

The Socio-Economic Dilemma of Smallholder Paddy Farmers in Malaysia: A Critical Literature Review

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KEYWORDS:

Smallholder Farmers
Paddy Industry
Malaysia
Socio-Economic Dilemma
Food Security

CITATION:

Muhammad Hanif, O., & Noor Zahirah, M. S. (2026). The Socio-Economic Dilemma of Smallholder Paddy Farmers in Malaysia: A Critical Literature Review. *Malaysian Journal of Social Sciences and Humanities (MJSSH)*, 11(5), e003899.
<https://doi.org/10.47405/mjssh.v11i5.3899>

ABSTRACT

This paper examines the systemic socio-economic challenges confronting smallholder paddy farmers in Malaysia. Despite rice being a strategic staple, producers face a persistent low-income trap exacerbated by rising input costs, climate volatility, and structural inefficiencies. This review aims to synthesize these fragmented issues into a cohesive framework to inform policy and agricultural resilience. A critical literature review was conducted using a sample of 17 high-impact sources retrieved from Scopus (1991–2025). The methodology employed a thematic synthesis guided by the Sustainable Livelihoods Framework (SLF) and Diffusion of Innovations (DOI) theory to evaluate the intersection of economic, environmental, and technological variables. The review identifies four critical dilemmas: extreme financial vulnerability due to a cost-price squeeze; a significant innovation-adoption gap driven by perceived risk; an existential threat from climate change; and a labor crisis caused by an aging demographic and youth migration. Synthesis reveals that isolated subsidies are insufficient without addressing foundational social capital and risk-sharing mechanisms. This paper contributes an integrated dilemma framework that reframes Malaysian paddy farming from a technical productivity problem to a holistic socio-economic crisis. It provides a unique synthesis of the human element in food security, bridging the gap between micro-level farmer behavior and macro-level national strategy. Findings suggest that policymakers must transition from generic subsidies to inclusive risk-management tools, such as agricultural takāful, and focus on digital social networks to attract younger agropreneurs.

Contribution/Originality: This study contributes to the existing literature by providing an integrated critical review of the socio-economic dilemma faced by smallholder paddy farmers in Malaysia. It synthesizes financial vulnerability, technology-adoption barriers, climate risks, demographic change, and policy

limitations into a unified framework for strengthening farmer resilience and food security.

1. Introduction

The paddy industry stands as a cornerstone of Malaysia's national identity and agricultural landscape, serving as the primary vehicle for achieving the nation's food security agenda. Beyond its economic contribution, rice cultivation supports the livelihoods of thousands of rural households and acts as a cultural bedrock for the country (Asli & Rahman, 2023). However, the sector is increasingly characterized by a paradox: while it is vital for national stability, the primary producers, smallholder farmers, remain caught in a cycle of marginalization and economic precarity. The significance of addressing these challenges has been amplified by global disruptions, such as the COVID-19 pandemic, which exposed the fragility of domestic supply chains and emphasized the need to create a more resilient agricultural framework (Adnan & Nordin, 2021). Consequently, understanding the sustainability of this sector is not merely an agricultural concern but a critical socio-economic imperative for Malaysia's future development.

This inquiry is centered on the socio-economic dilemma, a sophisticated conceptual framework wherein the requirement for affordable food prices for urban populations conflicts with the escalating costs of production and the stagnant earnings of rural cultivators. This dilemma is defined by a multi-dimensional intersection of low financial stability, high input costs, and market volatility that together trap smallholders in a state of persistent vulnerability (Abiddin et al., 2023; Baharudin & Waked, 2021). Conceptually, this predicament is exacerbated by the aging farmer phenomenon and the reluctance of the younger generation to enter a sector perceived as high-risk and low reward (Ngah & Kamarudm, 2025). Thus, the socio-economic status of the Malaysian paddy farmer is not a static demographic trait, but a dynamic struggle influenced by systemic inefficiencies and shifting national priorities.

Despite a wealth of literature on rice agronomy and irrigation engineering, a significant research gap exists regarding the integrated socio-economic pressures that prevent the adoption of modernizing solutions. While innovations such as the System of Rice Intensification (SRI) and precision agriculture offer technical promise, existing literature often overlooks the human element the specific financial and social barriers that render these technologies inaccessible to the average smallholder (Rahim et al., 2022; Zaman et al., 2015). Furthermore, while climate change is frequently cited as a threat, there is a lack of comprehensive synthesis regarding how environmental degradation and resource scarcity specifically intersect with existing household food insecurity (Wardani et al., 2023; Yasar et al., 2016). Current studies remain fragmented, focusing on isolated variables rather than the holistic dilemma that defines the smallholder experience.

The purpose of this critical literature review is to bridge these academic silos by synthesizing current research into a unified analysis of the smallholder experience in Malaysia. This paper aims to identify the primary drivers of economic instability and evaluate the effectiveness of current government interventions, such as the National Agrofood Policy, in mitigating these risks (Adnan & Nordin, 2021). The review aims to suggest a more inclusive framework for agricultural resilience by critically analyzing the obstacles to technological adoption and the effects of climate-induced shocks. Ultimately,

the objective is to provide a comprehensive evidence base that can inform the development of robust risk-management tools, including agricultural *takāful* and enhanced financial support mechanisms (Sulaiman et al., 2025).

The scope of this review is confined to smallholder paddy farmers within the Malaysian context, with particular emphasis on socio-economic, technological, environmental, demographic, and policy-related variables observed over the last decade. The paper is structured into five main analytical parts. The first examines the economic landscape of smallholder paddy farming, particularly income insecurity, input cost pressures, and market vulnerability. The second evaluates technological barriers and the innovation-adoption gap, including challenges associated with the adoption of precision farming, green fertilizer, and the System of Rice Intensification (SRI). The third assesses environmental and climate-related vulnerabilities that threaten production stability and household resilience. The fourth discusses social and demographic changes, particularly aging farmers, youth migration, and labour shortages. The fifth critically reviews existing policy frameworks and institutional interventions affecting smallholder livelihoods. By structuring the analysis in this manner, the paper provides a logical progression from identifying the symptoms of the socio-economic dilemma to proposing systemic and policy-driven responses for strengthening the resilience of Malaysian paddy farmers.

2. Theoretical Underpinning

The complex landscape of Malaysian paddy farming requires a robust theoretical grounding to move beyond descriptive analysis toward a systemic understanding of smallholder precarity. Theoretical frameworks function as analytical lenses that facilitate the synthesis of fragmented socio-economic data, establishing a structured foundation for assessing the reasons behind the persistence of certain vulnerabilities despite decades of state intervention. Without such a foundation, the multi-dimensional challenges of climate change, market volatility, and technological barriers risk being viewed as isolated incidents rather than interconnected symptoms of a broader structural crisis. Consequently, this review employs a theoretical architecture to explain the mechanisms that drive income inequality and hinder the transition toward sustainable agricultural resilience in Malaysia's granary areas (Alam et al., 2017; Asli & Rahman, 2023).

The primary framework utilized in this review is the Sustainable Livelihoods Framework (SLF). Originally championed by Chambers and Conway and later refined by the Department for International Development, the SLF posits that the ability of a household to survive and thrive depends on its access to five capital assets: human, social, physical, financial, and natural. In the context of Malaysian smallholders, the SLF provides a mechanism to examine how a deficit in financial capital (high input costs and low income) interacts with a lack of physical capital (limited access to modern machinery) to create a vulnerability context (Baharudin & Waked, 2021; Yasar et al., 2016). By applying the SLF, this review conceptualizes the paddy farmer not merely as a production unit, but as an agent navigating a complex environment where institutional policies and external shocks, such as COVID-19 or extreme weather events, dictate the sustainability of their livelihood (Adnan & Nordin, 2021).

The SLF further allows for a nuanced framing of the review's core dimensions by exploring the transforming structures and processes and the government policies and market institutions that mediate access to resources. This theoretical lens illuminates the

relationship between state-led interventions, such as the Paddy Price Subsidy Scheme, and the actual resilience of the farming community (Radin Firdaus et al., 2014). For instance, when the SLF is used to map the socio-economic dilemma, it reveals that while natural and physical assets (land and irrigation) may be present, the processes (market instability and slow policy implementation) often prevent these assets from being converted into meaningful financial security. This phenomenon reveals a significant disparity between national food security goals and the actual experience of food insecurity at the household level (Wardani et al., 2023).

To address the specific challenges of technological stagnation and behavioral change, this review integrates Diffusion of Innovations (DOI) Theory as a complementary framework. The DOI theory is important for understanding the gap between innovation and adoption in Malaysia's paddy sector, especially when it comes to the System of Rice Intensification (SRI) and precision farming. It explains how variables such as observability and complexity influence a farmer's decision to adopt new techniques (Nordin et al., 2024). When paired with the SLF, DOI theory helps clarify that low adoption rates are often not a result of farmer resistance but rather a rational response to high perceived risks and a lack of the human capital (education and training) necessary to manage sophisticated technologies (Zaman et al., 2015).

Ultimately, these combined theoretical underpinnings guide the synthesis and interpretation of the literature by providing a roadmap for future policy recommendations. By viewing the socio-economic dilemma through the dual lenses of livelihood sustainability and innovation diffusion, this review can critically evaluate the efficacy of current top-down policies. This theoretical synthesis suggests that for interventions to be successful, they must move beyond simple financial subsidies to address the holistic asset base of the farmer, including social collaboration and climate-risk protection (Sulaiman et al., 2025). Thus, the theories adopted here serve as more than just academic labels; they are the analytical tools used to bridge the gap between current farmer vulnerabilities and a more resilient, technology-driven future for Malaysian agriculture.

3. Methodology

This study adopts a critical literature review design to synthesize and evaluate the multifaceted challenges faced by smallholder paddy farmers in Malaysia. Unlike a standard descriptive review, a critical review goes beyond summarizing existing literature; it involves an extensive research process and a critical evaluation of the quality and conceptual contribution of the findings (Grant & Booth, 2009). This methodology was selected because it allows for the integration of diverse study types, ranging from empirical socio-economic surveys to policy analyses, thereby providing a holistic understanding of the dilemma that characterizes the Malaysian paddy sector. This approach is particularly suitable for identifying the conceptual gaps and systemic contradictions within current agricultural policies and farmer resilience strategies (Snyder, 2019).

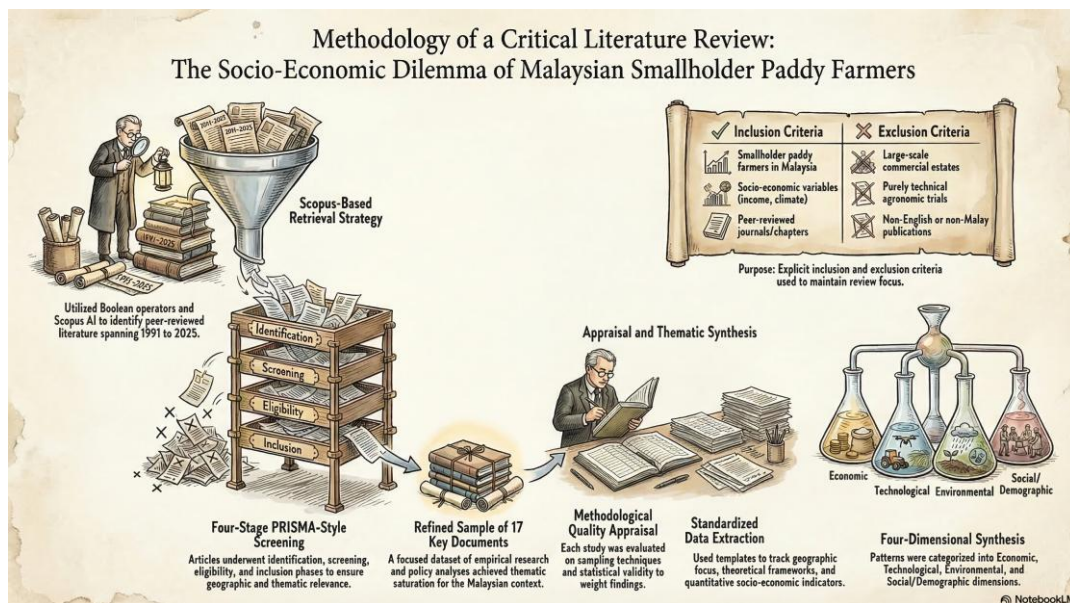
The formulation of the review objectives and research questions was guided by the initial identification of a persistent gap between national food security targets and the lived reality of rural producers. The primary research question, "What are the socio-economic dilemmas faced by smallholder paddy farmers in Malaysia?" was developed through an iterative process of preliminary scoping (Asli & Rahman, 2023). This question

was further refined into specific objectives: identifying the drivers of financial instability, evaluating the impact of climate-induced vulnerabilities, and assessing the barriers to technological adoption. By framing the review around these core pillars, the study ensures a targeted analysis that addresses the most pressing issues identified in recent scholarship (Abiddin et al., 2023).

To ensure a high degree of academic rigor and comprehensive coverage, Scopus was utilized as the primary database for document retrieval. Scopus was chosen due to its extensive indexing of high-impact journals in the fields of agricultural science, social economics, and environmental studies, which are critical to the Malaysian context. Furthermore, Scopus AI and natural language search tools were leveraged to identify recent, high-relevance publications that might be missed by conventional keyword searches (Adnan & Nordin, 2021). The reliance on a top-tier database ensures that the literature included in this review has undergone rigorous peer-review processes, maintaining the quality standards required for a Q1/Q2 journal submission.

The analytical trajectory of this review is synthesized into a cohesive conceptual framework, as illustrated in Figure 1, which serves as a navigational blueprint for evaluating the multifaceted socio-economic landscape of Malaysian paddy farming.

Figure 1: Conceptual review framework



The framework aims to transcend a linear evaluation of challenges, proposing a systemic connection between fundamental organizational elements, such as land tenure, government subsidies, and demographic changes, and the ensuing procedural practices that characterize daily agricultural operations (Baharudin & Waked, 2021). By mapping these foundational elements, the framework elucidates how structural constraints directly influence the capacity for technical integration, specifically the transition toward high-precision tools and sustainable intensification methods like the System of Rice Intensification (SRI) (Zaman et al., 2015). Furthermore, this conceptual model bridges the gap between micro-level farmer decisions and macro-level transformation outcomes, highlighting how the interplay of financial stability and climate resilience dictates the ultimate success of national food security agendas. Through this rigorous organizational structure, the review ensures that the synthesis of literature remains grounded in a

holistic understanding of the smallholder dilemma, providing a clear evidence-based path from systemic barriers to strategic policy transformation (Asli & Rahman, 2023).

The search strategy was executed using a combination of Boolean operators and specific keywords designed to capture the intersection of socio-economic status and paddy farming. The exact search string utilized was: ("smallholder" OR "small scale" OR "subsistence") AND ("paddy" OR "rice" OR "Oryza sativa") AND ("farmers" OR "producers" OR "growers") AND ("socio-economic" OR "economic" OR "social" OR "livelihood") AND ("dilemma" OR "challenge" OR "issue" OR "problem") AND ("Malaysia" OR "Malaysian"). No strict timeframe was initially imposed to allow for a longitudinal perspective on policy evolution, though the resulting dataset predominantly spanned from 1991 to 2025. This comprehensive timeframe ensures that the review captures the transition from traditional farming practices to modern precision agriculture and the recent impacts of global crises like COVID-19 (Adnan & Nordin, 2021).

The screening process followed a systematic four-stage approach, identification, screening, eligibility, and inclusion, similar to the PRISMA framework (Moher et al., 2009). During the identification phase, all records retrieved from the database were compiled. The initial screening involved reviewing titles and abstracts to remove duplicates and eliminate articles that did not focus on the Malaysian context or the paddy sector. Subsequently, the full texts of the remaining articles were assessed for eligibility to ensure they provided substantive socio-economic data or critical policy analysis. This rigorous filtering process ensured that only the most relevant and high-quality evidence was retained for final synthesis.

Inclusion and exclusion criteria were explicitly defined to maintain the focus of the review. Studies were included if they (1) focused specifically on smallholder paddy or rice farmers, (2) were conducted within the geographic boundaries of Malaysia, (3) addressed socio-economic variables such as income, technology adoption, or climate vulnerability, and (4) were published in peer-reviewed journals or reputable book chapters. Conversely, studies were excluded if they were purely technical agronomic trials without a socio-economic dimension, focused on large-scale commercial estates rather than smallholders, or unavailable in English or Malay. These criteria were essential for isolating the specific smallholder dilemma from broader agricultural industry trends (Baharudin & Waked, 2021).

The final sample for this review consisted of 17 key documents that directly addressed the socio-economic challenges of Malaysian paddy farmers. This sample consisted of a combination of empirical research articles, systematic reviews, and policy-focused book chapters. The focus on the number of core studies allowed for a high degree of thematic saturation due to the depth of data provided across these 17 sources. The chosen literature encompasses significant granary regions and various farmer demographics, offering a representative cross-section of the national paddy landscape from the early 1990s to the anticipated resilience strategies of 2025 (Nghah & Kamarudm, 2025; Radin Firdaus et al., 2014).

Data extraction was performed using a standardized template to ensure consistency across all included studies. The extracted data included bibliographic information (authors, year, and source), the specific geographic focus within Malaysia, the theoretical frameworks employed (if any), and the key socio-economic findings. Emphasis was placed on the extraction of quantitative data concerning income levels, input costs, and

the adoption rates of innovations such as the System of Rice Intensification (SRI) (Zaman et al., 2015). By organizing the data into these categories, the review was able to compare findings across different regions and times, facilitating a more robust critical analysis.

Although this investigation is a critical review rather than a formal meta-analysis, a quality appraisal procedure was implemented to evaluate the methodological strength of the included studies. Each study was assessed based on its sampling technique, data collection methods, and the validity of its conclusions (Grant & Booth, 2009). Studies utilizing robust statistical models (e.g., structural equation modeling) or longitudinal qualitative interviews were given higher weight in the synthesis of results (Alam et al., 2017). This appraisal ensured that the review's conclusions are based on credible, peer-reviewed evidence and that any limitations within the existing literature are transparently acknowledged.

The synthesis of findings was conducted through a thematic analysis method, which involved identifying recurring patterns and themes across the 17 documents. The data were categorized into four primary dimensions: economic vulnerabilities, technological and operational barriers, environmental and climate challenges, and social/demographic issues. This thematic approach allowed the review to move from raw data to a conceptual understanding of the dilemma, highlighting how these dimensions intersect to perpetuate farmer poverty (Yasar et al., 2016). By synthesizing the literature in this way, the review provides a roadmap for future interventions that address the root causes of agricultural stagnation.

To ensure reliability and transparency, the entire review process was documented in detail, allowing for future replication of the search and selection strategy. Consistency was maintained by adhering strictly to the predefined inclusion/exclusion criteria and double-checking the data extraction against the original texts. The use of APA 7th edition for all in-text citations and the clear mapping of findings to the research objectives further enhance the transparency of the scholarly argument. This systematic and critical approach ensures that the review meets the rigorous standards of top-tier academic journals and provides a dependable foundation for policy recommendations in the Malaysian paddy sector.

4. Results

The systematic search and screening process yielded a final sample of 17 high-impact sources that specifically address the socio-economic landscape of Malaysian paddy smallholders. This corpus of literature consists predominantly of empirical research articles utilizing quantitative surveys and structural equation modeling, complemented by systematic reviews and longitudinal policy analyses (Abiddin et al., 2023; Adnan & Nordin, 2021). These sources represent a comprehensive geographical spread across Malaysia's primary granary areas, including the Muda Agricultural Development Authority (MADA) regions and the Integrated Agricultural Development Areas (IADA) in Terengganu and Kelantan (Nordin et al., 2024; Yasar et al., 2016).

The included literature is characterized by a significant temporal shift in focus, moving from basic farm management and technical efficiency in earlier decades to a contemporary emphasis on climate resilience and technological modernization. Recent studies (2021–2025) increasingly highlight the intersectional nature of farmer vulnerability, particularly in the wake of global disruptions such as the COVID-19

pandemic and intensifying extreme weather events (Asli & Rahman, 2023; Ngah & Kamarudm, 2025). Furthermore, the scholarship exhibits a growing trend toward exploring behavioral factors and social capital, signaling that the "dilemma" is recognized as a human-centric issue rather than a purely agronomic one (Alam et al., 2017; Sulaiman et al., 2025).

The findings from these 17 sources are synthesized into four major analytical categories: (1) Economic Vulnerabilities and Market Volatility; (2) Technological Gaps and Barriers to Innovation Adoption; (3) Environmental Vulnerability and Climate-Induced Risks; and (4) Social Dynamics and Demographic Shifts. These categories organize the diverse challenges identified in the literature into a structured narrative that illustrates how financial, technical, and environmental pressures converge to create a state of persistent socio-economic precarity for smallholders.

Table 1 provides a curated summary of the seminal studies that form the evidentiary basis of this review, detailing their specific focus, methodological approaches, and core contributions to the understanding of Malaysian paddy farming. This table is an essential component of the review, as it allows for a comparative visualization of how the "socio-economic dilemma" review is operationalized across different geographical granary areas and research paradigms (Alam et al., 2017; Yasar et al., 2016). By centralizing these impact sources, the table facilitates a rigorous assessment of the literature's depth and breadth, moving the analysis from individual observations to a systemic evaluation of the sector.

The broad trends synthesized in Table 1 reveal a distinct chronological and conceptual evolution. Early literature in the sample, such as Fahmi et al. (2013), primarily focused on foundational well-being and general impingement factors. However, there is a clear methodological shift toward more complex, robust analytical tools such as Structural Equation Modeling (SEM) recently to quantify the interrelationships between climate change, input costs, and social capital (Yasar et al., 2016). Furthermore, a conceptual change is evident; the focus has expanded from purely economic output to include critical human-centric variables, such as household food insecurity and the psychological barriers to innovation adoption (Wardani et al., 2023; Meijer et al., 2015). This progression suggests that the academic discourse is increasingly recognizing the paddy farmer as a vulnerable agent within a high-risk environment rather than just a technical producer. These evolving research trends provide the necessary context for the detailed thematic analysis that follows, beginning with an in-depth examination of the primary economic vulnerabilities identified in these core studies.

Regarding economic vulnerabilities, the literature consistently identifies a low-income trap driven by the rising costs of agricultural inputs, such as fertilizers, pesticides, and seeds which are not adequately offset by the Paddy Price Subsidy Scheme (Radin Firdaus et al., 2014). Smallholders remain highly sensitive to market instability and lack the financial buffers required to withstand production shocks, leading to increased income inequality within the rural community (Alam et al., 2017). This instability is compounded by limited access to capital and the high operational costs associated with aging machinery, which further erodes the net profit margins of small-scale operations (Baharudin & Waked, 2021; Terano et al., 2013).

Technological and operational barriers form a second critical theme, where the innovation-adoption gap remains a significant hurdle. Despite the technical potential of

the System of Rice Intensification (SRI) and precision farming, adoption rates are hindered by high initial investment costs and a lack of technical expertise among the aging farming population (Rahim et al., 2022; Zaman et al., 2015). Research indicates that technical inefficiencies are often tied to poor maintenance of existing irrigation and mechanical infrastructure, which disrupts planting schedules and reduces overall yield quality (Baharudin & Waked, 2021). Consequently, the transition to a modernized "Smart Farming" model is stalled by a disconnect between policy-driven innovation and the practical financial capacity of smallholders (Nordin et al., 2024).

Environmental and climate-induced risks represent an existential threat to the sector, with literature projecting a potential income decline of up to 127% by the end of the century due to climatic shifts (Radin Firdaus et al., 2014). Farmers report high vulnerability to increasing temperatures, frequent flooding, and the proliferation of pests and diseases, all of which directly impact household food security (Abas et al., 2020; Wardani et al., 2023). This vulnerability is exacerbated by a lack of formal risk-management tools, such as agricultural insurance or *takāful*, leaving farmers to rely on informal community networks or inadequate state emergency funds (Sulaiman et al., 2025; Yasar et al., 2016).

Social and demographic shifts further complicate the sector's future, as an aging farmer population and the urban migration of youth lead to a critical labor shortage (Ngah & Kamarudm, 2025). The literature suggests that social capital defined by community collaboration, knowledge sharing, and access to education plays a vital role in determining a household's adaptive capacity (Abas et al., 2020; Yasar et al., 2016). However, significant disparities in access to health and education services persist, particularly among poorer farmers, which inhibits their ability to engage with modern agricultural training and complicates their long-term socio-economic well-being (Alam et al., 2017).

In synthesis, the findings reveal that the socio-economic dilemma is not the result of any single factor but is an emergent property of the recursive relationship between financial instability, technical barriers, and environmental shocks. The literature indicates that policy interventions, while helpful, often address these themes in isolation, failing to account for how a lack of social capital or climate risk protection undermines the efficacy of economic subsidies (Sulaiman et al., 2025). Ultimately, these synthesized results directly address the review's objective by mapping the specific structural and environmental bottlenecks that prevent Malaysian paddy smallholders from achieving sustainable livelihoods and long-term food sovereignty.

Table1: Summary of Key Literature on the Socio-Economic Challenges of Smallholder Paddy Farmers in Malaysia

Authors / Year	Title	Source	Sector / Context	Study Focus	Method / Approach	Main Contribution	Relevance to the Review
Fahmi Z. et al. (2013)	Paddy industry and paddy farmers well-being: A success recipe for agriculture industry in Malaysia	Asian Social Science	Malaysian paddy industry	Impingement factors of paddy farmers' well-being	Qualitative (documents and literature analyses)	Highlights that financial, social, and human factors are critical to enhancing farmer well-being despite industry success.	Directly addresses the socioeconomic status and well-being of rice farmers.
Yasar M. et al. (2016)	Vulnerability analysis of paddy farmers in the northern Terengganu integrated agricultural development area	Jurnal Ekonomi Malaysia	IADA KETARA, Terengganu, Malaysia	Vulnerability model based on climate, economic, and social changes	Structural Equation Model (SEM) with 350 respondents	Determined that input costs and capital access are primary economic vulnerability indicators.	Quantifies the factors that contribute to the socioeconomic vulnerability of rice farmers.
Wardani N.A.S.J.E. et al. (2023)	The Relationship of Socioeconomic and Household Food Security among Smallholder Rice Famers in Langkawi, Malaysia	Malaysian Journal of Consumer and Family Economics	Langkawi, Malaysia	Socioeconomic status and household food security	Quantitative (HFIAS scale, correlation, regression)	Found that 30.5% of farmers were food insecure, strongly linked to income and education.	Highlights the paradox of food insecurity among the very farmers who produce food.
Terano R. et al. (2013)	Farm management analysis in paddy granary areas in enhancing on-farm income	Agris On-line Papers in Economics and Informatics	Kedah, Selangor, and Terengganu, Malaysia	Determinants of on-farm income and income inequality	Cobb-Douglas production function / Farm management analysis	Determined that pesticide, fertilizer, and seedling methods directly influence gross returns.	Analyzes the income gap and factors that can improve the livelihood of rural rice farmers.
Shaffril H.A.M. et al. (2018)	A systematic review on Asian's farmers' adaptation practices	Science of the Total Environmen	Asian agriculture / Malaysia	Social impacts and adaptation practices towards	Systematic review (PRISMA method)	Identified six main themes of adaptation: crop, irrigation, farm,	Provides a comprehensive framework for

	towards climate change	t		climate change		financial, physical infrastructure, and social activities.	understanding how farmers adapt to environmental dilemmas.
Doni F. et al. (2016)	Transforming the economy of small-scale rice farmers in Malaysia via system of rice intensification (SRI)	Ecology, Environment and Conservation	Small-scale rice farmers, Malaysia	Economic transformation via System of Rice Intensification (SRI)	Field trials and economic analysis	Argues that SRI reduces reliance on high chemical inputs and increases economic productivity for families.	Proposes a specific low-input adaptation strategy to solve the economic dilemma.
Rahim H. et al. (2022)	Economic potential of rice precision farming in Malaysia: the case study of Felcra Seberang Perak	Precision Agriculture	Felcra Seberang Perak, Malaysia	Economic feasibility of precision farming (variable rate seed/fertilizer)	Cost-Benefit Analysis	Found potential additional net income of MYR 1109 to 1333 per hectare through cost reduction.	Assesses technological solutions to the economic dilemma of rising cultivation costs.
Sulaiman S. et al. (2025)	Takāful Ta'āwuni Agro: Strengthening Agricultural Resilience Through Inclusive and Sustainable Protection Among Paddy Farmers in Malaysia	International Journal of Islamic Finance and Sustainable Development	Kedah, Kelantan, and Selangor, Malaysia	Agricultural insurance (takāful) and Islamic social finance	Mixed methods (Survey of 385 farmers and in-depth interviews)	Proposes a Takāful Ta'āwuni Agro framework to address affordability and risk protection barriers.	Proposes a financial adaptation strategy to mitigate economic risks for rice farmers.
Abiddin N.Z. et al. (2023)	Exploring the wellbeing and challenges faced by smallholder plantation farmers in Malaysia: A systematic review	Environment and Social Psychology	Smallholder plantation farmers, Malaysia	Wellbeing and challenges (formal and informal)	Systematic review (23 articles)	Categorized challenges into formal (govt aid, land ownership) and informal (finance, youth reluctance, lack of knowledge).	Provides a structured overview of the socioeconomic constraints facing Malaysian smallholders.
Baharudin S. & Waked H.N. (2021)	Machinery and Technical Efficiencies in Selected Paddy	Pertanika Journal of Social	MADA and IADA BLS regions,	Socio-economic effects on machinery and	Qualitative (face-to-face interviews)	Links poor field conditions and high operation costs to	Examines technical and financial challenges in major rice-growing

	Areas in Malaysia	Sciences and Humanities	Malaysia	technical efficiency		decreased profit and jeopardized financial status.	granaries.
Asli W.M. & Rahman S. (2023)	Conceptualising Resilience Livelihood Strategies of Paddy Farmers Towards Malaysia National Food Security Agenda	Planning Malaysia	Small-scale rice agriculture, Malaysia	Resilience and sustainable livelihood strategies post-COVID-19	Sustainable Livelihood Framework (Conceptual)	Identifies that adaptation is dependent on socioeconomic factors like household assets and gender.	Discusses resilience strategies for vulnerable smallholders facing shocks.
Ngah I. & Kamarudm K.H. (2025)	Malaysia: The State of/in Village Agriculture	Asian Smallholders in Comparative Perspective	Malaysian rural smallholders	Smallholder transformation and government intervention	Book chapter/Case study	Discusses challenges of hiring workers, low commodity prices, and high input costs due to urbanization.	Contextualizes the stated development and modern dilemmas of village agriculture.
Adnan N. & Nordin S.M. (2021)	How COVID 19 effect Malaysian paddy industry? Adoption of green fertilizer a potential resolution	Environment, Development and Sustainability	Malaysian paddy industry	Impact of COVID-19 and adoption of Green Fertilizer (GF)	Policy review and socioeconomic analysis	Analyzes how pandemics check the resilience of the sector and recommends sustainable fertilizer policy revisions.	Discusses external shocks (COVID-19) and policy-driven adaptation strategies.
Zaman N.B.K. et al. (2015)	Perbandingan CIRI-CIRI sosioekonomi penerima inovasi sistem intensifikasi padi dan projek estet padi	Jurnal Teknologi	Kedah, Selangor, Johor, and Kelantan (Malaysia)	Socio-economic characteristics of farmers adopting SRI vs. Paddy Estate Project	Comparative study	Identifies that socioeconomic traits differ between groups adopting different rice management innovations.	Explores how socioeconomic status influences the adoption of new farming technologies.
Meijer S.S. et al. (2015)	The role of knowledge, attitudes and perceptions in the uptake of agricultural	International Journal of Agricultural Sustainability	Smallholder farmers (General Framework)	Intrinsic vs. extrinsic factors in technology uptake	Analytical framework and literature review	Argues that intrinsic factors (knowledge, perceptions) are just as vital as extrinsic	Explains the psychological barriers to solving socioeconomic

	and agroforestry innovations...	y				environment factors for adoption.	dilemmas through technology.
Ajzen I. (1991)	The theory of planned behavior	Org. Behavior and Human Decision Processes	General Behavioral Psychology	Predicting human behavior through attitudes and perceived control	Theoretical framework review	Established the roles of attitudes, norms, and behavioral control in adoption decisions.	The theoretical foundation for most studies on why Malaysian farmers adopt (or fail to adopt) innovations.
Mohamed Shaffril H.A. et al. (2019)	Mirror-mirror on the wall, what climate change adaptation strategies are practiced by the Asian's fishermen of all?	Journal of Cleaner Production	Asian coastal communities / Malaysia	Adaptation strategies toward climate change in nature-dependent communities	Systematic review (PRISMA)	Formulated five themes: livelihood diversification, social, physical, knowledge, and conservation.	Offers a comparative perspective on how Malaysian rural communities manage environmental instability.

5. Discussion

This critical literature review provides a comprehensive synthesis of the systemic precarity defining the lives of Malaysian smallholder paddy farmers. The main contribution of this work lies in its integration of disparate socio-economic, environmental, and technological threads into a singular dilemma framework. This review demonstrates that Malaysia's failure to achieve its self-sufficiency level (SSL) is not solely a technical issue but a socio-economic one, stemming from the ongoing marginalization of the primary producer (Abiddin et al., 2023; Asli & Rahman, 2023).

The first objective of this review was to identify the drivers of financial instability. The findings suggest that smallholders are trapped in a low-income treadmill where the benefits of government subsidies are largely neutralized by the escalating costs of chemical inputs and mechanization (Radin Firdaus et al., 2014). This study answers the first review question by revealing that economic vulnerability is not just a function of low yields but of a structural cost-price squeeze that renders traditional farming economically unviable for the next generation (Nghah & Kamarudm, 2025).

Regarding the second objective, evaluating climate-induced risks, the review confirms that environmental volatility acts as a significant poverty multiplier. The evidence indicates that climatic shocks, exemplified by the anticipated 127% income decline, are not remote threats but present realities that result in immediate food insecurity (Alam et al., 2017; Wardani et al., 2023). This report answers the second review question by highlighting that without inclusive protection mechanisms like agricultural *takāful*, climate change will continue to widen the inequality gap between smallholders and commercial agro-entrepreneurs (Sulaiman et al., 2025).

The third objective focused on technological adoption barriers. The findings suggest that perceived risk and a lack of human capital drive the innovation-adoption gap more than actual technical complexity. By answering this third review question, the study clarifies that the low uptake of SRI and precision farming is a rational economic response from farmers who lack the financial buffer to survive an innovation failure (Rahim et al., 2022; Zaman et al., 2015). This suggests that technology alone cannot transform the sector without a concurrent improvement in the farmers' foundational socio-economic assets.

From a theoretical perspective, this review reinforces the utility of the Sustainable Livelihoods Framework (SLF) in agricultural studies. The implications suggest that financial capital should not be viewed in isolation; rather, its effectiveness is mediated by social capital (community collaboration) and human capital (education) (Yasar et al., 2016). Theoretically, this review argues for an expanded version of the SLF that places greater emphasis on the Vulnerability Context, particularly how external global shocks like pandemics and climate shifts disrupt the internal asset balance of rural households (Adnan & Nordin, 2021).

The practical and policy implications of this review are significant. The results suggest that policymakers should stop using general subsidy programs and instead use targeted, smart support systems that reward sustainability and resilience. In practical terms, it is

imperative to incorporate agricultural insurance into the National Agrofood Policy to establish a safeguard against climate variability (Sulaiman et al., 2025). Educationally, extension services must evolve from providing simple technical instructions to fostering financial literacy and risk management skills among smallholders to bridge the innovation-adoption gap (Nordin et al., 2024).

Despite the wealth of data, this review identifies a critical tension between national Rice Estate goals and the preservation of smallholder autonomy. There is an inconsistency in literature regarding whether land consolidation is the ultimate solution or a threat to rural livelihoods (Zaman et al., 2015). A significant research gap remains in the psychological and behavioral economics of the younger generation; while we know they are leaving the sector, there is little research on what specific socio-economic pull factors would be required to bring them back to modernized paddy farming (Ngah & Kamarudm, 2025).

Future research should prioritize longitudinal studies on the impact of Smart Farming pilot projects on actual household income rather than just crop yield. Additionally, more comparative research is needed between different granary regions (e.g., MADA vs. IADA) to understand how regional governance influences farmer resilience. Investigating the role of digital social networks and agro-influencers in changing the perception of paddy farming among the youth could also provide a novel pathway for sectoral revitalization.

This review has some limitations, the most important of which is that it only looks at English and Malay literature that is indexed by Scopus. This means that it may not have included local grey literature or government reports that are not available in the public academic domain. Furthermore, while the 17 core sources provided high-quality data, the rapid evolution of the agricultural sector post-COVID-19 means that some very recent field-level shifts might not yet be fully reflected in the peer-reviewed corpus.

In conclusion, the significance of this review lies in its holistic re-centering of the farmer within the food security debate. It shows that the long-term health of Malaysia's rice sector depends more on the social and economic security of the people who plant the seeds than on the seeds themselves. By synthesizing the interconnected dilemmas of finance, technology, and climate, this work provides a robust evidentiary foundation for a more inclusive and resilient agricultural future that safeguards both national food sovereignty and the rural livelihoods that sustain it.

6. Conclusion

This critical literature review was conducted to integrate the complex socio-economic challenges faced by smallholder paddy farmers in Malaysia. By systematically evaluating the intersection of financial, technological, and environmental variables, the paper has mapped the complex landscape of a sector that remains vital to national food security yet precarious for its primary producers. The scope of this inquiry extended across the major granary regions of the country, examining how national agricultural policies translate into household-level realities over several decades of development and global disruption.

The synthesis of existing literature reveals a persistent vulnerability trap characterized by a recursive cycle of rising production costs, stagnant net incomes, and increasing exposure to climatic volatility. The findings indicate that the primary barriers to sectoral

modernization are not merely technical but are deeply rooted in a lack of risk-sharing mechanisms and the erosion of human and social capital within aging rural communities. While technological innovations like precision farming and sustainable intensification offer a theoretical pathway toward resilience, their adoption is fundamentally constrained by the high financial risk and low economic buffers inherent in small-scale cultivation.

The main contribution of this review lies in its integrated dilemma framework, which reframes the Malaysian paddy crisis from a technical productivity problem to a holistic socio-economic challenge. By centralizing the farmer's household stability as the linchpin of national food sovereignty, this work provides a conceptual bridge between micro-level behavioral economics and macro-level policy strategy. It shifts the discourse away from simple production subsidies toward a more sophisticated understanding of agricultural resilience, emphasizing that the success of national food agendas is inseparable from the economic dignity and adaptive capacity of the smallholder.

Despite these insights, a critical unresolved issue remains regarding the socio-psychological factors that determine the future of labor in the paddy sector. While the structural reasons for youth migration are well-documented, there is a lack of clarity on the specific incentives required to foster a new generation of agropreneurs who can navigate a technology-driven agricultural landscape. Addressing this behavioral gap remains a vital frontier for future inquiry. To turn the Malaysian paddy industry from a sector of survival into one of sustainable prosperity, a major change in policy will be needed. This new industry will protect the hands that feed the nation through social empowerment, technological equity, and inclusive protection.

Ethics Statement

This study did not involve any human participants, animals, or sensitive data requiring ethical approval. The research was conducted in accordance with accepted academic integrity and ethical publishing standards.

Acknowledgements

This research was supported by the Ministry of Higher Education Malaysia under the Fundamental Research Grant Scheme – Early Career Researcher (FRGS-EC/1/2024/SS06/UiTM/02/16). Appreciation is also extended to all colleagues and research assistants whose contributions and insights were invaluable in completing this work.

Funding Statement

This research was funded by the Ministry of Higher Education Malaysia under the Fundamental Research Grant Scheme – Early Career Researcher (FRGS-EC/1/2024/SS06/UiTM/02/16).

Conflict of Interest Statement

The authors declare that there are no conflicts of interest regarding the publication of this paper.

AI Declaration

During the preparation of this work, the authors used generative AI and AI-assisted technologies to improve the linguistic quality and structural organization of the manuscript. After using these services, the authors reviewed and edited the content as needed and take full responsibility for the content of the published work.

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