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Production And Risk Affecting Factors of Soybean Farming in Banyumas Regency Central Java Province, Indonesia

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Abstract. Indonesia's soybean consumption is rising in tandem with population growth, but it is not keeping pace with output. Farmers need to be encouraged to continue planting soybeans. The purpose of this study is to establish the function of soybean production, including production hazards and affecting factors in Banyumas Regency. The study was conducted in Banyumas Regency in August and October of 2023. Using simple random selection, 200 farmers who planted soybeans in 2022 were chosen from a population of about 2000 farmers. The Ordinary Least Squares (OLS) approach in conjunction with the Cobb-Douglas function was the data analysis tool used to identify significant variables influencing soybean production. The level of risk connected to soybean yield was determined using the coefficient of variation. Finally, Just and Pope's production risk function model was utilized to identify the components influencing the risk of soybean production. The findings showed that labor, land area, fertilizers, seeds, and insecticides all significantly affect soybean production. There is a high level of production risk associated with soybean farming in Banyumas Regency, with a coefficient variation of 0.54 (≥0.5); and labor has no significant effect on soybean production risk, while land area, fertilizers, seeds, and insecticides do.

1 Introduction

Any country's economy, but notably those of emerging countries that don't rely too much on oil, is strongly dependent on agriculture. It is considered one of the most important economic activities in terms of its contribution to the overall GDP [1]. One of Indonesia's most important agricultural commodities, soybeans have long been a vital component of the nation's agricultural landscape and are highly sought after in order to maintain competitiveness. Soybean (*Glycine max* L. Merrill) is a legume that grows in tropical, subtropical, and temperate climates [2]. Soybeans have straight or slightly curved fruit and range in height from 25 to 200 cm. Two to three seeds, either round, oval, or flat-spaced, are contained in the pods [3]. Because of its many uses as a food for humans and its widespread usage in the production of animal feed, cosmetics, and biodiesel, it is the most significant

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legume in the world [4]. Additionally, phenolic chemicals found in soybeans have been shown to function as antioxidants, preventing oxidative damage to body tissues, maintaining the nutritional content of food and food products, and maintaining food quality [5]. As the population grows and the food and animal feed industries expand, there is an annual increase in demand for soybeans, as both industries rely on soybeans as a basic ingredient [6]. After rice and maize, soybeans rank third in importance as food crops in Indonesia. Since tempeh and tofu are the preferred foods of the majority of Indonesian communities, soybeans play a significant role as an inexpensive and high-quality source of protein [7]. Given their significance in the Indonesian diet, there should be an adequate supply of soybeans accessible. The demand for soybeans in the country varied between 2.73 and 3.29 million tons between 2020 and 2024. The quantity of soybeans consumed at this time varies but generally rises by 1.46% annually [8]. But over the past ten years, there has been a gap in Indonesia between the country's soybean supply and demand [9].

The government must address this issue as a key priority [10]. The Indonesian government responded to this problem by importing 85% of the country's soybean requirements [11]. As a result, manufacturing has grown in significance, particularly for meeting domestic demand [12]. It is critical to comprehend the complexities of soybean production in order to lower import levels as the demand for soybeans rises [13]. One of Indonesia's locations with industrial centers based on soybeans is Banyumas Regency, located in the province of Central Java. Nonetheless, Banyumas regency's capacity to produce soybeans is declining yearly.

Table 1. Soybean production capability of Banyumas Regency in 2018-2022

Year	Harvest Yield (ton)	Harvest Area (ha)	Productivity (ton/ha)
2018	2548.00	3426.94	1.34
2019	999.00	1124.06	1.13
2020	238.30	298.51	1.25
2021	1079.40	1783.20	1.65
2022	292.00	437.20	1.50
Rate of Growth (%)	-40.24	-41.82	2.72

According to Table 1, Banyumas Regency's soybean output and harvest area have declined by 40.24 and 41.82 percent, respectively. However, productivity is expected to rise by 2.72 percent between 2018 and 2022. Changes in farmers' choices for producing soybeans may be the source of the drop in harvested area and soybean yield through land conversion. Due to the shortage of high-quality seeds, the high risk of farming, and the lack of a price guarantee for soybean products, farmers' desire and incentive to plant soybeans has decreased, which has resulted in a shift in preference [11]. Productivity growth per planted area is one of the elements driving higher soybean production [14]. The utilization of diverse farming inputs, such as land, seeds, fertilizers, growth promoters, pesticides, herbicides, labor, etc., supports this. Soybean productivity is determined by the quantity and combination of the several inputs (factors of production) mentioned above. Land, capital, manpower, and management are support resources for production. The production function is used to examine the link between production variables and production [15]. Understanding how limited resources may provide maximum production makes production function analysis crucial. Soybean production is also one of the activities that is characterized by risk. A number of factors, including market volatility, pest infestations, climate change, and policy changes, can have a substantial impact on the profitability and viability of soybean cultivation. These factors can also have an economic impact on the production of soybeans [16]. The different production levels will be a reflection of the risk and unpredictability that comes with growing soybeans [17]. Because of this, actions made by farmers are risky, and every choice they make now will have an impact later on. Prior to making a decision, producers must have a thorough understanding of the risk [18].

The Banyumas Regency is still working to maximize the potential of its resources for soybean production in a number of areas, including land utilization, labor, capital, and other factors. Because Banyumas Regency farmers still use antiquated methods and have limited access to information and innovation, productivity will be increased in terms of efficiency through the use of appropriate production variables and the management of production risks through the adoption of additional modern technologies [19]. In view of the issues with soybean farming in Banyumas Regency, this study attempts to determine key variables that impact soybean production, the degree of risk associated with soybean production in Banyumas Regency, and factors that affect the risk associated with soybean production, which tend to experience decreased production and low interest among farmers in cultivating soybeans. The novelty of this research lies in two parts. The first aspect of novelty is regarding the calculation of production risk in this research and distinguishes it from previous researchers who only reveal its efficiency. The second aspect is regarding the location of the research conducted in Banyumas. This location has quite a lot of soybean processing industry centers, so it is important to conduct research on efficiency and production risk to support the existing industry. The study's findings should have policy ramifications that the government can use as a guide to boost soybean production among farmers, which will raise their income.

2 Research Method

The research was conducted in Banyumas Regency from August to October of 2023. In order to determine which districts in Banyumas Regency contributed most to soybean production, five districts (Kebasen, Jatilawang, Wangon, Banyumas, and Kembaran) were specifically chosen as research locations. 200 soybean farmers in Banyumas Regency served as the study's sample; they were chosen at random from a population of about 2000 soybean farmers. Both primary and secondary data were gathered for this research. Primary data is gathered using questionnaires. Utilising standardised questions, farmer-level interviews were conducted as part of the survey methodology. Visits to the offices of pertinent organisations, such as the Banyumas Regency Agriculture Office and Central Bureau of Statistics, as well as other organisations connected to the study, are used to gather secondary data. The data analysis method known as Cobb-Douglas Function using Ordinary Least Squares (OLS) method was utilised to ascertain factors influencing soybean in Banyumas Regency. When there is a relationship between two or more variables and the dependent variable can be explained by the independent variable, the Cobb-Douglass function is employed [20]. The Cobb Douglass production function's basic model can be written as:

$$Y = aX_1^{\beta_1} X_2^{\beta_2} X_3^{\beta_3} X_4^{\beta_4} X_5^{\beta_5} \quad (1)$$

The Cobb-Douglass production function equation is made simpler to estimate by taking the logarithm of the equation, which converts the equation into a linear form and yields the following new equation:

$$LnY = a + \beta_1 LnX_1 + \beta_2 LnX_2 + \beta_3 LnX_3 + \beta_4 LnX_4 + \beta_5 LnX_5 + e \quad (2)$$

Where, Y was soybean production (kg); a was constant; X_1 was land area (ha); X_2 was Seeds (kg); X_3 was fertilizers (kg); X_4 was insecticides (L); X_5 was labor (Worked Man Day); $\beta_1 \ldots \beta_5$ was Guess parameters or elasticity; e was error.

The coefficient of variation is a tool used in data analysis to assess the risk level of soybean output in Banyumas Regency. The coefficient variation's fundamental model can be written as [21]:

$$CV=\frac{\sigma}{\bar{Y}} \tag{3}$$

Where, CV was coefficient variation; σ was standard deviation; $\bar{Y}$ was average productivity (ton/h)

Criteria:
If CV < 0.5, soybean farming has low risk
If CV ≥ 0.5, soybean farming has high risk

Factors influencing soybeans in Banyumas Regency were identified using the Just and Pope technique. By comparing farmers' actual productivity to their potential productivity, the Just and Pope technique can be used as a tool to mitigate production risk. By analyzing changes in output productivity, the Just and Pope technique can be utilized to ascertain how input factors affect production risk. The Just and Pope production risk function model can be stated mathematically as follows:

$$q = f(x) + h(x)\ e \tag{4}$$

Where, q was production (output); f was average production function; h was variance function (risk function); x was input or production factors; and e was error

An average production function plus a risk function made up the Just and Pope's risk production model [22]. Production risk, which is defined as differences in productivity results from the application of production factors, is evaluated using this model. The Cobb-Douglass production function, which is employed in the Just and Pope model, is converted into natural logarithmic form as follows:

Production Function:

$$LnY = a + \beta_1 LnX_1 + \beta_2 LnX_2 + \beta_3 LnX_3 + \beta_4 LnX_4 + \beta_5 LnX_5 + e \tag{5}$$

Variance Production Function:

$$Lne^2 = \theta_0 + \theta_1 LnX_1 + \theta_2 LnX_2 + \theta_3 LnX_3 + \theta_4 LnX_4 + \theta_5 LnX_5 + e \tag{6}$$

Where, Y was soybean production (kg); e^2 was variance error; X_1 was land area (ha); X_2 was seeds (kg); X_3 was fertilizers (kg); X_4 was insecticides (L); X_5 was labor (worked man day); $\beta_1/\theta_1 \ldots \beta_5/\theta_5$ was guess parameters or elasticity; a/θ_0 was intercept; e was error.

3 Results and Discussion

3.1 Factors Affecting Soybean Production in Banyumas Regency

The data analysis technique utilized to determine the factors impacting soybean in Banyumas regency is the Cobb-Douglas function. Tests for heteroscedasticity, multicollinearity, and normality are conducted before the analysis of classical assumptions. The three tests, as indicated in Table 2, have met all presumptions and can now proceed with the examination of the variables influencing production.

The coefficient of determination is explained by the modified R-square. The modified R-square test result is 0.495; this indicates that the variables of land size, seeds, fertilizers, pesticides, and labor jointly impact the dependent variable to a degree of 49.5%, with factors outside the model accounting for the remaining 50.5% of the variance. The results of the F test indicate that the tabulated F value is 2.260 and the value of the F statistic is 40.056, indicating that the value of the F statistic is higher. This suggests that the variables related to labor, land area, seeds, fertilizers, and insecticides all significantly affect the dependent variables. A test to ascertain the partial impact of independent factors on the dependent variable is the t-test [23]. Table 2 makes it clear that labor, seeds, pesticides, land area, and soybean production are all highly correlated, with a 99% confidence level. With a confidence level of 97.5%, fertilizers alone have a significant influence on soybean yield.

Table 2. Results of the Multiple Linear Regression Study on the Factors Influencing Banyumas Regency's Soybean Production

Variable	Coefficient	t-statistic	Sig.
Constant	4.611		
Land area	0.306***	3.673	0.000
Seeds	0.354***	3.949	0.000
Fertilizers	-0.084**	-2.568	0.011
Insecticides	-0.138***	-3.900	0.000
Labor	0.257***	4.242	0.000
R-squared			0.508
Adjusted R-squared			0.495
F-statistic			40.056

** = Significance at 97.5% confidence level (α = 0.025)
*** = Significance at 99% confidence level (α = 0.01)

The significance value of 0.000 (<0.05) for land area indicates a significant effect on agricultural productivity. Soybean output will increase by 0.306% for every 1% increase in land area, according to the coefficient value of 0.306. This statement is in accordance with the existing facts that if farmers add the area of land to be planted with soybeans, it will be in line with the addition of the cultivated soybean planting area. Thus, the addition of the area will provide higher production and allow for high productivity as well. This is in line with other studies that found that in Adamawa State, Nigeria, land area significantly affects the quantity and technical efficiency of soybean production [24]. The significant value of 0.000 (<0.05) for soybean seeds indicates a significant effect of seeds on soybean productivity. With a coefficient value of 0.354, more soybeans will be produced for every 1% increase in seeds. The addition of soybean seeds will certainly be in line with the number of plants that will grow and be cultivated, resulting in greater production. This is in line with other studies that state that soybean production in Indonesia is significantly influenced by soybean seeds [8]. Fertilizer is another factor that affects soybean production. The significance value of fertilizer is 0.011 (<0.05), which indicates a significant effect on soybean productivity. In addition, the coefficient value of -0.084 indicates that for every 1% increase in fertilizer, soybean yields will decrease by 0.084%. The meaning of this statement is that farmers have given too much fertilizer from the existing recommendations so that this addition does not increase production and is less effective. This is in line with other studies that found a significant effect on soybean yields with fertilizers containing 19 (N), 38 (P2O), and 7 (S) kg ha-1 by Katta and Korme [25]. In addition, the significance value of 0.000 (<0.05) for insecticide use indicates that it significantly affects soybean productivity. For every 1% increase in insecticide, soybean production will decrease by 0.138%, according to the coefficient value of -0.138. This is in line with other studies that found that the use of insecticides in Pancatengah District, Tasikmalaya Regency, significantly affected soybean farming and production (26). Labor, or workforce, has a significant impact on soybean productivity, as indicated by its significance value of 0.000 (<0.05). With a coefficient value of 0.257, every 1% increase in labor will increase soybean production by 0.257%. This statement means that farmers can add labor to optimize the soybean cultivation they are doing with the hope that the plants they cultivate will be well cultivated. This is in line with other studies that state that labor claims have a significant effect on soybean price and production efficiency [14].

3.2 Risk Level Production of Soybean Farming in Banyumas Regency

Production risk can be caused by both external and internal factors. Pests, plant diseases, genetic variances, and the seed input used are examples of internal factors that can affect output risks. It is also feasible to ascertain the impact of inputs on production risk [27]. In the meanwhile, external elements include those that are frequently challenging to account for, like abrupt changes in the weather or environment and issues that arise during harvesting operations [28]. Coefficients of variation can be used to determine the size of a risk. Table 3 displays the outcome of Banyumas Regency's risk-level production of soybean farming:

Table 3. Risk Level Production of Soybean Farming in Banyumas Regency

Information	Amount
Average Productivity (ton/ha)	1.33
Standard Deviation	0.72
Coefficient Variation (%)	0.54

The simplest unit of risk measurement, the standard deviation value, illustrates the deviation that occurs in farming as represented by production levels. Farmers are exposed to a greater degree of risk the larger the standard deviation is. Table 3 shows that the average productivity of soybeans in Banyumas Regency is 1.33 tons/ha, with a standard deviation of 72. The study's findings also show a coefficient variation of ≥0.5, indicating a high production risk associated with soybean growing in Banyumas Regency. This conclusion is in line with another study that found a relatively high degree of risk associated with soybean production in another Indonesian regency [29]. Farmers are exposed to a production risk equivalent to 54% of the produced value, according to a coefficient variation value of 0.54. Soybean farmers in Banyumas Regency have a production risk of 0.165 tons/ha/season, given the average soybean production of 0.33 tons/ha/season and a coefficient variation value of 50%. High rainfall during soybean cultivation is one of the factors contributing to high production risk. The amount of disease and weed attacks rises during the rainy season, and the photosynthesis process is also impacted by a decrease in solar radiation intensity [30][31].

3.3 Factors Affecting Soybean Risk Production in Banyumas Regency

The factors influencing the risk of soybean production are influenced by the inputs used. This study's production risk elements include labor, land area, seeds, fertilizers, and pesticides. The Cobb-Douglas models with Just and Pope in Table 4 can be used to infer the link between input levels and production variance.

Table 4. Outcome of a Multiple Linear Regression Study of the Elements Influencing Banyumas Regency's Soybean Risk Production

Variable	Coefficient	t-statistic	Sig.
Constant	4.827		
Land area	0.461**	2.437	0.016
Seeds	-0.060^{ns}	-0.296	0.768
Fertilizers	-0.020^{ns}	-0.273	0.785
Insecticides	0.027^{ns}	0.335	0.738
Labor	0.162^{ns}	1.177	0.241
R-squared			0.094
Adjusted R-squared			0.071
F-statistic			4.048

** = Significance at 97.5% confidence level (α = 0.025)
Ns = Not Significance

The dependent variable is influenced by the variables of land area, seeds, fertilizers, pesticides, and labor collectively by 7.1%, according to the adjusted R-square test result of 0.071, with 92.9% of the variation coming from sources outside the model. The F test results show that the F statistic value is 4.048 and the tabulated F value is 2.260. This suggests that the value of the F statistics is higher. This implies that the dependent variables are highly impacted by the labor, land area, seeds, fertilizers, and pesticides factors. The t-test (23) is a test to determine the partial influence of independent factors on the dependent variable. Table 4 makes it clear that the land area significantly affects the risk of soybean production at a 97.5% confidence level. While labor, fertilizers, seeds, and insecticides had no discernible effects on the risk associated with soybean production. The significance value of 0.016, which is smaller than 0.05, indicates that the land area has a substantial impact on the production of soybean risk. With a coefficient value of 0.461, an increase in land area of 1% results in soybean risk production will increase by 0.461%. Seeds are one of the inputs used in the production of soybeans. Given that the significance value of the seeds is higher than 0.05 (0.768), it can be concluded that the seeds had no discernible effect on the production of soybean risk. For every 1% increase in seeds, soybean risk production will reduce by 0.060%, according to the coefficient value of -0.060. This contradicts another study that found that seeds significantly affect the risk of soybean production at different land types in South Sulawesi (32).

The fertilizer did not significantly affect the risk of soybean production, as indicated by its significance value of 0.785, which is larger than 0.05 in this case. Additionally, the coefficient value of -0.020 indicates that for every 1% increase in fertilizers, the risk of soybean output will drop by 0.020 percent. The significance value for insecticide use is 0.738, over the threshold of 0.05. It indicates that the danger associated with soybean output was not significantly affected by the insecticides utilized. The coefficient value of 0.027 indicates that for every 1% increase in insecticide use, the risk to soybean production will rise by 0.027%. Finally, the significant value of labor use is 0,241 (>0.05), indicating that labor did not significantly affect the risk of soybean production. The coefficient value is 0.162, which means that with every 1% increase in labor, the risk of soybean production will increase by 0.162%.

This study concluded that there is a high production risk associated with growing soybeans in Banyumas Regency. The utilization of land area, seeds, fertilizers, pesticides, labor, and fertilizers affects overall production. Conversely, the usage of land area has a positive influence on production risk, which means that an increase in land area affects both production and production risk. Therefore, farmers need to manage the area of cultivated land by utilizing input as efficiently as possible [33]. This will of course strengthen product competitiveness and price stability, thereby making farmers willing to plant the crops they cultivate every year [34]. There are many things you can do, one of which is implementing weather risk management to lower production risk by effectively managing irrigation systems to prevent water shortages during the dry season and effective drainage systems to prevent water shortages during the rainy season. Furthermore, farmers can employ contemporary agricultural technology, like drones, to maximize field management and more accurately detect possible hazards.

4 Conclusion

Based on the research results, three things can be concluded. First, there are several factors that affect soybean production, namely labor, land area, fertilizer, seeds and insecticides. Second, the risk of soybean production in Banyumas Regency is relatively high. Third, the labor variable has no effect on the risk of soybean production, while land area, fertilizer, seeds and insecticides have a significant effect.

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