The Role of Marketing Technology Adoption on Farmers' Economic Sustainability through Market Access as a Mediating Variable

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Abstract

Purpose: This study aims to analyze the effect of marketing technology adoption on farmers' economic sustainability and to examine the mediating role of market access in strengthening this relationship.

Methodology: A quantitative descriptive–associative approach was employed using 330 farmers selected through the Isaac & Michael sampling table from a population of 6,563. Data were collected through structured questionnaires and analyzed using path analysis with SPSS 27 to test both the direct and indirect effects of marketing technology adoption on economic sustainability through market access.

Findings: The results show that marketing technology adoption significantly improves both market access and farmers' economic sustainability. Market access also demonstrates a strong positive effect on economic sustainability and partially mediates the relationship between technology adoption and sustainability outcomes. These findings indicate that digital marketing tools become more impactful when they successfully expand farmers' access to broader and more competitive markets, rather than functioning as isolated technological interventions.

Originality: The novelty of this study lies in its analytical approach, which incorporates market access as a mediating mechanism linking marketing technology adoption to farmers' economic sustainability. Unlike previous studies that examine these variables separately, this research provides empirical evidence on how digital adoption translates into economic benefits through improved market connectivity among smallholder farmers.

Research limitations: This study is limited to farmers in Nagrak District, with data collected solely through questionnaires. This may not fully capture deeper behavioral, contextual, and technological adoption dynamics.

Practical implications: The findings highlight the importance of integrating digital marketing initiatives with efforts to broaden market linkages. For policymakers and farmer institutions, strengthening e-commerce readiness, market networks, and digital literacy programs can significantly enhance farmers' bargaining power and long-term economic sustainability

Kata kunci: marketing technology adoption, middlemen, consignment sales, market access, economic sustainability

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Introduction

In the context of agricultural marketing in Nagrak District, Sukabumi, the role of adopting marketing technology, particularly agricultural e-commerce applications, has become increasingly relevant as an alternative solution to address limited market access and its implications for farmers' economic sustainability. Marketing through middlemen is currently the primary option for farmers due to the limited access they face. This is influenced by various constraints, including limited market knowledge and restricted distribution networks that directly connect farmers with end consumers (Ardelia et al., 2020). As a result, farmers are often compelled to sell their products at lower prices to middlemen, which adversely affects their economic well-being (Hardian et al., 2024). The challenge of limited market access is further compounded by the underutilization of digital technology in agricultural marketing activities.

Previous studies have shown that many farmers still depend on conventional marketing methods, which are less efficient and often result in suboptimal outcomes (Arvianti et al., 2022). Consignment-based sales through middlemen remain dominant, especially in Nagrak District (TSW Akbar et al., 2025). In this context, marketing technology offers a strategic alternative to help farmers overcome existing limitations by enabling wider market reach and enhancing product competitiveness through digital channels (Arvianti et al., 2022). The adoption of e-commerce platforms, social media, and digital marketplaces presents opportunities for farmers to promote their products directly to consumers, reduce dependence on intermediaries, and improve market transparency (Putra et al., 2023).

Agricultural extension workers also play a crucial role in supporting this transition by assisting farmers in adopting new technologies and providing training on effective marketing strategies (Sitorus, 2024). With proper support, farmers can improve their market knowledge, enhance digital literacy, and utilize technology more effectively for marketing activities (Nur Laely & Aris Widianto, 2024). These efforts contribute to the long-term economic sustainability of farmers by improving competitive advantage, increasing pricing power, and enabling better management of agricultural output (Dewi Listyati & Agus Wahyudi, 2014).

Overall, the dominance of middlemen in the consignment marketing system in Nagrak District shows that limited market access can be mitigated through the appropriate adoption of marketing technology. Among various digital platforms, agricultural e-commerce applications are among the easiest to introduce and adopt due to their accessibility and smartphone compatibility (Setiawan, 2024). Therefore, strengthening digital marketing adoption becomes an essential step toward enhancing market efficiency and farmers' economic sustainability.

However, despite the increasing attention to digitalization in agriculture, existing studies mostly examine marketing technology adoption and market access as separate factors influencing farmers' performance. Empirical evidence explaining *how* digital technology creates economic benefits through improved market access is still limited, particularly among smallholder farmers in Indonesia. This leads to an important research gap.

The originality of this study lies in its analytical model, which incorporates market access as a mediating variable linking marketing technology adoption to farmers' economic sustainability. Unlike previous research that focuses only on the direct role of technology or access separately, this study provides empirical evidence on the mediating mechanism through which technology adoption translates into improved economic outcomes. By testing this mediation effect, the study contributes to a deeper theoretical understanding of how digital technologies shape long-term economic sustainability in the agricultural sector.

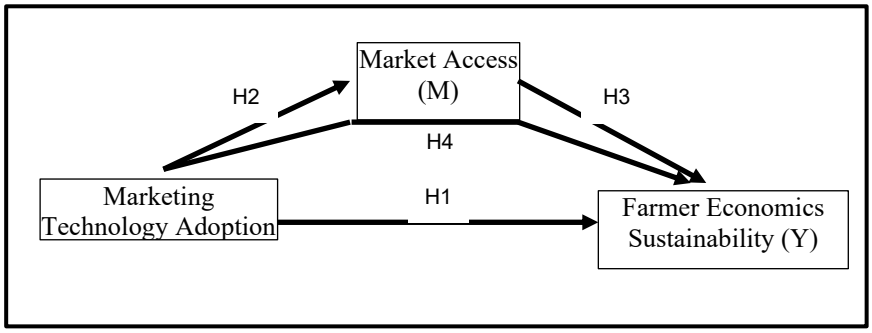

Figure 1. Framework Of Thought

Marketing Technology Adoption

Marketing Technology Adoption is marketing that leverages internet access, search engine promotion, digital advertising, social media, and mobile devices, connecting with various opportunities (Casciani & D'Itria, 2024). Agricultural e-commerce application platforms were chosen as the primary alternative for marketing agricultural products because they offer simple and easy-to-understand features and are compatible with smartphones, making them more mobile and flexible to use. E-commerce is a form of electronic commerce conducted via the internet, enabling buyers and sellers to conduct transactions without physical boundaries. E-commerce platforms and social media have revolutionized the way businesses promote and sell products, enabling consumers to make purchases from home using their smartphones. This digital transformation has created opportunities for economic growth, particularly for small businesses and entrepreneurs, including farmers (Setiawan, 2024; Amelia et al., 2025). Factors influencing the adoption of agricultural marketing technology include farmer characteristics, level of readiness, psychological and motivational factors, intervention and support, and access to technology and resources (Wahyudin et al., 2023)

Marketing technology adoption theoretically contributes to broader market access because digital tools reduce information asymmetry, enhance product visibility, and lower transaction barriers *(Klerkx et al., 2019; Zhang et al., 2022).*Through online promotion, digital catalogues, and mobile communication channels, farmers can reach potential buyers beyond local intermediaries *(Arvianti et al., 2022; Setiawan, 2024).*These mechanisms explain why the adoption of marketing technology is expected to positively influence market access *(Klerkx et al., 2019).*

Market Access

Market access refers to the ability of smallholder farmers to participate in commodity markets by reducing the barriers they typically face. Improved market access, facilitated through production contract programs that include credit to initiate production, guaranteed prices and quantities for harvests, and reduced transaction costs, can be indicators of improved market access for farmers (Abman & Lundberg, 2024).

Literature in agricultural economics emphasizes that farmers' economic sustainability improves when they diversify their marketing channels and gain stronger bargaining positions (Barrett, 2008; Morepje et al., 2024).Increased access to more competitive markets allows farmers to secure better prices, reduce dependence on middlemen, and minimize sales uncertainty (Abman & Lundberg, 2024; Barrett, 2008).These conditions contribute to greater income stability, which theoretically explains why market access is expected to directly and positively influence farmers' economic sustainability (Morepje et al., 2024).

Economic Sustainability

Economic sustainability refers to a business's ability to maintain, develop, and protect its resources, as well as meet its needs (Yuningsih et al., 2022). Business sustainability encompasses

efforts to maintain long-term business continuity, including growth, development, and strategies to ensure its existence amidst economic challenges (TSW Akbar, 2025). The sustainability of a business is supported by several factors, some of which are strong factors that contribute to its survival. These include the compilation of a business plan, regular updating of the business plan, regular competitor analysis, ease of venturing into a new business, and the ability to calculate risks (Yuningsih et al., 2022). The expected outcome of this research is a change in the farmer's marketing system, which has so far relied solely on middlemen. They can adopt marketing technology as an alternative to the current marketing system, thereby increasing sales and profits, thus impacting the economic sustainability of farmers (Utami, 2020).

Research on digital agriculture increasingly highlights the role of mediating variables that explain how technology adoption leads to improved outcomes (Klerkx et al., 2019; Zhang et al., 2022).In this study, market access is proposed as the mediating mechanism linking marketing technology adoption to farmers' economic sustainability (Zhang et al., 2022).Digital marketing tools help farmers expand their visibility to buyers, improve the flow of market information, and reduce structural barriers in distribution channels (Klerkx et al., 2019; Abman & Lundberg, 2024).hese improvements in market access then translate into higher income stability, enhanced bargaining power, and stronger long-term economic performance (Morepje et al., 2024).Therefore, market access serves as the pathway through which marketing technology adoption exerts its influence on farmers' economic sustainability (Zhang et al., 2022).

Hypotheses

The Impact of Marketing Technology Adoption on Farmers' Economic Sustainability

Based on the research findings and field evidence, marketing technology is a valuable strategic asset that can enhance market access, reduce costs, and improve farmers' economic sustainability. This is consistent with previous research in Iran, which shows that the adoption of marketing technology has a positive and significant effect on farmers' economic sustainability (Rahimi Bagmalek & Moosaei, 2023). Therefore:

H1: Marketing Technology Adoption has a positive and significant effect on Farmers' Economic Sustainability.

The Impact of Marketing Technology Adoption on Market Access

The role of marketing technology adoption in enhan cing farmers' capacity to connect with markets is highly significant. Through the use of digital platforms, farmers are able to reach wider markets, obtain real-time price information, and reduce geographical barriers, thereby strengthening their market access. This is consistent with previous research showing that technology adoption expands the market reach of SMEs in Bima City (Asriani, Al Fajar, & Ulhaq, 2025). Therefore:

H2: Marketing Technology Adoption has a positive and significant effect on Market Access.

The Impact of Market Access on Farmers' Economic Sustainability

According to Market Integration Theory, broader market access improves price transmission and enhances producer welfare. Farmers with stronger market access are able to obtain more favorable prices and enjoy more stable income. Empirical evidence from urban entrepreneurship development in Indonesia shows that market access has a significant positive effect on business growth and business sustainability, indicating that better market access supports long-term economic performance (Perdana, Sihombing, Chrisinta, Sahala, & Budaya, 2024). Therefore:

H3: Market Access has a positive and significant effect on Farmers' Economic Sustainability.

The Role of Marketing Technology Adoption in Farmers' Economic Sustainability through Market Access as a Mediating Variable

Marketing technology adoption not only directly enhances farmers' economic sustainability but also indirectly affects it by strengthening market access. By improving market connectivity, reducing transaction costs, and increasing price transparency, marketing technology enables farmers to access wider and more efficient markets, which in turn leads to higher and more stable income. Empirical evidence from Indonesian business sectors shows that digital marketing adoption and technological transformation significantly improve business sustainability through innovation and improved market performance, confirming the importance of mediating mechanisms in transmitting the impact of technology on sustainability outcomes (Budiarti & Wardani, 2025). This supports the argument that market access can function as a mediating mechanism linking marketing technology adoption to farmers' economic sustainability. Therefore:

H4: Marketing Technology Adoption positively influences Farmers' Economic Sustainability through Market Access as a mediating variable.

Research Methods

The problem-solving approach is an effort to adopt marketing technology to broaden market access for farmers in Nagrak District, Sukabumi Regency. The research method used is a quantitative approach with descriptive-associative methods. Data processing uses path analysis (path analysis) using SPSS 27. Hypothesis verification uses statistical hypotheses, and data collection techniques use questionnaires.

Population and Sample

The population in this study was 6,563 farmers in Nagrak District, Sukabumi Regency (BPS Sukabumi Regency, 2024). A sample size of 330 people was taken (rounded) using the Isaac & Michael table. The sample size was determined based on the Isaac & Michael table with a 5% deviation level (Sugiyono, 2024).

Data Sources and Data Collection Techniques

The data used in this study consisted of primary and secondary data. Primary data were collected directly from respondents through structured questionnaires distributed to farmers in Nagrak District, Sukabumi Regency. Secondary data were obtained from relevant documents, books, and related literature to support the analysis and strengthen the theoretical foundation of the study (Sugiyono, 2024).

Operational variabel Tabel

The operationalization of variables in this study was based on relevant empirical indicators. Marketing Technology Adoption (X) was measured using 10 statement items that represent all dimensions of marketing technology adoption. Market Access (M) was measured through 8 statement items reflecting key indicators of access to agricultural markets. Meanwhile, Farmers' Economic Sustainability (Y) was measured using 12 statement items that capture all indicators of economic sustainability among farmers. All indicators were assessed using a Likert scale to ensure consistency in measurement across variables.

Table 1. Operational Variable

Variable	Code	Indicators	Number of Items	Measurement Scale
Marketing Technology Adoption	X	- Farmer Character - Level of farmer readiness - Psychological and motivational factors - Intervention and support - Access to technology and resources	10 items	Likert Scale (1–5)
Market Access	M	- Credit granting - Guaranteed price and quantity - Reduction of transaction costs - Access to competitive markets	8 items	Likert Scale (1–5)
Farmers' Economic Sustainability	Y	- Compilation of a business plan - Regular updating of business plan - Bargaining power - Analyze competitors - Ease of entering new businesses - Risk calculation skills	12 item	Likert Scale (1–5)

Result

Respondent Profile

Based on the processed data from 330 respondents, the respondent characteristics indicate that the majority of farmers were male, totaling 268 individuals or 81.21%, while female respondents accounted for 62 individuals or 18.79%. In terms of age distribution, the respondents were predominantly from Generation X (45–60 years), with 178 individuals or 53.94%, followed by the Baby Boomer generation (60–78 years) with 88 individuals or 26.67%. The Millennial generation (29–44 years) comprised 58 respondents or 17.58%, while Generation Z (13–28 years)

represented the smallest proportion, with only 6 respondents or 1.82%. This distribution indicates that agricultural activities in the study area are largely dominated by middle-aged and older farmers. In practice, several farmers from Generation X and the Baby Boomer group operate e-commerce applications with assistance from their children and agricultural extension workers.

With respect to agricultural land area, most respondents managed land areas ranging from 1,000 to 9,999 m², totaling 234 individuals or 70.91%. Respondents with land areas of less than 1,000 m² accounted for 67 individuals or 20.30%, while those managing land areas of 10,000 m² or more constituted the smallest group, with 29 individuals or 8.79%. In terms of land ownership status, the majority of respondents were landowners, with 195 individuals or 59.09%, whereas 135 respondents or 40.91% cultivated land under a leasing arrangement.

Regarding agricultural commodities, vegetables were the most commonly cultivated commodity, produced by 126 respondents or 38.18%. This was followed by paddy rice cultivated by 87 respondents or 26.36%, tubers by 81 respondents or 24.55%, secondary crops by 22 respondents or 6.67%, and fruits by 14 respondents or 4.24%. In terms of fertilization practices, most respondents applied non-organic fertilizers, totaling 161 individuals or 48.79%, followed by organic fertilizers used by 125 respondents or 37.88%, and a combination of organic and non-organic fertilizers applied by 44 respondents or 13.33%.

Furthermore, in relation to the marketing process, the majority of respondents continued to market their agricultural products through middlemen, with 256 individuals or 77.58%. Respondents who sold their products in local markets accounted for 59 individuals or 17.88%, while none of the respondents relied exclusively on online markets (0%). Meanwhile, 15 respondents or 4.55% employed a combination of marketing channels. These findings indicate that traditional marketing systems remain dominant in the study area, although early signs of diversification toward alternative marketing channels have begun to emerge. A more detailed respondent profile can be seen in Table 2 below:

Table 2: Respondent Profile

No	Gender	Quantity	% Percentage
Gender			
1	Male	268	81,21 %
2	Female	62	18,79 %
Summary		330	100,00 %
Respondent Age			
No	Generation	Quantity	% Percentage
1	Z Generation (13-28 years old)	6	1,82 %
2	Milenial (29-44 years old)	58	17,58 %
3	X Generation (45-60 years old)	178	53,94 %
4	Baby Boomers (60 - 78 years old)	88	26,67 %
	Summary	330	100,00 %
Agriculture Land Area			
No	Land Area	Quantity	% Percentage
1	< 1000 M²	67	20,30 %
2	1000 s.d 9.999 M²	234	70,91 %
3	≥ 10.000 M²	29	8,79 %
	Summary	330	100,00 %
Land Ownership Status			
No	Ownership	Quantity	% Percentage
1	Owner	195	59,09 %

2	Lease	135	40,91 %
	Summary	330	100,00 %

Agriculture Commodities

No	Commodities	Quantity	% Percentage
1	Fruits	14	4,24 %
2	Paddy	87	26,36 %
3	Secondary crops	22	6,67 %
4	Vegetables	126	38,18 %
5	Tubers	81	24,55 %
	Summary	330	100,00 %

Types of Fertilization

No	Fertilization	Quantity	% Percentage
1	Organic	125	37,88 %
2	Non Organic	161	8,79 %
3	Mixture	44	13,33 %
	Summary	330	100,00 %

Marketing Process

No	Marketing System	Quantity	% Percentage
1	Through middlemen	256	77,58 %
2	Sold in Local Market	59	7,88 %
3	Online Market	0	0,00 %
4	Combine Market	15	4,55 %
Summary		330	100,00 %

Source: (processed data, September 2025)

Data Quality Test Results

Validity Test

Instrument validity testing was conducted to evaluate the extent to which the questionnaire items accurately measured the research variables. The validity test employed the Pearson Product Moment Correlation method. An item was considered valid if the calculated correlation coefficient (r-count) exceeded the r-table value of 0.31 and if the significance value (Sig. 2-tailed) was less than 0.05. With a total of 330 respondents, the r-table value at a 5% significance level ($\alpha = 0.05$) and degrees of freedom of 328 ($df = N - 2$) was determined to be 0.31. All statement items (X1–X10) in the Marketing Technology Adoption variable have a calculated r value greater than the table r (0.31) and a significance value less than 0.05. Therefore, all items are declared valid and suitable for use in further analysis.The detailed results of the instrument validity test for variable X, (M arketing Technology) Adoption, can be seen in table 3 below:

Table 3. Results of the Validity Test of Marketing Technology Adoption (X)

Item	r Count	r Table	Sig. (2-tailed)	Exegesis
Farmer Character 1	0,747	0,31	0,000	Valid
Farmer Character 2	0,720	0,31	0,000	Valid
Level of farmer readiness 1	0,663	0,31	0,000	Valid
Level of farmer readiness 2	0,599	0,31	0,000	Valid

Item	r Count	r Table	Sig. (2-tailed)	Exegesis
Psychological and motivational factors 1	0,739	0,31	0,000	Valid
Psychological and motivational factors 2	0,793	0,31	0,000	Valid
Intervention and support 1	0,542	0,31	0,000	Valid
Intervention and support 2	0,703	0,31	0,000	Valid
Access to technology and resources 1	0,741	0,31	0,000	Valid
Access to technology and resources 2	0,728	0,31	0,000	Valid

Source: SPSS 27 output (processed data, September 2025)

Based on the test results, all items the Market Access (M) variable have a calculated r value greater than the table r (0.31) and a significance level of 0.000 < 0.05. Therefore, all items are declared valid and suitable for use in this research.

The detailed results of the validity test of the Market Access variable instrument M can be seen in table 4 below:

Table 4. Results of Market Access Validity Test (M)

Item	rcount	rtable	Sig. (2-tailed)	Exegesis
Credit granting 1	0,734	0,31	0,000	Valid
Credit granting 2	0,728	0,31	0,000	Valid
Guaranteed price and quantity 1	0,734	0,31	0,000	Valid
Guaranteed price and quantity 2	0,779	0,31	0,000	Valid
Reduction of transaction costs 1	0,727	0,31	0,000	Valid
Reduction of transaction costs 2	0,707	0,31	0,000	Valid
Market Access 1	0,763	0,31	0,000	Valid
Market Access 2	0,767	0,31	0,000	Valid

Source: SPSS 27 output (processed data, September 2025**)**

All items in the Y variable, Farmers' Economic Sustainability, have a calculated r value greater than the r table (0.31) and a significance value less than 0.05. Thus, all items are declared valid and suitable for use in further analysis. The detailed results of the validity test of the Y variable instrument for Farmers' Economic Sustainability can be seen in Table 5 below:

Table 5. Results of the Validity Test of Farmers' Economic Sustainability (Y).

Item	r count	r table	Sig. (2-tailed)	Exegesis
Compilation of a business plan 1	0,690	0,31	0,000	Valid
Compilation of a business plan 2	0,777	0,31	0,000	Valid
Regular updating of business plan 1	0,590	0,31	0,000	Valid
Regular updating of business plan 2	0,759	0,31	0,000	Valid
Analyze competitors 1	0,697	0,31	0,000	Valid
Analyze competitors 2	0,759	0,31	0,000	Valid
Ease of entering new businesses 1	0,707	0,31	0,000	Valid
Ease of entering new businesses 2	0,640	0,31	0,000	Valid
Ease of entering new businesses 3	0,775	0,31	0,000	Valid
Risk calculation skills 1	0,794	0,31	0,000	Valid
Risk calculation skills 2	0,786	0,31	0,000	Valid
Risk calculation skills 3	0,796	0,31	0,000	Valid

Source: SPSS 27 output (processed data, September 2025).

Reliability Testing

Based on the reliability test results above, all variables had a Cronbach's Alpha value of >0.60, indicating that the variable instruments for Marketing Technology Adoption (X), Market Access (M), and Farmer Economic Sustainability (Y) had a very good level of reliability. Therefore, all questionnaire items were deemed consistent and suitable for use in this research.

The commonly used standard for reliability testing is the Cronbach's Alpha value. An instrument is considered reliable if its Cronbach's Alpha value is at least >0.60. The results of the reliability test for each variable are described in Table 6 as follows:

Table 6. Results of the Reliability Test of All Variable (X,M,Y)

Variable	Cronbach's Alpha	Number of Items	Criteria	Description
X	0,882	10	≥ 0,60	Reliable
M	0,882	8	≥ 0,60	Reliable
Y	0,921	12	≥ 0,60	Reliable

Source: SPSS 27 output (processed data, September 2025)

Goodness Of Fit Test

The chi-square goodness-of-fit test results presented in Table 6 indicate that all research variablesMarketing Technology Adoption, Market Access, and Farmers' Economic Sustainabilityexhibit statistically significant and non-random response patterns, as reflected by Asymp. Sig. values of 0.000, which are lower than 0.05. This finding leads to the rejection of the null hypothesis (H_0) that responses are randomly distributed and the acceptance of the alternative hypothesis (H_1). Respondents' answers across all variables follow consistent and systematic distributions, demonstrating clear response patterns. Furthermore, the absence of cells with low expected frequencies confirms that the assumptions of the chi-square test have been met. Overall, these results indicate strong internal validity and stable respondent perceptions, suggesting that the data are reliable and suitable for further analysis.

The results of the chi-square goodness-of-fit test indicate that all research variables exhibit statistically significant and non-random response patterns. For the Marketing Technology Adoption variable, a significance value (p-value) of less than 0.05 demonstrates a significant difference between the observed and expected frequencies, indicating that respondents' answers do not occur randomly but follow a consistent and discernible pattern.

Similarly, the Market Access variable shows a very large chi-square value accompanied by a significant p-value, suggesting that respondents' perceptions of market access differ substantially from a random distribution and reflect a clear tendency in their responses. The validity of this result is further supported by the absence of cells with low expected frequencies, confirming that the assumptions of the chi-square test have been met.

Furthermore, the Farmers' Economic Sustainability variable also exhibits a significant and non-random distribution of responses, characterized by strong and consistent patterns. Overall, these findings indicate that respondents' perceptions across all variables are systematically structured, and the test results can therefore be considered reliable.Table 7 Goodness of Fit Test Results (Chi-Square Test). The results of the goodness of fit test can be seen in Table 7 below:

Table 7. Goodness of Fit Test Results

Test Statistics

	Marketing Technology Adoption	Access Market	Farmers Economic Sustainability
Chi-Square	250.000[a]	522.800[b]	259.491[c]
Df	24	21	28
Asymp. Sig.	.000	.000	.000

a. 0 cells (0.0%) have expected frequencies less than 0.5. The minimum expected cell frequency is 13.2.
b. 0 cells (0.0%) have expected frequencies less than 0.5. The minimum expected cell frequency is 15.0.
c. 0 cells (0.0%) have expected frequencies less than 0.5. The minimum expected cell frequency is 11.4.

Classical Assumption Test

a. Normality Test

The results of the residual normality test from data processing using SPSS 27 can be seen in the

image below:

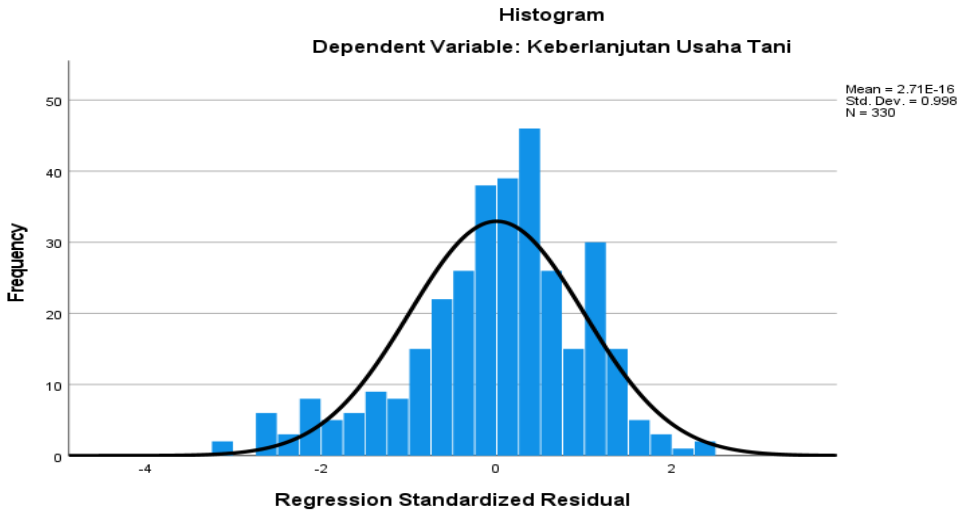

Figure 2. Normality test results

Figure 2 above shows the standardized residual distribution. The figure shows that the residual distribution pattern forms a bell-shaped curve and is evenly distributed around a mean of zero with a standard deviation approaching one (Mean = 2.71E-16; Std. Dev. = 0.998). This indicates that the residual data is normally distributed. Thus, the normality assumption in the regression model has been met, allowing the regression analysis to be used further to test the research hypothesis.

b. Multicollinearity Test

The multicollinearity test criteria are a Tolerance value >0.1 and a VIF value <10, the results of the multicollinearity test show that there is no multicollinearity between variables, so that the Marketing Technology Adoption variable can be used to explain the Farmer Economic Sustainability variable. The results of the multicollinearity test can be seen in table 8 below:

Partial T-Test

The partial T test aims to measure whether there is an influence between variable X on Y by comparing the t table and the calculated t, assuming that if the calculated t value is > than the t table value then the hypothesis H0 is rejected and H1 is accepted and if vice versa the calculated t value < t table means Ho is accepted and H1 is rejected. The calculated t value for the number of samples is 330 df = 328 with a probability standard deviation of 0.05 based on the table is 1.9672. Based on table 7 above, the calculated t value is 11.075, this means that the calculated t value is > t table so that the hypothesis is H1 variable X has a positive and significant effect on variable Y.

The results of the t-test then test the variable X against M (X⟶M) and the results are in table 9 below:

Table 9. Partial T-Test Results for Variable X⟶M

Coefficients[a]

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	13.887	1.464		9.488	000
Marketing Technology Adoption	.457	.037	.560	12.240	000

a. Dependent Variable: Market Access

Source: SPSS 27 output (processed data, September 2025)

We can interpret the calculated t-value of 12.240 as greater than the t-table value of 1.967, meaning that variable X ⟶M has a significant influence. H0 is rejected and H1 is accepted.
H0: There is no influence between variables X ⟶ Y
H1: There is an influence between variables X ⟶ Y

Simultaneous F-Test

The simultaneous F-test in this study aims to measure the extent to which variable X and the mediating variable M jointly influence the dependent variable Y ([X⟶M] ⟶Y). Using the following hypotheses:
H0: There is no influence between variables X and M on Y ([X and M] ⟶ Y). If F count < F table
H1: There is an influence between variables X and M on Y ([X and M] ⟶ Y). If F count > F Table.

The test results show that variables X and M simultaneously have a positive and significant influence on variable Y, with the F-count value of 136.213 as greater than F-table value of 3.0233 for df1:2 and df2:327, as shown on the table 9 above. Therefore, H0 is rejected and H1 is accepted. Based on the F-test table below, it can be concluded that the marketing technology adoption variable, mediated by the market access variable, jointly has a positive and significant effect on farmers' economic sustainability. This is indicated by a significance value of 0.000, which is lower than 0.05, and an F-statistic of 136.213, which is greater than the F-table value of 3.0233.

Table 10. Simultaneous F-Test Results ([X⟶M] ⟶Y

ANOVA[a]

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	4952.929	2	2476.464	136.213	.000[b]
	Residual	5945.144	327	18.181		
	Total	10898.073	329			

a. Dependent Variable: Farmers Economic Sustainability
b. Predictors: (Constant), Market Access, Marketing Technology Adoption

Source: SPSS 27 output (processed data, September 2025)

Regression Test

Steps for Regression Testing with Mediating Variables

The regression analysis with a mediating variable in this study was conducted by referring to the Baron and Kenny (1986) method, as cited in Setiadi and Utomo (2023), which is widely applied in social science research. The analysis was carried out through several sequential steps, including estimating the regression model between the independent variable (X) and the dependent variable (Y), estimating the regression model between the independent variable (X) and the mediating variable (M), and subsequently estimating the regression model between the independent variable (X) and the dependent variable (Y) by incorporating the mediating variable (M). The final step involved determining whether the mediating variable provides a full or partial mediation effect based on the changes in the significance and magnitude of the regression coefficients.

Regression Test 1 (X → Y): The Effect of Marketing Technology Adoption on Farmers' Economic Sustainability

Regression Test 1 was conducted to examine the direct effect of Marketing Technology Adoption (X) on Farmers' Economic Sustainability (Y) as the initial step in testing the proposed mediation model. The results of the regression analysis indicate that Marketing Technology Adoption has a positive and statistically significant effect on Farmers' Economic Sustainability. The regression coefficient (B) of 0.598 shows that every one-unit increase in Marketing Technology Adoption leads to an increase of 0.598 units in Farmers' Economic Sustainability, assuming other variables remain constant. This result is supported by a calculated t-value of 11.075 with a significance level of 0.000, which is lower than the 0.05 threshold, indicating a statistically significant relationship. In addition, the standardized beta coefficient of 0.522 suggests a moderate to strong contribution of Marketing Technology Adoption in explaining variations in Farmers' Economic Sustainability. These findings confirm that the first requirement of the mediation analysis is satisfied, as the independent variable significantly influences the dependent variable.

The detailed results of the regression analysis are presented in Table 11 below.

Table 11. Results of Regression Test of the Effect of X on Y

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		Sig.
		B	Std. Error	Beta		
1	(Constant)	19.645	2.116		9.283	.000
	Marketing Technology Adoption	.598	.054	.522	11.075	.000

a. Dependent Variable: Farmers Economic Sustainability

Source: SPSS 27 output (processed data, September 2025)

Regression Test 2 (X → M) The Effect of Marketing Technology Adoption on Market Access

Regression Test 2 (X → M) was conducted to examine the effect of Marketing Technology Adoption on Market Access. The results show a correlation coefficient (R) of 0.560, indicating a strong relationship between the two variables. The coefficient of determination (R^2) of 0.314 suggests that Marketing Technology Adoption explains 31.4% of the variation in Market Access, while the remaining 68.6% is influenced by other factors outside the model. The Adjusted R^2 value of 0.311 indicates that the model is stable, and the standard error of the estimate (3.40090) reflects an acceptable level of predictive accuracy. The Durbin–Watson value of 1.083 indicates mild positive autocorrelation but remains acceptable for cross-sectional data. Based on the regression results, the regression equation is Y = 13.887 + 0.457X, indicating that every one-unit increase in Marketing Technology Adoption increases Market Access by 0.457 units. The significance value of less than 0.05 confirms that Marketing Technology Adoption has a positive and statistically significant effect on Market Access, thereby fulfilling the second requirement of the mediation analysis, namely that the independent variable significantly influences the mediating variable.By using SPSS 27, the results of the regression test for the influence of X on M (mediation) can be seen in detail in table 12 below:

Table 12. Results of Regression Test 2 of Variable X ⟶M

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.560[a]	.314	.311	3.40090	1.083

a. Predictors: (Constant), Marketing Technology Adoption

b. Dependent Variable: Market Access

Model		Unstandardized Coefficients		Standardized Coefficients	T
		B	Std. Error	Beta	
1	(Constant)	13.887	1.464		9.488
	Marketing Technology Adoption	.457	.037	.560	12.240

a. Dependent Variable: Market Access

Source: SPSS 27 output (processed data, September 2025)

Regression Test 3 (M→Y) The Influence of the Mediating Variable Market Access on Farmers' Economic Sustainability

Regression Test 3 was conducted to examine the effect of Market Access (M) on Farmers' Economic Sustainability (Y). The regression results indicate that the regression coefficient (B) for Market Access is 0.907, meaning that every one-unit increase in Market Access leads to an increase of 0.907 units in Farmers' Economic Sustainability, assuming other variables remain constant. This effect is statistically significant, as indicated by a calculated t-value of 7.506 with a significance level of 0.000, which is lower than the 0.05 threshold. Furthermore, the standardized beta coefficient of 0.646 suggests a moderate to strong relationship, indicating that Market Access contributes substantially to explaining the variation in Farmers' Economic Sustainability. Based on the

regression output presented in Table 12, the regression equation can be expressed as Y = 14.181 + 0.907The results of Regression 3: M → Y with the dependent variable (Y): Farmers' Economic Sustainability and the independent variable (M): Market Access can be seen in Table 13 below:

Table 13. Results of Regression Test 3 Of Variable M⟶Y

Model		Coefisien Unstandardized Coeffic		Standardiz Coefficier	T	Sig
		B	Std. Er	Beta		
1	(Constant)	14.181	1.889		7.506	.000
	Market Access	.907	.059	.646	15.322	.000

a. Dependent Variable: Farmers Economic Sustainability
b. Predictors: (Constant), Market Access

Source: SPSS 27 output (processed data, September 2025)

Regression Test 4 ([X + M] → Y) The Influence of Marketing Technology Adoption on Farmers' Economic Sustainability Mediated by Market Access

The purpose of this regression analysis is to examine the extent to which Marketing Technology Adoption (X) influences Farmers' Economic Sustainability (Y) through the mediating role of Market Access (M). Specifically, this analysis aims to assess whether Market Access significantly affects Farmers' Economic Sustainability when tested simultaneously with Marketing Technology Adoption, as well as to determine whether the mediation effect of Market Access is partial or full based on changes in the significance and magnitude of the regression coefficients.

The results of the simultaneous regression analysis show an R value of 0.674, indicating a strong relationship between Marketing Technology Adoption (X) and Market Access (M) in explaining variations in Farmers' Economic Sustainability (Y). The coefficient of determination (R Square) of 0.454 indicates that both Marketing Technology Adoption and Market Access jointly explain 45.4% of the variation in Farmers' Economic Sustainability, while the remaining 54.6 % is influenced by other factors not examined in this study, such as capital and access to financing, government policies, the quality of farmers' human resources, agricultural infrastructure, production technology, environmental and climate conditions, and the role of farmer institutions. Furthermore, the Adjusted R Square value of 0.451 suggests that the regression model is stable and reliable, confirming that the explanatory power of the model remains consistent after adjusting for sample size. Following up on the ANOVA results (F Test) in table 14 below, it can be explained that the F value = 136.213, Sig. = 0.000 (<0.05) indicates a significant regression model, meaning that X and M together influence Y. This means that the regression model built is simultaneously significant, so that the independent variable Marketing Technology Adoption (X) and the mediator variable Market Access (M) together have a significant effect on the dependent variable Farmer Economic Sustainability (Y).

Table 14. Results of Regression Test 4 ([X+M] ⟶ Y)

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.674[a]	.454	.451	4.26390

a. Predictors: (Constant), Market Access, Marketing Technology Adoption
b. Dependent: Farmers Economic Sustainability

Source: SPSS 27 output (processed data, September 2025)

Regression Test 4 (X + M → Y): The Mediating Effect of Market Access

Regression Test 4 (X + M → Y) shows that both Marketing Technology Adoption and Market Access have positive and statistically significant effects on Farmers' Economic Sustainability. The constant value of 9.596 indicates that when both independent variables are zero, Farmers' Economic Sustainability is estimated at 9.596. When Market Access is included in the model, the regression coefficient of Marketing Technology Adoption decreases to 0.267 (t = 4.729; Sig. = 0.000), while Market Access exhibits a stronger effect with a coefficient of 0.724 (t = 10.453; Sig. = 0.000). This reduction in the effect of Marketing Technology Adoption indicates that part of its influence on Farmers' Economic Sustainability is transmitted through Market Access. Because both variables remain significant, Market Access is confirmed to function as a partial mediator in the relationship between Marketing Technology Adoption and Farmers' Economic Sustainability, as reflected in the regression equation Y = 9.596 + 0.267X + 0.724M. The detailed results of the regression analysis are presented in Table 15 below.

Table 15. Partial Contribution Values in Regression Test 4

Coefficients[a]

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
(Constant)	9.596	2.072		4.632	.000
Marketing Technology Adoption	.267	.057	.233	4.729	.000
Market Access	.724	.069	.515	10.453	.000

a. Dependent Variable: Farmers Economic Sustainability

Source: SPSS 27 output (processed data, September 2025)

Discussion

The findings of this study show that marketing technology adoption significantly improves both market access and farmers' economic sustainability. These results indicate that the use of digital tools does not merely introduce new marketing channels, but fundamentally changes how farmers interact with markets. The partial mediation effect found in this study reveals that marketing technology becomes more effective when farmers gain improved access to buyers, price information, and distribution networks.

First, the positive influence of marketing technology adoption on market access aligns with the behavioral pattern observed in farmers in Nagrak District. Although none of the respondents rely exclusively on online marketplaces, many of them use digital devices often with assistance from their children or extension workers to explore prices, potential buyers, and marketing information. This supports the argument that technology adoption influences farmers' market outcomes even when used partially or complementarily, not only through full e-commerce engagement. These findings are consistent with Arvianti et al. (2022) and Putra et al. (2023), who found that digital marketing tools increase product visibility and reduce information asymmetry in agricultural markets.

Second, the direct effect of marketing technology adoption on economic sustainability suggests that technology contributes to increased efficiency, reduced dependency on middlemen, and improved negotiation capacity. Digital information access enables farmers to better estimate prices, control harvest timing, and avoid exploitative pricing structures. These mechanisms explain why the adoption of marketing technology contributes directly to better economic outcomes. The result is consistent with previous studies by Klerkx et al. (2019) and Amelia et al. (2025), which show that digital adoption enhances competitiveness and long-term business viability.

Third, the strong influence of market access on economic sustainability highlights the critical role of structural market constraints faced by farmers. Improved market access provides farmers with more alternatives to sell their products, reduces price volatility, and strengthens their bargaining power. When farmers have access to competitive markets, they are less dependent on middlemen and are able to negotiate better prices. This aligns with the findings of Abman and Lundberg (2024) and supports the theory that market integration is strongly correlated with improved sustainability outcomes in smallholder agriculture.

Finally, the mediation analysis illustrates why marketing technology adoption becomes more impactful when supported by enhanced market access. Technology alone cannot fully improve economic sustainability unless farmers gain the ability to reach broader buyer networks and access real-time market information. Market access functions as a structural enabler that transforms digital adoption into tangible economic benefits. This explains the partial mediation effect found in this study and confirms the conceptual model that digital adoption indirectly influences economic sustainability through its influence on market access. This is consistent with Zhang et al. (2022), who emphasize that market linkages are the mechanism through which digital agriculture creates measurable economic value.

Overall, the results reinforce the argument that marketing technology adoption must be accompanied by broader efforts to open market access for farmers. Without strengthened market linkages, the benefits of digital tools remain limited. Conversely, when farmers are able to connect to more competitive markets, digital marketing tools significantly enhance their economic resilience and long-term sustainability.

Conclution

This study analyzes the role of Marketing Technology Adoption (X) and Market Access (M) in improving Farmers' Economic Sustainability (Y) using a mediation analysis approach. The results show four main findings, including:

First, Marketing Technology Adoption has a positive and significant effect on Market Access, indicating that technology implementation can expand the reach of farmers' markets, with an influence value of 45.7% (Table 13). This phenomenon occurs because farmers are highly enthusiastic about gaining new market alternatives beyond selling solely to middlemen.

Second, Marketing Technology Adoption has a positive and significant effect on Farmers' Economic Sustainability, at 59.8%. This means that the higher the level of digital marketing utilization, the higher the level of Economic Sustainability of Farmers in Nagrak District, Sukabumi Regency. Through innovations brought by marketing technology adoption, marketing performance improves and profits increase. This, in turn, has positive implications for farmers' economic sustainability.

Third, Market Access has a very significant effect on Farmers' Economic Sustainability, especially in Nagrak District, Sukabumi Regency, with an influence value of 90.7%. Direct access to markets enhances farmers' bargaining power compared to the period prior to market access enabled by technology adoption, ultimately contributing to improved economic conditions.

Fourth, the role of marketing technology adoption, mediated by market access, has a very positive and significant effect on Farmers' Economic Sustainability, with a contribution value of 67.4%, indicating that technology implementation can expand the reach of farmers' markets. The role of marketing technology adoption has an increasingly significant impact on farmers' economic sustainability through the mediation of market access, as farmers can more easily access markets, possess stronger bargaining power, and enjoy greater autonomy in selling their agricultural products rather than relying exclusively on middlemen.

Theoretical Implications

This research strengthens previous empirical findings that confirm that the adoption of digital

technology in agricultural systems can improve productivity, market access, and the sustainability of farming businesses. For example, research by Klerkx L, Jakku E, and Labarthe P (Klerkx et al., 2019) shows that the adoption of smart farming technologies not only increases production efficiency but also opens up broader market opportunities. Similarly, a study (Zhang et al., 2022) found that the use of digital technology in agricultural marketing contributes significantly to expanding distribution networks and strengthening business sustainability. In line with these findings, this study identifies market access as a partial mediator explaining the indirect mechanism of the influence of marketing technology on farming business sustainability.

Managerial Implications

From a practical perspective, this study emphasizes the importance of encouraging farmers to adopt digital marketing technologies, such as e-commerce platforms, social media, and mobile-based applications, to improve distribution efficiency and product visibility. Furthermore, policymakers and private sector stakeholders need to prioritize programs that expand farmers' market access through infrastructure development, integration with digital markets, and supply chain partnerships. Sustainable farming also requires broader ecosystem support, including access to financing, digital literacy training, and strengthening farmer institutions. Therefore, collaboration between farmers, the government, and the private sector is key to achieving long-term sustainability of farming businesses.

Further Research Agenda

This study has limitations that could provide opportunities for future research. First, the variables used were limited to marketing technology adoption and market access, while other factors such as government policy support, access to financing, human resource capacity, product innovation, and environmental sustainability also have the potential to influence farming business sustainability. Therefore, future research is recommended to expand the model to include these variables. Second, this study used a quantitative approach with cross-sectional data, thus failing to capture the long-term dynamics of the farming business sustainability process. Farmers. Future research could use longitudinal studies to monitor changes over time, or mixed methods to combine quantitative and qualitative approaches to understand the phenomenon more comprehensively**.** Third, this research focused on a specific local context. Future research could be conducted in a broader regional context to further encourage technology adoption in those areas.

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