World Journal of Advanced Research and Reviews
eISSN: 2581-9615 CODEN (USA): WJARAI
Cross Ref DOI: 10.30574/wjarr
Journal homepage: https://wjarr.com/

(Research Article)

Understanding factors influencing rose productivity in Central Java Province, Indonesia

Levana Masitajasmin Putri, Muhammad Luthfie Fadhilah * and Nur Indah Cahyaningtyas

Department of Agriculture, Faculty of Animal and Agricultural Sciences, Universitas Diponegoro, Semarang, Central Java, Indonesia.

World Journal of Advanced Research and Reviews, 2025, 27(03), 1426-1434

Publication history: Received on 16 August 2025; revised on 20 September 2025; accepted on 23 September 2025

Article DOI: https://doi.org/10.30574/wjarr.2025.27.3.3302

Abstract

Central Java Province is recognized as one of the main rose-producing regions in Indonesia, ranking second in production volume nationwide. However, this high production level has not been accompanied by a positive trend in productivity. This study aims to analyze the factors influencing rose productivity using the Cobb–Douglas production function with the Ordinary Least Squares (OLS) method for parameter estimation. The independent variables considered include plant population (X1), organic fertilizer (X2), chemical fertilizer (X3), labor (X4), and pesticides (X5), with rose productivity as the dependent variable. The results reveal that plant population, chemical fertilizer, labor, and pesticides positively and significantly affect productivity, while organic fertilizer shows no significant impact. The findings highlight the importance of optimizing production inputs particularly plant density, chemical fertilizers, labor allocation, and effective pest control to enhance rose productivity efficiently and sustainably.

Keywords: Central Java; Indonesia; Productivity; Regression; Rose

1. Introduction

The horticulture subsector is a crucial sector in agricultural development in Indonesia, contributing to food security and strategic roles in increasing farmers' incomes, creating jobs, and developing agribusinesses based on superior commodities [1,2]. Horticulture encompasses fruit, vegetable, ornamental, and medicinal plants. Among the various types of horticulture, ornamental plants occupy a crucial position due to their unique beauty and aesthetic value compared to other horticultural commodities. One of the leading ornamental plants is the rose (Rosa spp.), which has high economic value. Roses are widely used as cut flowers, decorations, and for other industrial needs, with demand levels relatively stable and tending to increase. This increase in market demand has direct implications for improving the income of ornamental plant farmers [3]. Demand for roses is relatively stable and tends to increase yearly. This is due to their diverse uses, from cut flowers for home decoration, weddings, and religious celebrations to applications in the tourism and hotel industries. This stable demand makes roses a strategic commodity for intensive development. High rose consumption also positively impacts the income of ornamental plant farmers, thus developing the rose agribusiness has significant potential to improve community welfare, particularly in production centers.

Central Java Province is one of the largest rose-producing regions in Indonesia. Several regencies in this province have long been known as centers for ornamental plant production, particularly roses. Boyolali, Magelang, and Semarang Regencies contribute significantly to national rose production. Semarang Regency, particularly the Bandungan area and its surroundings, boasts agro climatic conditions highly suitable for rose cultivation. Environmental factors such as cool temperatures, high humidity, and mountainous elevation support the growth of high-quality roses [4].

* Corresponding author: Muhammad Luthfie Fadhilah

Furthermore, relatively easy market access and supporting infrastructure make Central Java Province a production center and a distribution hub for roses. According to data from the Central Statistics Agency [5], rose production in Central Java in 2024 reached approximately 18.8 million stems. This figure demonstrates Central Java's strategic role in meeting the domestic rose market demand. However, this potential production has not yet fully matched the expected productivity. Significant productivity variations remain between production centers. For example, Boyolali and Bandungan, known as rose production centers, experience inconsistent harvests in quantity and quality.

The challenges to increasing rose productivity in Central Java Province are complex. From a technical perspective, frequently encountered problems include the availability of superior seeds, inadequate fertilization techniques, limited pest and disease control, and suboptimal irrigation management [6]. Meanwhile, from a non-technical perspective, obstacles include limited farmer access to business capital, weak farmer institutions, and an inefficient marketing system [7]. Furthermore, climate change is an external factor that can impact production, such as erratic rainfall and increased pest infestations [8]. The gap between the potential agro climate and actual productivity highlights the need for a more in-depth study of the factors influencing rose productivity in Central Java Province. Quantitative studies on the determinants of rose productivity at the provincial level are relatively limited. A better understanding of these factors is crucial for formulating targeted policy interventions. Analysis of the determinants of productivity can also form the basis for developing extension and training programs for farmers, enabling them to increase production capacity and improve the quality of their harvests.

This research is relevant in developing the floriculture agribusiness in Indonesia. The study's findings are expected to contribute to increased productivity and income for rose farmers and support government policies encouraging strengthening the horticultural sector. Furthermore, increased rose production and quality can open up greater export opportunities, thus positively contributing to the national economy. Therefore, the analysis of rose productivity factors in Central Java Province is not only academically significant but also has practical implications for agricultural development and enhancing the competitiveness of Indonesian floriculture in the global market.

2. Material and methods

This research was conducted in Central Java Province, Indonesia, one of the major rose producing centers on the island of Java. The region was selected due to its favorable agroclimatic conditions for rose cultivation, particularly in highland areas with relatively cool temperatures, and the presence of a substantial number of horticultural farming households.

The data used in this study are secondary data obtained from the Horticulture Household Survey (STH) conducted by the Central Java Bureau of Statistics (BPS). This survey is carried out periodically to collect information on input utilization, farm management practices, and the productivity of horticultural commodities at the household level. This study's analysis unit is rose-farming households recorded in the survey.

The variables employed in the analysis consist of one dependent variable and five independent variables. The dependent variable is rose productivity (stems/ha). The independent variables include plant population (plants/ha), organic fertilizer (kg/ha), chemical fertilizer (kg/ha), labor input (HOK/ha), and pesticide (liters/ha). The operational definitions of these variables are presented in Table 1.

Table 1 Details of Selected Variables

Variable	Code	Operational Definition	Unit
Rose productivity	Y	Total rose output per unit of cultivated land area	Stems/Ha
Plant population	X1	Number of rose plants cultivated per unit of land area	Plants/Ha
Organic fertilizer	X2	Quantity of organic manure applied per unit of land area during one year	Kg/Ha
Chemical fertilizer	X3	Quantity of inorganic fertilizer (e.g., Urea, NPK) applied per unit of land area during one year	Kg/Ha
Labor input	X4	Total person-days of labor used per unit of land area during one year	HOK/Ha
Pesticide	X5	Quantity of pesticides applied per unit of land area during one year	liter/Ha

The empirical model employed in this study is the Cobb Douglas production function in a log-linear form. This model was selected due to its several advantages in agricultural productivity analysis. First, the Cobb Douglas function directly reflects the output elasticity of each input, thereby facilitating economic interpretation [9]. Second, it enables the examination of returns to scale by summing the regression coefficients of the input variables [10]. Third, its simple logarithmic form allows for straightforward estimation using Ordinary Least Squares (OLS) while mitigating heteroskedasticity issues commonly found in cross sectional data [11]. Mathematically, the Cobb Douglas productivity function in this study is specified as follows:

$$lnY = \beta_0 + \beta_1 lnX_1 + \beta_2 lnX_2 + \beta_3 lnX_3 + \beta_4 lnX_4 + \beta_5 lnX_5 + \varepsilon$$

Where: Y represents rose productivity (stems/ha); X_1 denotes plant population (plants/ha); X_2 refers to farmyard manure (kg/ha); X_3 represents chemical fertilizer (kg/ha); X_4 indicates labor input (person-days/ha); X_5 refers to pesticide use (liters/ha); β_0 is the intercept; and ε is the error term. The expected signs of the parameters are $\beta_i > 0$. A positive coefficient in the Cobb–Douglas model ($\beta_1, \beta_2, \beta_3, \ldots, \beta_5 > 0$) implies that an increase in inputs such as plant population, farmyard manure, chemical fertilizer, labor, and pesticide use will lead to higher rose productivity.

Parameter estimation was conducted using the Ordinary Least Squares (OLS) method. OLS is appropriate because it provides linear and unbiased estimators with minimum variance under the Gauss Markov assumptions. The validity of the estimation results was examined through a series of classical assumption tests, including multicollinearity, heteroskedasticity, autocorrelation, and residual normality, to ensure that the estimators satisfy the properties of the Best Linear Unbiased Estimator (BLUE) as stated in the Gauss Markov theorem [9].

Multicollinearity was tested using the Variance Inflation Factor (VIF), with multicollinearity assumed to exist if the VIF exceeds 10 or the tolerance value falls below 0.1. If no indication of multicollinearity is found, the independent variables can be used jointly in the regression model. Heteroskedasticity was tested using the Harvey test; if the significance level exceeds 0.05, the model can be considered free from heteroskedasticity, and the residual variance is homoskedastic. Durbin Watson statistics were employed to test for autocorrelation, with values close to 2 indicating the absence of serial correlation in the residuals. The Jarque Bera test was applied to test the normality of residuals; if the probability value is greater than 5 percent, the residuals can be considered normally distributed.

The research methodology was systematically designed to address the study's objectives. Secondary data from the Central Java Horticultural Household Survey (BPS) provided a robust empirical foundation. At the same time, the Cobb Douglas model was selected due to its advantages in estimating input elasticities and returns to scale. The OLS method, combined with a comprehensive set of classical assumption tests, ensures the results' validity, reliability, and economic interpretability, thereby offering meaningful insights into the factors influencing rose productivity in Central Java Province..

3. Results and discussion

The production function model employed in this study is the Cobb Douglas production function, with parameter estimation carried out using the Ordinary Least Squares (OLS) method. The analytical procedure was conducted sequentially, beginning with the presentation of descriptive statistics to illustrate the fundamental characteristics of the research variables. Subsequently, the model was subjected to a series of classical assumption tests, including multicollinearity, autocorrelation, heteroskedasticity, and normality, to ensure the validity of the regression model. Once the classical assumptions were satisfied, model adequacy was evaluated using the coefficient of determination (R^2) and the F-test. The final stage of the analysis involved examining the effects of individual production factors plant population, farmyard manure, chemical fertilizer, labor, and pesticide use on rose productivity.

3.1. Statistical Description

The descriptive statistics present the minimum, maximum, mean, and standard deviation of all variables used in the study, namely rose productivity, plant population, farmyard manure, chemical fertilizer, labor, and pesticide use. The detailed descriptive statistics are summarized in Table 2.

The descriptive analysis in Table 2 reveals substantial heterogeneity in productivity and input use among rose farming households. The average productivity of 17,304.60 stems/ha falls significantly below the potential yield range reported in the literature for rose cultivation under optimal agroclimatic conditions (±40,000–60,000 stems/ha) [12]. Meanwhile, the empirical range (4,114.29–55,200.00 stems/ha) indicates that while some farmers are approaching maximum potential, others remain far below it. This disparity suggests differences in technological efficiency and/or management practices across farming households.

Table 2 Statistical Description of Selected Variables

Variable	Unit	Min	Maks	Average	Standard Deviation
Rose productivity	Stem/Ha	4,114.29	55,200.00	17,304.60	10,174.24
Plant population	Plant/Ha	300.00	16,000.00	3,927.26	3,558.00
Organic fertilizer	Kg/Ha	176.47	265,125.00	8,692.51	29,278.37
Chemical fertilizer	Kg/Ha	36.04	6,820.00	826.38	1,210.76
Labor input	HOK/Ha	59.82	1,386.13	345.82	227.81
Pesticide	liter/Ha	0.48	88.11	18.03	14.84

The average plant population of 3,927.26 plants/ha demonstrates that most farmers in the sample apply planting densities above the agronomic recommendations for roses (approximately 3,300 plants/ha for optimal density under several production systems) [13]. Such sub optimal density is likely a key determinant of relatively low productivity, as it directly affects yield potential per unit of land.

The average application of organic fertilizer, 8,692.51 kg/ha (≈8.7 tons/ha), is below the commonly recommended organic fertilization rates of 10 tons/ha, which are often suggested to improve soil physical and chemical properties depending on local conditions and cropping systems [14]. This shortfall, particularly when combined with chemical fertilization practices, may restrict long term nutrient availability and soil fertility, ultimately constraining yield potential.

The average application of 826.38 kg/ha for chemical fertilizers falls within the range typically reported for ornamental crops (160 kg/ha depending on formulation and soil conditions) [15–17]. This finding implies that in terms of inorganic fertilization, some farmers are approaching or operating within recommended technical thresholds. However, given the varied plant responses to fertilizer composition, this average does not guarantee efficient nutrient use across all households, with the possibility of overdosing or under application among different farmers.

The average labor input of 345.82 workdays/ha underscores the labor intensive nature of rose cultivation, particularly for maintenance and harvesting, which require high precision and care [16,17]. While high labor requirements are typical of ornamental horticulture, the wide empirical variation (59.82–1,386.13 workdays/ha) highlights substantial differences in managerial practices and labor efficiency, influencing production costs and net productivity.

Lastly, the average pesticide use of 18.03 liters/ha is relatively high compared to Good Agricultural Practices (GAP) guidelines, which often recommend more measured and targeted applications (typically 5–10 liters/ha, depending on formulation and scheduling). Excessive pesticide use increases the risks of pest resistance, environmental contamination, and disproportionate input costs relative to short term yield gains.

3.2. Classical Assumption Test

Before interpreting the estimation results, the Cobb–Douglas regression model must be tested against the classical assumptions to ensure that the estimators satisfy the properties of the Best Linear Unbiased Estimator (BLUE), in accordance with the Gauss–Markov theorem (Gujarati & Porter, 2009). The classical assumption tests applied in this study include multicollinearity, heteroskedasticity, autocorrelation, and normality.

3.2.1. Multicollinearity Test

Table 3 Multicollinearity Test Output

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
LnX_1	0.001199	80.69677	1.107640
LnX_2	0.001177	87.84641	1.223416
LnX_3	0.000680	27.06733	1.111057
LnX_4	0.003426	118.5074	1.597557
LnX_5	0.002015	16.09900	1.701403
C	0.170464	182.6896	NA

Source: Author's calculation using Eviews

Multicollinearity is a condition in which independent variables are correlated with each other. The classical assumption test requires that the OLS regression be free from multicollinearity. Multicollinearity can be detected using the Variance Inflation Factor (VIF). If the VIF value is less than or equal to 10, it can be concluded that the model is free from multicollinearity. However, if the VIF value exceeds 10, multicollinearity exists among the independent variables. Based on Table 3, it can be observed that each independent variable has a VIF value of less than 10; therefore, it can be concluded that the model is free from multicollinearity.

3.2.2. Autocorrelation Test

The autocorrelation test is conducted to determine whether there is a correlation among the error terms in the regression model. One of the methods to test the presence of autocorrelation is the Durbin Watson (DW) test. The DW statistic ranges between 0 and 4, with the hypotheses as follows:

- Autocorrelation exists if DW < dL or DW > (4 – dL).
- No autocorrelation exists if dU < DW < (4 – dU).
- Inconclusive if dL < DW < dU or (4 – dU) < DW < (4 – dL).

Based on the EViews calculation, the Durbin–Watson (DW) value is 2.00. Referring to the Durbin Watson table for 82 observations (n = 82) and five independent variables (k = 5), the critical values at the 95% confidence level are dL = 1.51 and dU = 1.77. Accordingly, since the DW value satisfies the second hypothesis (1.77 < 2.00 < 2.23), it can be concluded that the production function model does not exhibit autocorrelation.

3.2.3. Heteroscedasticity Test

The heteroskedasticity test is conducted to examine whether the errors or residuals have a constant variance across data values. In this study, the Harvey test was employed to detect the presence of heteroskedasticity. The decision rule is based on the probability value of the F-statistic: if the Prob. F-statistic is greater than the significance level (α), it can be concluded that heteroskedasticity does not occur. Based on the results obtained using EViews, the Prob. The F-statistic value was 0.37, greater than 0.05 (α = 5%). Therefore, it can be concluded that the model used in this study does not exhibit heteroskedasticity.

3.2.4. Normality Test

The normality test examines the significance of the influence of independent variables on the dependent variable through the t-test, which is only valid if the residuals follow a normal distribution. Normality was tested using the Jarque-Bera test. Based on the results obtained with EViews, the probability value of the Jarque-Bera test was 0.441, which is greater than the 5% significance level (α = 0.05). Therefore, it can be concluded that the residuals are normally distributed. Overall, the classical assumption tests conducted indicate that the estimated production function model for roses in Central Java has satisfied the OLS assumptions, and thus, the estimation of the rose productivity model can proceed.

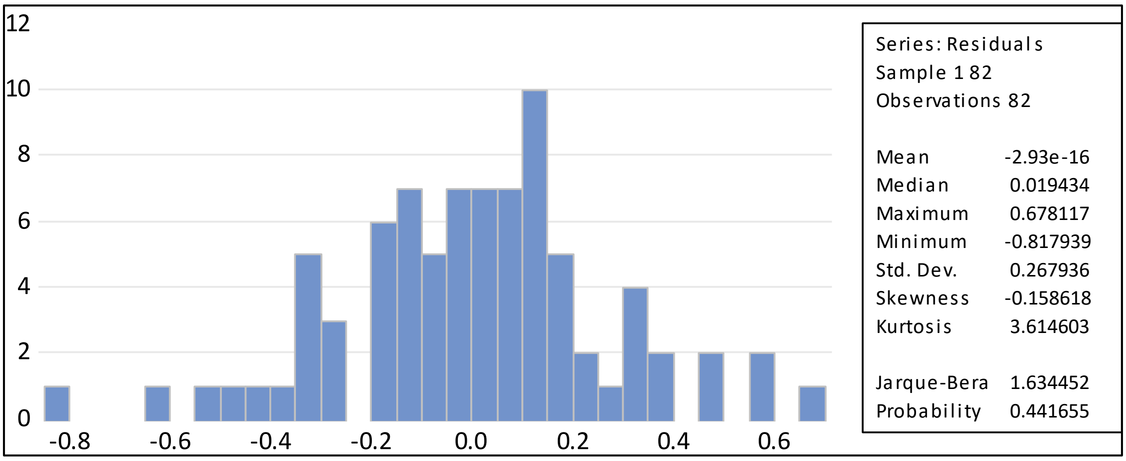

Figure 1 Jarque Bera Test Ouput - Normality Test

3.3. Model Fit Test

Before discussing the partial effect of each variable, it is necessary to evaluate the feasibility of the regression model used. The model feasibility test aims to assess how the model specification can explain the variation in rose productivity. This analysis includes examining the coefficient of determination (R^2) to measure the model's ability to explain data variation and the F-test to evaluate the overall significance of the model. Thus, the model feasibility test provides a strong basis before interpreting the coefficients of each production factor.

Table 4 Estimation Results of Rose Productivity Function Using the OLS Estimation Method

Variable	**Coefficient**	**Std. Error**	**t-Statistik**	**Prob**
C	5.056	0.412	12.246	0.000
LnX_1	0.363	0.034	10.486	0.000**
LnX_2	0.009	0.034	0.266	0.790
LnX_3	0.045	0.026	1.729	0.087*
LnX_4	0.181	0.058	3.093	0.002**
LnX_5	0.130	0.044	2.913	0.004**
R-square	0.731			
F-hitung	41.430			
Durbin Watson	2.004			

1% and 10% significance levels are denoted by ** and * respectively.
Source: Author's calculation using Eviews

Based on Table 4, the coefficient of determination (R^2) was obtained at 0.73, indicating that 73 percent of the variation in rose productivity can be explained by the independent variables included in the model, namely land area, plant population, manure, chemical fertilizer, labor, and pesticides. The remaining 27 percent is explained by other factors not incorporated into the model. Theoretically, the closer the R^2 value is to one or 100 percent, the better the model represents the relationship between independent and dependent variables, making the model feasible to use as an analytical tool [9]. An R^2 value of 0.73 is considered relatively high in socio economic and agribusiness research, signifying this model has sufficient predictive power to analyze rose productivity in Central Java.

In addition, the F-test result yielded a value of 41.43, far greater than the F-table value of 2.33 at the 95 percent confidence level. This demonstrates that, simultaneously, all independent variables have a statistically significant effect on the dependent variable, namely, rose productivity, ceteris paribus. In other words, the production factors analyzed collectively substantially contribute to productivity. This finding is consistent with previous horticultural studies employing the Cobb–Douglas regression model, in which the combination of production inputs such as land, plant density, fertilizers, labor, and pest control significantly influenced flower production outcomes [10]. Therefore, the model used is statistically valid and economically relevant in explaining variations in rose productivity in Central Java Province.

3.4. Factors That Affect Rose Productivity

In addition to assessing the overall goodness of fit of the model, it is also necessary to test the parameters of each independent variable to determine their individual effects on the dependent variable, namely, rose productivity. The t-test, which can also be interpreted through the p-value, was employed for this purpose. An independent variable significantly affects the dependent variable if the p-value < α. Based on the estimation results (Table 4), it can be concluded that plant population, chemical fertilizer, labor, and pesticides significantly affect rose productivity, whereas manure does not show a significant effect.

The estimation results indicate that plant population (X_1) has a positive and significant coefficient of 0.363 at the 1% level. This implies that a 1% increase in plant population would increase rose productivity by 0.363%, ceteris paribus. This finding is consistent with production theory, which states that plant density can influence yield per unit area, although its effectiveness depends on crop management and seed quality [18–20].

Organic fertilizer (X2) has a positive coefficient of 0.009 but is statistically insignificant, suggesting that variation in organic fertilizer use among farmers does not have a notable impact on productivity. This may be due to the relatively low dosage compared to technical recommendations or the slower effect of organic fertilizers on soil fertility [21–23].

Chemical fertilizer (X3) shows a positive and significant effect at the 10% level, meaning that a 1% increase in inorganic fertilizer use could raise productivity by 0.045%, ceteris paribus. This finding aligns with the literature, which notes that chemical fertilizers provide readily available nutrients that enhance rose growth, particularly during vegetative and generative stages [24–26].

Furthermore, labor (X4) has a positive and highly significant effect at the 1% level, confirming that adequate labor intensity plays a crucial role in maintenance, fertilization, pest control, and harvesting activities, thereby boosting rose productivity [27–29].

Finally, pesticides (X5) also have a positive and significant effect at the 1% level, indicating that a 1% increase in pesticide use can increase productivity by 0.13%, ceteris paribus. This demonstrates that the proper use of pesticides can enhance rose productivity by effectively controlling pests and plant diseases. This result is consistent with GAP guidelines, which emphasize the importance of measured pest management to support optimal yields.

The analysis reveals that plant population, chemical fertilizers, labor, and pesticides are the dominant factors influencing rose productivity in Central Java Province. At the same time, manure has no significant effect. These findings provide practical implications: productivity improvement efforts should focus on optimal land and crop management, balanced use of chemical fertilizers, efficient labor allocation, and appropriate pest control, whereas manure application should be integrated into a more effective soil fertility management strategy.

4. Conclusion

The results of the Cobb Douglas regression analysis indicate that plant population, chemical fertilizers, labor, and pesticides have a positive and significant effect on rose productivity, whereas manure is not statistically significant. These findings emphasize that enhancing rose productivity should focus on optimizing plant density management, balanced fertilization, adequate labor allocation, and effective pest control. This study provides an empirical basis for developing efficient and sustainable strategies to improve horticultural productivity in Central Java Province.

Compliance with ethical standards

Disclosure of conflict of interest

The author(s) declare no conflict of interest.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

References

[1] Fadhilah ML, Fariyanti A, Asmarantaka RW. Price Stability and Shallot Market Integration in Central Java. AGRISOCIONOMICS 2023;7:114.

[2] Fitria AV, Khayati N, Novitaningrum R. POTENSI TANAMAN KELADI SEBAGAI PENUNJANG PEREKONOMIAN MASYARAKAT DIMASA PANDEMI n.d.

[3] Jaragi FAP, Setiyawan H, Handayani M. Risk Analysis Of Rose Petal Production In Candi Village, Bandungan District, Semarang Regency. Mimbar Agribisnis: Jurnal Pemikiran Masyarakat Ilmiah Berwawasan Agribisnis 2025;11:2762–74.

[4] Awasthi P, Adhikari SP. Blooming markets: The economic dynamics of the Nepal rose trade. Heliyon 2024;10. https://doi.org/10.1016/j.heliyon.2024.e35585.

[5] Central Bureau of Statistics Indonesia. Ornamental Plant Production by Regency/City and Plant Type in Central Java Province. Available at: Https://JatengBpsGoId/En/Statistics-Table/3/TUROUllreE5ZemRHYUcxWFkyaHJNMjU2TWxSTFFUMDkjMw==/Produksi-Tanaman-Hias-Menurut-Kabupaten-Kota-Dan-Jenis-Tanaman---Di-Provinsi-Jawa-Tengah--2024Html?Year=2024 2024.

[6] Elings A, Den Belder E, Yilma Y, Dawd M, Lemessa F. Integrated pest management in ethiopian rose horticulture. Acta Hortic, vol. 911, International Society for Horticultural Science; 2011, p. 511–8. https://doi.org/10.17660/ActaHortic.2011.911.59.

[7] Vasco C, Ortega C, Cepeda D, Salazar D, Pazmiño J. The socioeconomic drivers of pesticide use in floriculture: insights from greenhouse rose production in Ecuador. J Environ Stud Sci 2024. https://doi.org/10.1007/s13412-024-00964-8.

[8] Zarif H, Fan C, Yuan G, Zhou R, Chang Y, Sun J, et al. Drought Stress in Roses: A Comprehensive Review of Morphophysiological, Biochemical, and Molecular Responses. Int J Mol Sci 2025;26. https://doi.org/10.3390/ijms26094272.

[9] Gujarati DN., Porter DC. Basic econometrics. McGraw-Hill Irwin; 2009.

[10] Coelli T, Rao D, O'Donnell C, Battese G. An Introduction to Efficiency and Productivity Analysis Second Edition. Second Edition. United States of America: Springer Science; 2005.

[11] Kmenta Jan. Elements of econometrics. Second Edition. Macmillan ; Collier Macmillan; 1986.

[12] Ministry of Research T and HE. TTG BUDIDAYA PERTANIAN M A W A R (Rosa damascena Mill.). 2000.

[13] Bastos FEA, Allebrandt R, Lerin S, Kretzschmar AA, Rufato L. Planting density on roses cultivars "Avalanche" and "Carola" in Lages-SC. Ornamental Horticulture 2017;23:58–62. https://doi.org/10.14295/oh.v23i1.914.

[14] Liu X, Zhang Y, Jiang Z, Yue X, Liang J, Yang Q, et al. Micro-moistening irrigation combined with bio-organic fertilizer: An adaptive irrigation and fertilization strategy to improve soil environment, edible Rose yield, and nutritional quality. Ind Crops Prod 2023;196. https://doi.org/10.1016/j.indcrop.2023.116487.

[15] Silva DMR, Santos JCC dos, Sab MPV, Silva M de A. Morpho-physiological and nutritional responses of safflower as a function of potassium doses. J Plant Nutr 2021;44:1903–15. https://doi.org/10.1080/01904167.2021.1881550.

[16] Ikiz M, Demircan V. Comparative Economic Analysis of Organic and Conventional Rose Oil (Rosa damascenae Mill.) Cultivation in Lakes Region, Turkey. Journal of Essential Oil Bearing Plants 2013;16:352–63. https://doi.org/10.1080/0972060X.2013.813213.

[17] Rusanov K, Kovacheva N, Rusanova M, Atanassov I. Traditional Rosa damascena flower harvesting practices evaluated through GC/MS metabolite profiling of flower volatiles. Food Chem 2011;129:1851–9. https://doi.org/10.1016/j.foodchem.2011.05.132.

[18] Zhang N, Tian L, Feng L, Xu W, Li Y, Xing F, et al. Boll characteristics and yield of cotton in relation to the canopy microclimate under varying plant densities in an arid area. PeerJ 2021;9. https://doi.org/10.7717/peerj.12111.

[19] Haque MA, Sakimin SZ. Planting Arrangement and Effects of Planting Density on Tropical Fruit Crops—A Review. Horticulturae 2022;8. https://doi.org/10.3390/horticulturae8060485.

[20] Li YC, Dai HY, Chen H. Effects of plant density on the aboveground dry matter and radiation-use efficiency of field corn. PLoS One 2022;17. https://doi.org/10.1371/journal.pone.0277547.

[21] Pei B, Liu T, Xue Z, Cao J, Zhang Y, Yu M, et al. Effects of Biofertilizer on Yield and Quality of Crops and Properties of Soil Under Field Conditions in China: A Meta-Analysis. Agriculture (Switzerland) 2025;15. https://doi.org/10.3390/agriculture15101066.

[22] Li G, Niu W, Ma L, Du Y, Zhang Q, Sun J, et al. Legacy effects of wheat season organic fertilizer addition on microbial co-occurrence networks, soil function, and yield of the subsequent maize season in a wheat-maize rotation system. J Environ Manage 2023;347. https://doi.org/10.1016/j.jenvman.2023.119160.

[23] Umar H, Okoye C. Productivity Analysis of sesame (Sesamum indicum L.) production under organic and inorganic fertilizers applications in Doma Local Government Area, Nasarawa State, Nigeria. Tropical and Subtropical Agroecosystems 2011;14.

[24] Yeo K-H, Choi KY, Rhee H-C, Choi GL, Lee Y-B. Optimal levels of N, P, and K for the cultivation of single-stemmed roses in a closed hydroponic system. Hortic Environ Biotechnol 2016;57:580–8. https://doi.org/10.1007/s13580-016-0120-y.

[25] Ma Q, Wang X, Yuan W, Tang H, Luan M. The optimal concentration of kh2 po4 enhances nutrient uptake and flower production in rose plants via enhanced root growth. Agriculture (Switzerland) 2021;11. https://doi.org/10.3390/agriculture11121210.

[26] Hou D, Su D, Hao K. Reduced Chemical Fertilizer Combined with Vermicompost Application Affects the Growth, Yield, and Quality of Watermelon. Horttechnology 2024;34:505–12. https://doi.org/10.21273/HORTTECH05441-24.

[27] van 't Ooster A, Bontsema J, van Henten EJ, Hemming S. Model-based analysis of skill oriented labour management in a multi-operations and multi-worker static cut rose cultivation system. Biosyst Eng 2015;135:87–102. https://doi.org/10.1016/j.biosystemseng.2015.04.014.

[28] Hou D, Su D, Hao K. Reduced Chemical Fertilizer Combined with Vermicompost Application Affects the Growth, Yield, and Quality of Watermelon. Horttechnology 2024;34:505–12. https://doi.org/10.21273/HORTTECH05441-24.

[29] Särkkä LE, Eriksson C. Effects of bending and harvesting height combinations on cut rose yield in a dense plantation with high intensity lighting. Sci Hortic 2003;98:433–47. https://doi.org/10.1016/S0304-4238(03)00065-7.