



# Adoption of Integrated Crop Management Technology Innovation and Sustainable Lowland Rice Development Strategy in Tasikmalaya Regency, West Java Province

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## ABSTRACT

*Adoption of Integrated Crop Management (ICM) technology affects both productivity and the sustainability of farming practices. This study aims to analyze the level of ICM adoption, identify influencing factors, and formulate strategies for sustainable rice cultivation. The research employed a quantitative approach using a survey of 76 rice farmers in Salawu District, Tasikmalaya Regency. Adoption levels were assessed based on 11 key indicators. Factors influencing adoption were examined using multiple linear regression with F-test for simultaneous significance and t-test for partial effects. SWOT analysis was employed to develop rice cultivation strategies. The results indicate that the overall ICM adoption level is low. Indicators with high adoption include the use of superior seed varieties, organic fertilizers, intermittent irrigation, integrated weed and pest management (IPM), and post-harvest handling. Eight significant variables were identified: land size, self-efficacy, formal education, cosmopolitan orientation, productivity, extension worker role, availability of farming inputs, and innovativeness. SWOT analysis places the adoption condition in quadrant I (aggressive strategy), emphasizing the optimization of internal strengths, strengthening agricultural extension, and diversifying simple innovations aligned with traditional practices. Participatory extension, target determinants of adoption, and support simple sustainable ICM innovations need to be strengthened to increase rice production.*

## 1. INTRODUCTION

Rice is the staple food of the Indonesian population (Habibah *et al.*, 2024). In 2023, national rice consumption increased by 0.30% compared to 2022. Overall, rice consumption, at 93.79 kg/capita/year, remains relatively high, with 60% of the population consuming rice (Kementerian Pertanian, 2024). The high demand for rice is not in line with the fluctuating national rice production capacity (Ningsih *et al.*, 2024). Consumption levels exceeding rice production have prompted the government to import food (Kurniawan *et al.*, 2024). In 2024, rice production will reach 52.66 million tons of dry milled grain (GKG), a decrease of 1.32 million tons or 2.45% from 2023 (BPS, 2024).

The decline in rice production in Indonesia is caused by various factors, such as land conversion, suboptimal use of technology, and extreme climate change (Pratama *et al.*, 2018; Murniati & Mutolib, 2020), as well as limited access to superior varieties (Malau *et al.*, 2023). Suboptimal rice productivity in paddy fields is due to low fertilizer efficiency, ineffective pest and disease control, the use of low-quality inputs (seeds, fertilizers, and pesticides), poorly adapted varieties, and suboptimal soil physical properties, which hamper plant growth (Makarim, *et al.*, 2000).

The government's strategy to increase rice production is implemented through the National Rice Production Improvement Program, including the Integrated Crop Management (ICM) program (Rosadillah *et al.*, 2017). ICM technology is developed in a participatory manner with farmers through an innovative and dynamic approach to increase productivity and farm efficiency (Sulastri *et al.*, 2022). ICM technology innovation combines all selected, harmonious and complementary farming components to achieve optimal yields and environmental sustainability (Suharyanto *et al.*, 2013). The ICM technology model consists of several cultivation technology components that can be applied according to local agro-ecosystem conditions to increase rice production (Sawitri & Nurtalawati, 2019). The ICM technology model approach can increase yields by up to 10%, or approximately 0.68 ton/ha, and can increase farm profitability by between 25-58% (Pramono *et al.*, 2005). Numerous studies have been conducted on the adoption rate of ICM technology innovations in Indonesia, but adoption remains low (Iskandar *et al.*, 2020; Mulyani *et al.*, 2023; Nofitasari *et al.*, 2024). Factors influencing the adoption rate of ICM technology innovations include numerous factors, including the cosmopolitan nature and active participation of farmers (Yahya, 2016), the availability of labor and agricultural inputs, the role of government institutions (Arya & Mahaputra, 2020), internal farmer characteristics (Sulastri *et al.*, 2022), education level, family size, and farming experience (Amardani *et al.*, 2022).

Tasikmalaya Regency in West Java has the potential for sustainable rice production development. According to Statistics Indonesia (BPS), rice production in Tasikmalaya Regency is projected to reach 353,415.07 tons in 2024 (BPS Jawa Barat, 2025). One effort to establish Tasikmalaya as a rice production center is the adoption of Integrated Crop Management (ICM) technology innovations, which were introduced in 2013 through the Integrated Crop Management Field School (SL-PTT) program. However, the adoption rate of Integrated Crop Management (ICM) technology innovations in rice farming in Tasikmalaya Regency remains low. Agricultural cultivation innovations often stop at the delivery process by the innovator, without adoption by the target farmers (Hidayat *et al.*, 2024). Farmers have many considerations before adopting a new innovation (Mukarromah & Widodo, 2022).

Numerous studies have examined the adoption of ICM technology innovations in various regions. However, most studies have focused on the adoption rate or the factors that influence it partially (Dasipah & Ibrahim, 2023; Abani *et al.*, 2023; Rahmawati *et al.*, 2024). Studies that integrate the analysis of adoption levels, influencing factors, and the formulation of sustainable rice cultivation development strategies based on SWOT analysis in the national context and/or Tasikmalaya Regency level have not yet been conducted (Wibowo *et al.*, 2023; Serlilino *et al.*, 2024). The current research aims to this research has a novelty that examines the adoption levels, factors influencing the application of ICM technology and the formulation of strategies in developing sustainable agricultural systems through a comprehensive ICM approach.

This research is crucial because of the low adoption of ICM technology in Tasikmalaya Regency, potentially hampering increased rice production and food self-sufficiency. ICM technology is considered complex, leading farmers to neglect its adoption. Therefore, a comprehensive study is needed to encourage the adoption of ICM technology innovations in sustainable rice cultivation. The objectives of this study are to analyze the adoption rate of ICM technology innovations, analyze the factors influencing their adoption, and develop a strategy for developing sustainable rice cultivation in Tasikmalaya. This research provides academic and practical benefits by enriching the study of agricultural innovation adoption, identifying determinants of ICM technology adoption, and formulating a strategy for sustainable rice cultivation as a basis for policymaking and the development of sustainable agricultural programs, as well as strengthening the rice production system to support increased food security in Tasikmalaya.

## 2. MATERIALS AND METHODS

### 2.1. Research Location

The research was conducted from June to August 2025 in Salawu District, Tasikmalaya Regency, that was purposively selected as one of the areas with the highest rice productivity at 6.90 ton/ha (DPKPP, 2025).

### 2.2. Research Methods and Data Collection

The research method used in this study was a survey. According to Sugiyono (2020), a survey method is a quantitative research method used to obtain past or current data regarding beliefs, income, characteristics, behaviors, and

relationships between variables. The data collected in this study included primary and secondary data. Primary data was obtained through interviews with respondents guided by a questionnaire. A questionnaire is a data collection technique implemented by providing respondents with a set of written statements or questions related to the adoption of ICM technology innovations (Sugiyono, 2020). This study used a Focus Group Discussion (FGD) method to collect data related to issues and strategies for developing sustainable lowland rice cultivation. This was conducted after primary data collection and involved 16 informants consisting of representatives from the Agricultural Extension Center, Field Agricultural Extension Workers (PPL), farmer groups, and farmers.

### 2.3. Sample Size

The population in this study consisted of 310 lowland rice farmers belonging to 13 farmer groups spread across 7 villages in Salawu District. These farmer groups participated in the SL-PTT program in 2013-2014. The population size was determined using the Yamane (1967) formula:

$$n = \frac{N}{1 + N e^2} \quad (1)$$

where  $n$  is the number of samples required,  $N$  is population size (in this case number of farmers joining in the farmer groups in Salawu District), and  $e$  is sampling error rate. With population size of 310 members of farmers groups and sampling error rate of 10%, it can be easily showed that number of samples required is  $n = 76$  farmers.

Based on these calculations, the sample size for this study was 76 individuals, distributed across 13 farmer groups. The sample for each farmer group was determined using proportional random sampling, a technique that ensures proportional representation of the group. Details of the research sample for each group are shown in Table 1.

Table 1. Proportion of research sample by farmer group

No	Farmer Group	Number of Farmers	Number of Sample
1	Sarimukti Satu Cibodas	25	6
2	Tirta Bumi Satu	30	7
3	Tirta Bumi Dua Sukamaju	35	6
4	Harapan Cipulus	25	7
5	Mulus Rahayu	20	5
6	Serbaguna Satu Neundeut	25	6
7	Bina Mukti Satu	20	5
8	Bina Mukti II	20	5
9	Tani Mukti II	30	7
10	Tani Mekar	25	6
11	Panghegar	20	5
12	Sari Mukti	20	5
13	Sundamekar I	25	6
<b>Total Sample</b>			<b>76</b>

### 2.4. Data Analysis

#### 2.4.1. Adoption Level of ICM Innovation

The level of farmer adoption of ICM technology innovation was measured using a Likert scale ((Prajawahyudo *et al.*, 2020)). The ICM technology innovation adoption variable consists of 11 indicators: 1) Superior varieties, 2) Quality and labeled seeds, 3) Young seedlings, 4) Number of seedlings and planting system, 5) N fertilization based on leaf color chart called BWD (*Bagan Warna Daun*), 6) P and K fertilization based on soil nutrient status, 7) Organic fertilizer application, 8) Intermittent irrigation, 9) Integrated weed control, 10) Integrated pest and disease control, and 11) Harvest and post-harvest handling (BPTP, 2013).

The adoption level of ICM technology was classified into four categories: very high, high, low, and very low. Measurement of each category of ICM technology used a Likert scale with four alternative answers: very appropriate

(weighted 4), appropriate (weighted 3), less appropriate (weighted 2), and not appropriate (weighted 1). The level of ICM technology implementation was classified using the following formula:

$$\text{ICM Adoption Level} = \frac{(\text{Score}_{\text{max}} - \text{Score}_{\text{min}})}{\text{Number of Classes}} \tag{2}$$

where  $\text{Score}_{\text{max}}$  and  $\text{Score}_{\text{min}}$  is respectively the highest and the lowest score. Both were calculated from score multiplied by number of respondents and number of questions.

**2.4.2. Factors Influencing the Adoption of ICM Technology Innovation**

Multiple linear regression analysis using SPSS was used to analyze the factors influencing the adoption of ICM technology innovation simultaneously and partially. Prior to conducting the regression test, classical assumption tests were conducted, including normality, multicollinearity, and heteroscedasticity tests to ensure the feasibility and validity of the analysis model. Multiple Linear Regression Analysis is used to measure between two or more independent variables against a single dependent variable measured such as the level of adoption of ICM Technology innovation as a dependent variable influenced by independent variables including Age (X1), Formal education (X2), Non-formal education (X3), Farming experience (X4), Land area (X5), Self-efficacy (X6), Cosmopolitan (X7), Number of farmer dependents (X8), Productivity (X9), Government support (X10), Role of farmer groups (X11), Role of farmer group leaders (X12), Role of agricultural extension workers (X13), Availability of farming inputs (*saprodi*) (X14), Communication channels (X15), and Nature of innovation (X16). The equation of multiple linear regression analysis is as follows:

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + b_8X_8 + b_9X_9 + b_{10}X_{10} + b_{11}X_{11} + b_{12}X_{12} + b_{13}X_{13} + b_{14}X_{14} + b_{15}X_{15} + b_{16}X_{16} + e \tag{3}$$

where  $Y$  is level of adoption of lowland rice ICM innovation,  $a$  is constant,  $b_1 - b_{16}$  is coefficient of variable  $X$ ,  $X_1$  is age,  $X_2$  is formal education,  $X_3$  is non-formal education,  $X_4$  is farming experience,  $X_5$  is land area,  $X_6$  is self-efficacy,  $X_7$  is cosmopolitan,  $X_8$  is number of farmer dependents,  $X_9$  is productivity,  $X_{10}$  is government support,  $X_{11}$  is role of farmer groups,  $X_{12}$  is role of farmer group leaders,  $X_{13}$  is role of agricultural extension workers,  $X_{14}$  is availability of farming inputs,  $X_{15}$  is communication channels,  $X_{16}$  is nature of innovation, and  $e$  is error term.

**2.4.3. SWOT Analysis**

The development strategy for sustainable rice cultivation in Tasikmalaya Regency was derived from the SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis method. SWOT analysis is a strategic planning method used to evaluate the strengths, weaknesses, opportunities, and threats within a project or business venture based on the identification of internal and external factors (Rangkuti, 2018). The stages of a SWOT analysis include: 1) Identification of internal factors, 2) Identification of external factors, 3) Preparation of a SWOT matrix, 4) Scoring and weighting, 5) Quadrant analysis, and 6) Formulation of alternative strategies (Rangkuti, 2018).

**3. RESULTS AND DISCUSSION**

**3.1. Adoption Level of ICM Technology Innovations**

The level of adoption on agricultural innovations reflects the extent to which farmers implement new technologies in the rice cultivation practices. Innovation adoption is influenced by internal factors, such as experience, knowledge, and innovative nature of farmers', as well as external factors, including extension services, production facility support, and access access to information (Listiana et al., 2020; Putra et al., 2025). High adoption rates improve the efficiency, productivity, and sustainability of farming, whereas low adoption indicates technical, social, or economic barriers that need to be addressed (Ruzzante et al., 2021; Geng et al., 2024). The level of innovation adoption of ICM technology in rice crops in Tasikmalaya Regency is shown in Table 2.

Table 2 illustrates the adoption rate of ICM technology innovations in lowland rice farming. Differences in scores between indicators are influenced by the varying number of questions used in the measurement, so the scores for each indicator are not directly comparable. For example, the harvest and post-harvest handling indicator received the highest

Table 2. Level of adoption of ICM innovation in rice farming

No	Indicator	# Questions	Score	Category
1	Superior seed varieties	2	420	High
2	High quality seed	2	364	Low
3	Young Seedlings	1	160	Low
4	Number of seedlings and planting system	2	336	Low
5	Nitrogen (N) fertilization based on Leaf Color Chart (BWD)	2	308	Low
6	Phosphate (P) and Potassium (K) fertilization based on soil nutrient status	2	260	Very Low
7	Use of organic compost	1	196	High
8	Intermittent irrigation	1	232	High
9	Integrated weed control	2	435	High
10	Integrated pest and disease management	3	614	High
11	Harvest and post-harvest handling	5	1.038	High
<b>Total</b>		<b>23</b>	<b>4.363</b>	<b>Low</b>

score of 1,038. However, this score does not necessarily indicate a higher level of ICM implementation than other indicators, as each indicator is classified based on the number of questions. The results in Table 2 show varying results for each indicator observed. Overall, the adoption rate is in the low category, with a total score of 4,363 out of an optimal score of 6,992. This illustrates that although some innovations have been well-practiced by farmers, several important components remain under-adopted due to various inhibiting factors, both internal and external.

Indicators of adoption that fall into the high category include the use of superior seed varieties called VUB (*Varietas Unggul Benih*), the application of organic matter, the application of intermittent irrigation, the application of integrated weed control, the implementation of integrated pest and plant disease control (IPM), and harvest and post-harvest handling. This achievement indicates that farmers are relatively accustomed to and more readily adopt technologies that are applicable and offer immediate benefits. For example, the use of VUB is considered to increase productivity, while the implementation of intermittent irrigation has proven to be efficient in water use and suitable to local rice field conditions. Similarly, the use of organic materials is more readily accepted because some farmers already have experience using manure or compost from livestock (Ishak *et al.*, 2022).

Conversely, several indicators categorized as low include the use of good quality seeds, the use of young seedlings, setting the number of seeds per hole or planting system, and nitrogen (N) fertilization using the color chart (BWD). This situation indicates that even though farmers use VUB, most still use seeds without quality guarantee, either due to limited access to certified seeds or the habit of using seeds from previous harvests. Meanwhile, the use of young seedlings and the seedling number per hole are often hampered by inherited habits that are difficult to change. Adoption of BWD-based fertilizer application is also still low due to the lack of familiarity with the tool among most farmers, minimal support from extension workers, and a lack of understanding of the long-term benefits of implementing this technology (Oktaviani, 2019).

Another indicator that is considered very low is P and K fertilization based on soil nutrient status using the soil testing kit called *Perangkat Uji Tanah Sawah* (PUTS). Research shows that PUTS-based fertilizer recommendations can increase productivity and improve fertilizer dosage efficiency in rice farming (Jauhari *et al.*, 2021; Oktareza, 2022). However, this is a fundamental weakness in the adoption of ICM technology due to limited PUTS facilities, a lack of socialization and technical training, and a lack of intensive support from agricultural extension workers (PPL). Furthermore, the cost of using the PUTS and the perceived complexity of fertilizer recommendations discourage farmers from implementing it. As a result, fertilization tends to be carried out conventionally without considering specific land conditions, potentially reducing the effectiveness and efficiency of farming efforts.

From these findings, we can conclude that although some ICM technology innovations have been well-received and practiced, the overall adoption rate remains low. The main obstacles lie in scientifically tested technology aspects such as PUTS and BWD, limited access to production inputs such as high-quality seeds, and socio-cultural factors such as traditional habits that are difficult to change. Therefore, efforts to increase adoption need to focus on

strengthening agricultural extension, providing supporting facilities, and field demonstrations (demplots) that can provide tangible evidence of the innovation's benefits. With this strategy, it is hoped that farmers will be more motivated to adopt ICM technology innovations comprehensively, thereby achieving better productivity and sustainability of lowland rice farming in the future.

### 3.2. Factors Influencing the Adoption Rate of ICM Technology Innovation

Factors influencing the adoption rate of the ICM Technology innovation were analyzed using the *t*-test and the *F*-test. The *F*-test is a regression model that analyzes the overall, collective influence of independent variables on the adoption rate of ICM Technology innovation. Meanwhile, the *t*-test is used to identify which variables have a partial influence.

The *F*-test, or ANOVA (Analysis of Variance), is a statistical technique used to test the significance of the overall regression model. In other words, this test aims to determine whether all independent variables included in the model jointly influence the dependent variable. In the context of regression analysis, the *F*-test serves to ensure that the constructed model is suitable for explaining the relationship between the independent and dependent variables.

The basis for decision-making in the *F*-test is by comparing the significance value (Sig.) with the error rate ( $\alpha = 0.05$ ). If the significance value is less than 0.05, the null hypothesis (H0) is rejected, and it can be concluded that the regression model is significant. Conversely, if the significance value is greater than 0.05, then H0 is accepted, meaning the regression model is insignificant. The results of the *F*-test calculation are shown in Table 3.

Table 3. Summary of the *F*-test results

ANOVA <sup>a</sup>						
	Model	Sum of Squares	df	Mean Square	<i>F</i> - value	Sig.
1	Regression	2502.441	16	156.403	5.681	.000 <sup>b</sup>
	Residual	1624.300	59	27.531		
	Total	4126.741	75			

a. Dependent Variable: ICM Adoption

b. Predictors: (Constant), Nature of innovation, Role of farmer group leader, Non-formal education, Number of family dependents, Land area, Communication channels, Age, Cosmopolitan, Formal education, Role of farmer group, Role of extension worker, Self-efficacy, Government support, Productivity, Availability of farming input, Farming experience

\*Sig. (0.000) <  $\alpha$  (0.05) → Reject H0

The *F*-test analysis showed that the regression model was simultaneously significant, with a calculated *F*-value of 5.681 and a significance level of 0.000 (<0.05). This indicates that the independent variables analyzed jointly influence the adoption rate of ICM technology innovations. Therefore, the regression model is suitable for explaining variations in the dependent variable.

Theoretically, the *F*-test is used to test the feasibility of the regression model, to determine whether all included predictors simultaneously make significant contributions (Munguia *et al.*, 2021). This finding aligns with previous studies showing that the adoption of agricultural innovations is not determined by a single factor, but rather by a combination of social, economic, psychological, and institutional factors (Rizzo *et al.*, 2024).

The overall significance of the model also supports the view that adoption agricultural innovation is resulted from a complex interaction between internal farmer factors and external support, such as extension services and the availability of farming inputs (Masi *et al.*, 2022). This is reinforced by Ruzzante *et al.* (2021), who found that although the influence of partial variables can vary, these variables simultaneously explain significant variations in adoption rates. Furthermore, the research of Alemayehu *et al.* (2024) also confirms that the simultaneous regression model provides a more comprehensive picture of the determinants of agricultural innovation adoption. Thus, the *F*-test demonstrates strong statistical validity of the regression model used. The analysis of factors influencing the adoption rate of ICM technology innovations used a *t*-test to identify the influence of the independent variable (X) on the adoption rate of ICM (Y) technology innovations partially. The results of the *t*-test calculation are shown in Table 4.

Table 4 shows eight independent variables that significantly influence the dependent variable include formal education, land area, self-efficacy, cosmopolitanism, productivity, the role of agricultural extension workers, the availability of production inputs, and the nature of the innovation. Variables that did not influence this included age, non-formal education, farming experience, the number of dependents in the family, government support, the role of farmer groups, the role of farmer group leaders, and communication channels.

Table 4. Summary of the *t*-test results

Coefficients <sup>a</sup>					
Model	Unstandardized Coefficients		Standardized Coefficients	<i>t</i> -value	Sig.
	B	Std. Error	Beta		
(Constant)	5.099	9.579		0.532	0.597
X1 = Age	0.020	0.189	0.027	0.105	0.917
X2 = Formal education	-3.373	0.874	-0.360	-3.861	0.000*
X3 = Non-formal education	0.753	0.753	0.093	1.001	0.321
X4 = Farming experience	-0.021	0.178	-0.030	-0.117	0.907
X5 = Land area	-9.272	3.004	-0.356	-3.086	0.003*
X6 = Self efficacy	0.810	0.266	0.347	3.048	0.003*
X7 = Cosmopolitan	1.217	0.312	0.433	3.896	0.000*
X8 = Number of farmer dependents	-0.494	0.562	-0.077	-0.878	0.383
X9 = Productivity	3.198	1.168	0.341	2.739	0.008*
X10 = Government support	0.281	0.215	0.149	1.305	0.197
X11 = Role of farmer groups	0.192	0.141	0.138	1.365	0.177
X12 = Role of farmer group leaders	0.011	0.157	0.008	.070	0.945
X13 = Role of agricultural extension workers (PPL)	0.794	0.245	0.374	3.244	0.002*
X14 = Availability of farming inputs	-1.424	0.300	-0.697	-4.739	0.000*
X15 = Communication channels	0.385	0.236	0.150	1.629	0.109
X16 = Nature of innovation	0.825	0.162	0.486	5.101	0.000*

Note: \* = significant

The results of this study demonstrate that innovation adoption and farmer capacity building are influenced by not only technical factors but also by psychological and social factors. Interestingly, formal education and land area negatively impacted the dependent variable (Y). This is understandable, as farmers with higher formal education tend to be more critical or selective about new technologies, thus preventing automatic innovation adoption (Majid *et al.*, 2023). Similarly, farmers with larger land areas are more focused on diversification and efficiency of business scale and therefore tend to be cautious in implementing risky innovations.

Psychological factors such as self-efficacy and innovativeness have a significant positive effect. This confirms that self-confidence and the courage to try new things are key assets in increasing the adoption of agricultural innovations. Farmers with high levels of self-efficacy are more confident in managing risks, thus being more open to adopting new technologies (Mishra *et al.*, 2024). Based on interviews with farmers, it was found that they demonstrate an open attitude towards new innovations, including ICM technology. However, farmers tend to be selective and conduct in-depth evaluations before adopting these innovations, especially regarding the potential increase in rice productivity. In practice, innovations presented by extension workers are often not accompanied by empirical evidence that can be directly observed by farmers regarding the results and impacts of the technology application. This condition results in a relatively low level of farmer confidence in the innovation effectiveness. Therefore, an evidence-based extension approach, such as the implementation of demonstration plots or field demonstrations, is needed to increase farmer confidence and encourage the sustainable adoption of ICM technology. This aligns with several studies that show that the innovative nature of technology is a crucial factor in the adoption of new technologies (Faiz *et al.*, 2024; Tohidyan Far *et al.*, 2025). These findings also underscore the need to build participatory institutions between extension workers, farmers, and related parties to encourage increased rice production (Dewi *et al.*, 2024; Azhari *et al.*, 2025).

In addition to psychological factors, social factors have also proven significant. The positive influence of the Cosmopolitan variable indicates that farmers with broader access to information and external networks are more likely to adopt agricultural innovations. The role of agricultural extension workers also has a significant positive influence, underscoring the importance of extension as a means of technology transfer and field assistance (Oktareza, 2022). Extension workers act as a link between research and field practice, thereby enhancing farmer understanding of the benefits of innovation and how to implement it (Ishak *et al.*, 2022). These findings strengthen the argument that social interaction and external support play a significant role in driving transformation in farmer behavior.

Furthermore, farm productivity has a positive effect, meaning that the higher the productivity, the greater the tendency of farmers to adopt new innovations due to the motivation to maintain or increase yields (Oktaviani, 2019). An interesting finding from the study was the variable of production input availability, which had a negative and significant effect on the adoption of ICM innovations. This finding implies that the availability of relatively adequate production inputs does not always directly correlate with increased innovation adoption. Several studies have shown that adequate inputs can reduce farmers' urgency to seek and try new practices, although the mechanism of this relationship is highly contextual and influenced by other factors such as perceived benefits, risks, and farming habits (Jauhari *et al.*, 2021). The diffusion of innovation theory explains that physical inputs or production factor support alone are insufficient to encourage the adoption of a technological innovation if the innovation is not perceived as profitable, compatible, simple, testable, or its benefits are not visible (Campobasso *et al.*, 2025). Research findings indicate that farmers' high perceptions of relative advantage, compatibility, triability, and observability can influence the adoption rate of ICM innovations (Imani *et al.*, 2025). In general, the adoption of ICM technology innovations is influenced by complex variables, necessitating a comprehensive strategy to accelerate the implementation of ICM technology to increase rice productivity in Tasikmalaya Regency.

### 3.3. Sustainable Rice Cultivation Development Strategy

The SWOT analysis results indicate that the adoption of ICM technology innovations in rice farming in Tasikmalaya Regency falls into Quadrant I, or an aggressive strategy (Strength–Opportunity). This strategy is implemented when both internal strengths and external opportunities are equally high, with an IFE score of 1.25 and an EFE score of 0.95. This indicates that farmers possess internal strengths, such as the use of superior seed varieties (VUB), the implementation of integrated pest and disease management (IPM), and relatively good harvesting and post-harvest practices. However, they also face external threats, including limited technological resources such as Paddy Soil Testing Kits (PUTS) and BWD, difficult-to-change traditional habits, and the high cost of adopting new technologies (Kohl, 2023).

Table 5 illustrates that the sustainable rice development strategy falls into quadrant I, with an aggressive strategy oriented toward growth and expansion, leveraging all internal strengths to maximize external opportunities. The SWOT analysis follows from the multiple linear regression analysis, which yielded general conclusions regarding the level of adoption of ICM technology innovations and the factors influencing them. Based on this research, a comprehensive study was developed to support sustainable rice development through the adoption framework of ICM technology innovations in Tasikmalaya Regency.

The analysis identified three strategies applicable to sustainable rice development: 1) Optimizing internal strengths to mitigate the risk of threats (S-T strategy), 2) Strengthening field extension to facilitate the implementation of scientific agricultural technology, and 3) Diversifying simple agricultural innovations that are readily accepted by farmers. The S-T strategy, optimizing internal strengths to mitigate the risk of external threats, requires maximizing the use of VUB, organic compost, and IPM to maintain productivity, despite the limitations of farming inputs (*saprodi*) remain a constraint. This aligns with findings that superior varieties and simple cultivation practices are more readily adopted by farmers due to their immediate benefits (Irawan, 2025).

Furthermore, strengthening agricultural extension services is crucial to facilitate the adoption of scientific technologies such as PUTS and BWD. Extension workers act as facilitators and motivators through participatory extension methods that emphasize hands-on practice in the field (Sutanto, 2019). Other research confirms that intensive extension services can improve farmers' understanding of innovations and accelerate behavioral changes in cultivation (Azhari *et al.*, 2025; Nouatin *et al.*, 2025).

Table 5. SWOT analysis calculation table

No	Code	Factor	Weight	Rate	Score
<b>1</b>	<b>Internal Factor Evaluation (IFE)</b>				
<b>a</b>	<b>Strengths (S)</b>				
	S1	Farmers have used superior seed VUB)	0.10	4	0.40
	S2	Integrated pest and disease management (IPM) has been consistently implemented	0.15	3	0.45
	S3	Extension activities have been carried out on a scheduled and continuous basis	0.20	4	0.80
	S4	Farmers have sufficient experience in lowland rice farming	0.15	4	0.60
	Total Score Strengths (S)		<b>0.60</b>		<b>2.25</b>
<b>b</b>	<b>Weaknesses (W)</b>				
	W1	Utilization of scientific technologies such as PUTS and BWD is still low	0.10	3	0.30
	W2	ICM technology implementation has not been comprehensive and integrated	0.10	2	0.20
	W3	Traditional cultivation practices still dominate farmer decision-making	0.15	2	0.30
	W4	Farmers' understanding of the long-term benefits of ICM technology is still limited	0.05	4	0.20
	Total Score Weaknesses (W)		<b>0.40</b>		<b>1.00</b>
	Total Score IFE				<b>1.25</b>
<b>2</b>	<b>External Factor Evaluation (EFE)</b>				
<b>a</b>	<b>Opportunities (O)</b>				
	O1	Availability of government programs that support sustainable rice development	0.20	4	0.80
	O2	The role of agricultural extension workers has the potential to be enhanced through a participatory approach	0.10	3	0.60
	O3	Availability of simple agricultural innovations that are easily accepted by farmers	0.10	3	0.30
	O4	Increased attention to food security and agricultural sustainability issues	0.15	4	0.60
	Total Score Opportunities (O)		<b>0.55</b>		<b>2.30</b>
<b>b</b>	<b>Threats (T)</b>				
	T1	Limited agricultural technology facilities such as PUTS and BWD	0.10	2	0.20
	T2	The cost of adopting agricultural technology is relatively high for farmers	0.10	3	0.30
	T3	Farmer resistance to changes in cultivation technology	0.15	3	0.45
	T4	Climate uncertainty and fluctuations in production inputs	0.10	4	0.40
	Total Score Threat (T)		<b>1.00</b>		<b>1.35</b>
	Total Score EFE				<b>0.95</b>

In addition, the diversification of simple innovations that are appropriate to farmers' socio-cultural contexts is also important. Innovations that are applicable, uncomplicated, and easily integrated with traditional practices tend to be more accepted (Ijatuyi *et al.*, 2025; Milardo, 2025). External support from the government, production input providers, and agricultural institutions is crucial in creating a conducive environment for innovation adoption (Sutanto, 2019). Thus, the S-T strategy emphasizes leveraging farmers' internal strengths while mitigating the impact of external barriers through innovation synergy and strengthening the role of extension workers in supporting the development of sustainable rice cultivation in Tasikmalaya Regency.

#### 4. CONCLUSIONS AND RECOMMENDATIONS

The overall adoption rate of ICM technology innovations in rice farming in Tasikmalaya Regency is low, although several indicators, such as superior seed varieties, integrated pest and disease management, organic matter use, intermittent irrigation, and harvest and post-harvest practices, are high. The *F*-test results show a significant

simultaneous regression model, with eight independent variables influencing ICM technology adoption: formal education, land area, self-efficacy, cosmopolitanism, productivity, the role of extension workers, the availability of farming inputs, and the nature of the innovation. Psychological and social factors, such as self-efficacy, cosmopolitanism, the nature of the innovation, and the role of extension workers, are the main determinants of farmer readiness to adopt innovation.

The SWOT analysis places the conditions for the adoption of ICM technology in Tasikmalaya Regency in quadrant I (S-O Aggressive Strategy), so that relevant strategies include 3 (three) strategies, namely: 1) Optimizing internal strengths to reduce the risk of threats, 2) Strengthening field extension so that scientific agricultural technology is easier to implement, and 3) Diversifying simple agricultural innovations that are easily accepted by farmers.

**Recommendations**

1. Increasing farmer capacity through training and field demonstrations, providing farming inputs and technology based on scientific testing (PUTS, BWD), and strengthening information networks and mentoring extension workers are necessary to increase the adoption of innovations comprehensively and encourage the implementation of ICM in Tasikmalaya Regency.
2. Agricultural extension agencies and workers need to strengthen extension services that are more applicable and sustainable, especially for ICM components with low adoption rates, as well as develop farmer capacity through increased self-efficacy and innovative attitudes.
3. Recommended further research includes a longitudinal approach (repeated research over a specific period) to examine factors influencing the adoption of ICM technology, and the need for mixed-methods research to more comprehensively understand the dynamics of farmer groups in adopting ICM technology innovations.

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**AUTHOR CONTRIBUTION STATEMENT**

Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
AM	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		✓
CN	✓		✓	✓		✓	✓	✓		✓		✓	✓	
KNI						✓					✓		✓	

  

C: Conceptualization	Fo: Formal Analysis	O: Writing - Original Draft	Fu: Funding Acquisition
M: Methodology	I: Investigation	E: Writing - Review & Editing	P: Project Administration
So: Software	D: Data Curation	Vi: Visualization	
Va: Validation	R: Resources	Su: Supervision	

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