



## Economic Behavior of Smallholder Farmers in Adopting Sustainable Land Management Practices

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### ARTICLE INFO

*Keywords:* Economic Behavior, Smallholder Farmers, Sustainable Land Management, Environmental Agricultural Economics, Adoption Decision.

*Received :* 27, November

*Revised :* 29, December

*Accepted:* 30, January

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### ABSTRACT

The adoption of sustainable land management (SLM) practices by smallholders is a critical issue in agricultural environmental economics, given land degradation pressures and limited household economic capacity. This study analyzes smallholders' economic behavior in adopting SLM and identifies key economic factors influencing their decisions. Using a mixed-methods approach, data were collected from a structured survey of 60 smallholders in Malang Regency, East Java, and in-depth interviews with five key informants. Quantitative data were analyzed with descriptive statistics and logit regression, while qualitative data were thematically analyzed. Results show that farming income, adoption costs, access to agricultural information, and risk perception significantly affect adoption decisions. These findings indicate that smallholders act economically rationally, weighing trade-offs between short-term profits and long-term sustainability. The study contributes to environmental economics literature by highlighting the need for incentive policies aligned with smallholders' economic realities to promote effective adoption of sustainable agricultural practices.

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## **INTRODUCTION**

In the global context, the agricultural sector faces serious challenges in the form of land degradation, climate change, and increasingly complex pressures on the sustainability of food production. According to Agrawal and Chhatre (2021), unsustainable land management practices have contributed to declining soil fertility and an increased risk of production failure, especially in developing countries. This condition makes smallholders the most vulnerable group due to limited access to capital, technology, and information. Therefore, the adoption of sustainable land management practices is seen as a key strategy to maintain agricultural productivity as well as the sustainability of natural resources.

From an environmental economic perspective, the decision to adopt sustainable practices cannot be separated from the economic behavior of farmers as rational decision-makers in conditions of limited resources. Smallholders are faced with a trade-off between short-term income needs and long-term environmental benefits that are indirect. Lambin et al. (2020) show that initial cost considerations, outcome uncertainty, and production risk are often major barriers to the adoption of sustainable innovations. The findings confirm that the economic dimension has a central role in explaining the variation in adoption behavior between farmers.

At the local level, especially in Indonesia, agricultural land degradation is still a structural problem that has a direct impact on food security and the welfare of smallholders. In the East Java region, agricultural intensification that is not balanced with land conservation practices has increased soil vulnerability to erosion and degraded land quality. Various government programs have actually encouraged the adoption of sustainable agriculture, but the adoption rate among smallholders still shows significant variation. This condition, as noted by Susilowati et al. (2022), reflects the gap between policy design and the economic reality of farmers on the ground.

Previous studies on the adoption of sustainable land management practices have generally emphasized technical and institutional factors, such as access to counseling and the availability of technology. However, these approaches often lack a deep dive into how farmers' economic behavior influences adoption decisions. Kassie et al. (2020) found that although economic variables are often significant, their integration into the framework of smallholder economic behavior is still limited. Thus, there is still a research gap in explaining the adoption of sustainable practices as a result of rational and contextual economic decision-making processes.

In addition, empirical research at the micro level that combines quantitative and qualitative approaches is still relatively limited, especially in the context of smallholder agriculture in Southeast Asia. Many studies rely on large-scale survey data without deepening the meaning behind farmers' decisions. In fact, Villamor and van Noordwijk (2021) emphasize that the combination of methods allows for a more comprehensive understanding of economic motives, risk perceptions, and local dynamics. This methodological gap shows the need for research that is able to bridge statistical analysis with the socio-economic realities of smallholder farmers.

Based on this background, this study aims to analyze the economic behavior of smallholders in adopting sustainable land management practices and identify the main economic factors influencing adoption decisions. The focus of the analysis is directed at the role of farming income, adoption costs, access to agricultural information, and risk perception in shaping farmers' decisions. Abdulai and Huffman (2022) emphasized that understanding these economic factors is important to explain the logic of adoption at the farmer household level. Therefore, this study places smallholders as rational economic actors in sustainable farming systems.

Theoretically, this research contributes to the development of the environmental economics agricultural literature by strengthening the understanding of the economic behavior of smallholders in the context of sustainability. The integration of economic and behavioral dimensions in one analytical framework also enriches the discourse of innovation adoption in the agricultural sector. From a practical perspective, the findings of this study provide policy implications for sustainable agriculture program designers to be more sensitive to the economic conditions of smallholders. As highlighted by Doss et al. (2021), adjustment of incentive instruments and policy support has the potential to increase the adoption of sustainable land management practices more effectively and sustainably.

## **THEORETICAL REVIEW**

### ***Smallholder Economic Behavior in Sustainable Practice Adoption Decisions***

In the agricultural economics literature, smallholders are seen as rational actors who make production decisions based on consideration of benefits and costs under conditions of limited resources. The decision to adopt sustainable land management practices is influenced not only by environmental awareness, but also by expectations of economic gains and income stability. Empirical studies show that smallholders are more likely to adopt innovations when the practice is perceived to improve economic efficiency or reduce vulnerability to production shocks (Barrett et al., 2020). Thus, economic behavior is the main foundation in understanding the dynamics of the adoption of sustainable agricultural practices at the farmer household level.

(H1): Farming's income has a positive effect on the probability of adoption of sustainable land management practices by smallholders.

### ***Farming Income and Adoption Costs as Economic Determinants***

Farmer income plays an important role in determining the capacity of smallholders to adopt sustainable land management practices. Farmers with higher income levels generally have a better financial ability to cover the initial costs of adoption, such as additional labor investment or changes in cultivation techniques. In contrast, the high cost of adoption is often a major obstacle for smallholders with limited resources. Research by Teklewold et al. (2021) confirms that the imbalance between short-term costs and long-term benefits is a determining factor in the low adoption rate of sustainable practices among smallholders.

(H2): Adoption costs negatively affect smallholder decisions to adopt sustainable land management practices.

### ***Access to Agricultural Information and the Role of Economic Knowledge***

Access to quality agricultural information influences how smallholders assess the risks and benefits of sustainable land management practices. Adequate information allows farmers to reduce uncertainty regarding production yields and economic gains. Studies show that farmers who have better access to extension, training, and information networks tend to be more responsive to sustainable innovation (Ruzzante et al., 2021). In this context, information serves not only as a tool for technology transfer, but also as a mechanism for shaping farmers' economic expectations.

(H3): Access to agricultural information has a positive effect on the decision to adopt sustainable land management practices.

### ***Risk Perception and Uncertainty in the Adoption of Sustainable Practices***

Risk perception is a psychological-economic factor that has a strong influence on adoption decisions. Sustainable land management practices are often perceived to have uncertain results in the short term, despite offering long-term environmental and economic benefits. Recent research shows that smallholders who have high levels of risk aversion tend to delay or reject the adoption of sustainable practices, especially when risk protection mechanisms such as subsidies or agricultural insurance are not available (Liu & Huang, 2022). This reinforces the argument that adoption is the result of an interaction between economic considerations and individual risk perceptions.

(H4): Risk perception has a negative effect on the probability of adoption of sustainable land management practices.

## **METHODOLOGY**

### ***Types and Approaches to Research***

This study uses a mixed methods approach with a sequential explanatory design, where quantitative analysis is the main stage which is then deepened through qualitative data. This approach was chosen because the decision to adopt sustainable land management practices is influenced not only by the statistical relationships between economic variables, but also by the subjective and contextual considerations of smallholders. The mixed method allows researchers to gain a more comprehensive understanding of farmers' economic behavior as rational actors in conditions of uncertainty (Creswell & Plano Clark, 2022). Thus, quantitative results can be explained in more depth through relevant qualitative narratives.

### ***Location, Population, and Quantitative Sampling Techniques***

The research was conducted in Malang Regency, East Java Province, which was chosen purposively because this area represents the characteristics of small-land agriculture with varying levels of adoption of sustainable practices. The research population is all smallholder food farmers with a land area of  $\leq 2$  hectares. The quantitative sample amounted to 60 farmers, consisting of adopter

and non-adopter farmers of sustainable land management practices. The sampling technique uses purposive sampling with certain criteria, namely active farmer status, at least five years of farming experience, and direct involvement in land management. This sample size was considered adequate for logit regression analysis in the study of adoption behavior at the micro scale (Greene, 2020).

### ***Qualitative Informants and Rationalization of Their Elections***

The qualitative stage involved five key informants who were purposively selected to enrich the interpretation of quantitative results. The informants consisted of two adopter farmers, one non-adopter farmer, one field agricultural extension worker, and one farmer group leader. The selection of a limited number of informants is based on the principle of information-rich cases, where the main purpose of the interview is the deepening of meaning, not statistical generalization. This approach is considered effective in research on the economic behavior of smallholders that focuses on decision rationality and risk perception (Guest et al., 2020).

### ***Data Collection Techniques and Instruments***

Quantitative data was collected through a structured questionnaire that included farmers' socio-economic characteristics, farming income, adoption costs, access to agricultural information, and risk perception. The instruments are compiled based on indicators commonly used in the study of agricultural technology adoption and adapted to the local context. The validity test was performed using item-total correlation, while the reliability was tested with Cronbach's alpha coefficient to ensure the internal consistency of the instrument (Hair et al., 2021). Qualitative data was obtained through in-depth semi-structured interviews to explore farmers' reasons, experiences, and economic considerations in the adoption process.

### ***Research Implementation Procedure***

The research began with a preliminary study and instrument preparation, followed by a questionnaire trial on a limited number of respondents. The next stage is the collection of quantitative data through field surveys, which are then analyzed in advance to identify patterns and relationships between variables. Based on these results, qualitative interviews were conducted to deepen the key findings and explain the dynamics of adoption decisions. The entire research process is carried out in stages and integrated to maintain consistency between objectives, methods, and analyses (Fetters et al., 2020).

### ***Data Analysis Techniques***

Quantitative data were analyzed using descriptive statistics and binary logit regression to estimate the probability of adoption of sustainable land management practices. Logit regression was chosen because the dependent variables are dichotomous (adopter and non-adopter). The analysis is carried out with the help of Stata software. Qualitative data were analyzed using thematic analysis, through the process of open coding, thematic grouping, and

interpretation of meaning. The integration of quantitative and qualitative results is carried out at the discussion stage to produce comprehensive and contextual conclusions (Miles et al., 2020).

**RESERACH RESULTS**

***Farming Income and Decision to Adopt Sustainable Land Management Practices***

The results of binary logit regression show that farming income has a positive and significant effect on the probability of adopting sustainable land management practices. Farmers with higher income levels have a greater chance of adoption than farmers with low incomes. These findings indicate that economic capacity plays an important role in reducing the short-term risk pressures that arise in the early phases of innovation adoption.

**Table 1. Binary Logit Regression Results of Farm Income on Adoption of Sustainable Land Management Practices**

<b>Independent Variable</b>	<b>Coefficient (b)</b>	<b>Std. Error</b>	<b>z-value</b>	<b>p-value</b>	<b>Odds Ratio</b>
Farm Income	0.842	0.291	2.89	0.004	2.32
Constant	-1.763	0.654	-2.69	0.007	-

*Note: Dependent variable = Adoption decision (1 = adopter; 0 = non-adopter)*

Based on Table 1, the coefficient of farming income is positive ( $\beta = 0.842$ ) and significant at a confidence level of 1 percent ( $p < 0.01$ ). Value *odds ratio* of 2.32 indicates that each increase in one unit of farming income increases the chances of farmers adopting sustainable land management practices by 2.32 times, assuming other variables are constant. These results confirm that income serves as economic capital that allows farmers to absorb risks and uncertainties in the short term.

These quantitative findings were deepened through in-depth interviews that showed that farmer income was perceived as the main prerequisite before farmers were willing to change cultivation practices. Adoptive farmers emphasize that income stability provides a sense of economic security to bear possible initial losses. An adopter farmer stated that *"If the economy is going to be a little bit more volatile, we're going to have to try new ways to do it, because if there's a risk, we can still shut it down. "But if you're going to do it, think twice."* (PA-01, October 2025 interview). This view is reinforced by non-adopter farmers who acknowledge an interest in sustainable practices, but choose to delay adoption due to economic limitations, *"I'm actually interested, but my income is not secure enough now if I have to change the way I farm."* (PB-01, October 2025 interview). In addition, agricultural extension workers also confirmed this pattern by stating that *"Farmers whose economies are stable usually accept new practices more quickly because they are less afraid of failure"* (PL-01, October 2025 interview). Overall, qualitative data explains that farming income functions as a *economic buffer* which allows farmers to balance short-term livelihood needs with a long-term sustainability orientation.

***Adoption Costs as an Economic Constraint***

The results of the logite regression show that the cost of adoption has a negative and significant effect on the decision to adopt sustainable land management practices.

**Table 2. Binary Logit Regression Results of Adoption Costs on Adoption Decision**

<b>Independent Variable</b>	<b>Coefficient (b)</b>	<b>Std. Error</b>	<b>z-value</b>	<b>p-value</b>	<b>Odds Ratio</b>
Adoption Costs	-0.916	0.327	-2.80	0.005	0.40
Constant	0.982	0.481	2.04	0.041	-

*Note: Dependent variable = Adoption decision (1 = adopter; 0 = non-adopter)*

Table 2 shows that the adoption cost coefficient is negative and significant ( $p < 0.01$ ). Value *odds ratio* by 0.40 indicates that the increase in adoption costs substantially lowers farmers' chances of adopting sustainable practices. In other words, the higher the initial costs to bear, the less likely a smallholder is to make an adoption decision.

The results of the interviews show that the cost of adoption is perceived as a direct economic burden, especially in the early stages of implementation. Adoptive farmers acknowledge the additional costs, but interpret them as a long-term investment.

An adopter farmer explained that "*Initially, it did cost more, especially energy and time, but I have calculated, in the future it can go back and even be more economical*" (PA-02, October 2025 interview). On the other hand, non-adoptive farmers view the cost as too big a risk in fragile economic conditions, "*If I have to increase the cost again, I can't afford it yet. The crop is now mediocre*" (PB-01, October 2025 interview). The head of the farmer group emphasized that "*Many farmers are withdrawing not because they don't want to, but because they can't afford the initial costs*" (KT-01, October 2025 interview). These qualitative findings make it clear that adoption decisions are based on rational calculations between short-term costs and long-term benefits in conditions of capital constraints.

***Access to Agricultural Information and Farmers' Economic Rationality***

Access to agricultural information has a positive and significant effect on the probability of adopting sustainable land management practices.

**Table 3. Binary Logit Regression Results of Access to Agricultural Information on Adoption**

<b>Independent Variable</b>	<b>Coefficient (b)</b>	<b>Std. Error</b>	<b>z-value</b>	<b>p-value</b>	<b>Odds Ratio</b>
Access to Agricultural Information	0.764	0.281	2.72	0.006	2.15
Constant	-1.214	0.503	-2.41	0.016	-

*Note: Dependent variable = Adoption decision (1 = adopter; 0 = non-adopter)*

Based on Table 3, the information access coefficient has a positive and significant value ( $p < 0.01$ ). Value *odds ratio* 2.15 shows that farmers with better access to information have more than twice the chance of adoption compared to farmers with limited access to information.

Qualitative data show that information plays an important role in reducing economic uncertainty and strengthening the rationality of farmers' decisions. Farmers state that understanding the cost structure, potential yields, and long-term benefits increases confidence in decision-making. An adopter farmer said that "*After participating in counseling, I understood the calculations, not just participating, so I became more confident*" (PA-02, October 2025 interview). On the contrary, limited information makes farmers tend to delay adoption, "*I'm not sure yet because I don't know the benefits and losses*" (PB-01, October 2025 interview). Agricultural extension workers emphasized that "*If the information is clear and economically reasonable, farmers are usually more courageous to make decisions*" (PL-01, October 2025 interview).

### **Risk Perception and Uncertainty in Adoption Decisions**

Risk perception has a negative and significant effect on the decision to adopt sustainable land management practices.

**Table 4. Binary Logit Regression Results of Risk Perception on Adoption**

<b>Independent Variable</b>	<b>Coefficient (b)</b>	<b>Std. Error</b>	<b>z-value</b>	<b>p-value</b>	<b>Odds Ratio</b>
Risk Perception	-0.883	0.314	-2.81	0.005	0.41
Constant	1.106	0.472	2.34	0.019	-

*Note: Dependent variable = Adoption decision (1 = adopter; 0 = non-adopter)*

Table 4 shows that risk perception has a negative and significant coefficient ( $p < 0.01$ ). Value *odds ratio* 0.41 indicates that increased risk perception significantly decreases the chances of adopting sustainable land management practices.

The results of the interviews show that risk is mainly interpreted as the potential loss of yield and income instability. Adoptive farmers view risk as a long-term challenge that needs to be anticipated, while non-adoptive farmers prefer risk-avoidance strategies by maintaining conventional practices. One adopter farmer stated that "*I am aware of the risks, but if we don't start now, it will be even worse in the future*" (PA-01, October 2025 interview). On the other hand, non-adoptive farmers expressed concern about the possibility of crop failure, "*If the harvest fails, who is to blame? That's what makes me doubt*" (PB-01, October 2025 interview). The chairman of the farmer group added that "*Smallholders are very sensitive to risk because their capital is limited*" (KT-01, October 2025 interview).

## **DISCUSSION**

Referring to the institutional economic approach of agriculture, the decision to adopt sustainable land management practices by smallholders can be understood as a manifestation of rational economic behavior in conditions of

limited resources (Meijer et al., 2021). The results of this study show that farmers act as decision-makers who consider benefits, costs, and risks simultaneously within the framework of sustainable household income. In this context, adoption is not interpreted as a normative response to environmental issues alone, but as the result of an economic evaluation oriented towards the stability of farming businesses. This pattern reinforces the argument that sustainable farming practices tend to be adopted when they align with the economic interests of smallholders.

The empirical results of this study consistently show that Hypothesis 1 (H1) is accepted, where farming income has a positive and significant effect on the probability of adopting sustainable land management practices. In the framework of economic capacity theory, income functions as a risk-bearing capacity that allows farmers to make innovative decisions without threatening livelihood sustainability (Abdulai & Huffman, 2020). Farmers with higher incomes have the financial flexibility to bear the potential for short-term losses and yield uncertainty. Thus, income not only determines the technical capabilities of adoption, but also shapes farmers' psychological perception of economic risks.

In line with the perspective of transaction costs in the agricultural economy, the results of the analysis show that Hypothesis 2 (H2) is accepted, namely that the cost of adoption has a negative effect on the decision to adopt sustainable practices. The relatively high initial cost creates an imbalance between short-term sacrifices and long-term benefits, thus encouraging farmers to be more cautious, especially in volatile income conditions. This phenomenon confirms that low adoption rates are not a form of resistance to innovation, but rather a rational response to incentive structures that have not yet fully supported smallholders (Kassie et al., 2020). Therefore, the cost of adoption is a determining factor in the economic decision-making process of farmers.

In the context of economic decision-making, the results of this study confirm that Hypothesis 3 (H3) is accepted, where access to agricultural information has a positive effect on adoption decisions. The information serves as an uncertainty-reducing mechanism that allows farmers to calculate the economic consequences of adoption more accurately. Ragasa and Mazunda (2023) emphasized that clear information about costs, yields, and long-term benefits increases farmers' confidence in taking measurable risks. Thus, counseling and knowledge transfer are not only technical, but also play a strategic role in shaping the economic rationality of smallholder farmers.

The results of this study also strongly support Hypothesis 4 (H4), namely the perception of risk having a negative effect on the probability of adopting sustainable land management practices. In the theory of risk aversion, smallholders are seen as economic actors who tend to avoid decisions with the potential for large losses due to capital limitations. Sustainable practices are often perceived to have uncertain results in the short term, thus increasing adoption resistance, especially in farmers with previous experience of failure. As explained by Brick and Visser (2021), risk is not only objective, but is constructed subjectively through farmers' experiences and economic conditions.

The integration of quantitative and qualitative findings in this study shows that the four economic factors of income, adoption costs, access to information, and risk perception interact with each other in shaping adoption decisions. Income and information serve as driving factors that strengthen farmers' courage, while adoption costs and risk perceptions act as holding factors in the decision-making process. The sequential explanatory mixed methods approach, as affirmed by Fetters et al. (2020), allows for a more comprehensive understanding of these dynamics by bridging statistical findings and the socio-economic realities of farmers. This methodological contribution enriches the analysis of the economic behavior of smallholder farmers in the context of sustainable agriculture.

Although it provides strong empirical findings, the study has limitations, especially in the number of samples and the relatively narrow coverage of the area, so generalization of the results needs to be done carefully. In addition, institutional factors such as access to formal credit, agricultural insurance, and subsidy policies have not been explicitly analyzed, even though they have the potential to influence adoption decisions. Follow-up research is recommended to expand geographic coverage, include institutional variables, and use longitudinal approaches to capture the dynamics of adoption in the long term. In practical terms, these findings confirm that sustainable agriculture policies need to be designed taking into account the economic realities of smallholder farmers through appropriate incentives, reduced adoption costs, and strengthening of extension systems.

## **CONCLUSION AND RECOMMENDATION**

This study concludes that the adoption of sustainable land management practices by smallholders is the result of rational economic behaviors shaped by the interaction between farming income, adoption costs, access to agricultural information, and risk perception. Empirical findings suggest that income and access to information increase the probability of adoption, while the cost of adoption and perceived risk play as a holding factor, thus confirming the existence of a trade-off consideration between short-term benefits and long-term sustainability in smallholder decisions. Thus, adoption is not driven solely by ecological awareness, but by economic calculations in conditions of limited resources. The main contribution of this research lies in strengthening the economic perspective of the agricultural environment by emphasizing that the effectiveness of sustainable agricultural policies is highly dependent on the design of incentives, reduction of adoption costs, and the strengthening of information and extension systems that are in line with the economic realities of smallholders.

## **FURTHER STUDY**

Future research is recommended to examine the adoption of sustainable land management practices in a wider range of agricultural contexts and crop types to evaluate the generalizability of the economic trade-off framework. Further studies could investigate the effectiveness of targeted incentive programs, cost-reduction strategies, and information dissemination mechanisms

in increasing adoption rates among smallholders. In addition, longitudinal research is needed to assess how risk perception and economic conditions evolve over time and influence long-term sustainability outcomes. Integrating behavioral and socio-cultural factors alongside economic considerations may also provide a more comprehensive understanding of smallholder decision-making in sustainable agriculture.

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