

Predicting Divestment Decisions in Rice Farms Using Machine Learning Approach: A Mixed Method Study

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Abstract

This study examines the external factors influencing divestment decisions among smallhold rice farmers in Tacurong City, utilizing a mixed-method approach. By combining qualitative analysis of respondents' narratives with quantitative data, the research identifies key factors driving divestment. The findings highlight that persistent crop failures, rising production costs, low rice prices, and delayed or insufficient government support are central to farmers' decisions to sell their land. Family needs, particularly for food and education, often outweigh the tradition of rice farming. High input costs, such as for fertilizers, seeds, and labor, coupled with low rice prices, lead to debt accumulation and unsustainable farming practices. Although government subsidies provide some relief, delays and inadequacies force farmers to depend on high-interest loans or alternative sources of income. Despite the economic challenges, many farmers prioritize immediate survival over maintaining farming traditions. The study emphasizes that without effective interventions, including price stabilization, improved financial aid systems, and stronger community support, further divestment from rice farming is likely. This trend threatens the livelihoods of farmers and local food security. The mixed-method approach enabled a comprehensive understanding of the complex economic and social factors shaping divestment decisions, providing critical insights for addressing the challenges faced by farmers in Tacurong City.

Keywords: Divestment Decisions; Agricultural Sustainability; Knowledge Management; Business Resilience; Machine Learning; Food Security

1. Introduction

In the Philippines, rice production remains a vital sector supporting rural livelihoods and food security. Nonetheless, fluctuating rice prices, increasing production costs, and climatic risks place Tacurong City farmers in Sultan Kudarat under growing economic pressure, often leading them to abandon the rice sector (Satpathi, 2024; Rivera et al., 2022; Dizon et al., 2023). The formulation of policies that promote agricultural sustainability and economic resilience depends on understanding and predicting farmers' divestment choices. Recent advances in machine learning offer feasible approaches to enhance the prediction accuracy of agricultural decision-making, enabling early interventions to support farmers at risk (Wang, 2024; Chen & Yu, 2022; Mendoza & Ramos, 2021).

1.1 Divestment Decision of Rice Farms

In Tacurong City, Sultan Kudarat, the decision to divest from rice farming is shaped by multiple factors, including the age, education, and family structure of farmers. Older farmers are more likely to exit rice farming due to physical limitations and the difficulty in adapting to new agricultural practices (Santos et al., 2023). Moreover, many farmers in Tacurong with limited educational attainment struggle to implement modern techniques and are heavily impacted by fluctuating rice prices and low annual net income (Dizon et al., 2023; Tan & Rivera, 2022). The size and structure of farming families also influence this decision, as smaller families with fewer members available for labor face increased challenges in sustaining farm operations (Morales et al., 2022). Additionally, the lack of proper irrigation and poor infrastructure, such as inadequate farm-to-market roads, further burdens farmers, making it financially unviable for them to continue rice production in Tacurong (Lim & Tan, 2022).

1.2 Application of Machine Learning

Existing research on agricultural investment and risk management highlights a clear gap in predictive models for divestment among rice farmers in Tacurong City, Sultan Kudarat. While farm closure prediction has been widely studied, most research focuses on macroeconomic variables and climate change effects without considering the application of machine learning and behavioral economic theories (Wang, 2024; Zhang, 2020; Liu et al., 2021). Recent findings

emphasize that without a combined approach using both behavioral insights and technological models, predictions often miss the subtle but critical personal and environmental factors influencing farmers' decisions (Morimoto & Garcia, 2023; Alvarez et al., 2022). This study integrates qualitative and quantitative methods to develop a comprehensive framework for evaluating divestment decisions.

The primary goal of this study is to develop an accurate predictive model that can forecast when and why rice farmers decide to quit their farming operations. By using a machine learning approach, the project aims to identify significant economic, environmental, and social factors influencing divestment decisions (Xu et al., 2022; Ramirez et al., 2023; Chua & Dela Cruz, 2021). Using an explanatory sequential mixed-method design, this study first analyzes quantitative data with machine learning algorithms to identify statistical trends before conducting qualitative interviews with farmers to better understand the underlying causes of divestment. This approach ensures that the predictive model incorporates both statistical patterns and farmers' real-world experiences, improving resource allocation and policymaking (Patel & Singh, 2022; Lopez et al., 2023; Tanaka, 2024).

1.3 Theoretical Basis and Study Focus

This study is anchored on prospect theory and real options theory to explain farmers' divestment decisions. Prospect theory, developed by Kahneman and Tversky (1979), suggests that individuals evaluate potential gains and losses differently, often placing greater weight on perceived losses, which leads to risk-averse behavior during uncertain times (Barberis, 2021; Flores & Gomez, 2023; Kimura, 2022). In the context of rice farming, this theory helps explain why farmers might choose to exit the sector when faced with immediate financial hardships, even if there are potential long-term gains. Complementing this is real options theory, which views investment and divestment decisions as dynamic choices influenced by fluctuating market conditions (Dixit & Pindyck, 1994; Truong & Sims, 2020; Nakamura et al., 2023). Real options theory highlights that farmers may delay abandoning their rice farms until they gather sufficient information, given the irreversible nature of such a decision. Together, these theories provide a strong foundation for understanding the behavioral and economic factors that influence divestment among rice farmers.

This study is significant as it responds to the urgent challenges facing the Philippine agricultural sector, particularly rice farming, which is vital for food security and rural livelihoods (Cruz et al., 2022; Sarmiento & Yu, 2023; Velasco, 2024). In Tacurong City, where rice farming is a key livelihood, farmers are increasingly at risk of leaving the sector due to rising production costs, fluctuating prices, and climate-related risks, necessitating informed responses (Wang, 2024; Chen & Yu, 2022). By developing a predictive model through machine learning, this research provides valuable insights into the factors influencing farmers' divestment decisions and offers practical tools for designing more effective intervention strategies (Morimoto & Garcia, 2023; Alvarez et al., 2022). The study aims to support rural communities in Tacurong and Sultan Kudarat, strengthening agricultural productivity and ensuring continued food security in the region.

2. Material and Methods

2.1. Research Design

This study employed an explanatory sequential mixed-methods research design, integrating both quantitative and qualitative approaches to comprehensively examine the factors influencing divestment decisions among rice farmers. The first phase involved quantitative data collection and analysis to identify patterns and statistically significant predictors of divestment decisions. This was followed by a qualitative phase designed to explain, elaborate, and provide deeper insights into the quantitative findings. The integration of machine learning-based predictions and qualitative thematic insights enabled a more holistic understanding of the socioeconomic and cultural drivers behind farmers' divestment decisions.

2.2 Research Locale

The research was conducted in Tacurong City, Sultan Kudarat, a well-known rice-producing area in the Philippines. The city plays a significant role in regional rice production but faces persistent agricultural challenges such as climate variability, fluctuating market prices, and increasing production costs. These challenges make the area suitable for examining factors influencing farmers' decisions to divest from rice farming. The locale provided a relevant context for understanding both economic and environmental pressures affecting smallhold rice farmers.

2.3 Respondents of the Study

The respondents of the study were primary smallhold rice farmers with at least five years of experience in rice farming. Farmers who were tenants or primarily engaged in cultivating crops other than rice were excluded from the study to maintain focus and consistency. A snowball sampling technique was utilized to identify qualified participants, beginning with initial respondents who referred other eligible farmers. This method ensured that participants had sufficient experience and firsthand knowledge to provide meaningful insights into divestment decisions.

2.4 Research Instrument

Data were collected using two primary research instruments: a structured survey questionnaire and a semi-structured interview guide. The survey questionnaire was used during the quantitative phase to gather demographic information and data related to divestment decisions and influencing factors. The semi-structured interview guide was utilized in the qualitative phase to explore participants' personal experiences, perceptions, and motivations regarding divestment. The combination of these instruments allowed for both measurable data collection and in-depth exploration of contextual factors.

2.5 Data Specification

Data	Specification
Age	Continuous variable (measured in years)
Gender	Categorical variable (1 = Male, 2 = Female)
Marital Status	Categorical variable (1 = Single, 2 = Married, 3 = Widowed, 4 = Others)
Educational Attainment	Categorical variable (1 = No Schooling, 2 = Elementary, 3 = High School, 4 = College, 5 = Graduate Studies)
Members of the Family in School	Discrete variable (number of family members currently enrolled in school)
Family Structure	Categorical variable (1 = Nuclear, 2 = Extended, 3 = Single Parent, 4 = Others)
Number of Family Members	Discrete variable (total number of family members)
Irrigation Status	Categorical variable (1 = Irrigated, 2 = Rainfed)
Farm to Market Road Accessibility	Categorical variable (1 = Accessible, 2 = Not Accessible)
Price of Palay per Kilo	Continuous variable (price in local currency per kilogram)
Net Annual Income	Continuous variable (annual net income in local currency)

2.6 Data Gathering Procedure

The data gathering process was conducted in two sequential phases consistent with the explanatory mixed-methods design. In the first phase, survey questionnaires were distributed to identified rice farmers to collect quantitative data on demographic characteristics and divestment-related variables. After analyzing the quantitative results, selected participants were invited to participate in semi-structured interviews to further explain and contextualize the statistical findings. This sequential procedure ensured that qualitative insights were grounded in and directly linked to the quantitative results.

2.7 Statistical Treatment of the Data

Descriptive statistics, specifically frequency and percentage distribution, were used to summarize the demographic profile of respondents and their divestment decisions. Logistic regression analysis was employed to determine the influence of various socioeconomic, environmental, and technological factors on the likelihood of divestment. Additionally, machine learning techniques were integrated to enhance predictive modeling of divestment behavior. For the qualitative data, thematic analysis was conducted to identify recurring patterns and key themes such as economic pressures, environmental stress, social influences, and technological factors. The integration of statistical analysis and thematic interpretation provided a comprehensive understanding of the research problem.

3. Results and Discussion

3.1 Profile of Rice Farm Owners

Understanding the profile of rice farm owners is crucial in determining the factors that may influence their decision to divest from rice farming. The following sections discuss the respondents' age, gender, marital status, educational attainment, family structure, family size, and economic conditions.

3.1.1 Age of Rice Farmers

The results indicate that the majority of rice farm owners belong to the age group of 41-70 years old, with the highest concentration in the 61-70 (24.76%) and 41-50 (23.81%) age brackets. This suggests that rice farming in Tacurong City is largely dominated by middle-aged and older individuals. The presence of a smaller proportion of younger farmers (21-30 years old at 5.71%) indicates a potential generational gap, which may pose challenges for the long-term sustainability of the industry. The aging farmer population may contribute to divestment decisions; as older farmers might opt for retirement or find it increasingly difficult to manage farm operations.

3.1.2 Gender of Rice Farmers

The study reveals that 64.76% of rice farm owners are male, while 35.24% are female. This finding reflects the traditional gender roles in the agricultural sector, where men are more likely to own and manage farms, while women often take on

supportive roles. However, the presence of a significant proportion of female farm owners suggests that women actively contribute to agricultural decision-making. Gender dynamics may influence divestment decisions, as female-headed farms might face unique challenges related to land ownership, access to financial resources, and labor availability.

3.1.3 Marital Status of Rice Farmers

Marital status plays a significant role in farm management and decision-making. The findings show that 77.14% of respondents are married, followed by widowed individuals (14.29%) and single farm owners (8.57%). The absence of separated respondents suggests that family stability is a common characteristic among rice farmers. Married individuals may have more stable sources of labor through family members, but they may also face higher financial obligations, which could influence divestment decisions. Badstue et al. (2020) highlight that marital status influences access to resources and decision-making capacities in agricultural households. Their research emphasizes that married individuals often benefit from collaborative relationships within the family, which can enhance farm productivity and sustainability. Wicklow and Shortall (2024) explore the dynamics of farm families, noting that marital status impacts labor availability and financial obligations. They found that married farm owners often rely on family labor but face challenges in balancing household expenses and farm investments.

3.1.4 Educational Attainment of Rice Farmers

Education is a key factor in agricultural decision-making, as it affects farmers' ability to adopt new technologies, access financial resources, and engage in business-oriented farming. The study shows that the highest percentage of respondents are college graduates (30.48%), followed by those with some college education (19.05%) and high school graduates (18.10%). A well-educated farming population suggests that farm owners may be more open to innovations and alternative livelihood opportunities. The presence of individuals with only elementary education (9.52%) indicates that some farmers may have limited access to information and financial management skills, which could affect their ability to sustain farm operations.

3.1.5 Family Structure of Rice Farmers

The study classifies farm owners into three types of family structures: nuclear (69.52%), extended (14.29%), and others (16.19%). The dominance of nuclear families suggests that most farm owners manage their farms independently, without extended family support. Extended families may have more labor resources, while nuclear families may face challenges in terms of manpower, which could influence their decision to divest, especially when children pursue careers outside of agriculture.

3.1.6 Irrigation Status of Farms

Irrigation access significantly impacts farm productivity. The findings show that 77.14% of farms are irrigated, while 22.86% rely on rain-fed systems. Irrigation access significantly impacts farm productivity, as irrigated farms generally have higher yields and are more resilient to climate variability, while rain-fed farms face higher risks of crop failure. Farmers with rain-fed farms may be more likely to divest due to lower productivity and profitability.

3.1.7 Access to Farm-to-Market Roads

The study finds that 60% of rice farm owners lack access to farm-to-market roads, while only 40% have access. Poor road access increases transportation costs, limits market opportunities, and reduces profitability.

3.1.8 Members of the Family Continuing Education, Number of Family members, Price of Palay and Annual net income.

The data provided on Table 8 reveals insights into various factors influencing rice farm owners and their circumstances. The number of family members continuing education ranges from 0 to 5, with a mean of 0.905 and a standard deviation of 1.21. This indicates that, on average, fewer than one family member per household is involved in education, though there is variability. This suggests financial constraints may limit educational opportunities within families, which could influence the farm owner's capacity to make long-term investments, including decisions about divestment.

For the total number of family members, the range spans from 1 to 9, with a mean of 4.24 and a standard deviation of 1.81. This highlights that rice farming households tend to have medium to large family sizes, which may lead to both economic pressure and a need for additional sources of income, further impacting divestment decisions. The price of palay (unmilled rice) varies between PHP 15.5 and PHP 22 per kilo, with a mean price of PHP 17.11 and a standard deviation of 1.27. This relatively narrow range reflects market conditions for rice farmers in Tacurong City. A price closer to the lower end of the range might result in reduced profitability and heightened financial stress, pushing farm owners toward divestment.

Lastly, the annual net income displays significant variation, ranging from a deficit of PHP -55,607 to a maximum of PHP 211,393, with an average of PHP -2,332 and a standard deviation of PHP 177,893. This substantial variability, combined

with the negative average income, points to financial instability among rice farmers. Many may be incurring losses, which likely pressures them to consider divesting their farms to stabilize their household income.

3.2 Divestment Decision of Rice Farm Owners

The data on divestment decisions among rice farm owners reveals that out of the 105 respondents, 20 farmers (19.05%) chose to divest, while 85 farmers (80.95%) opted to retain their farms. This indicates that the majority of rice farm owners decide to continue farming despite significant challenges. However, the minority who choose to divest highlight critical issues that make it difficult for them to sustain their agricultural activities, such as fluctuating market prices, high production costs, and limited financial support.

Farmers who chose divestment often cited financial instability as the driving factor behind their decision. Fluctuating market prices emerged as a key challenge, with some farmers reporting that the farm-gate price for rice often falls to as low as ₱15-16 per kilo, making it nearly impossible to recover production costs. Conversely, the majority of farmers (80.95%) chose to retain their farms, demonstrating resilience and adaptability in the face of these challenges. Many retained farmers adopt strategies to mitigate economic pressures, such as diversifying crops, cutting costs, and exploring cooperative farming systems.

3.3 The influence of Demographic Profile ON Divestment Decision

The analysis identifies key predictors influencing divestment decisions among farmers. The number of family members continuing school, irrigation status, price of palay per kilo, and net annual income significantly affect the likelihood of divestment. Specifically, more family members in school ($B = -0.409$, $\text{Sig.} = 0.001$) and access to irrigation ($B = -1.169$, $\text{Sig.} = 0.014$) decrease divestment odds, suggesting that educational aspirations and improved farm productivity encourage farm retention. Lower palay prices ($B = -0.177$, $\text{Sig.} = 0.035$) and lower net annual income ($B = 0.000$, $\text{Sig.} = 0.04$) increase divestment risks, indicating that profitability remains crucial for sustaining farming activities. Odds ratios further reveal that irrigation access reduces divestment likelihood by 69%, and every drop in palay price increases divestment risk by 16.2%.

Other variables such as age, gender, marital status, educational attainment, family structure, number of family members, and farm-to-market road accessibility show no significant impact on divestment decisions ($\text{Sig.} > 0.05$). These findings are consistent with previous studies, including Llanto (2020), Meza and Valera (2020), and Ruhinduka et al. (2020), which emphasize the critical role of irrigation access, market prices, and financial stability in farm sustainability. This highlights the need for targeted interventions to support farmers through improved irrigation systems, better price mechanisms, and strengthened financial resilience.

3.4 Qualitative Analysis

3.4.1 Theme 1: Economic Pressure

Rice farmers in the Philippines are under increasing economic strain due to several interconnected challenges: surging production costs, persistently low farm-gate prices, limited access to affordable credit, and the rapid conversion of agricultural land. Rising input prices, particularly fertilizers affected by global supply chain disruptions (International Rice Research Institute, 2022), combined with the high cost of mechanization (ADB, 2022), have severely impacted farmers' profitability. The Rice Tariffication Law (Philippine Institute for Development Studies, 2021) further intensified this problem by introducing cheaper imported rice, driving down local prices. Access to credit remains limited, pushing farmers toward informal lenders and unsustainable debt cycles (Social Science Research Network, 2023). Although government credit programs exist, they often fail to reach the majority of small-scale farmers (ADB, 2022; Philippine Statistics Authority, 2024). Simultaneously, urbanization pressures and land conversion reduce available farmland, as reported by the Department of Agrarian Reform (2023), further threatening rice production sustainability. This situation is consistent with recent findings by Mendoza and Serrano (2023), who noted that structural weaknesses in rural financing and land-use governance accelerate rural disinvestment and agricultural abandonment.

The study revealed that economic pressure is a primary driver behind farmers' decisions to divest or consider alternative farming strategies. Informants consistently cited rising production costs, such as fertilizer, seeds, and operational expenses, alongside the persistently low market price of rice as critical factors influencing their decisions. Many farmers highlighted that income from farming is insufficient to support their families' needs, particularly with the financial burden of sending children to school. While some attempted coping mechanisms, such as crop diversification and drying rice for better market prices, many saw land selling as the only viable option to ease financial stress. Additionally, government subsidies were noted to be insufficient and often delayed, further exacerbating farmers' vulnerability.

3.4.2 Theme 2: Community Influences

Community-based structures such as farmer cooperatives, special support networks, and community-based market access play a crucial role in strengthening the resilience of rice farm owners against financial and operational pressures. Farmer

cooperatives help smallholders reduce costs, access modern technologies, and negotiate better prices through collective action (FAO, 2023). Special support networks, including local organizations and government agencies, provide funding, technical training, and disaster preparedness resources, promoting climate-resilient farming practices (Spezia et al., 2024). Additionally, community-based trade networks connect farmers directly to larger markets, improving profitability and reducing reliance on exploitative intermediaries, as noted by O'Mara-Eves et al. (2015). Together, these community initiatives enhance the economic stability and long-term sustainability of farming communities.

The study reveals that community influences, particularly the strength or absence of farmer cooperatives, support networks, and market access, play a significant role in rice farm owners' divestment decisions. Farmers expressed that family expectations, economic hardships, and the declining profitability of farming pushed them toward selling their farmland. Informants cited the high cost of inputs, low price of palay, insufficient harvest yields, and the unstable market as major contributors to their financial struggles. Despite the presence of some community support, most farmers highlighted the inadequacy of tangible assistance to offset rising production costs and market uncertainties. This is consistent with the findings of Rola et al. (2021), who reported that weak institutional and community support exacerbates the vulnerability of smallholder farmers. Similarly, recent research by Magsino et al. (2023) emphasized that while community structures are vital for agricultural resilience, their ineffectiveness or absence accelerates farmers' decisions to abandon farming. The farmers' testimonies in this study demonstrate how fragile and underperforming support systems influence the increasing trend of farmland divestment.

4. Conclusion

The findings reveal that rising production costs, low rice market prices, and delayed or insufficient financial support are major factors driving rice farmers to divest their land. Family needs, economic hardships, and lack of strong community or cooperative support further pressure farmers to abandon traditional farming practices. Many respondents emphasized that survival and daily sustenance outweigh the value of preserving farming traditions. Even when assistance is available, it is often delayed, inadequate, or inaccessible, leaving farmers heavily indebted. Overall, improving market conditions, timely financial aid, and stronger community support are crucial to sustaining rice farming livelihoods. Without immediate and effective intervention, more farmers may permanently shift away from rice cultivation. This trend threatens not only their economic security but also the long-term stability of local food systems.

Compliance with ethical standards

This study was conducted in accordance with established ethical research standards and received approval from the appropriate institutional ethics committee prior to data collection. All participants were informed about the purpose and procedures of the research, and written informed consent was obtained before their voluntary participation. The study adhered to the ethical principles, ensuring respect, confidentiality, and the protection of participants' rights throughout the mixed-method process. The authors declare that there are no conflicts of interest related to this study

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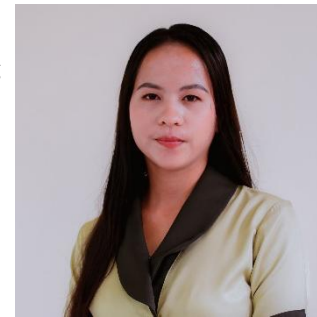
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