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FACTORS AFFECTING CABBAGE PRODUCTION IN MAGELANG REGENCY, INDONESIA

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Abstract

Cabbage is a strategic horticultural commodity in Indonesia with high economic value and strong development potential. However, fluctuations in cabbage productivity are often associated with suboptimal allocation of production inputs. This study aims to examine the key factors influencing cabbage production in Magelang Regency, Indonesia. The research was conducted in three districts, Dukun, Pakis, and Ngablak, using a multistage cluster sampling method involving 120 farmers. Data were analyzed using a Cobb-Douglas production function estimated through multiple linear regression. The results indicate that land area, manure, and pesticide use significantly affect cabbage production. These findings highlight the importance of optimizing input allocation and improving farmers' management practices to enhance agricultural productivity

Keywords: Production Factors, Cobb-Douglas, Cabbage Farming.

INTRODUCTION

The agricultural sector plays a vital role in Indonesia's economy. It contributes the second-highest share of Gross Domestic Product (GDP) after manufacturing and trade (Wiyani, 2023). The agricultural sector plays a significant role in economic development, as the majority of Indonesians rely on it for their livelihoods (Dewi et al., 2016). Magelang Regency is one of the cabbage-producing centers in Central Java, with a harvest area, production, and productivity that have fluctuated from 2019 to 2023. However, it has the lowest productivity among other cabbage-producing regencies in Central Java (Wonosobo, Banjarnegara, Brebes, Temanggung, and Purbalingga), averaging 11.33 tons/ha, which is still below the national average productivity of 17.50 tons/ha (BPS Kabupaten Magelang 2020-2024).

Agricultural production is influenced by various input factors such as land, labor, seeds, and fertilizers. According to Soekartawi (2002), optimal allocation of production inputs is necessary to achieve maximum output. Inefficient use of inputs can lead to lower productivity even when resources are available. Previous studies have shown that factors such as labor, fertilizer use, and farm management significantly influence agricultural production (Lestari, 2021). However, empirical evidence on cabbage farming at the regional level is still limited. This study contributes to the literature by providing empirical evidence on the key production factors affecting cabbage farming at the regional level, which remains relatively underexplored in previous studies.

LITERATURE REVIEW

Agricultural production is influenced by the efficient use of various inputs, including land, labor, and capital. The Cobb-Douglas production function is widely applied to examine the relationship between input use and output (Douglas, Paul H., 1976, in Sulistyowati, et al, 2024). The relationship between inputs and output is commonly analyzed using the Cobb-Douglas production function, which explains how changes in input use affect production levels (Farrell, 1957). Research by Lubis (2021) also found that labor and production inputs significantly affect crop yield. Empirical evidence by Rahman (2010) shows that labor significantly contributes to farm productivity and efficiency. Fertilizer application is another key determinant of crop production. Proper use of nitrogen-based and compound fertilizers improves soil fertility and increases crop yield. A global study by Zhang, Wei et al. (2015) demonstrated that balanced nutrient management significantly enhances agricultural productivity and reduces yield gaps. In addition to chemical fertilizers, organic inputs such as manure play an important role in maintaining soil quality and long-term productivity. According to Lal, R (2015), organic matter improves soil structure, water retention, and nutrient availability, which positively affect crop growth. Similarly, Suripto (2020) reported that organic fertilizer has a positive impact on agricultural production. However, not all inputs necessarily have a significant effect on production. The effectiveness of input use depends on management practices, environmental conditions, and the efficiency of resource allocation. Therefore, identifying the key factors affecting cabbage production is essential to improve productivity and optimize input use. This study contributes to the literature by providing empirical evidence on the identification of key factors influencing cabbage farming production, particularly in Magelang Regency.

METHOD

Sampling and Data Collection

The research was conducted in Magelang Regency, with the research area determined using the Multi-Stage Cluster Sampling method. The selected areas are those located at the lowest altitude (Dukun District, 578 masl), medium altitude (Pakis District, 841 masl), and the highest altitude (Ngablak District, 1,378 masl). The research employed a survey method using a structured questionnaire, with primary data obtained from a sample of 120 cabbage farmers, and 40 farmers from each sub-district selected through a simple random sampling technique. In multivariate research (including multiple regression analysis), the sample size is generally determined to be at least ten times the total number of variables (independent and dependent) studied (Sekaran, 2006, in Prajanti, 2022).

Analytical Framework

This study adopts a quantitative approach using a Cobb-Douglas production framework estimated through multiple linear regression. The model is specified in its linear form and estimated using Ordinary Least Squares (OLS) without logarithmic transformation, which is a function obtained from the production function of the Cobb-Douglass function equation to analyze factors that influence agricultural production (Van Passel, et al, 2006 in Syahputra, 2023). Before estimating the regression model, classical assumption tests were conducted to ensure that the model meets the requirements of the Ordinary Least Squares (OLS) method. These tests include normality, multicollinearity, and heteroscedasticity tests.

Normality testing was conducted to examine whether the residuals in the regression model are normally distributed. The t-test and F-test require that the residual values follow a normal distribution; if this assumption is violated, the statistical test results may become invalid, especially when the sample size is relatively small (Ghozali, 2001). In this study, normality was tested using the Kolmogorov–Smirnov test to ensure that the residuals in the regression model are normally distributed. The multicollinearity test was conducted to determine whether there is a correlation among independent variables in the regression model. Multicollinearity was assessed using tolerance values and the Variance Inflation Factor (VIF), with the following criteria:
(1) Multicollinearity is indicated if the tolerance value is ≤ 0.10 or the VIF value is ≥ 10.
(2) No multicollinearity is present if the tolerance value is > 0.10 or the VIF value is < 10.

The heteroscedasticity test was conducted to examine whether there is a non-constant variance of residuals across observations by analyzing the Scatterplot graph (Imam Ghozali, 2001). The decision criteria are as follows:
(1) If a specific pattern appears in the Scatterplot, such as points forming a systematic pattern (e.g., widening and narrowing), it indicates the presence of heteroscedasticity.
(2) If there is no clear pattern and the points are randomly dispersed, it indicates the absence of heteroscedasticity.

The production function for cabbage farming is assumed to have a Cobb-Douglas form transformed into a linear natural, namely:
$Yit = \beta 0 + \beta 1X1 + \beta 2X2 + \beta 3X3 + \beta 4X4 + \beta 5X5 + \beta 6X6 + \beta 7X7 + \beta 8X8 + \varepsilon$
Where Xi is the estimated input, namely land, seeds, labor, urea, NPK, KCl, manure, and pesticides.

RESULTS AND DISCUSSION

Before conducting the regression analysis, classical assumption tests were performed to ensure that the model meets the requirements of the Ordinary Least Squares (OLS) method.

Normality Test, Multicollinearity Test, and Heteroscedasticity Test

The results indicates that the Monte Carlo significance (2-tailed) value is 0.10, which is > 0.05.

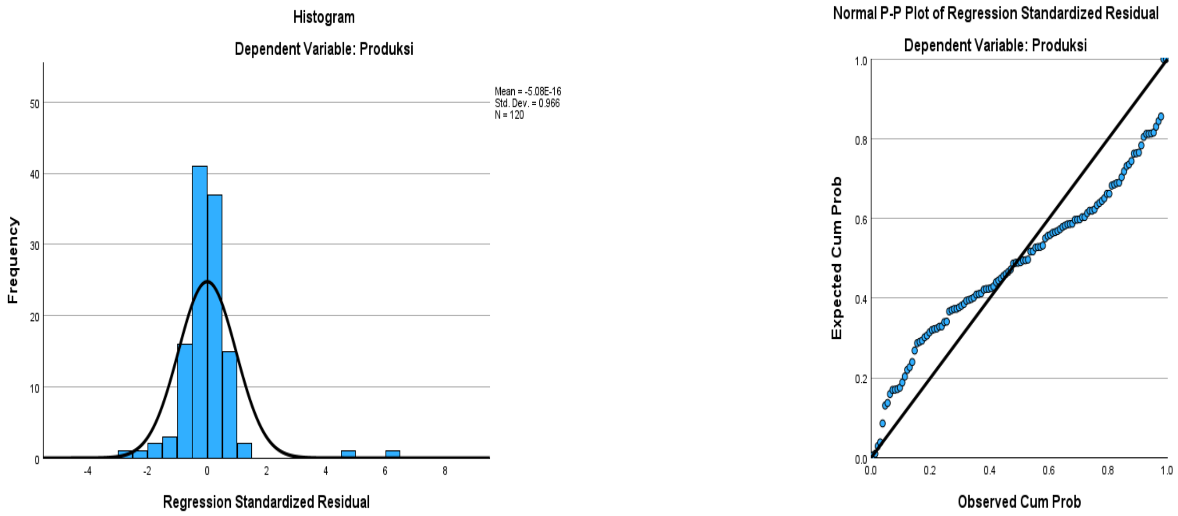
Table 1. Normality Testing

One-Sample Kolmogorov-Smirnov Test

			Unstandardiz ed Residual
N			120
Normal Parameters[a,b]	Mean		.0000000
	Std. Deviation		20252.91695
Most Extreme Differences	Absolute		.146
	Positive		.146
	Negative		-.130
Test Statistic			.146
Asympt. Sig. 2 (2-tailed)			.000[c]
Monte Carlo Sig. (2-tailed)	Sig.		.100[d]
	99% Confidence Interval	Lower Bound	.008
		Upper Bound	.013

Source: primary data (processed), 2026

The normality of residuals is assessed based on the Monte Carlo significance value. In this study, the decision for the normality test is determined using the Exact Monte Carlo Test. If the Monte Carlo significance (2-tailed) value is greater than 0.05, the data are considered to be normally distributed (Ghozali, 2001).



Gambar 1. Histogram and Normal P-Plot Regression Standardized Residual.
Source: primary data (processed), 2026

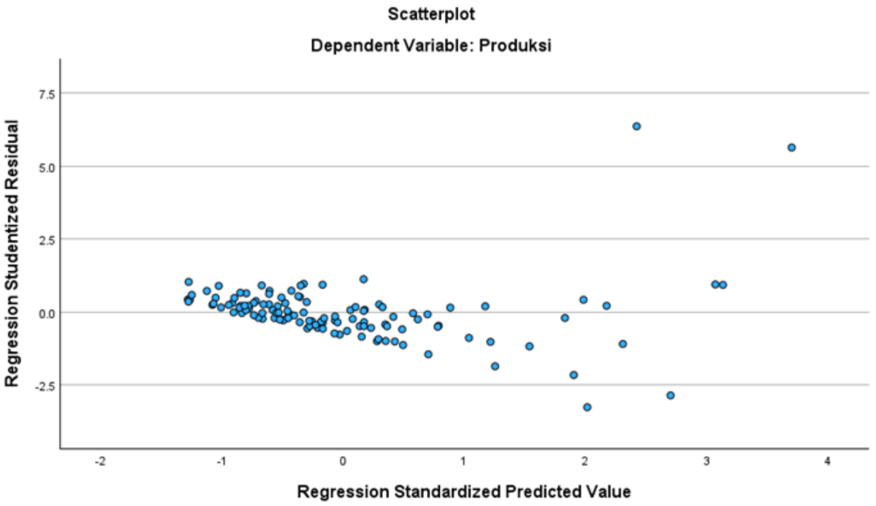
The residuals are normally distributed, as indicated by the Normal Probability Plot (Appendix 4). The plot shows that the points in the Normal P-Plot of Regression Standardized Residuals closely follow the diagonal line, indicating that the normality assumption is satisfied. This is consistent with Muliana et al. (2025), who state that a symmetrical pattern aligning with the diagonal line reflects normally distributed residuals.

Table 2. Multicollinearity Testing

Variabel	VIF
Land	1.038
Seeds	1.119
Labor	2.018
Urea	1.219
NPK	1.279
KCL	1.313
Manure	1.496
Pesticides	2.008

Source: primary data (processed), 2026

Table 2. presents the results of the multicollinearity test using tolerance and Variance Inflation Factor (VIF) values. The results indicate that there is no multicollinearity issue, as all variables have tolerance values above 0.10 and VIF values below 10.



Gambar 2. Scatterplot
Source: primary data (processed), 2026

Based on the scatterplot results, the data points are randomly dispersed and do not exhibit any systematic pattern, such as a wave-like formation. This indicates that the regression model does not suffer from heteroscedasticity.

Multiple Linear Regression Analysis

The multiple linear regression model is used to analyze the effect of production factors on cabbage output. The estimated regression equation is as follows:

$$Y = -14749.511 + 24434.290X_1 + 9608.227X_2 + 12.904X_3 + 7.934X_4 + 4.798X_5 + 12.378X_6 + 0.145X_7 + 1714.794X_8.$$

Where:
Y = Cabbage production
X_1 = Land area
X_2 = Seed
X_3 = Labor
X_4 = Urea fertilizer
X_5 = NPK fertilizer
X_6 = KCl fertilizer
X_7 = Manure
X_8 = Pesticide

The regression coefficients indicate the direction and magnitude of the relationship between each independent variable and cabbage production. A positive coefficient implies that an increase in the variable will lead to an increase in production, while a negative coefficient indicates the opposite relationship.

Table 3. T Testing

Variables	Coefficient	Standard Error	t ratio	Sign. (t sign)
Constant	-14.749,511	5.445,338	-2,709	0,008
Land	24.434,290	11.720,370	2,085	0,039
Seeds	9.608,227	5.094,791	1,886	0,062
Labor	12,904	11,003	1,173	0,243
Urea	7,943	8,655	0,917	0,361
NPK	4,798	2,724	1,762	0,081
KCL	12,378	7,640	1,620	0,108
Manure	0,145	0,064	2,270	0,025
Pesticides	1.714,794	594,159	2,886	0,005

Source: primary data (processed), 2026

The results of the multiple linear regression analysis show that land area, manure, and pesticide use significantly influence cabbage production in Magelang Regency. These findings indicate that both farm scale and input management are critical determinants of agricultural productivity. The significant effect of land area suggests that farm size plays a crucial role in enhancing production capacity. Larger landholdings enable farmers to expand cultivation and increase output. Land area (X_1) has a significance value of 0.039 (< 0.05) with a t-statistic of 2.085, exceeding the critical value (1.982). Larger landholdings allow farmers to expand cultivation and allocate resources more efficiently, resulting in higher output. This finding is consistent with Rahman (2010), who found that farm size significantly contributes to agricultural productivity and efficiency in developing countries. Similarly, Fulginiti. et al. (2004) emphasized that resource endowment, including land, strongly determines farm output.

The positive and significant effect of manure indicates the importance of organic inputs in improving soil fertility and sustaining crop productivity. Organic fertilizers enhance soil structure and nutrient availability, leading to better plant growth. Manure (X_7) shows a significance value of 0.025 (< 0.05) with a t-statistic of 2.27. The positive and significant effect of manure indicates the importance of organic inputs in sustaining soil fertility and improving crop productivity. Organic fertilizers enhance soil structure, increase nutrient availability, and support microbial activity. This finding aligns with Rattan Lal, R (2015), who highlighted that soil organic matter is essential for maintaining long-term agricultural productivity and mitigating soil degradation. More recent evidence by Zhang, X. et al. (2020) also shows that organic fertilizer application significantly improves crop yield and soil health.

Furthermore, pesticide use significantly affects cabbage production, highlighting the importance of pest and disease control in vegetable farming. Effective pest management helps reduce crop losses and ensures optimal production. Pesticide use (X_8) has a significance value of 0.005 (< 0.05) with a t-statistic of 2.886, indicating that pest and disease management is a crucial factor in horticultural farming. Vegetable crops such as cabbage are highly susceptible to pest attacks, which can substantially reduce yield if not properly controlled. This result is supported by Popp. et al. (2013), who demonstrated that appropriate pesticide use contributes to increased crop productivity by minimizing losses caused by pests and diseases.

On the other hand, variables such as seeds, labor, urea, NPK, and KCl fertilizers were found to have no significant effect on production. This suggests that these inputs may already be used at relatively similar levels among farmers or are not applied efficiently. It also indicates that increasing input quantity alone does not necessarily lead to higher output without proper management practices. According to Coelli. et al. (2005), the efficiency of input utilization is more important than the quantity of inputs in determining production performance. Overall, the findings emphasize that improving the management and allocation of key production inputs is essential for enhancing cabbage productivity. Rather than focusing solely on increasing the quantity of inputs, greater attention should be given to optimizing their use to achieve more efficient and sustainable production outcomes.

Table 4. F Testing

Anova	
Df	111
F statistic	13,997
Sign. (f sign)	0,000

Source: primary data (processed), 2026

Based on Table 4, the results show that the significance value for the simultaneous effect of land area (X_1), seeds (X_2), labor (X_3), urea (X_4), NPK (X_5), KCl (X_6), manure (X_7), and pesticides (X_8) on cabbage production is 0.000 (< 0.05), with an F-statistic of 13.997, which is greater than the F-table value of 2.02. This indicates that all independent variables jointly have a significant effect on cabbage production.

Table 5. Coefficient of Determination (R^2)

Model Summary	
R	0,709
R square	0,502
Adjust square	0,466

Source: primary data (processed), 2026

Table 5 shows that the Adjusted R^2 value is 0.502, which indicates that 50.2% of the variation in cabbage production can be explained by the independent variables, namely land area (X_1), seeds (X_2), labor (X_3), urea (X_4), NPK fertilizer (X_5), KCl fertilizer (X_6), manure (X_7), and pesticides (X_8). The remaining 49.8% is attributed to other factors not included in the model.

CONCLUSION

This study concludes that land area, manure, and pesticide use significantly influence cabbage production in Magelang Regency. These findings highlight that optimizing the use of key production inputs is essential for improving agricultural productivity, and that enhancing input efficiency is more important than merely increasing input quantities. This study is limited by the use of cross-sectional data, which may not fully capture temporal variations in production. In addition, external factors such as climate conditions and market dynamics were not included in the analysis and may also influence production outcomes.

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