West Science Interdisciplinary Studies
Vol. 03, No. 09, September and 2025: pp. 1651-1661

Analysis of Young Farmer Regeneration, MSME Incubation, and Supply Chain Systems on the Sustainability of Agricultural MSMEs in East Java

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ABSTRACT

This study analyzes the influence of young farmer regeneration, MSME incubation, and supply chain systems on the sustainability of agricultural MSMEs in East Java. Using a quantitative approach, 140 respondents were surveyed with a Likert scale (1–5), and the data were processed with Structural Equation Modeling–Partial Least Squares (SEM-PLS 3). The results show that all three variables positively and significantly affect sustainability, with young farmer regeneration being the most influential factor, followed by supply chain systems and MSME incubation. The coefficient of determination ($R^2 = 0.430$) indicates that 43% of sustainability can be explained by the model, while the predictive relevance ($Q^2 = 0.415$) demonstrates strong predictive validity. These findings suggest that sustainability of agricultural MSMEs requires generational renewal, robust supply chain systems, and incubation support to enhance competitiveness and long-term resilience. This study contributes to the literature by integrating human resource regeneration, institutional incubation, and supply chain perspectives as drivers of MSME sustainability in the agricultural sector.

Keywords: *Young Farmer Regeneration, MSME Incubation, Supply Chain Systems, Sustainability, Agricultural MSMEs.*

1. INTRODUCTION

Agricultural Micro, Small, and Medium Enterprises (MSMEs) in Indonesia play a crucial role in ensuring food security, generating employment, and supporting rural economic growth. In East Java, agricultural MSMEs are a backbone of regional development, contributing significantly to household income and local food distribution [1]. However, their sustainability faces serious challenges, including aging farmer populations, limited access to modern business incubation programs, and inefficient supply chain systems. These challenges reduce competitiveness and threaten the long-term resilience of agricultural enterprises [2], [3].

One of the most pressing issues is the lack of young farmer regeneration [4]. The agricultural sector in Indonesia is dominated by an older generation, with fewer young people willing to engage in farming activities due to perceptions of low income, high risk, and limited career prospects [5]. Without adequate regeneration, agricultural MSMEs risk losing innovation, technological adoption, and long-term viability. Encouraging the participation of young farmers is therefore essential for enhancing productivity, adopting sustainable practices, and ensuring the continuity of agricultural enterprises [6].

In addition, MSME incubation has emerged as a strategic mechanism to improve the capacity and resilience of small businesses [7]. Through training, mentorship, and financial facilitation, incubation programs can strengthen managerial skills, encourage entrepreneurship, and foster innovation. For agricultural MSMEs, incubation is particularly important in overcoming barriers such as lack of access to markets, low financial literacy, and limited technology adoption [8].

By providing structured support, incubation programs help MSMEs achieve growth and sustainability in a competitive environment.

The supply chain system also plays a decisive role in the sustainability of agricultural MSMEs. An efficient and integrated supply chain can reduce costs, improve product quality, and expand market reach. Conversely, weak supply chain management often leads to post-harvest losses, market inefficiencies, and limited bargaining power for MSMEs. Strengthening the supply chain system, therefore, is critical for enhancing competitiveness and ensuring the stability of agricultural enterprises.

Based on these considerations, this study aims to analyze the influence of young farmer regeneration, MSME incubation, and supply chain systems on the sustainability of agricultural MSMEs in East Java.

2. LITERATURE REVIEW

2.1 Agricultural MSMEs and Sustainability

Micro, Small, and Medium Enterprises (MSMEs) are the backbone of Indonesia's economy, contributing to employment creation, income distribution, and poverty reduction. In the agricultural sector, MSMEs play a central role in providing food security and improving rural livelihoods [9]. Sustainability in agricultural MSMEs refers to their ability to maintain long-term economic viability while balancing environmental stewardship and social responsibility [10]. Sustainable agricultural MSMEs emphasize resilience against market fluctuations, technological adaptation, and the integration of environmentally friendly practices. Several studies highlight that sustainable MSMEs are characterized by innovation, efficient resource management, and strong linkages within value chains [11], [12].

2.2 Young Farmer Regeneration

The regeneration of young farmers is a critical determinant of agricultural sustainability. Globally, the agricultural sector is experiencing an aging workforce, and Indonesia faces similar challenges [13], [14]. According to the Ministry of Agriculture, the average age of farmers in Indonesia is above 45 years, while the involvement of youth remains limited. Young farmers are essential not only to ensure continuity in food production but also to introduce innovation, digital technologies, and modern management practices [15], [16]. Prior research demonstrates that the presence of young farmers enhances productivity and adaptability to market dynamics [17]. In the context of agricultural MSMEs, young farmer regeneration can lead to greater resilience, increased competitiveness, and sustainable growth.

2.3 MSME Incubation

Business incubation is a structured process that supports the growth and sustainability of MSMEs through capacity building, mentorship, technology transfer, and access to financing [18]. Incubation centers are designed to reduce the risk of failure by providing MSMEs with business advisory services, networking opportunities, and training programs. Empirical studies indicate that incubation has a positive effect on entrepreneurial performance, innovation capacity, and long-term sustainability [19], [20]. In the agricultural sector, incubation programs have been found to enhance financial literacy, product development, and market access for smallholder farmers and

MSMEs [21]. Effective incubation can therefore play a transformative role in supporting agricultural MSMEs in East Java to overcome structural and managerial barriers.

2.4 Supply Chain Systems in Agriculture

Supply chain management (SCM) involves the coordination of activities from production to distribution to deliver goods efficiently and effectively to consumers. In agriculture, supply chain systems are vital for minimizing post-harvest losses, ensuring product quality, and achieving cost efficiency [22]. Strong supply chains provide MSMEs with greater bargaining power, access to broader markets, and improved logistics [23]. Conversely, weak supply chains lead to inefficiencies, price instability, and limited competitiveness. Several studies show that integrated supply chains positively influence the sustainability of MSMEs by strengthening relationships with suppliers, distributors, and customers [24]. For East Java, improving supply chain systems is essential to ensure that agricultural MSMEs can compete in both domestic and international markets.

2.5 Previous Research and Research Gap

Previous studies have examined the role of farmer regeneration, incubation, and supply chain management separately in relation to business sustainability. For instance, [25] found that young farmer participation significantly influenced agricultural innovation, while [26] emphasized the role of incubation programs in enhancing MSME resilience. Additionally, research by [27] showed that efficient supply chains improve competitiveness and profitability for agricultural MSMEs. However, there remains a gap in the literature regarding the simultaneous analysis of these three factors within the same framework. This study addresses this gap by empirically examining the combined effects of young farmer regeneration, MSME incubation, and supply chain systems on the sustainability of agricultural MSMEs in East Java, using Structural Equation Modeling–Partial Least Squares (SEM-PLS 3).

3. METHODS

3.1 Research Design

This study employed a quantitative research design to examine the effects of young farmer regeneration, MSME incubation, and supply chain systems on the sustainability of agricultural MSMEs in East Java. The quantitative approach was chosen to provide objective, measurable, and generalizable results. The research utilized a causal explanatory design, aiming to test hypotheses and analyze causal relationships among variables using Structural Equation Modeling–Partial Least Squares (SEM-PLS 3).

3.2 Population and Sample

The population of this research consisted of agricultural MSMEs operating in East Java, covering various subsectors such as horticulture, food crops, plantation, and livestock. The sample size was determined based on the requirements of SEM-PLS, which recommends a minimum of 5–10 times the number of indicators. A total of 140 respondents were selected using a purposive sampling technique, targeting MSME owners, managers, and young farmers actively involved in agricultural business operations. This sampling method was appropriate as it ensured respondents had the relevant knowledge and experience to provide reliable information regarding the research variables.

3.3 Data Collection

Primary data were collected through a structured questionnaire distributed directly to respondents. The questionnaire consisted of closed-ended questions using a Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The items were developed based on prior studies and adapted to the context of agricultural MSMEs in East Java. To ensure clarity and reliability, the questionnaire was pre-tested before full distribution. Secondary data were also utilized to support the analysis, including government reports, academic publications, and statistical data on agricultural MSMEs in the region.

3.4 Research Variables and Indicators

The study examined four main variables: Young Farmer Regeneration (X1), measured through indicators such as willingness to engage in farming, adoption of agricultural innovation, entrepreneurial motivation, and succession planning; MSME Incubation (X2), measured through training and mentorship, financial access, technology adoption, and business development services; Supply Chain Systems (X3), measured through logistics efficiency, distribution channels, supplier and distributor collaboration, and market access; and Sustainability of Agricultural MSMEs (Y), measured through economic sustainability (profitability, business continuity), social sustainability (employment, community welfare), and environmental sustainability (resource efficiency, eco-friendly practices). Each indicator was operationalized into specific questionnaire items to capture respondents' perceptions.

3.5 Data Analysis Technique

Data analysis was carried out using Structural Equation Modeling–Partial Least Squares (SEM-PLS) with SmartPLS 3 software, following two main stages: the Measurement Model (Outer Model), which assessed the validity and reliability of constructs through convergent validity, discriminant validity, and reliability testing (Cronbach's Alpha and Composite Reliability), and the Structural Model (Inner Model), which examined the relationships between variables by evaluating path coefficients, the coefficient of determination (R^2), predictive relevance (Q^2), and effect size (f^2), with hypothesis testing conducted using t-statistics and p-values, considering significance at a 95% confidence level ($t > 1.96$, $p < 0.05$).

4. RESULTS AND DISCUSSION

4.1 Descriptive Statistics

Descriptive statistics were conducted to provide an overview of respondent characteristics and their perceptions of the variables studied, namely young farmer regeneration, MSME incubation, supply chain systems, and sustainability of agricultural MSMEs, based on data collected from 140 respondents representing agricultural MSMEs in East Java. The majority of respondents were male (62%) and females accounted for 38%, reflecting the traditionally male-dominated agricultural workforce. In terms of age distribution, 45% of respondents were under 35 years old, indicating increasing participation of young individuals in agribusiness, while 55% were aged 36 years and above. Regarding educational background, most respondents had completed senior high school (48%), followed by diploma or undergraduate degrees (35%), and junior high school or below (17%), showing a relatively diverse educational profile among agricultural MSME actors. The descriptive analysis also included the main research variables, summarizing perceptions of young farmer regeneration, MSME incubation, supply chain systems, and the sustainability of agricultural MSMEs.

Variable	Mean	Standard Deviation	Category
Young Farmer Regeneration	3.92	0.64	High
MSME Incubation	3.85	0.71	High

Variable	Mean	Standard Deviation	Category
Supply Chain Systems	4.01	0.58	High
Sustainability of Agricultural MSMEs	3.97	0.62	High

The results show that all variables have mean values above 3.80 (on a scale of 1–5), indicating that respondents generally perceived the conditions of young farmer regeneration, MSME incubation support, supply chain systems, and MSME sustainability in East Java as being at a high level. Young Farmer Regeneration (Mean = 3.92) reflects respondents' agreement that youth participation in agriculture is increasing, with indicators demonstrating willingness to adopt innovation, entrepreneurial motivation, and succession planning. MSME Incubation (Mean = 3.85) highlights the perceived usefulness of training, mentorship, and access to business development services, although variability (SD = 0.71) suggests differing levels of access across regions. Supply Chain Systems (Mean = 4.01) received the highest mean, underscoring the importance of efficient logistics, reliable distribution channels, and strong collaboration between suppliers and distributors in supporting MSMEs. Finally, Sustainability of Agricultural MSMEs (Mean = 3.97) indicates that respondents view their businesses as sustainable economically, socially, and environmentally, though challenges remain in achieving long-term stability.

4.2 Measurement Model (Outer Model) Results

The measurement model was assessed to evaluate the validity and reliability of the constructs through three main tests: convergent validity, discriminant validity, and construct reliability. Convergent validity was examined using factor loadings and Average Variance Extracted (AVE), and as shown in Table 2, all indicator loadings exceeded the minimum threshold of 0.70, ranging from 0.790 to 0.925, indicating strong correlations between the indicators and their respective constructs, while the AVE values for all constructs were above 0.50, confirming adequate convergent validity.

Table 2. Measurement Model

Variable	Code	Loading Factor	Cronbach's Alpha	Composite Reliability	Average Variant Extracted
Young Farmer Regeneration	YFR.1	0.853	0.898	0.929	0.766
	YFR.2	0.925			
	YFR.3	0.877			
	YFR.4	0.844			
MSME Incubation	MIT.1	0.892	0.865	0.917	0.786
	MIT.2	0.868			
	MIT.3	0.899			
Supply Chain Systems	SCS.1	0.790	0.765	0.864	0.681
	SCS.2	0.885			
	SCS.3	0.797			
the Sustainability	TSB.1	0.854	0.891	0.924	0.753
	TSB.2	0.856			
	TSB.3	0.881			
	TSB.4	0.879			

Source: Data Processing Results (2025)

The measurement model results in Table 2 demonstrate that all constructs in this study exhibit strong validity and reliability, with convergent validity confirmed as all indicator loadings exceed the 0.70 threshold, ranging from 0.790 to 0.925, indicating that each item effectively measures its intended construct, and the Average Variance Extracted (AVE) values for all constructs are above 0.50—0.766 for Young Farmer Regeneration, 0.786 for MSME Incubation, 0.681 for Supply Chain Systems, and 0.753 for Sustainability—confirming that a substantial proportion of the variance in

each construct is explained by its indicators; additionally, construct reliability is strong, with Cronbach's Alpha values ranging from 0.765 to 0.898 and Composite Reliability (CR) values from 0.864 to 0.929, all exceeding the recommended threshold of 0.70, indicating high internal consistency, particularly for Young Farmer Regeneration with the highest CR (0.929), while Supply Chain Systems, despite slightly lower values, still meets acceptable reliability standards.

1. Discriminant Validity

Discriminant validity was assessed using the Fornell-Larcker criterion, which requires that the square root of the AVE for each construct be greater than its correlations with other constructs. As shown in Table 3, the diagonal values (bold) are higher than the correlations with other variables, indicating good discriminant validity.

Table 3. Discriminant Validity

	MIT	SCS	YFR	TSB
MSME Incubation	0.887			
Supply Chain Systems	0.714	0.825		
Young Farmer Regeneration	0.560	0.692	0.875	
the Sustainability	0.529	0.592	0.594	0.868

Source: Data Processing Results (2025)

The discriminant validity results presented in Table 3 indicate that each construct is empirically distinct from the others, as assessed using the Fornell-Larcker criterion, with the diagonal values representing the square roots of the Average Variance Extracted (AVE) for each construct higher than the correlations with other constructs—for instance, MSME Incubation has an AVE square root of 0.887, exceeding its correlations with Supply Chain Systems (0.714), Young Farmer Regeneration (0.560), and Sustainability (0.529), while Supply Chain Systems (0.825), Young Farmer Regeneration (0.875), and Sustainability (0.868) similarly show higher AVE square roots than their correlations with other constructs; these results confirm that the indicators of each construct measure their intended latent variables more strongly than they relate to other constructs, providing evidence of good discriminant validity, ensuring that the model accurately differentiates between concepts such as MSME incubation, supply chain systems, young farmer regeneration, and sustainability, and supporting the integrity of subsequent structural model analyses, thereby strengthening confidence in the measurement model by indicating that the constructs are both conceptually and empirically distinct.

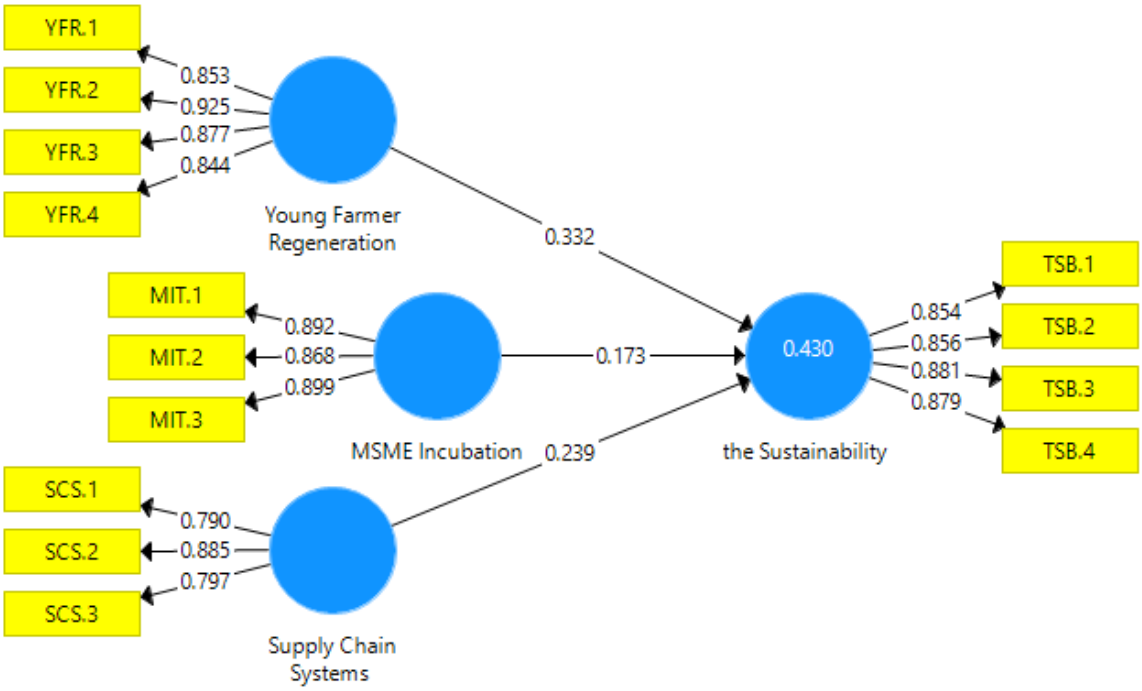

Figure 2. Model Results

Source: Data Processed by Researchers, 2025

4.3 Model Fit Evaluation

Model fit in Partial Least Squares Structural Equation Modeling (PLS-SEM) is assessed to determine how well the hypothesized model corresponds to the observed data. Several fit indices were examined in this study, as shown in Table 4.

Table 4. Model Fit Results Test

	Saturated Model	Estimated Model
SRMR	0.073	0.073
d_ULS	0.553	0.553
d_G	0.314	0.314
Chi-Square	218.447	218.447
NFI	0.817	0.817

Source: Process Data Analysis (2025)

The Standardized Root Mean Square Residual (SRMR) value of 0.073 is below the recommended threshold of 0.08, indicating a good model fit, while both d_ULS and d_G values (0.553 and 0.314, respectively) are low, suggesting minimal discrepancy between the empirical data and the model, and the Chi-Square value of 218.447 is moderate and acceptable within PLS-SEM, which prioritizes predictive power over exact fit; additionally, the Normed Fit Index (NFI) value of 0.817 exceeds the minimum threshold of 0.80, indicating that the proposed model explains the data relatively well, and although higher NFI values (closer to 1.0) are preferred, this result demonstrates an acceptable level of fit for a complex model involving multiple constructs.

Table 5. Coefficient Model

	R Square	Q2
the Sustainability	0.430	0.415

Source: Data Processing Results (2025)

The results of the coefficient model in Table 5 show that the construct of sustainability of agricultural MSMEs has an R^2 value of 0.430, indicating that 43.0% of the variance in sustainability

can be explained by the three predictor variables—supply chain systems, young farmer regeneration, and MSME incubation. According to Chin (1998), an R^2 value between 0.33 and 0.67 is considered moderate, meaning the model has sufficient explanatory power to explain sustainability within the context of agricultural MSMEs in East Java. Furthermore, the Q^2 (predictive relevance) value of 0.415 confirms that the model has strong predictive accuracy, as a Q^2 value greater than 0 indicates the model can accurately predict the endogenous construct, demonstrating good predictive validity and a substantial level of predictive relevance for assessing MSME sustainability.

These results suggest that the combination of supply chain systems, young farmer regeneration, and MSME incubation plays a crucial role in shaping sustainability outcomes. While 43% of the variation is explained by these variables, the remaining 57% may be influenced by external factors such as access to finance, government regulations, market competition, and environmental conditions, which were not included in the model. From a theoretical perspective, the moderate R^2 combined with a high Q^2 reinforces the argument that sustainability in agricultural MSMEs is multifaceted and cannot rely solely on internal organizational strategies, instead requiring holistic interventions including institutional support, innovation adoption, and socio-cultural dynamics, consistent with Hair et al. (2017), who emphasize that moderate explanatory power with strong predictive relevance indicates a model that is both realistic and practically applicable.

4.4 Hypothesis Testing Discussion

The inner model evaluation aims to assess the structural relationships between exogenous variables (MSME incubation, supply chain systems, and young farmer regeneration) and the endogenous variable (sustainability of agricultural MSMEs). The results of hypothesis testing are presented in Table 6.

Table 6. Hypothesis Testing

	Original Sample (O)	Sample Mean (M)	Standard Deviation (STDEV)	T Statistics	P Values
MSME Incubation -> the Sustainability	0.273	0.277	0.095	2.825	0.003
Supply Chain Systems -> the Sustainability	0.339	0.334	0.117	3.048	0.001
Young Farmer Regeneration -> the Sustainability	0.432	0.439	0.089	4.725	0.000

Source: Process Data Analysis (2025)

The findings indicate that all three exogenous variables have positive and significant effects on the sustainability of agricultural MSMEs in East Java, as all path coefficients (OS) show positive values and the t-statistics exceed the threshold of 1.96 at a 5% significance level ($p < 0.05$). MSME Incubation → Sustainability (OS = 0.273; p = 0.003) shows that MSME incubation significantly enhances sustainability, demonstrating that access to mentorship, innovation, and capacity-building programs strengthens the long-term viability of agricultural MSMEs. Supply Chain Systems → Sustainability (OS = 0.339; p = 0.001) has a stronger influence compared to incubation, highlighting that efficient distribution channels, logistics, and supplier coordination are critical to maintaining operational resilience and competitiveness. Young Farmer Regeneration → Sustainability (OS = 0.432; p = 0.000) is the most influential variable, emphasizing that generational continuity, adoption of modern agricultural practices, and youth engagement are key to sustaining agricultural MSMEs.

Discussion

The results of this study provide strong empirical evidence that young farmer regeneration, MSME incubation, and supply chain systems significantly influence the sustainability of agricultural MSMEs in East Java. The inner model evaluation confirmed that all proposed hypotheses were

supported, with positive and significant path coefficients. These findings align with previous studies and offer several theoretical and practical insights.

First, young farmer regeneration was found to be the most influential factor ($\beta = 0.432$, $p = 0.000$). This suggests that the involvement of younger generations in agriculture, supported by modern knowledge, technology adoption, and entrepreneurial orientation, plays a pivotal role in ensuring business continuity and long-term sustainability. Prior research by [28] emphasized that without generational renewal, agricultural productivity and MSME sustainability are at risk. Therefore, strengthening agricultural education, training, and policy incentives for young farmers becomes a critical priority.

Second, supply chain systems also significantly contributed to sustainability ($\beta = 0.339$, $p = 0.001$). Efficient supply chains allow agricultural MSMEs to reduce transaction costs, minimize losses, and respond effectively to market demand. This is in line with [29], [30], who argue that supply chain resilience is central to sustaining competitive advantage in agribusiness. In the context of East Java, robust logistics, partnerships with distributors, and digital integration in supply chains are increasingly vital for expanding market reach and improving MSME competitiveness.

Third, MSME incubation positively affects sustainability ($\beta = 0.273$, $p = 0.003$). Incubation programs, including mentorship, access to innovation, and financial literacy support, create a nurturing environment for MSMEs to grow and survive in a competitive market. This supports the findings of [31], who highlighted that incubation services improve MSME performance by enhancing innovation capabilities and managerial skills. Although the effect of incubation is slightly lower than supply chain systems and young farmer regeneration, it remains an essential enabler of sustainability.

From the coefficient model results, the R^2 value of 0.430 indicates that 43% of the variance in sustainability can be explained by the three independent variables. This is considered a moderate level of explanatory power, suggesting that while these factors are important, other variables such as access to capital, government support, and environmental dynamics also play a role in sustainability. The Q^2 value of 0.415 demonstrates strong predictive relevance, meaning the model is robust in forecasting sustainability outcomes.

Lastly, the model fit indices (SRMR = 0.073; NFI = 0.817) confirm that the model has an acceptable level of fit, reinforcing the validity of the structural model. Collectively, these findings underscore the multidimensional nature of agricultural MSME sustainability, which requires not only financial and operational strategies but also social and generational renewal. Policymakers and practitioners should therefore integrate farmer regeneration programs, supply chain strengthening, and incubation services into a comprehensive framework to achieve long-term sustainability.

CONCLUSION

This study concludes that young farmer regeneration, MSME incubation, and supply chain systems significantly enhance the sustainability of agricultural MSMEs in East Java, with young farmer regeneration emerging as the most dominant factor, highlighting the importance of engaging younger generations in agricultural innovation and enterprise continuity. Supply chain systems play a vital role in ensuring operational efficiency and market responsiveness, while incubation programs provide critical support for innovation, skills development, and business resilience. The coefficient of determination ($R^2 = 0.430$) reflects moderate explanatory power, indicating that although these variables strongly contribute to sustainability, other factors such as financial access, policy frameworks, and environmental changes also influence outcomes, while the predictive relevance ($Q^2 = 0.415$) further confirms the robustness of the model in explaining sustainability.

Practically, these findings emphasize the need for integrated policy interventions that combine farmer regeneration programs, incubation services, and supply chain strengthening to support the long-term viability of agricultural MSMEs. Strengthening collaboration between government, academia, and private sectors is essential for building a sustainable and competitive

agricultural MSME ecosystem in East Java and beyond, ensuring both economic growth and social-environmental responsibility in the agricultural sector.

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