivity of 3.82 tonnes per hectare and an average land area of just over 10 million hectares. Rice production in Indonesia is dynamic and supported by adequate land resources, although it still tends to be concentrated in the Java-Bali region (Panuju et al., 2013).

Meanwhile, the country with the lowest rice production is Pakistan, where the highest and lowest production was achieved in 2021 and 1962, respectively. This country’s average rice land area is 2,143,756.37 hectares, with an average productivity of 2.67 tons per hectare. Apart from lower productivity compared to the other nine countries, the rice harvested area in this country also tends to be lower. Hence, production is not greater than in other countries.

Bangladesh is ranked fourth, with an average production of 30,487,924.25 tons. The highest production (56,944,553.97) occurred in 2021. Rice production in Bangladesh is increasing, with an average growth rate of 2.51% per year. Likewise, the harvest area has an increasing trend with a yearly growth rate of 0.58%. The increase in rice production in Bangladesh is supported by increased rice productivity, with an average growth rate of 1.89% annually. The average rice productivity in Bangladesh from 1961-2021 is 2.86 tonnes/ha.

Vietnam and Thailand are ranked fifth and sixth with relatively similar average production. The average rice production in Vietnam is 23,987,042.73 tons. Rice production in Vietnam has a positive trend with a significant increase. The growth rate of rice production from 1961 to 2021 was 387.39%, with an average annual growth rate of 2.84%. The average annual growth rate of harvested area in Vietnam is only 0.74%, but rice productivity has an average growth rate of 2.84%.

Meanwhile, Thailand has an average production of 22,192,586.70 tons. Rice production in Thailand had a positive trend from 1961 to 2011 but experienced a downward trend until 2014, with an average decline rate of 7.46% each year. This decrease was caused by a reduction in harvested area by 6.62% every year. In general, the average growth rate of harvested area in Thailand increases by 1.19% each year, with an average productivity growth rate of 1.15% per year. An increase in harvested area and balanced productivity have increased rice production in Thailand.

Myanmar and the Philippines are ranked seventh and eighth, with production contributions of 2.56% and 1.59%, respectively, to world production. Average production in Myanmar is 17,208,247 tons, with an average growth rate of 2.45% per year. This is in line with an increase in harvested area and productivity. The harvested area has an average growth rate of 0.83% per year, while productivity has an average growth rate of 1.55% per year. The Philippines has an average rice production of 10,638,944.29 tons with an average growth rate of 3.09%. Harvested areas in the Philippines have increased by an average of 0.83% per year, while productivity has experienced a more significant increase with a growth rate of 2.20% per year.

Brazil is ranked ninth and the only country from the American continent included in the central rice-producing countries in the world. Rice production in Brazil has an average output of 9,530,061.39...
tons. The highest production in Brazil reached 13,476,994 tons in 2011. The harvested area in Brazil has a negative growth rate, with an average decrease of 0.48% every year. Even though the harvested area has a negative average growth rate, rice production still has a positive trend, with an average growth of 2.36% per year. This is supported by increased rice productivity, with an average growth rate of 2.73% annually.

Figure 1 shows rice production in ten world rice-producing countries over 61 years. It can be seen that China and India are the countries with the most significant production and tend to increase yearly. Likewise with eight other countries, rice production in each country also shows a positive trend from year to year. Over 61 years, all rice-producing countries in the world had an average positive production growth value ranging from 2.37 to 4.54 percent. Brazil was the country with the lowest production growth, namely 2.37 percent. In comparison, Pakistan experienced the highest rice production growth in the period between 1961 and 2021 with an average percentage of 4.54 percent. The highest growth in this country occurred in 2019, with a value reaching 54.4 percent. Increasing rice production is influenced by many things, land area, rice seeds used, fertilizer, availability of labor, and livestock ownership tend to have a positive effect on increasing rice production (Takele, 2017; Wijaya et al., 2022). Furthermore, farmers' preferences in facing risk also influence rice production. Based on research conducted by Lien et al. (2022), organic rice farmers who tend to avoid risk (risk-avertor) get lower production results compared to farmers who are risk-neutral or risk-preferer.

**Rice Production Risks in World Rice Producing Countries: 1961-2021**

Risk is a common thing that occurs in every farming activity, including rice production. The risk of rice production can be influenced by many things, both through farming inputs such as seeds used, use of chemical fertilizers and pesticides Yardha et al. (2021) as well as climatic factors such as temperature (Khodaverdi et al., 2016) and rainfall (Anggela et al., 2019). Figure 2 depicts the risk value shown by the coefficient of variation for each world rice-producing country over the last 61 years.

Based on Figure 2, it can be seen that Vietnam is the country with the highest production risk, followed by Pakistan and the Philippines. Meanwhile, the countries with the lowest production risk are Brazil and China. Production risk is influenced by many factors, including climate and natural disasters. Rice production in Vietnam faces many obstacles arising from natural disasters. Where natural disasters that occurred in 2016-2017, including floods and typhoons, harmed rice productivity (Nguyen et al., 2018). This shows the high risk of rice production due to natural disasters. Pakistan, the country with the second highest risk, is also not free from risks due to climate change. In research conducted by Ahmad et al. (2020), farmers believe that heavy rainfall and hail, high input prices, drought, and diseases that attack rice plants are the main threats to rice plants, while on the other hand, most farmers are risk averse. The same study explained that rice farmers’ attitudes and perceptions of risk were significantly influenced by education, gender, agricultural land area, religion, age, credit, off-farm income, farmer’s livestock, and farming experience.
Apart from Vietnam and Pakistan, the Philippines also experiences the same thing; this country's very vulnerable to natural disasters that occur due to climate change (Ruzol et al., 2021; Smith, 2022). Farmers' knowledge of climate change is high. In general, climate conditions are divided into three categories, namely dry, wet, and Maria Loka, which means unpredictable weather (Ruzol et al., 2021). Climate change and unpredictable weather will then affect pests and other factors, so the risk of rice production in this country is also high. The threat of natural disasters due to climate change, including typhoons, can also be considered a risk factor in rice farming.

Muraoka et al. (2022) evaluated the determinants of farmers' adaptation to climate risks often faced by rice farmers in the Ayeyarwady River region, Myanmar. In this area, the common risks are salt water intrusion and hurricanes. Farmers who have experienced foreign water intrusion tend to avoid risks and plant local varieties. On the other hand, Han (2023) stated that rising temperatures and an ever-changing climate also threaten rice production in Myanmar. Moreover, the lack of government policy regarding prices causes the risks faced by farmers to be higher.

Bangladesh is one of the countries that have high production risk compared to other rice-producing countries, with a coefficient of variation of 0.455. The country's challenges are quite complex and stem from various climate factors, such as increasing temperatures, abnormal rainfall patterns, extreme weather, and rising salinization. Furthermore, rice production, availability, and access are increasingly disrupted by reduced agricultural land, labor shortages, crop diversification, and low profitability (Jamal et al., 2023). One of the disasters caused by climate change that often occurs is flooding. Still, the Bangladesh Rice Research Institute (BRRI) and the Bangladesh Institute of Nuclear Agriculture (BINA) have succeeded in developing and introducing five plant varieties that are resistant to flooding, namely BRRI dhan51, BRRI dhan52, BRRI dhan79, BINA Dhan 11, and BINA Dhan 12, where these five varieties are suitable for planting in the Aman season which runs from July to November (Bairagi et al., 2021).

Various factors influence the risk of rice production in Indonesia. Sholihah et al. (2018) in their study stated that the factors of seeds, liquid fertilizer, natural pesticides, farmer's age, farmer's education, and farming experience are factors that reduce risk in rice farming. On the contrary, land area and the use of organic fertilizer increase the risk of rice production in Indonesia. This is supported by research conducted by Yardha et al. (2021), which states that the production factors that significantly influence the risk of rice production are KCI fertilizer, organic fertilizer, and labor. On the other hand, climate is also a variable that influences Dhamira & Irham (2020); Ham (2020) found an increase in mean temperature and rainfall in Indonesia from year to year. The agricultural sector, including rice production, is very vulnerable to the impacts of climate change, with indications of a high level of danger of decreasing rice production as a result of increasing temperatures and changes in rainfall patterns (Ruminta et al., 2018)

India, as one of the world's largest rice-producing countries, is not free from production risks arising from climate change. The rice commodity is a variety that is quite vulnerable to drought in India, although not more susceptible than Vietnam and Thailand (Leng & Hall, 2019). Meanwhile, based on research conducted by Nguyen et al. (2022), fertilizers and pesticides are among the inputs...
that reduce risk in Thailand, meaning farmers who don’t want to take risks tend to apply more fertilizer and pesticides. That PBS World (2023) stated that El Nino, which causes drought, also increases the risk for rice farmers in Thailand. This climate anomaly is likely to impact reducing rice production by up to 6 percent in 2023. China also experiences the risks of climate change. Chen et al. (2020) estimated the effects of global warming on rice production in China. This study concludes that if the current agricultural structure and system are maintained, global warming will reduce China’s total rice production by up to 5% in 2060. However, if the climate in areas that practice intercropping continues, production could fall by up to 13.5%, so this system must be maintained to ensure food security amid global warming. Even so, Clow risk a low-risk coefficient, presumably because its farmers tend to avoid risks. This is confirmed by research conducted by Tong et al. (2019), which states that farmers’ preferences in China are risk averters, where risk avoidance reduces technical efficiency significantly.

Brazil has the lowest production risk, with a coefficient of variation value of 0.234. These results align with research conducted by Haverman (2013), which states that the risk of rice production in Brazil is low, as is the risk of income. However, the price risk for this commodity is in the high category. Furthermore, Brazil also faces production risks due to climate change, which has an impact on the emergence of natural disasters due to climate change.

In general, the risk of rice production in the world’s rice-producing countries has decreased yearly. The coefficient of variation value decreases every year in line with production, which continues to increase. This is due to implementing programs that support increased rice production in each country. One program that is quite effective in Indonesia is the System of Rice Intensification (SRI). According to Adrianto et al. (2016), the implementation of SRI can increase the productivity of rice farming, and this program is influenced by the land, frequency of counseling, and period of membership in a farmer group.

Meanwhile, Santoso et al. (2022) in their research state that dissemination of information related to this program is carried out in various ways in many regions in Indonesia, one of which is in Banjar Regency, where farmers are given education regarding SRI method rice cultivation until this knowledge reaches the farmers. The same program is also implemented in India, where rice managed using the SRI system becomes healthier and more resistant to damage caused by pests and diseases where in 1965-2015, the number of essential pests in India has risen from 3 to 19 with planthoppers the most severe concern, plus there is an increase in rice productivity (Chintalapati et al., 2023).

On the other hand, the Climate-smart Agriculture program is implemented in China, where the activities are crop rotation and land conservation. These activities can then increase technical efficiency, which has decreased due to the characteristics of farmers who tend to avoid risks. The impact is that rice production in this country remains optimal and, risks production remains low (Tong et al., 2019).

CONCLUSIONS AND SUGGESTIONS

The ten central rice-producing countries, namely Bangladesh, Brazil, China, India, Indonesia, Myanmar, Pakistan, Philippines, Thailand, and Vietnam, experience an increase in rice production from year to year. Brazil and China are the countries with the lowest production risk. Conversely, Pakistan and Vietnam are the countries with the highest production risk compared to other major rice-producing countries. In general, production risks arise due to climate change. Even so, the risk of rice production decreases every year. This reduction in production risk, accompanied by an increase in production, was realized thanks to the programs launched by the government in each rice-producing country, such as SRI and Climate-smart Agriculture. To maintain and increase rice production, there needs to be synergy between the government and farmers. Through the right program and following the conditions of farmers and agriculture in each country, it is hoped that production in each country can be increased and the risk of rice production can be further minimized.

REFERENCES


Han, D. (2023). *The Challenges of Regulating Rice in Myanmar.* JSTOR. https://www.thaipbsworld.com/a-matter-of-rice-


Thai PBS World. (2023, June 4). *El Niño could reduce Thailand's rice output by up to 6 percent this year*. Thai PBS. https://www.thaipbsworld.com/el-nino-could-reduce-thailands-rice-output-by-up-to-6-percent-this-year/


