



Research Paper

The Influence of Paddy Field Area and Rice Harvested Area on Rice Production in Aceh Province

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Abstract

This study aims to determine the effect of paddy field area and rice harvested area on rice production in Aceh Province. The study used a quantitative approach with panel data covering 23 regencies and cities in Aceh Province over the 2019–2023 period, resulting in 115 observations. The data were analyzed using panel data regression, with paddy field area (X1) and rice harvested area (X2) as independent variables and rice production (Y) as the dependent variable. Based on the Chow, Hausman, and Lagrange Multiplier tests, the random effect model was selected as the best model. The results indicate that paddy field area has a positive and significant effect on rice production, while rice harvested area has a negative and significant effect on rice production when paddy field area is held constant. Simultaneously, both variables have a significant effect on rice production. The coefficient of determination of 0.944 indicates that paddy field area and rice harvested area explain 94.4% of the variation in rice production, while the remaining 5.6% is explained by other variables outside the model. These findings underline the importance of protecting paddy fields from conversion to sustain rice production in Aceh Province.

Keywords: Paddy Field Area, Rice Harvested Area, Rice Production, Panel Data, Aceh

1. Introduction

Aceh Province has fertile soil supported by a tropical climate, making it rich in agricultural products, especially rice. Rice production is an important foundation for economic growth in Aceh, and good rice production cannot be separated from the availability of land and supporting irrigation: the wider the land, the more rice can be harvested, and the better irrigation is managed, the higher the production obtained by farmers [1]. Studies in various districts of Aceh confirm that



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land area is one of the main production factors that significantly affects rice output [2], [3], while harvested area has been shown to influence rice productivity and availability [4].

Harvested area refers to the area of land from which a crop is harvested and is closely related to the area of land that has the potential to be developed for food crops. Harvested area may continue to increase even when the area of paddy fields tends to decrease, because harvested area is essentially the product of land area and cropping intensity, that is, the number of times the land is planted and harvested in a year [5]. Increasing rice production can therefore be pursued through agricultural intensification, in which land management is an important cultivation activity [6]. Land as a production factor is determined not only by its area but also by other natural factors, such as water, temperature, sunlight, soil type, type of land use, and topography.

Rice production is also vulnerable to climatic conditions. Dry seasons and El Niño-related droughts reduce water availability for rice fields, disrupt plant growth, and lower production [7], [8], while limited irrigation channels constrain the supply of water to paddy fields [9], [10]. In addition, the conversion of agricultural land to residential and urban uses reduces the area of paddy fields and threatens food production and food security [11], [12], [13].

Although Aceh Province is known as one of the rice granaries of Indonesia, rice production in recent years has not always increased in line with the area of paddy fields and harvested area. Most previous studies have been conducted at the national level or in other provinces [14], [15], [16], and studies in Aceh have generally used provincial time series data [1] or farm-level data from individual districts [2], [3]. Some studies state that land area and harvested area affect production, but in practice production is also influenced by other factors, such as labor, seed types, irrigation systems, and other agricultural inputs [1]. Studies that use district-level panel data to examine the effects of paddy field area and harvested area on rice production across Aceh therefore remain limited. This study aims to determine the effect of paddy field area and rice harvested area, both partially and simultaneously, on rice production in the regencies and cities of Aceh Province in 2019–2023.

2. Method

Research Approach

This study used a quantitative approach with panel data regression analysis. Panel data combine time series data (2019–2023) and cross-sectional data (23 regencies and cities in Aceh Province), resulting in 115 observations.

Data Types and Sources

This study used secondary data on rice production (Y), paddy field area (X1), and rice harvested area (X2) for each regency and city in Aceh Province from 2019 to 2023. The data were obtained from publications of the Central Statistics Agency (*Badan Pusat Statistik*, BPS) [17]. Rice production is measured in tons, while paddy field area and harvested area are measured in hectares.

Data Analysis Techniques

The data were analyzed using panel data regression with EViews 12. Panel data were chosen because they offer several advantages: they increase the number of observations, thereby increasing the degrees of freedom and the efficiency of estimation; they can control for unobserved heterogeneity across regions, thereby reducing bias; and they allow a more comprehensive analysis of the dynamics of economic variables across years and regions [18]. The regression model is specified as follows:

$$Y_{it} = \beta_0 + \beta_1 X_{1it} + \beta_2 X_{2it} + \varepsilon_{it}$$

where Y is rice production, X_1 is paddy field area, X_2 is rice harvested area, i denotes regencies and cities, and t denotes years. Three estimation models were considered: the common effect model, the fixed effect model, and the random effect model. The best model was selected using the Chow test (common effect versus fixed effect), the Hausman test (fixed effect versus random effect), and the Lagrange Multiplier test (common effect versus random effect) [18], [19]. Hypotheses were then tested using the F-test, the t-test, and the coefficient of determination (R^2) at a significance level of 5%.

3. Result and Discussion

Descriptive Statistics

Table 1 presents the descriptive statistics of the research variables.

Table 1. Descriptive statistics of the research variables

Statistic	Rice Production (Y)	Paddy Field Area (X1)	Harvested Area (X2)
Mean	75,646.27	9,521.61	7,977.47
Median	43,980.43	7,461.00	5,853.90
Maximum	396,467.60	38,417.00	34,298.00
Minimum	0.00	0.00	0.00
Std. Dev.	90,428.37	9,567.91	8,658.06
Observations	115	115	115

Source: Data processed with EViews 12 (2025).

Rice production has a mean of 75,646.27 tons, with a maximum of 396,467.60 tons, a minimum of 0, and a standard deviation of 90,428.37. Paddy field area has a mean of 9,521.61 hectares, with a maximum of 38,417 hectares, a minimum of 0, and a standard deviation of 9,567.91. Rice harvested area has a mean of 7,977.47 hectares, with a maximum of 34,298 hectares, a minimum of 0, and a standard deviation of 8,658.06. The minimum values of 0 indicate that some regencies or cities recorded no paddy fields or rice production in certain years, while the large standard deviations reflect considerable differences between regions.

Selection of the Best Model

Table 2. Results of model selection tests

Test	Statistic	d.f.	Prob.	Selected model
Chow (cross-section F)	1.699964	(22, 90)	0.0428	Fixed effect
Chow (cross-section chi-square)	39.964319	22	0.0109	Fixed effect
Hausman (cross-section random)	1.608014	2	0.4475	Random effect
Lagrange Multiplier (Honda, cross-section)	1.669635	–	0.0475	Random effect

Source: Data processed with EViews 12 (2025).

As shown in Table 2, the probability of the Chow test (0.0109 for the chi-square statistic) is smaller than 0.05, so the fixed effect model is preferred over the common effect model. The probability of the Hausman test (0.4475) is greater than 0.05, so the null hypothesis is accepted and the random effect model is preferred over the fixed effect model. The probability of the Lagrange Multiplier test (0.0475) is smaller than 0.05, so the random effect model is preferred over the

common effect model. Based on these three tests, the random effect model was selected as the best model.

Random Effect Model Estimation

Table 3. Random effect model estimation results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-14,375.03	3,336.213	-4.308785	0.0000
Paddy field area (X1)	13.53021	1.909994	7.083901	0.0000
Harvested area (X2)	-4.864708	2.110607	-2.304886	0.0230
R-squared	0.943966			
Adjusted R-squared	0.942966			
F-statistic	943.3967			0.0000
Durbin-Watson	1.626412			

Note: Dependent variable is rice production; panel EGLS (cross-section random effects), Swamy and Arora estimator; 23 cross-sections, 2019–2023, 115 balanced observations. Source: Data processed with EViews 12 (2025).

Based on Table 3, the estimated regression equation is:

$$Y_{it} = -14,375.03 + 13.530X1_{it} - 4.865X2_{it} + \varepsilon_{it}$$

Hypothesis Testing

The coefficient of determination (R^2) is 0.943966, meaning that paddy field area and rice harvested area together explain 94.4% of the variation in rice production, while the remaining 5.6% is explained by other variables outside the model. The F-statistic is 943.3967 with a probability of $0.0000 < 0.05$, so H_0 is rejected and H_a is accepted; paddy field area and harvested area simultaneously have a significant effect on rice production in the regencies and cities of Aceh Province.

The t-test shows that paddy field area has a coefficient of 13.53021 and a t-statistic of 7.083901 with a probability of $0.0000 < 0.05$, meaning that paddy field area has a positive and significant effect on rice production. Harvested area has a coefficient of -4.864708 and a t-statistic of -2.304886 with a probability of $0.0230 < 0.05$, meaning that harvested area has a negative and significant effect on rice production when paddy field area is held constant.

The Effect of Paddy Field Area on Rice Production

The positive coefficient of paddy field area indicates that, holding harvested area constant, an increase of one hectare of paddy fields is associated with an increase in rice production of about 13.53 tons, and conversely, a reduction in paddy field area is associated with a decline in rice production. This finding is in line with Fitri and Murtala [1], who found that land area affects rice production in Aceh Province, and with studies in Aceh Utara [2], Aceh Barat Daya [3], and North Kalimantan [12], which reported that land area significantly influences rice production. It also supports evidence that the conversion of paddy fields to non-agricultural uses threatens food production and food security [11], [13]. The magnitude of the coefficient, which exceeds the yield of a single harvest per hectare, reflects the fact that paddy fields in many areas are planted more than once a year, so that each additional hectare of paddy field contributes to production across several growing seasons [5].

The Effect of Harvested Area on Rice Production

The negative coefficient of harvested area indicates that, holding paddy field area constant, an increase of one hectare of harvested area is associated with a decrease in rice production of about

4.86 tons. This result should be interpreted with caution. Harvested area and paddy field area are closely related, because harvested area is determined by paddy field area and cropping intensity [5]. When two highly correlated variables are included in the same regression, multicollinearity can produce coefficients with unexpected signs, even though the model as a whole fits the data well [20]. A similar negative coefficient for harvested area attributed to multicollinearity was reported in a study on rice production in Tasikmalaya [21]. In contrast, studies that include harvested area without paddy field area generally find a positive effect of harvested area on production [4], [15]. The negative coefficient may also reflect regional differences in productivity, such as areas with high cropping intensity but lower yields per harvest due to limited irrigation or drought [7], [9].

4. Conclusion

Based on the panel data regression analysis of 23 regencies and cities in Aceh Province in 2019–2023, this study concludes that the random effect model is the best model. Paddy field area has a positive and significant effect on rice production, while rice harvested area has a negative and significant effect on rice production when paddy field area is held constant, a result that is likely related to the close relationship between the two variables. Simultaneously, paddy field area and harvested area have a significant effect on rice production and explain 94.4% of its variation.

Many paddy fields have been converted into urban and residential areas, which reduces the area of paddy fields and jobs for local residents and encourages migration from villages to cities. Policies are therefore needed to control the conversion of agricultural land and to protect sustainable food agricultural land. Improving irrigation is also important for increasing cropping intensity and productivity. This study is limited to two independent variables and a five-year period; future research could add other variables, such as labor, irrigation, fertilizer, seeds, and capital, extend the observation period, and test for multicollinearity between land variables.

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Authors' contributions and responsibilities

Zulfikar: conceptualization, data curation, formal analysis, writing – original draft. Yuliana: supervision, methodology, writing – review & editing. Edi Saputra: supervision, validation, writing – review & editing.

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Availability of data and materials

The data used in this study are publicly available from the Central Statistics Agency (BPS) and are also available from the corresponding author upon reasonable request.

Competing interests

The authors declare no competing interest.

Additional information

No additional information from the authors.

Declaration of Generative AI and AI-Assisted Technologies

During the preparation of this manuscript, Claude (Anthropic) was used to improve the language and readability of the English text and to format the manuscript, tables, and references according to the journal template. The tool was not used to generate research data, perform the analysis, or draw conclusions. The authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

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