International Journal of Life Science and Agriculture Research
ISSN (Print): 2833-2091, ISSN (Online): 2833-2105
Volume 05 Issue 01 January 2026
DOI: https://doi.org/10.55677/ijlsar/V05I01Y2026-09
Impact Factor: 7.88 , Page No : 60-67

Analysis of Farmer Decision Making on the Selection of Paddy Rice Seeds as an Environmental Adaptation Strategy in Supporting the Sustainability of Tidal Land

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ABSTRACT

From July 1st to January 1st, 2025, this study was carried out in a chicken farm in Tidal land has a strategic role in supporting national food security, particularly in South Kalimantan, but paddy farming systems in this region are highly vulnerable to environmental change and climate uncertainty. This condition encourages farmers to adapt, one of which is through decision-making in the selection of paddy rice seeds that are in accordance with the characteristics of tidal land. This study aims to analyze the characteristics and stages of decision-making of farmers in the selection of paddy rice seeds, identify the factors that influence these decisions as an environmental adaptation strategy, and evaluate their implications for the sustainability of paddy rice farming in Barito Kuala Regency. The research was carried out using a survey method with a total of 100 respondents who were selected through multistage random sampling techniques. Data analysis was carried out using descriptive analysis to examine the stages of farmer decision-making, binary logistics regression to identify determinants of seed selection decisions, and sustainability index analysis to assess its impact on farming sustainability. The results of the study showed that farmers' decision-making followed the stages of identification of needs, information search, alternative evaluation, seed selection decisions, and post-use evaluation, with a dominant preference for local varieties. Factors of farming experience, perception of environmental risks, and access to agricultural information have a significant effect on seed selection decisions. The sustainability index value of 0.731 shows that the selection of paddy rice seeds by tidal land farmers is in the category of quite sustainable. This study concludes that seed selection is an important environmental adaptation strategy in supporting the sustainability of paddy rice farming in tidal lands.

KEYWORDS: farmer decision-making; rice seed selection; environmental adaptation; tidal land; sustainability of farming

Published Online: January 28, 2026

***Cite the Article:** Hartoni, Azis, Y., Wilda, K., Anjardiani, L. (2026). Analysis of Farmer Decision Making on the Selection of Paddy Rice Seeds as an Environmental Adaptation Strategy in Supporting the Sustainability of Tidal Land. International Journal of Life Science and Agriculture Research, 5(1), 60–67. https://doi.org/10.55677/ijlsar/V05I01Y2026-09*

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1. INTRODUCTION

Tidal land is a strategic resource for supporting national food security and sustainability, especially in areas outside Java, such as South Kalimantan, but its dynamic biophysical characteristics make the rice production system on this land highly vulnerable to environmental and extreme climate changes [1,2]. Barito Kuala Regency, as the largest tidal rice production center in South Kalimantan, has made a significant contribution to regional production, but in recent years it has experienced declining harvests and production areas due to climate uncertainty, tidal floods, and land quality degradation [3,4]. Data from the Central Statistics Agency of Barito Kuala Regency showed that the rice harvest area decreased from more than 62 thousand hectares in 2021 to around 57 thousand hectares in 2022, with a direct impact on the stability of farmers' production and income [3,5].

Environmental changes in tidal land not only affect the physical aspects of production but also alter farmers' behavior and decision-making in managing paddy rice farming, including seed selection as a key technological component [6,7]. The selection of rice seeds by tidal land farmers is an adaptive response to the risks of inundation, soil acidity, pest attacks, and fluctuations in the growing season, which are increasingly difficult to predict [8,9]. Empirical studies in tidal lands in South Kalimantan show that farmers tend to choose local varieties because they are more environmentally adaptable, although their productivity is lower than that of national superior varieties [10,11].

Previous research in Barito Kuala Regency has shown that local varieties, such as Siam Mayang, still dominate the paddy farming system due to their yield stability and tolerance to extreme environmental conditions, which indirectly contribute to the food security of farmers' households [11,12]. Hartoni et al. affirm that adaptation based on local knowledge, including in variety selection, plays an important role in maintaining the household food system's income structure and sustainability among tidal farmers [13]. In addition, farmers' decisions in choosing production inputs, including seeds, are strongly influenced by risk perception, farming experience, and limited access to resources [14,15].

Farmer decision-making approaches in the context of environmental adaptation are increasingly receiving attention in the agribusiness and agricultural economics literature, especially within the frameworks of sustainable and climate-smart agriculture [16,17]. However, most studies still focus on productivity and technical efficiency, while the behavioral dimensions of farmers' decisions in selecting seeds as an environmental adaptation strategy in tidal lands remain relatively limited [11,18]. In fact, the decision to select seeds is the starting point of the entire production system that determines the success of adaptation and sustainability of farming [17, 19].

State-of-the-art research shows that rice seed selection is generally conducted on technical irrigation land or rainfed rice fields, with a technology-preference and innovation-adoption approach [20,21]. In the context of tidal land, research that integrates environmental factors, production risks, and farmers' decision-making behavior remains rare, especially research based on microdata from farmers in production centers such as Barito Kuala Regency [10,13]. Therefore, this study offers novelty by examining farmers' decision-making in selecting paddy rice seeds as an environmental adaptation strategy that directly contributes to the sustainability of the tidal production system.

This research approach combines the analysis of farmers' decision-making behavior with the context of environmental adaptation and tidal land sustainability, enabling explanation not only of "what" farmers choose, but also of "why" the decision is made in the face of environmental uncertainty [15,17]. Problem-solving strategies involve identifying internal and external factors that influence seed selection decisions, including farmer characteristics, agroecological conditions, production risks, and their implications for farming sustainability [11,14].

Based on this description, the formulation of this research problem is: (i) how are the characteristics of farmers' decision-making in the selection of paddy rice seeds in tidal land; (ii) what factors influence the decision to select seeds as an environmental adaptation strategy; and (iii) what are the implications of the decision on the sustainability of paddy rice farming in Barito Kuala Regency [10,13].

The purpose of this study is to comprehensively analyze the decision-making of farmers in the selection of paddy rice seeds in the tidal land of Barito Kuala Regency, identify the determinants of these decisions in the context of environmental adaptation, and evaluate the role of seed selection as an adaptation strategy in supporting the sustainability of the paddy rice farming system, so that it can be the basis for policy formulation and recommendations for the development of tidal agriculture. sustainable..

II. RESEARCH METHODS

A. Place and Time of Research

This study was carried out in Barito Kuala Regency, South Kalimantan Province, which is the center of rice production in tidal fields and has a diversity of tidal overflow types that affect farmers' adaptation strategies [2,8]. The location was selected purposively, given the dominance of the tidal rice farming system and the high environmental vulnerability to climate change, which affects farmers' technological decisions [5,17]. The research period spans one rice planting season, including the preparation stage, field data collection, data processing, analysis, and report preparation, namely in the current year, to capture the dynamics of farmers' decisions in real time [15,18].

B. Sample Withdrawal Method

The sample withdrawal method used was multistage random sampling, which began with the selection of sub-districts and villages within the tidal rice center, followed by the selection of simple random respondent farmers [22,23]. This technique is considered effective for reducing spatial bias and ensuring the representation of various agroecological conditions of tidal land [10,24]. A total of 100 paddy farmers were used, which was considered adequate for analyzing decision-making behavior using econometric and inferential statistical models [11,12].

Data collection was carried out through a field survey using structured questionnaires and in-depth interviews to explore farmers' characteristics, farming experience, perceptions of environmental risks, and preferences and decisions regarding the selection of paddy rice seeds [13,14]. Primary data are strengthened by secondary data sourced from the Central Statistics Agency, regional agricultural agencies, and scientific publications on tidal land and agricultural adaptation [15,17]. The data triangulation approach is used to improve the validity and reliability of the information obtained from respondents [5,7].

C. Data Analysis

Data analysis was carried out quantitatively, with several stages integrated to explain farmers' decision-making in seed selection as an environmental adaptation strategy [18,25]. Descriptive analysis was used to describe the socioeconomic characteristics of farmers and the selection patterns of paddy rice seeds in tidal lands [20, 26]. To analyze the factors influencing farmers' seed selection decisions, a binary logistic regression model was used because the decision variables were dichotomous (local versus superior paddy rice varieties) [23,24]. Mathematically, the logistic regression model is formulated as follows [27,28]:

$$ln\left(\frac{P_i}{1-P_i}\right) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6$$

where Piis the probability of farmers choosing a certain type of seed, β0is constant, β1is the parameter coefficient, and Xi is an explanatory variable such as age (X1), education (X2), farming experience (X3), land area (X4), perception of environmental risks (X5), and access to information (X6) [20,25]. The odds ratio (OR) is used to assess the magnitude of each variable's influence on farmers' decision-making opportunities [29,30].

In addition, to assess the role of seed selection in the sustainability of farming, a sustainability index analysis based on economic and environmental indicators was conducted using a scoring and normalization approach [31,32]. The sustainability index is formulated as follows [33,34]:

$$IK = \frac{\sum_{i=1}^{n} S_i W_i}{\sum_{i=1}^{n} W_i}$$

where IK is the sustainability index, Si is the ith indicator score, and Wi is the weight of the indicator [35,36]. All data analysis was performed using statistical software, and the estimation results were tested using significance and goodness-of-fit tests to ensure the reliability of the model [37,38].

III. RESULTS AND DISCUSSION

A. Characteristics and Stages of Farmer Decision Selection in Rice Seed Selection

Results and discussion of the characteristics and stages of decision-making of farmers in the selection of paddy rice seeds in the tidal lands of Barito Kuala Regency as an adaptation strategy to risky environmental conditions. Seed selection is considered a strategic initial decision because it determines the direction of farming management in subsequent production stages, especially amid uncertainty about tidal inundation, soil acidity, and climate variability. Therefore, the analysis focuses on the stages of farmer decision-making, from need identification, information search, alternative evaluation, purchase decision, and evaluation of results, to gain a comprehensive understanding of farmers' adaptive behavior and the contextual factors that underlie it.

Table 1. Characteristics of Farmer Decision Making in Rice Seed Selection

Decision Stages	Key Indicators	Categories	Number of Farmers (people)	Percentage (%)
Need Recognition	Environmental risk perception	Height	62	62
		Medium	28	28
		Low	10	10
Information Search	Main source of information	Personal experience	45	45
		Fellow farmers	32	32
		Extension workers/farmer groups	23	23
Alternative Evaluation	Dominant criteria	Adaptation of inundation and sour soil	48	48
		Yield stability	31	31
		Seed cost	21	21
Seed Selection Results	Selected seed type	Local varieties	68	68
		Superior varieties	32	32

Yield (Post-Seed Use)	Satisfaction with seeds	Satisfied	71	71
		Quite satisfied	22	22
		Dissatisfied	7	7

The results of the descriptive analysis show that the decision-making of paddy rice farmers in the tidal lands of Barito Kuala Regency follows the classic stages of electoral decision-making, namely identification of needs, search for information, alternative evaluation, seed selection, and post-use evaluation of seeds. At the need recognition stage, the majority of farmers (62%) are in the high environmental risk perception category, characterized by concerns about tidal inundation, soil acidity, and the uncertainty of the planting season. These findings confirm that the context of environmental risk is a major trigger of awareness of the need for adaptation in seed selection, consistent with the literature, which states that perceptions of climate risk encourage adaptive behavior in high-risk agricultural systems.

At the information search stage, farmers rely more on personal experiences (45%) and social networks among fellow farmers (32%) than on formal sources such as extension workers and farmer groups (23%). The dominance of informal sources indicates the strength of experiential learning in tidal land environments, where high uncertainty leads farmers to prioritize local empirical evidence, which they consider more relevant and reliable. This pattern is consistent with findings on agricultural technology adoption, which suggest that in high-risk contexts, local information is often more influential than formal recommendations.

The alternative evaluation stage showed that adaptation criteria to inundation and acidic soils were the dominant considerations (48%), followed by yield stability (31%) and seed cost (21%). This means that farmers assess seed alternatives not solely based on yield potential, but based on the ability of seeds to maintain production stability across seasons. This approach aligns with the theory of decision-making under uncertainty, which holds that decision-makers tend to maximize safety-first utility rather than pursue the maximum outcome.

At the seed selection stage, 68% of farmers choose local varieties, while 32% choose superior varieties. This proportion shows a strong preference for local seeds as an adaptive technology tested in context. This choice cannot be understood as resistance to innovation, but rather as an adaptive rationality that considers the risk of failure and resource limitations. At the yield/post-use stage of seeds, a high level of satisfaction (71% satisfied) indicates that the decisions taken have met farmers' expectations, both in terms of yield and environmental conditions. This satisfaction reinforces the intention to reuse, which in the context of risky agriculture is an important indicator of the sustainability of adaptation decisions.

B. Determinants of Seed Selection

After understanding the patterns and stages of farmers' decision-making in selecting paddy rice seeds, the next discussion focuses on identifying the determinants that shape their decisions. Decision determinant analysis is important to explain the variation in farmers' behavior in choosing seed types, both local and superior varieties, in the midst of tidal land conditions that are full of environmental risks and limited resources. By examining the socioeconomic characteristics of farmers, perceptions of environmental risks, and access to agricultural information, this section aims to uncover the rational mechanisms underlying seed selection decisions and to quantify and empirically clarify the role of each factor in shaping farmers' adaptation strategies.

Table 2. Results of Binary Logistic Regression Estimation of Rice Seed Selection Results

Independent Variables	Coefficient (β)	Std. Error	Wald	Sig. (p-value)	Odds Ratio
Constant	-1,842	0,721	6,53	0,011	0,159
Age (years)	0,018	0,012	2,25	0,134	1,018
Education (year)	-0,062	0,041	2,28	0,131	0,94
Farming experience (years)	0,091	0,029	9,83	0,002	1,095
Land area (ha)	-0,784	0,331	5,61	0,018	0,456
Environmental risk perception	0,963	0,284	11,5	0,001	2,619
Access to agricultural information	0,547	0,238	5,27	0,022	1,728
-2 Log Likelihood = 89.42 Nagelkerke R^2 = 0.41 Classification accuracy = 78.0%					

The −2 Log Likelihood (−2LL) value describes the degree of suitability of the logistic regression model to the observed data; smaller values indicate a better model for predicting the probability of the dependent variable. The −2LL value of 89.42 indicates that the model has a relatively low error rate, suggesting it is quite good at representing the pattern of farmers' decisions in selecting paddy rice seeds. In the context of farmer behavior research, the −2LL value in this range indicates that the model captures important information from the explanatory variables and warrants further interpretation.

The Nagelkerke R^2 value of 0.41 indicates that approximately 41% of the variation in farmers' decisions regarding paddy rice seed choice is explained by the independent variables in the logistic regression model, including farming experience, perception of environmental risks, land area, and access to agricultural information. In logistic regression, pseudo-R^2 measures such as Nagelkerke are not intended as direct equivalents of the determination coefficient in linear regression, but rather as indicators of the model's relative explanatory power for the phenomenon under study. Therefore, Nagelkerke R^2 values above 0.30 have generally been considered adequate to strong in socioeconomic and behavioral research, including farmer decision-making studies.

The Nagelkerke R^2 value of 0.41 in this study indicates that the model has a fairly substantial explanatory power, given that farmer decisions are complex behaviors influenced by many qualitative and contextual factors that are difficult to quantify. These findings are in line with previous studies showing that the logistic regression model used in studies of technology adoption and agricultural adaptation generally produces pseudo-R^2 values in the range of 0.20–0.45, which have been judged representative and feasible for policy conclusions. Thus, the Nagelkerke R^2 value obtained strengthens the argument that the environmental adaptation variables used in the model play an important role in shaping the selection decision of paddy rice seeds in tidal lands.

A classification accuracy of 78.0% means the logistic regression model correctly classified farmers' decisions (local vs. superior seeds) in 78 of 100 cases. This level of accuracy indicates that the model has strong predictive power, particularly in distinguishing farmers who choose local, superior varieties. In studies of decision-making behavior in the agricultural sector, classification accuracy above 70% is generally considered adequate, so a value of 78% reinforces the belief that the model is reliable enough to be used as a basis for analysis and policy recommendations.

The results of binary logistic regression estimation deepen our understanding of the determinants of decisions observed descriptively. Farming experience has a positive and significant effect on the likelihood of choosing local seeds (OR=1.095), indicating that accumulated experience increases farmers' confidence in varieties shown to be adaptive. These findings are consistent with the literature, which views experience as a key form of cognitive capital in agricultural decision-making in risky environments.

Environmental risk perception emerged as the strongest determinant (OR=2,619), confirming that awareness of the threat of tidal flooding and climate uncertainty directly drives defensive seed choices. These results corroborate evidence that risk perception, not just objective risk exposure, is the main driver of adaptation at the farmer level. Access to agricultural information also had a positive effect (OR=1,728), suggesting that although informal sources are dominant, connectivity with information (formal and informal) expands adaptation options and drives more robust decisions.

In contrast, land area had a significant negative effect (OR=0.456), indicating that farmers with larger land tend to have a higher risk tolerance and are more open to trying superior seeds. This differentiation aligns with the theory of business scale and risk behavior, which holds that the capacity to absorb losses increases with scale, enabling exploratory strategies. The variables of age and education were insignificant, suggesting that in the context of tidal land, site-specific experience factors and risk perceptions were more decisive than general demographic attributes.

If linked back to the decision stage, this determinant explains why, at the alternative evaluation stage, the criteria for environmental adaptation and outcome stability are dominant. Experienced farmers with high risk perceptions and adequate access to information will assess alternatives through a risk-reduction lens, leading them to choose local varieties. Thus, the regression findings do not stand alone; rather, they confirm descriptive patterns at each stage of the decision.

C. Implications of Seed Selection on Farming Sustainability

The implications of selecting paddy rice seeds for the sustainability of farming in tidal land are a consequence of decisions made by farmers at the previous stage. Seed selection not only affects short-term production outcomes but also influences economic efficiency, income stability, and the suitability of farming management to local agroecological conditions. Therefore, a sustainability analysis is carried out to assess the extent to which farmers' seed selection decisions contribute to the sustainability of the paddy farming system, both economically and environmentally, and to provide an evaluative basis for the formulation of sustainable tidal agricultural development strategies.

Table 3. Seed Selection Sustainability Indicator and Index Scores

Dimensions	Indicator	Normalization Score (Si)	Weight (Wi)	Weighted Score
Economy	Stability of production output	0,74	0,25	0,185
	Production cost efficiency	0,71	0,25	0,178
Environment	Compatibility of seeds with agroecology	0,78	0,25	0,195
	External input dependency	0,69	0,25	0,173
Total Sustainability Index (IK)			1	0,731

The analysis of the Sustainability Index (IK) yielded a value of 0.731, classified as quite sustainable, with the largest contributions from seed suitability for agroecology (0.195) and yield stability (0.185). This value confirms that seed selection, as an upstream decision, has a systemic impact on economic sustainability and the farming environment. From an economic perspective, cost efficiency (0.178) indicates that using local seeds helps reduce input costs and dependence on more expensive certified seeds, thereby increasing income resilience to price and production fluctuations.

From an environmental perspective, the high agroecological conformity score reflects the compatibility of local varieties with tidal conditions, thereby reducing the need for external inputs and environmental stress. The sustainability literature emphasizes that the suitability of technology with the local context is an important prerequisite for long-term sustainability, especially on suboptimal land. Nevertheless, the external input dependency score (0.173) indicates room for improvement, indicating that although local seeds are relatively adaptive, supportive practices (nutrient and water management) still determine sustainability outcomes.

When linked to high post-use satisfaction with seeds, this sustainability index explains a positive feedback mechanism: decisions that provide satisfaction and stable results increase the likelihood that the same practice will be sustained in the following season. This mechanism aligns with the concept of path dependence, in which early decisions shape the trajectory of subsequent practices, especially in risk-laden agricultural systems.

IV. CONCLUSION

This study concludes that farmers' decision-making in the selection of paddy rice seeds in the tidal lands of Barito Kuala Regency is a rational and gradual process of environmental adaptation, starting from the identification of needs due to high environmental risks, the search for information dominated by local experience, the evaluation of alternatives based on adaptability and yield stability, to purchasing decisions that tend to choose local varieties. Factors such as farming experience, perceptions of environmental risks, and access to agricultural information have proven important in shaping these decisions, while differences in business scale affect farmers' willingness to take technological risks. The selection of seeds by farmers has positive implications for the sustainability of paddy rice farming, with a sustainability index value of 0.731, indicating a quite sustainable category, mainly supported by the suitability of seeds for the agroecology of tidal land and the stability of production yields.

Based on these findings, it is suggested that seed development policies in tidal lands should not be uniform, but should place adaptive local seeds as an important part of sustainable agriculture strategies, while encouraging the innovation of superior varieties that are sensitive to local agroecological conditions. Strengthening the agricultural extension system, grounded in risk and local experience, is needed to expand farmers' access to information, especially for small-scale farmers, who are often more vulnerable to production failures. In addition, further research is suggested to integrate social and institutional dimensions, including the roles of farmer groups and local seed systems, to provide a more comprehensive picture of the dynamics of farmer decision-making and the sustainability of paddy rice farming systems in tidal lands.

V. ACKNOWLEDGMENTS

The researcher expressed his gratitude to the Institute for Research and Community Service (LPPM) of Lambung Mangkurat University for providing research funds through the Compulsory Lecturer Research Grant (PDWM) in 2025 with PNBP Financing of Lambung Mangkurat University for the 2025 Fiscal Year, Number: 1755/UN8/LT/2025 dated June 10, 2025..

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