The Impact of Technology Adoption on Productivity, Sales, Performance and Farmer Satisfaction: Evidence From Rose Cultivation in Ngliman Village Indonesia

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Abstract : Rose cultivation is an important agricultural sector in Ngliman Village. However, conventional cultivation practices that remain widely adopted have resulted in low productivity, declining sales, and reduced farmer satisfaction. This study aims to analyse the effect of applying cultivation technology on rose productivity, increased sales, and farmer satisfaction. The research employed an experimental method on a 4 × 15 metre plot planted with 60 rose plants. Cultivation technology was implemented to improve plant growth and production yields. Data were collected over six planting cycles and compared with conventional cultivation methods. The results showed a significant increase in productivity following the application of cultivation technology. Increased yields directly contributed to higher sales and greater levels of farmer satisfaction. These findings indicate that integrating technology into rose cultivation can improve farming performance while providing economic benefits for farmers. Furthermore, the application of technology supports more efficient and sustainable cultivation practices. This study demonstrates that the use of technology has the potential to strengthen the competitiveness and sustainability of rose cultivation businesses in Ngliman Village and other areas with similar characteristics.

Keywords : Productivity, Sales, Farmer Satisfaction, Technology

Abstrak *: Budidaya tanaman mawar merupakan salah satu sektor penting dalam kegiatan pertanian di Desa Ngliman. Namun, praktik budidaya konvensional yang masih banyak diterapkan menyebabkan tingkat produktivitas yang rendah, penurunan penjualan, serta berkurangnya kepuasan petani. Penelitian ini bertujuan untuk menganalisis pengaruh penerapan teknologi budidaya terhadap produktivitas tanaman mawar, peningkatan penjualan, dan kepuasan petani. Metode penelitian yang digunakan adalah eksperimen pada lahan berukuran 4 × 15 meter yang ditanami 60 batang mawar. Teknologi budidaya diterapkan sebagai upaya untuk meningkatkan pertumbuhan dan hasil produksi tanaman. Pengumpulan data dilakukan selama enam siklus tanam dan hasilnya dibandingkan dengan metode budidaya konvensional. Hasil penelitian menunjukkan adanya peningkatan produktivitas yang signifikan setelah penerapan teknologi budidaya. Peningkatan hasil panen berdampak langsung pada kenaikan penjualan dan tingkat kepuasan petani. Temuan ini menunjukkan bahwa integrasi teknologi dalam budidaya mawar* *mampu meningkatkan kinerja usaha tani sekaligus memberikan manfaat ekonomi bagi petani. Selain itu, penerapan teknologi mendukung praktik budidaya yang lebih efisien dan berkelanjutan. Penelitian ini menunjukkan bahwa pemanfaatan teknologi berpotensi memperkuat daya saing dan keberlanjutan usaha budidaya mawar di Desa Ngliman serta wilayah lain yang memiliki karakteristik serupa.*

Kata Kunci *: Produktivitas, Penjualan, Kepuasan Petani, Teknologi*

INTRODUCTION

Rose cultivation is an important component of horticultural production because its productivity and quality are closely related to cultivation practices, input management, irrigation, pest control, and environmental conditions. In Ngliman Village, Sawahan District, Nganjuk Regency, rose cultivation has developed as an important livelihood activity. The village is located on the slopes of Mount Wilis at an altitude of approximately 1,361 metres above sea level, with a relatively cool climate and high humidity. These agroecological conditions provide favourable conditions for rose cultivation and other highland horticultural crops. However, favourable environmental conditions alone do not guarantee high and consistent agricultural productivity. Cultivation practices and the efficiency of production inputs remain important determinants of crop performance.

The concept of agricultural technology adoption refers to the utilisation of technological approaches, tools, and management practices to improve the efficiency and effectiveness of agricultural production. In rose cultivation, technological interventions can include improved fertilisation, irrigation management, integrated pest management, soil monitoring, and automated cultivation systems. Previous studies have demonstrated the relevance of these technologies to rose production. Improved fertiliser management, for example, can increase the productivity and quality of cut roses (Tariq et al., 2020), while irrigation scheduling and fertigation can influence plant growth and yield (Yahaya et al., 2020). Similarly, drip irrigation has been shown to improve water-use efficiency and rose yield (Faozi et al., 2021). Integrated pest management can also improve the effectiveness of pest control in rose cultivation (Yan et al., 2021). These findings indicate that technological intervention should not be viewed solely as the introduction of equipment, but as an integrated approach to improving cultivation practices.

Despite these technological developments, rose farmers in Ngliman Village continue to face practical challenges in maintaining productivity. One of the problems is the persistence of conventional cultivation practices, including the local practice known as *Utun*, in which roses are cultivated repeatedly on the same land for several years without adequate crop rotation or systematic soil management. Continuous cultivation can contribute to declining soil conditions and may eventually affect plant growth and production. Soil conditions are particularly important in determining the effectiveness of cultivation inputs. The development of soil-monitoring technologies, including soil pH measurement using sensor-based systems, provides an opportunity to support more informed decisions regarding soil management (Yakin et al., 2021). Likewise, automated systems for monitoring soil moisture, temperature, and other soil parameters demonstrate the potential of Internet of Things (IoT) technology to improve the precision of cultivation management (Winsen et al., 2020).

Low productivity has consequences beyond the agricultural production process. When harvest volumes and quality decline, farmers may experience lower sales and reduced economic returns. These conditions can subsequently affect farmers' perceptions of the benefits and feasibility of their farming activities. Therefore, evaluating cultivation technology should not be limited to biological indicators such as plant growth and harvest volume. Economic outcomes and farmer responses should also be considered because successful agricultural innovation should provide practical and economic benefits to its users.

Several studies have examined specific technological interventions in rose cultivation. Research has investigated fertiliser management (Tariq et al., 2020), drip irrigation (Faozi et al., 2021), irrigation scheduling and fertigation (Yahaya et al., 2020), integrated pest management (Yan et al., 2021), and greenhouse cultivation (Zheng et al., 2020). Other studies have examined specific cultivation practices, such as pruning and foliar fertilisation, to promote rose reflowering (Ula et al., 2018). In addition, IoT-based monitoring systems have been developed for horticultural cultivation (Pinem, 2019). Collectively, these studies demonstrate the potential of technology to improve different aspects of agricultural production. However, the existing literature predominantly evaluates individual technological interventions and production-related outcomes. Limited attention has been given to examining the combined implications of cultivation technology for productivity, sales performance, and farmer satisfaction within a specific rural farming community.

This gap is particularly relevant in Ngliman Village, where rose cultivation represents an important agricultural activity but remains constrained by conventional practices and limited technological integration. The novelty of this study lies in examining cultivation technology from an integrated perspective that connects production performance, economic outcomes, and farmer-level responses within the same analytical framework. Rather than assessing technology solely through changes in crop yield, this study evaluates whether technological cultivation practices are associated with increased productivity, improved sales, and higher farmer satisfaction. This approach provides a broader assessment of the practical value of agricultural technology at the farm level.

Accordingly, this study aims to analyse the effect of applying cultivation technology on rose productivity, sales, and farmer satisfaction in Ngliman Village. The study specifically examines changes in rose production following the implementation of cultivation technology and evaluates whether improvements in production are accompanied by increased sales and farmer satisfaction. The study is important because evidence from a specific rural farming context can provide practical information for farmers, agricultural extension workers, and local policymakers when designing technology-based interventions. More efficient cultivation practices may improve resource utilisation, production performance, and economic returns while supporting the longer-term sustainability of rose farming. Thus, the findings are expected to contribute empirical evidence for strengthening technology-based rose cultivation in Ngliman Village and other areas with comparable agroecological and farming characteristics.

RESEARCH METHODS

This study employed a quantitative research approach using an experimental design to examine the effect of cultivation technology on rose productivity, sales, and farmer satisfaction. The population comprised the agricultural area cultivated by rose farmers in Ngliman Village, Sawahan District, Nganjuk Regency. Following Sugiyono (2019), the population represents the entire unit to which the research findings are intended to be generalised. The population in this study was defined based on the geographical and agricultural characteristics of the research area, namely Ngliman Village, which has approximately 2.58 km^2 of agricultural and plantation land, including approximately 1.64 km^2 of rose plantation area. The experimental site was selected purposively based on its suitability for rose cultivation and its representation of the local cultivation conditions.

The experimental sample consisted of a 4 × 15 metre plot containing 60 rose plants, arranged in four rows with 15 plants per row. The plants were monitored periodically on a weekly basis throughout the experimental period to record changes in growth and productivity. In addition to experimental observations, interviews with the farmer were conducted to obtain supporting information related to cultivation practices, production, sales, and farmer satisfaction. The combination of experimental observations and interview data was used to provide a more comprehensive assessment of the effects of cultivation technology. The collected data were analysed using Structural Equation Modelling with Partial Least Squares (SEM-PLS). SEM is a multivariate statistical technique that enables researchers to examine relationships among multiple variables simultaneously (Sholihin & Ratmono, 2020). The analysis was conducted in two main stages, namely evaluation of the measurement model and evaluation of the structural model. The measurement model was assessed through convergent validity, discriminant validity, and reliability. Convergent validity was evaluated based on factor loading, with a minimum acceptable value of 0.50 (Indrawati, 2015). Discriminant validity was assessed by comparing the square root of the Average Variance Extracted (AVE) for each construct with its correlations with other constructs. A construct is considered to demonstrate adequate discriminant validity when the square root of its AVE is greater than its correlations with other constructs (Indrawati, 2015). Reliability was assessed using composite reliability and Cronbach's alpha. A composite reliability value above 0.70 indicates acceptable reliability, while a Cronbach's alpha coefficient of at least 0.70 indicates that the measurement instrument has adequate internal consistency (Indrawati, 2015, 2017).

After the measurement model met the required validity and reliability criteria, the structural model was evaluated to examine the relationships among the research constructs. Structural model assessment focused on the path coefficients and their statistical significance, including the t-value, to determine whether the hypothesised relationships were supported (Indrawati, 2017). This analytical procedure enabled the study to evaluate the relationships between the application of cultivation technology and the observed outcomes, particularly rose productivity, sales, and farmer satisfaction. The use of SEM-PLS was therefore intended to provide an integrated assessment of the relationships among the variables rather than evaluating each outcome independently.

RESULTS AND DISCUSSION

The results of the experiment were conducted for 6 cycles on a 4x15 meter plot of land, where special attention was given to rose plants by monitoring nutrient and mineral intake using technology in the cultivation process. The productivity level was measured as a result of the cultivation, which was used to measure the satisfaction level of farmers and sales.

The data analysis in this research was carried out using SmartPLS version 3 software because this software does not require a large amount of data, considering that the research results involved less than 50 data. It can be used to predict the relationship between constructs and confirm the theory used in the research. It can also be used to determine if there is a relationship between latent variables.

Table 1. Indicators Loading and Latent Variable Coefficient

Item	Loading Factor	Cronbach's Alpha	Composite Reliability
B1	0.834	0.75	0.843
B2	0.59		
B3	0.707		
B4	0.878		
K1	0.932	0.708	0.716
K2	0.725		
K3	0.5		
K4	0.246		
PO1	0.481	0.431	0.718
PO2	0.614		
PO3	0.906		
S1	0.898	0.628	0.805
S2	0.915		
S3	0.404		

Table 1 presents the results of the measurement model evaluation for the Budidaya (B), Farmer Satisfaction (K), Productivity (PO), and Sales (S) constructs. The results show that three indicators, namely K3, K4, and S3, have outer loading values below 0.50. In contrast, the remaining indicators have outer loading values above 0.50, indicating that they meet the minimum criterion for convergent validity and can be retained for further analysis (Latan & Ghozali, 2015). Indicators with outer loading values below the recommended threshold were therefore excluded from the subsequent analysis to improve the measurement quality of the respective constructs.

The reliability results were assessed using Composite Reliability and Cronbach's alpha. According to Latan and Ghozali (2015), Composite Reliability values above 0.70 indicate adequate construct reliability, while Cronbach's alpha values above 0.60 indicate acceptable internal consistency. The reliability assessment was conducted to ensure that the retained indicators consistently measured their respective constructs. Based on these criteria, the measurement model was considered sufficiently reliable for subsequent structural model evaluation.

Table 2. Correlations Among Latent Variables and Errors

	Cultivation	Farmers Satisfaction	Productivity	Sales
AVE	0.579	0.427	0.476	0.602

Table 3 displays the values of AVE for each variable, where the cultivation and sales variables have values >0.5, while the farmer satisfaction and productivity variables have values <0.5. Result of PLS-SEM Analysis:

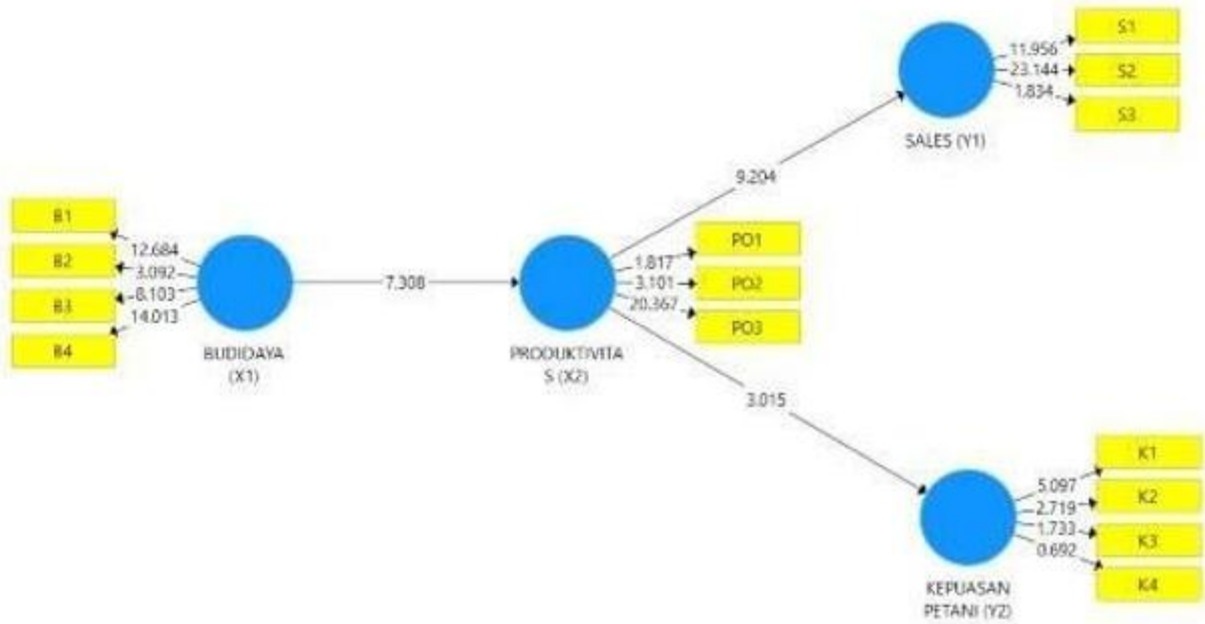

Figure 1. Inner Model

Establishing Figure 2 above shows that the results of the path coefficient have a direction between variables. In this model, the T-Statistic values are positive, indicating a significant influence of the independent variables on the dependent variables, which can be explained as follows:

Table 3. Inner Model Path Coefficients

	Path Coefficient	Sample Mean (M)	Standard Deviation (STDEV)	Tstatistics	Pvalues
CULTIVATION (X1)-> PRODUCTIVITY(X2)	0.062	0.654	0.086	7.308	0.000
PRODUCTIVITY(X2) -> FARMERSSATISFACTION (Y2)	0.590	0.600	0.196	3.015	0.003
PRODUCTIVITY (X2) -> SALES (Y1)	0.704	0.716	0.077	9.204	0.000

Source: Processed data (2025)

The structural model was evaluated using the path coefficients, T-statistics, and p-values obtained from the SmartPLS analysis. The results indicate that all hypothesised relationships have positive path coefficients, suggesting that improvements in the exogenous variables are associated with increases in the endogenous variables. Statistical significance was determined based on the p-value, with a value below 0.05 indicating a significant relationship. Therefore, the positive direction of the path coefficient describes the direction of the relationship, whereas the T-statistic and p-value determine whether the relationship is statistically significant.

As presented in Figure 2 and Table 4, the strongest relationship was observed between productivity and sales, with a path coefficient of 0.704. This result indicates that productivity has a substantial positive relationship with sales. In practical terms, higher rose productivity provides farmers with greater harvest volumes that can be marketed, thereby creating greater opportunities to increase sales. This finding is consistent with the argument that improvements in cultivation practices should ultimately generate measurable production and economic benefits for farmers. Previous research on rose cultivation has similarly demonstrated that improved fertiliser management and irrigation practices can enhance crop productivity and yield quality (Faozi et al., 2021; Tariq et al., 2020; Yahaya et al., 2020). The present finding extends this evidence by showing that increased productivity is also associated with improved sales performance at the farmer level.

The second relationship concerns the effect of cultivation on productivity. The path coefficient is 0.628 and has a positive direction, with a p-value below 0.05. This result confirms that cultivation practices have a significant positive effect on rose productivity. The finding suggests that improvements in cultivation management can contribute directly to better production outcomes. In the context of Ngliman Village, the application of improved cultivation technology may help farmers manage production inputs more efficiently and provide more appropriate conditions for plant growth. Previous studies have shown that irrigation management, fertigation, fertiliser management, and pest management can influence the growth and yield of roses (Faozi et al., 2021; Tariq et al., 2020; Yan et al., 2021; Yahaya et al., 2020). Thus, the present finding reinforces the importance of integrating cultivation technology into rose farming rather than relying exclusively on conventional cultivation practices.

The third relationship shows that productivity has a significant positive effect on farmer satisfaction. The path coefficient is 0.590, with a p-value below 0.05. This finding indicates that improvements in productivity are associated with higher levels of farmer satisfaction. Higher productivity can provide farmers with more tangible outcomes from their cultivation activities, particularly through increased harvest availability and potentially improved economic returns. Farmer satisfaction is therefore not only related to the cultivation process itself but also to the outcomes generated from farming activities. When farmers perceive that improved cultivation practices produce better results, they are more likely to perceive the farming activity as beneficial and worthwhile.

The indirect-effect analysis further indicates that productivity plays an important role in linking cultivation practices with farmer-related outcomes. The reported indirect effect of cultivation on farmer satisfaction through productivity is 0.196. This finding suggests that productivity functions as an important intermediary mechanism through which improved cultivation practices can contribute to farmer satisfaction. In other words, the benefits of cultivation technology may not be limited to improving plant performance but can extend to farmers' perceptions of the outcomes of their agricultural activities. This result strengthens the argument that technological interventions should be evaluated not only from a production perspective but also from their economic and farmer-level consequences.

Overall, the structural model demonstrates a coherent relationship among the three main constructs. Cultivation has a positive and significant relationship with productivity, while productivity has positive and significant relationships with both sales and farmer satisfaction. The strongest path coefficient occurs between productivity and sales (0.704), followed by the relationship between cultivation and productivity (0.628) and productivity and farmer satisfaction (0.590). These findings indicate that productivity represents a central construct in the model because it connects improvements in cultivation practices with both economic outcomes and farmer satisfaction. The results therefore support the proposition that strengthening cultivation practices through appropriate technological interventions can improve rose productivity, which in turn contributes to better sales performance and greater farmer satisfaction.

CONCLUSIONS AND RECOMMENDATIONS

This study concludes that the application of technology-based cultivation monitoring provides a positive contribution to rose cultivation in Ngliman Village. The use of Internet of Things (IoT) technology through five sensors, consisting of three sensors for monitoring soil NPK levels, one sensor for soil pH, and one sensor for soil moisture, enables farmers to monitor important soil conditions regularly. The experimental results demonstrate that technology-supported cultivation is associated with increased rose productivity. Soil NPK, pH, and moisture levels were monitored every 7 to 10 days, allowing cultivation inputs to be adjusted according to soil conditions. When soil pH fell below 5.5, lime was applied to support soil condition management. The structural model further confirms that cultivation has a positive and significant effect on productivity, with a path coefficient of 0.628. Productivity also has a positive and significant effect on sales, with a path coefficient of 0.704, and on farmer satisfaction, with a path coefficient of 0.590. The experimental results support these relationships, with harvest frequency increasing from approximately four harvests per week with an average of three buckets per harvest to approximately seven to fourteen harvests per week with an average of five buckets per harvest. These improvements indicate that technology-supported cultivation can strengthen production performance while generating positive economic outcomes and increasing farmer satisfaction.

For practitioners and local agricultural stakeholders, technology-based monitoring should be integrated with routine cultivation management rather than implemented as a stand-alone technological intervention. Farmers should receive practical training in sensor operation, interpretation of monitoring results, and appropriate responses to changes in soil conditions. Agricultural extension programmes should also support farmers in adopting monitoring technologies according to local cultivation conditions. For policymakers, technology-based horticultural programmes should be accompanied by training, technical assistance, and continuous evaluation to ensure that technological adoption is sustainable and accessible to farmers. Future research should involve larger experimental areas, more farmers, longer observation periods, and additional production and economic indicators to strengthen the generalisability of the findings. Comparative studies between conventional and technology-based cultivation should also be conducted to estimate the magnitude of productivity improvement and assess the economic feasibility of IoT adoption in rose farming.

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