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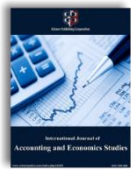

# Socio-Economic Impacts of Rubber Farming on Rural Communities: A Systematic Literature Review

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**Abstract**

The expansion of rubber farming over the last two to three decades has been significant globally. Previously, it was mostly seen in Southeast Asian countries and was cultivated in large areas covered with rubber trees; however, this cultivation has also expanded to new regions, such as South Asia, Southwest China, India, Africa, and parts of Latin America. Therefore, it is essential to study its positive and negative socio-economic impacts on the economy. Apart from the negative consequences for people, the environment, and the economy, rubber farming has benefited growers and rural communities by generating employment opportunities and income, helping them improve their households' or families' financial situations. To further emphasize its various socio-economic impacts, especially on rural communities, such as economic, social, and environmental benefits, this systematic review was conducted. In this research, from an initial pool of 3,364 papers identified through specific search terms in our literature review, only 50 were selected, and after applying all inclusion and exclusion criteria, only 41 papers published between 2010 and 2025 were found to be relevant for this study. This includes journal articles, conference papers, theses, reports, and book chapters, among others. The review examines all the selected works, evaluates them, identifies gaps and inconsistencies, and then collects the necessary information or data to address our five main research questions, offering several recommendations in the process.

***Keywords***: *Rubber Farming; Rural Communities; Socio-Economic Impacts; Systematic Review.*

## 1. Introduction

Rubber farming has expanded significantly over the past few decades and now plays a crucial role in the agricultural economies of many tropical and subtropical regions. Rubber (Hevea brasiliensis) is a globally important commodity essential for various industrial sectors, contributing to a market valued at approximately US$400 billion annually. (Warren-Thomas et al., 2015; Zang, n.d.). It serves as a key driver of rural livelihoods, with smallholder farmers responsible for nearly 85% of worldwide production. ("Rubber | Preferred by Nature," 2025). Consequently, rubber farming remains a significant focus of development, crucial for poverty reduction and structural change, albeit facing increasing scrutiny due to its complex environmental impacts and socio-economic disparities. (Mateko et al., 2025; Van Der Meer Simo, 2020). Nevertheless, this farming practice is also influenced by ongoing conflicts between its economic advantages for smallholders and nations and its considerable environmental and social drawbacks. (Jayathilake et al., 2023). Unlike providing income and jobs, plantation expansion often leads to deforestation, loss of biodiversity, and degradation of ecosystem services, particularly when forests are converted into monoculture plantations. (Gitz et al., 2022; Lang et al., 2019). Additionally, issues such as land-tenure insecurity, price fluctuations, and unequal distribution of benefits exacerbate rural inequalities, making rubber farming a contentious rather than universally advantageous development path. (Villamor and Van Noordwijk, 2011; Wee and Singaravelloo, 2018).

The findings suggest that there is a significant number of studies pertaining to rubber and rubber farming. However, scholars have mainly investigated income dynamics, livelihood vulnerability, and land-use changes, exploring how price volatility, land tenure, and plantation expansion affect rural welfare and environmental outcomes. However, the evidence is fragmented across regions and themes, with limited coverage of interactions between socio-economic factors, governance, and agroforestry-based sustainability pathways. (Jayathilake et al., 2023; Singh et al., 2021; Wang et al., 2023; Warren-Thomas et al., 2022; Zou et al., 2024).

Despite ample evidence, current research on rubber farming often examines economic, social, and environmental aspects separately, hindering a comprehensive socio-economic understanding of trade-offs and synergies. Comparative studies across regions and long-term panel analyses are rare, limiting insights into the temporal dynamics of household livelihoods, land use, and ecosystem change. Furthermore, relatively few studies have systematically explored how impacts vary across farmer types, gender, land-tenure categories, or wealth groups, leaving intra-community inequalities insufficiently examined (Jayathilake et al., 2023; Singh et al., 2021; Wang et al., 2023). Similarly, there are limited interconnections between economic, social, and environmental inequalities and their effects on livelihood outcomes. This study seeks to bridge these gaps by systematically reviewing existing research to investigate the socio-economic impacts of rubber farming

across various geographical settings, with the aim of identifying patterns, disparities, and contextual variations and highlighting critical gaps to inform future research and policy initiatives.

# 2. Literature Review

The following section explores the latest studies on the socio-economic impacts of rubber farming, emphasizing its historical expansion, effects on rural livelihoods, and consequent social, economic, and environmental transformations. This section identifies key trends, inconsistencies, and gaps in the literature across different regions.

## 2.1. Expansion of rubber farming

Over the last few decades, rubber farming has rapidly expanded throughout tropical areas, spurred by increasing global demand, government-driven agricultural policies, and strategies focused on market development. While rubber farming has traditionally been centered in Southeast Asia, especially in Thailand, Malaysia, and Indonesia, it has progressively spread to new regions such as Laos, Cambodia, Vietnam, India, parts of China, and several African nations (Fox and Castella, 2013). This growth often involves the transformation of forests, swidden agriculture, and communal lands into monoculture plantations. (Viswanathan and Bhowmik, 2016).
In several nations, such as Laos, Cambodia, and India, this expansion has been actively supported through policy incentives and land concessions, reshaping local agricultural systems and livelihoods. (Luangmany and Kaneko, 2013; Mohapatra, 2022; Sakayarote and Shrestha, 2017; Sarkar, 2024).

## 2.2. Economic and social impacts of rubber farming

### 2.2.1. Employment and income effects

Several studies have noted that the distribution of income and employment benefits varies across households, often favoring those with greater landholdings and access to capital, thereby benefiting more than smallholders. (Andriesse, 2014; Kusakabe and Chanthoumphone, 2021; Patton and Ezung, 2019; Sakayarote and Shrestha, 2017).

### 2.2.2. Education and human capital

Some studies suggest that income from rubber farming is associated with increased educational investment in certain regions. (Gunarathne et al., 2022; Vongkhamheng et al., 2016). In certain areas, this financial boost has led to increased school attendance and lower dropout rates in others. However, this beneficial impact is not consistent. In places where there is a high demand for labor, children may be pulled out of school to help with family work, especially during busy tapping periods. (Keating 2012; Tiko et al. 2025).

### 2.2.3. Health and well-being

The health outcomes associated with rubber farming are equally intricate. In some instances, higher income has led to better access to healthcare services and improved nutrition. (Fox and Castella, 2013). Nevertheless, rubber farming poses occupational health hazards, such as extended physical labor, musculoskeletal issues, and exposure to chemicals from pesticides and herbicides. (Friis et al., 2016; Vongkhamheng et al., 2016).

## 2.3. Gender and social differentiation

It is also prevalent that gender-specific labor patterns are a common characteristic in rubber farming. In many regions where rubber is produced, women have been engaging in labor-intensive and low-paid activities and bearing the primary responsibility for household work, limiting their access to education, income, and decision-making power. Some studies indicate that women's participation in rubber farming may increase household income and influence social status. (Gunarathne et al., 2022; Kusakabe and Chanthoumphone, 2021). Numerous studies have also pointed out that the advantages of rubber expansion are not evenly shared among different social groups. Ethnic minorities, households with limited land, and migrant workers often face marginalization, have restricted access to land titles, and are excluded from decision-making processes. (Friis et al., 2016; Vongkhamheng et al., 2016).

## 2.4. Environmental and land-use implications

The expansion of rubber farming has also significantly altered land-use patterns, frequently at the cost of forests and traditional farming systems in the region. Several studies have documented deforestation, biodiversity loss, and soil degradation associated with the conversion of natural ecosystems into monoculture rubber plantations. (Fox and Castella, 2013; Terauchi and Inoue, 2010). The increased dependence on chemical inputs has sparked concerns regarding water pollution and the long-term fertility of soil. (Vongkhamheng et al., 2016).

## 2.5. Synthesis and research gaps

Across these studies, factors such as land tenure security, market access, and institutional support have repeatedly emerged as mediating conditions that shape livelihood outcomes. However, despite the increasing pool of research in this domain, numerous gaps remain. Most existing research depends on short-term or area-specific studies, which limit our understanding of the long-term livelihood progression. Furthermore, inadequate consideration has been given to the intersection of the economic, social, and environmental dimensions. Addressing these gaps necessitates longitudinal and comparative research approaches capable of capturing the complex and evolving nature of rubber-based rural livelihoods.
Based on this synthesis, a conceptual framework is proposed to guide the analysis of the impacts of rubber farming.

### 2.6. Conceptual framework

The following subsection illustrates a conceptual framework (Fig.1), serving as an analytical device that organizes and interprets existing evidence on the socio-economic impacts of rubber farming in the rural context, bringing together key themes emerging from the literature review. The framework highlights that the effects of rubber farming are shaped by a range of mediating conditions, such as access to markets, land tenure, institutional and policy support, availability of financial and extension services, and local environmental characteristics, which influence how rubber farming translates into livelihood outcomes. These contextual conditions help explain why similar rubber farming practices can lead to different outcomes across regions, social groups, and time periods. Socio-economic outcomes within the framework are grouped into three interrelated domains: economic, social, and environmental. Social outcomes encompass household well-being, social differentiation, and gendered labor relations. Environmental outcomes are related to land-use change, ecosystem conditions, and the long-term sustainability of rural livelihoods. By integrating these domains, the framework provides a coherent structure for examining the differentiated and context-dependent impacts of rubber farming, guiding the analysis of the findings presented in the subsequent sections and supporting a balanced interpretation of economic gains alongside social and environmental trade-offs. However, it does not propose causal relationships but serves as an analytical synthesis to organize and interpret evidence from the reviewed literature.

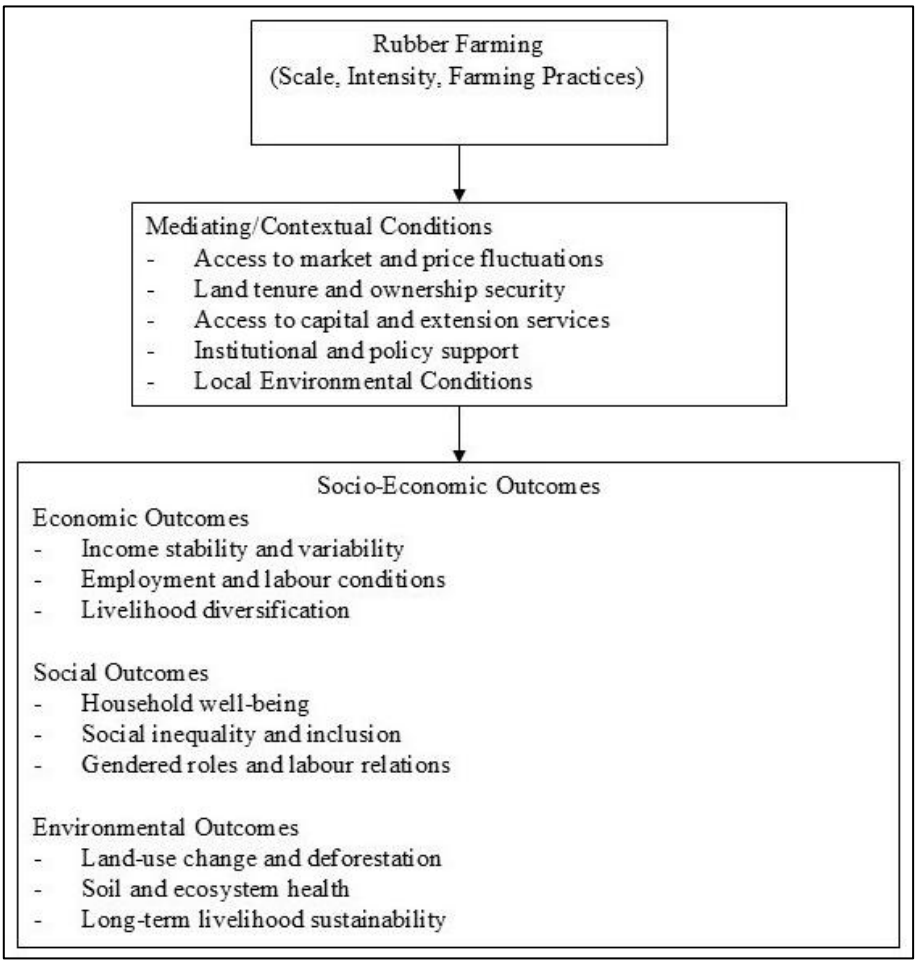


**Fig. 1:** Conceptual Framework Depicting How Rubber Farming Influences Socio-Economic and Environmental Outcomes in Rural Communities Through Mediating Contextual Factors.

## 3. Methodology

In this study, a systematic literature review (SLR) method was employed to explore the socio-economic effects of rubber farming on rural areas. This review adheres to the methodological guidelines set forth by Kitchenham and Charters. (Kitchenham and Charters, 2007), which offer a structured and transparent framework for identifying, assessing, and synthesizing existing academic evidence. This method enhances the reliability, replicability, and rigor of the review process. The review was carried out in three main stages: (i) planning the review, (ii) conducting the review, and (iii) reporting and synthesizing the results. Each stage was designed to ensure methodological consistency and reduce selection bias. These stages are illustrated in Fig. 2.

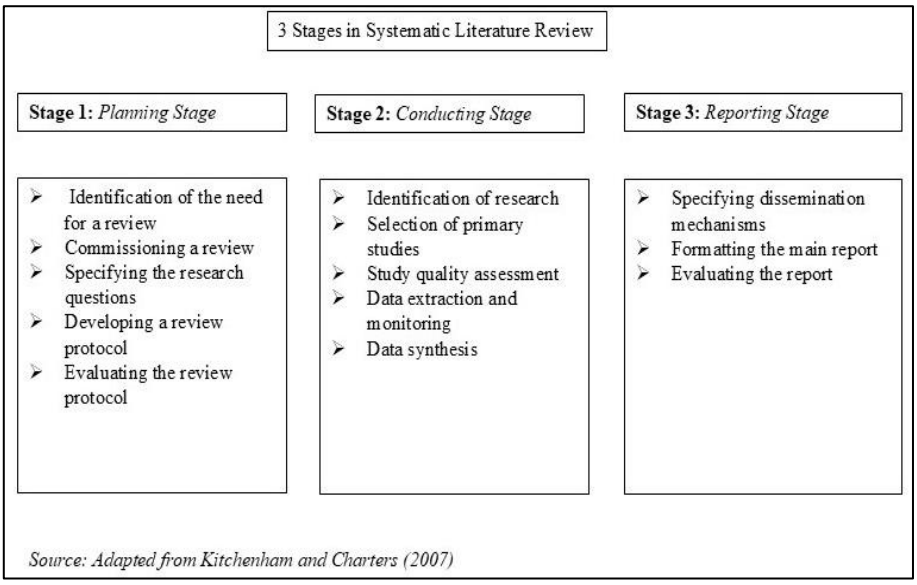


**Fig. 2:** Stages in a Systematic Literature Review.

## 3.1. Research questions

The initial phase of the project involved outlining the study's scope and goals, identifying pertinent research questions, and setting criteria for inclusion or exclusion. The main aim of this study was to evaluate how rubber farming affects the socio-economic conditions of rural communities in various geographical areas. After a preliminary review of the literature, five research questions were developed to steer the review process.

RQ1. What are the key socio-economic impacts of rubber farming on rural communities?
RQ2. How does rubber farming influence rural household income and employment?
RQ3. What social changes are associated with rubber farming, such as those related to education, health, and migration issues?
RQ4. Are there any negative socio-economic consequences associated with rubber farming in the region?
RQ5. How do the effects of rubber farming vary across regions and over time?

These questions aimed to explore both the beneficial and adverse aspects of rubber farming, enabling a comparative study across various socio-economic and geographical settings.

## 3.2. Search strategy and source of data

A thorough literature review was performed by accessing various academic databases to ensure a wide-ranging collection of relevant studies. The main databases used were Google Scholar, Scopus, Web of Science, JSTOR, SpringerLink, and ScienceDirect. Google Scholar was heavily relied upon because of its extensive range of peer-reviewed journal articles, conference proceedings, theses, and institutional reports. A predetermined set of search terms was used to locate relevant literature. These terms included combinations of keywords such as “rubber farming,” “rubber cultivation,” “socio-economic impacts,” “rural livelihoods,” “income,” and “employment.” Boolean operators (AND/OR) were used to refine the search results and enhance their relevance. The final compilation of the search terms and their respective results is detailed in Table 1.

**Table 1:** Search Strings Used for Literature Review

| Search string | Total number of articles returned on Google Scholar | Total number of pages of articles returned on Google Scholar | Relevant articles selected |
|---|---|---|---|
| S1: “rubber farming” AND “socio-economic impact” AND “rural communities.” | 1 | 1 | 1 |
| S2: “natural rubber cultivation” AND “rural livelihood” AND “India.” | 13 | 2 | 1 |
| S3: “rubber plantation” AND “economic development” AND “villages.” | 2170 | 100 | 29 |
| S4: “rubber production” AND “income” AND “employment” AND “rural areas." | 2170 | 100 | 10 |

## 3.3. Inclusion and exclusion criteria

Initially, the search yielded a large number of articles on screens. To narrow down the selection, we employed five inclusion and exclusion criteria (IE1-IE5, as outlined in Table 2) to focus on pertinent papers. Specific inclusion and exclusion criteria were applied to ensure the relevance and quality of the selected studies. Studies were included if they investigated the socio-economic effects of rubber farming or livelihoods related to rubber, focused on rural or semi-rural settings, were published in peer-reviewed journals, conference proceedings, theses, or institutional reports, were written in English, and were published between 2010 and 2025. Studies were excluded if they concentrated solely on the agronomic or technical aspects of rubber farming without a socio-economic analysis, were not peer-reviewed, or were outside the specified time frame.

**Table 2:** Inclusion and Exclusion Criteria

| No. | Inclusion criteria | Exclusion criteria |
|---|---|---|
| IE1 | Studies examining the socio-economic impacts of rubber farming | Studies not related to |
| IE2 | Research conducted in rural areas, especially in developing countries like India | Studies focusing on urban or non-rural populations |
| IE3 | Peer-reviewed journal articles, theses, and reports | Articles from unverified or non-peer-reviewed sources |
| IE4 | Studies published in English | Studies published in languages other than English |
| IE5 | Studies between 2010 and 2025 | Studies published before 2010 |

## 3.4. Selection of the study and screening process

In the initial database search, 3,364 records were identified. After removing duplicates and conducting a relevance check of titles and abstracts, 50 articles were selected for full-text review. A thorough evaluation using the inclusion and exclusion criteria led to the final selection of 41 studies that were suitable for detailed analysis. These articles, comprising research papers from 31 journals, one conference paper, one thesis, four reports, and two book sections, constitute the basis for a systematic literature review. This varied collection of evidence facilitated a comprehensive understanding of the socio-economic aspects of rubber farming across various geographical and institutional settings. Tables 3, 4, 5, 6, and 7 list the journals, conferences, theses, reports, and book sections, along with the number of articles from each.

**Table 3:** List of Journals and Years

| Sl. No. | Journal (years and conference papers) | Number of articles |
|---|---|---|
| 1 | The Southeast Asian Review | 1 |
| 2 | Journal of Human Ecology | 1 |
| 3 | TROPICS | 1 |
| 4 | Singapore Journal of Tropical Geography | 1 |
| 5 | Journal of Peasant Studies; 2013 | 1 |
| 6 | Journal of International Development and Cooperation; 2013 | 1 |
| 7 | Conservation; 20 | 1 |
| 8 | ASIA Network Exchange: A Journal for Asian Studies in the Liberal Arts | 1 |
| 9 | Journal of Global Economy; 2024 | 1 |
| 10 | Sustainability; 2021 | 1 |
| 11 | FORMATH; 2022 | 1 |
| 12 | Vidyodaya | 1 |
| 13 | International Journal of Research in Economics and Social Sciences; 2019 | 1 |
| 14 | International Journal of Applied Research | 1 |
| 15 | Journal of Land and Rural Studies; 2015 | 1 |
| 16 | International Journal of Law and Management | 1 |
| 17 | International Journal of Sustainable Development and World Ecology; | 2 |
| 18 | Rubber Science; 2018 | 1 |
| 19 | Stochastic | 1 |
| 20 | Jurnal | 1 |
| 21 | Global Journal of Agricultural Sciences; 2018 | 1 |
| 22 | Journal of Applied Sciences and Environmental Management; 2024 | 1 |
| 23 | Open Access Library Journal; 2016 | 1 |
| 24 | International Journal of Agriculture, Forestry and Plantation; 2016 | 1 |
| 25 | Mountain Research and Development; 2017 | 1 |
| 26 | Journal of Southeast Asian Studies; 2011 | 1 |
| 27 | Environmental Monitoring and Assessment; 2024 | 1 |
| 28 | EcceS | 1 |
| 29 | International Multidisciplinary Journal; 2015 | 1 |
| 30 | SAGE Open; 2021 | 1 |
| 31 | Transcience | 1 |

**Table 4:** List of Conferences and Years

| Sl. No. | Conference name and year | Number of articles |
|---|---|---|
| 1 | 9th European IFSA Symposium; 2010 | 1 |

**Table 5:** List of Theses

| Sl. No. | University | Number of articles |
|---|---|---|
| 1 | Yangon University of Economics, | 1 |

**Table 6:** List of Reports and Years

| Sl. No. | Name of the Institution and year | Series Title | No. of articles |
|---|---|---|---|
| 1 | Centre for International Forestry Research (CIFOR); 2016 | CIFOR | 1 |
| 2 | Centre for Development Studies; 2010 | NRPPD Discussion Paper | 1 |
| 3 | Humboldt-Universität Zu Berlin | SURUMER- Sustainable Rubber Cultivation in the Mekong Region | 1 |
| 4 | CGIAR Research Program on Forests, Trees and Agroforestry (FTA); 2020 | FTA Brief | 2 |

**Table 7:** List of Book Sections and Years

| Sl. No. | Book Title and year | No. of articles |
|---|---|---|
| 1 | Monoculture Farming: Global Practices, Ecological Impact, and Benefits/Drawbacks | 1 |
| 2 | Cost-Benefit Studies of Natural Resource Management in Southeast Asia; 2015 | 1 |

# 4. Results and Findings

This section outlines the principal findings regarding the socio-economic effects of rubber farming based on a systematic review of the selected studies. The results were categorized thematically to highlight the key economic, social, and environmental impacts. These findings are supported by empirical data from various geographical regions, notably Southeast Asia, South Asia, and certain areas of Africa.

## 4.1. Economic impacts

A significant portion of the literature reviewed suggests that rubber farming has led to an increase in household income, especially for smallholder farmers with access to land, labor, and market connections. In countries such as Laos, Cambodia, India, and China, the shift from subsistence farming to rubber farming has allowed households to earn higher and more consistent cash income (Fox and Castella, 2013; Polthanee et al., 2021; Vongkhamheng et al., 2016). In Northeastern Thailand, the introduction of rubber farming has shifted livelihoods from subsistence to a market economy and reduced reliance on natural capital. (Thongyou, 2014). It is also a major livelihood source in Nigeria (Delta State) (Achoja and Akparobi, 2023; Uwumarongie et al., 2025). However, the distribution of income benefits is not uniform. Research consistently shows that households with larger landholdings or better access to credit and infrastructure tend to gain more, whereas smallholders and landless workers are more vulnerable. (Andriesse, 2014; Gunarathne et al., 2022). Smaller landholders and landless laborers often do not experience substantial income improvements because of the high cost of rubber farming and input requirements. (Keating, 2012; Phimmavong, 2022). Moreover, income instability is exacerbated by price volatility driven by global market fluctuations. (Tiko et al., 2025; Vijayan et al., 2024). However, the diversification of income sources, including non-rubber farming and non-agricultural activities, further reduces income inequality and enhances household resilience. (Khaswarina and Eliza, 2025). The Upper Mekong region in Southern China serves as a prime example. (Jin et al., 2021). Overall, the evidence indicates that income gains from rubber farming are substantial but uneven, shaped primarily by land ownership, access to credit, and market conditions.

## 4.2. Employment changes

Rubber farming has created numerous job opportunities beyond the farmers. Laborers are employed for tapping latex, maintaining plantations, processing, and marketing the product, creating a ripple effect in rural economies and supporting ancillary businesses and services. (Achoja and Akparobi, 2023; Uwumarongie et al., 2025). For example, in Nigeria, it is a significant source of rural employment and contributes to socio-economic development. (Uwumarongie et al., 2025). As the rubber industry expands, the demand for skilled workers, particularly tappers, who require specialized training and knowledge, is increasing. (Friis et al., 2016; Sarkar, 2024). Workers' participation is influenced by factors such as land size, education level, and availability, where challenges such as insufficient labor and unstable prices can constrain productivity and income. (Kikon et al., 2025; Yusuf and Sulaiman, 2015). Many rural households depend on a range of rubber-related activities for their daily income. (Patton and Ezung, 2019; Sakayarote and Shrestha, 2017). Additionally, the industry offers seasonal work for migrant laborers, especially during peak tapping season. This can also result in periods of unemployment or underemployment for workers during the off-season. (Gunarathne et al., 2022; Phimmavong, 2022). However, the quality and stability of jobs vary considerably across regions and worker categories. Several studies have pointed out unstable working conditions, low pay, and lack of job security, particularly for casual and migrant workers. Rubber tapping is physically taxing, and workers often lack access to health insurance, social protection, or formal employment contracts. These factors contribute to job vulnerability, especially among older workers and women in labor-intensive roles. (Effiong and Aboh, 2018; Keating, 2012).

## 4.3. Education and human capital development

Evidence indicates that many smallholder families involved in rubber farming reported that the increased income from rubber output allowed them to invest in their children's education, resulting in better school attendance and educational outcomes. (Tiko et al., 2025; Vongkhamheng et al., 2016). However, there are also instances of rubber farming impacting educational outcomes. Children are frequently engaged in rubber tapping or plantation work, especially during peak seasons, which results in school absenteeism or early dropouts. This is especially common in areas where labor is cheap and abundant. While some households benefit from increased educational investment, others face challenges related to child labor and school discontinuation. (Keating, 2012; Tiko et al., 2025).

There are also instances where smallholder families have managed to build wealth and expand landholdings through rubber farming, offering greater security and enabling asset investments. (Fox and Castella, 2013; Viswanathan and Bhowmik, 2016) and allowing farmers to improve housing, education, and healthcare (Rajasenan, 2010; Tiko et al., 2025). However, rubber farming can increase land tenure insecurity when land shifts from communal to private ownership or when large plantations displace smallholders. (Friis et al., 2016; Terauchi and Inoue, 2010). Smallholders often incur debt from loans during the initial planting phase, when profits are minimal. (Gunarathne et al., 2022; Patton and Ezung, 2019). These contrasting findings highlight the context-dependent relationship between rubber income and education outcomes.

## 4.4. Health and well-being

Research findings suggest that rubber farming has a multifaceted impact on health. Increased earnings can improve access to healthcare and dietary quality, leading to better health. (Fox and Castella, 2013; Vongkhamheng et al., 2016). Improved financial conditions have also helped reduce poverty-related diseases, such as malnutrition, which are common in rural communities dependent on subsistence farming. (Sarkar, 2024). However, there are still significant occupational health concerns. Rubber tappers, particularly those in poorly regulated sectors, face occupational hazards, including back pain, joint problems, and repetitive strain injuries due to the physical nature of tapping. The repetitive physical labor of rubber tapping leads to health problems, such as musculoskeletal injuries, especially among older tappers. (Vongkhamheng et al., 2016). Additionally, exposure to agrochemicals, such as pesticides and fertilizers, presents further health risks, especially in situations where safety gear and training are lacking. (Friis et al., 2016; Vongkhamheng et al., 2016). These health issues disproportionately affect informal workers and women, who frequently lack health insurance or employer-provided protections.

### 4.5. Gender dimensions

Rubber farming has provided employment opportunities for women, both as tappers and in the rubber-processing industry. Women have gained economic independence through participation in rubber tapping and processing, leading to improved social status and decision-making power. (Friis et al., 2016; Gunarathne et al., 2022). In certain cases, women's roles in rubber farming have helped increase their social and economic standing within the family and community, enhancing their ability to influence household decisions. (Kodoh, 2016; Viswanathan and Bhowmik, 2016). However, despite increased participation, women often face gendered labor divisions, with men handling more physically demanding tasks (e.g., tapping). In contrast, women are relegated to less visible or lower-paid tasks such as processing rubber or household duties. Women are frequently concentrated in lower-paid and less visible roles, whereas men dominate higher-status tasks, such as tapping. (Friis et al., 2016; Sarkar, 2024). In many households, women still bear the bulk of domestic responsibilities despite also contributing to rubber farming, leading to increased physical and mental stress on women. Women's involvement in rubber farming often increases their domestic workload, as they are expected to balance farm work with household chores. (Viswanathan and Bhowmik, 2016). These patterns indicate that increased female participation does not necessarily translate to reduced gendered divisions of labor.

### 4.6. Land use, community impacts, and environment

Local communities face land-related challenges in the expansion of rubber farming. Communities often sacrifice land without adequate compensation or resettlement plans because of large land requirements. (Friis et al., 2016; Keating, 2012). Land procurement transforms traditional agricultural areas into rubber farms, thereby reducing local food production space. Studies by Anan Polthanee et al. (2021) and Daisuke Terauch & Makoto Inoue (2010) confirmed these impacts on food security. (Polthanee et al., 2021; Terauchi and Inoue, 2010).
Land utilization conflicts arise when rubber farming competes with food production, forestry, and the conservation of biodiversity. These conflicts are significant, where rubber farming replaces agroforestry or forest areas, causing environmental displacement by rubber corporations with political power or government support. (Dararath et al., 2011; Friis et al., 2016).
Rubber farming expansion has been linked to deforestation and habitat loss in some regions, raising concerns about environmental sustainability. (Fox and Castella, 2013; Friis et al., 2016; Jayathilake et al., 2024, 2023). These processes have intensified social tensions, particularly where customary land rights are weak. (Dararath et al., 2011; Terauchi and Inoue, 2010), affecting food security and social cohesion. For example, in Xishuangbanna, China, rubber expansion increased income but caused environmental degradation and livelihood challenges. (Wang et al., 2023). The severity of these impacts varies according to the regulatory frameworks, land governance systems, and enforcement capacity. Thus, ensuring secure land ownership and access to agricultural extension services is essential for encouraging sustainable rubber farming practices that reduce environmental impact while enhancing socio-economic advantages. (Jayathilake et al., 2023).

## 5. Discussion

This section interprets the findings in relation to the five research questions, drawing on the literature reviewed to explain the patterns, contradictions, and broader implications. By organizing the discussion around these research questions, this section offers a cohesive synthesis of how rubber farming influences socio-economic outcomes in various contexts.
RQ1: What are the key socio-economic impacts of rubber farming on rural communities?
This finding indicates that rubber farming has a complex range of socio-economic effects and reshapes rural livelihoods in uneven ways, with both beneficial and adverse aspects. Income gains tend to favor households with greater land, capital, and market access, often reinforcing existing socio-economic hierarchies. In addition, it has exposed several smallholders to price volatility and rising production costs, making their income unstable. Monoculture production has reduced livelihood flexibility and increased dependence on a single commodity. People who shifted from diversified subsistence systems have experienced weakened household resilience, especially when combined with environmental pressures, such as soil degradation and declining ecosystem services.
Overall, the socio-economic effects of rubber farming should be viewed as conditional rather than inherently positive or negative in nature. This is because the results are influenced by factors such as easy access to resources, institutional backing, and households' ability to adjust to economic and environmental shifts. These insights underscore the importance of developing strategies that emphasize resilience, fairness, and diversification rather than focusing solely on productivity. These findings suggest that rubber farming functions less as a universal poverty reduction strategy and more as a conditional livelihood pathway shaped by access to resources and adaptive capacity.
RQ2. How does rubber farming influence rural household incomes and employment?
The nature of employment generated by rubber farming reflects broader structural weaknesses in rural labor markets, where informality and limited labor protections are common. This suggests that these employment patterns reflect broader structural issues within agricultural labor markets, particularly in developing nations, where regulatory enforcement is often weak. The prevalence of casual and seasonal work arrangements also indicates that jobs in rubber farming may provide short-term income without long-term stability. This situation threatens household stability and well-being, especially for migrant and landless workers. From a policy standpoint, these results highlight the necessity of labor-focused interventions, such as enhanced occupational safety standards, social protection measures, and support for labor organizations in the agricultural sector. This highlights the need to view employment creation not only in quantitative terms but also in relation to job quality, security, and worker protection.
RQ3. What social changes are associated with rubber farming?
While expansion can boost household earnings and invigorate local economies, it modifies traditional social interaction and livelihood practices. The shift from diversified farming to commercial rubber farming has altered the labor relations, social hierarchies, and cooperative practices. A key result is the transformation of the social capital. In some cases, the shared reliance on rubber farming encourages collaboration, mutual aid, and collective responses to environmental or economic challenges. These networks can bolster community resilience, particularly in regions prone to climate or market disruptions. However, this coherence differs depending on the situation of the user. In situations where access to land, capital, or market opportunities is unequal, rubber expansion can exacerbate social disparities and undermine traditional support systems. Labor relations highlight this tension. The increased dependence on hired and informal labor has revealed weaknesses in governance structures, including inadequate labor protection and limited collective bargaining rights. These conditions increase social vulnerability, particularly among migrant and low-income workers. The shift towards monoculture may disrupt cultural practices and livelihood traditions, creating social uncertainty. The social effects of rubber farming extend beyond economic

changes, altering community relationships, power dynamics, and social resilience. These outcomes underscore the importance of inclusive governance and social protection to ensure fair benefit distribution. More specifically, these dynamics indicate that social change associated with rubber farming is mediated by governance structures and the inclusiveness of local institutions.

RQ4. Are there any negative socio-economic consequences associated with rubber farming?

In addition to its benefits, rubber farming can lead to various socio-economic vulnerabilities that threaten long-term livelihood stability. A key challenge is income instability, which is driven by global price fluctuations and climate-related production risks. These challenges create financial uncertainty for smallholders, especially in areas where alternative income opportunities are scarce and credit access is limited. Additionally, land tenure insecurity exacerbated these risks. The expansion of rubber farming can lead to land concentration, displacement, and conflicts over resources, particularly in areas where land rights are poorly enforced. These factors marginalize small-scale farmers and weaken social cohesion. Furthermore, environmental degradation from monoculture expansion, such as soil depletion and biodiversity loss, worsens these issues by diminishing the long-term productivity of farming systems. These socio-economic pressures are interlinked, with environmental degradation increasing livelihood vulnerability, while economic insecurity restricts farmers' ability to implement sustainable practices. Together, they form a cycle of risk that limits development. Collectively, these interconnected pressures illustrate how economic, environmental, and institutional vulnerabilities reinforce one another in rubber-dependent household livelihoods.

RQ5. How do the effects of rubber farming vary across regions or over time?

The impacts of rubber farming vary greatly across regions and historical contexts, depending on the ecological conditions, policies, and economic development. In established rubber-producing regions, income gains are often accompanied by environmental degradation. In newer expansion areas, immediate economic benefits often come with ecological risks and institutional weaknesses. The timing of these developments was crucial. Initially, rubber farming boosted household income and local economies. However, issues such as declining soil fertility, market instability, and environmental harm can lower these advantages, particularly without diversification or effective governance. Evidence shows that adaptive strategies, such as intercropping systems, integrated farming, enhanced land management, and policy support, are vital for long-term outcomes. The differences in impact across regions and time demonstrate that rubber farming is not a universal development solution. Its socio-economic effects depend on local ecological conditions, governance frameworks, and the ability of farming systems to adapt to economic and environmental challenges. In other words, these variations demonstrate that the outcomes of rubber farming are historically contingent and institutionally mediated rather than uniform across space or time.

### 5.1. Policy implications

The conclusions drawn from this review have various implications for policies aimed at promoting fairer and more sustainable rubber-based rural livelihoods. Firstly, enhancing land tenure security is crucial to ensure that smallholder farmers can enjoy the benefits of rubber cultivation without facing displacement or long-term vulnerability. Well-established land rights can promote sustainable land management practices. Secondly, policies designed to improve market access and stabilize producer prices, such as price support systems, cooperative marketing, or better value chain integration, can help reduce revenue volatility and strengthen livelihood resilience. Thirdly, increasing access to agricultural extension services and credit facilities can facilitate the adoption of diverse and environmentally sustainable farming practices, including agroforestry and mixed-cropping systems. Fourthly, labor regulations and social protection measures must be strengthened to tackle informal work arrangements, gender-based disparities, and work-related health dangers within the rubber industry. Lastly, region-specific policy strategies are necessary, as the effects of rubber farming differ across various ecological and institutional settings.

## 6. Conclusion

The majority of this systematic literature review reveals that the socio-economic impacts of rubber farming are not consistent or necessarily profitable but are instead influenced by complex relationships among market forces, institutional structures, and local environmental factors. While rubber farming can potentially boost rural incomes and drive economic growth, its advantages are unevenly distributed and often come with new vulnerabilities for farmers. The findings indicate that income improvements, when they occur, often depend on secure land ownership, access to capital, and market integration, whereas households lacking these resources face increased economic and environmental risks. The study also shows that the shift in rural livelihoods due to rubber farming has altered social connections and labor relations, often reinforcing existing inequalities. Additionally, environmental degradation and changes in land use threaten the long-term sustainability of rubber-based rural livelihoods, particularly in areas where environmental adaptability is already weak. These results suggest that rubber farming should not be viewed solely as an economic activity but as a socio-ecological process influenced by policy decisions, governance structures, and local capacities. Overall, the findings indicate that the developmental potential of rubber farming relies less on its expansion and more on how it is managed. To achieve outcomes that are both sustainable and fair, it is essential to adopt integrated strategies that balance economic objectives with social inclusion and environmental care.

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