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Cultivating Resilience: The Synergy of Upland Rice (Padi Huma) and Multi-Purpose Tree Species (MPTS) in Indonesia's Social Forestry Schemes for Community Welfare

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A B S T R A C T

Indonesia's ambitious Social Forestry program aims to alleviate poverty for communities living within and around forest areas while ensuring environmental sustainability. However, a critical gap remains in reconciling the immediate food security needs of forest farmers with long-term ecological conservation goals. This study employs a qualitative literature review to analyze the opportunities and challenges of integrating Upland Rice (Padi Huma)—a cultural staple of shifting cultivators—with Multi-Purpose Tree Species (MPTS) within Social Forestry agroforestry systems. By synthesizing data from more than 40 reputable journal articles mainly published between 2020 and 2026, this review identifies a thematic framework comprising economic resilience, ecological interactions, and socio-institutional dynamics. The results indicate that while MPTS provides a sustainable mid- to long-term income stream (the "saving account"), Padi Huma serves as a crucial short-term subsistence buffer (the "daily plate") during the initial years of tree establishment. Nevertheless, significant agronomic challenges exist regarding the shade intolerance of upland rice under closing MPTS canopies, alongside institutional bottlenecks in market access for agroforestry products. The study concludes that successful integration requires site-specific silvicultural interventions—such as widening alley cropping spacing—and robust institutional support to connect Social Forestry Business Groups (KUPS) with downstream markets. This paper contributes to the literature by moving beyond tenure-focused analysis to livelihood-based agronomic solutions

INTRODUCTION

1. Background: The Nexus of Forestry and Food Security

The tension between state-mandated conservation and the subsistence needs of local communities has long defined the contestation over forest land in tropical developing nations. In Indonesia, this tension is acute. Approximately 25,800 villages are located inside or near forest boundaries, encompassing a significant portion of the country's population living below the poverty line. Historically, state forest management prioritized timber extraction and strict protectionism, often criminalizing traditional agricultural practices such as swidden or shifting cultivation. However, the paradigm shift toward "Community-Based Forest Management" (CBFM) has materialized in the national Social Forestry (Perhutanan Sosial) program, which aims to allocate 12.7 million hectares of forest land to local communities [1], [2], [3], [4].

While the granting of legal access—through schemes such as Village Forests (Hutan Desa), Community Forests (Hutan Kemasyarakatan/HKm), and Customary Forests (Hutan Adat)—is a monumental step regarding tenure reform, access alone guarantees neither welfare nor conservation. A critical post-permit challenge emerges: what should farmers plant to survive? The abrupt transition from shifting cultivation to sedentary farming within Social Forestry concessions poses a threat to food security. Traditional farmers rely on Padi Huma (upland rice) for their carbohydrate needs. Yet, forestry regulations generally mandate a permanent tree cover, creating a potential conflict between the "rice bowl" and the "canopy." [5], [6], [7], [8], [9]

The contestation over forest land in tropical developing nations has long been defined by the tension between state-mandated conservation and the subsistence needs of local communities. In Indonesia, this tension is acute. Approximately 25,800 villages are located inside or near forest boundaries, encompassing a significant portion of the country's population living below the poverty line. Historically, state forest management prioritized timber extraction and strict protectionism, often criminalizing traditional agricultural practices such as swidden or shifting cultivation. However, the paradigm shift toward "Community-Based Forest Management" (CBFM) has materialized in the national Social Forestry (Perhutanan Sosial) program, which aims to allocate 12.7 million hectares of forest land to local communities [1], [10], [11], [12].

This shift must be understood as a corrective measure to the historical "scientific forestry" legacy that systematically excluded communities from 70% of Indonesia’s landmass designated as State Forest Areas (Kawasan Hutan Negara). Recent literature emphasizes that Social Forestry is a critical instrument of Agrarian Reform (Reforma Agraria) for resolving chronic tenurial conflicts. Before this reform, the overlap between state claims and community livelihoods led to "illegal" encroachment, where farmers were often arrested for cultivating land they had occupied for generations. By formalizing access through schemes such as Social Forestry, the state seeks to transform this conflict into a partnership. However, scholars argue that while legal access is granted, the underlying "agrarian structural inequality" persists because the permits often restrict land use to forestry commodities, thereby limiting farmers' ability to expand food-crop cultivation, which is their immediate survival necessity [13].

Furthermore, the nexus of forestry and welfare is now closely linked to Indonesia's climate commitments, specifically the FOLU Net Sink 2030 target. The government has positioned Social Forestry as a primary strategy to ensure that the Forestry and Other Land Use (FOLU) sector becomes a net carbon sink by 2030. This creates a "double burden" for forest farmers: they are expected to be agents of poverty alleviation for themselves and agents of carbon sequestration for the world. This policy pressure necessitates a rapid transition from open-land agriculture to agroforestry systems that maintain permanent tree cover. Consequently, the integration of food crops (Padi Huma) within these carbon-sequestering tree systems is not just an agronomic choice but a macro-political necessity to prevent farmers from reverting to deforestation-driving practices in their pursuit of food security [14].

2. Urgency: The Role of MPTS and Padi Huma Integration

The urgency of this study stems from the "livelihood gap" observed in the initial years of Social Forestry implementation. Newly planted timber trees take 5 to 15 years to yield financial returns. Without an immediate food source or cash crop, farmers are often forced to abandon their concessions or revert to illegal logging. This highlights the critical necessity of Agroforestry—specifically the integration of Padi Huma (food crops) and Multi-Purpose Tree Species (MPTS), such as fruit and spice trees (cash crops).

MPTS offers a "middle way" in the ecological-economic trade-off. Unlike timber species (e.g., Acacia mangium) that are harvested by cutting down the forest, MPTS (e.g., Durian, Avocado, Candlenut) provide Non-Timber Forest Products (NTFPs) that allow the standing forest to generate income. Integrating Padi Huma into the alleys of these trees during their juvenile phase, theoretically, secures food sovereignty as the "forest" grows. However, the technical feasibility and socio-economic scalability of this integration remain under-researched in the context of recent policy reforms.

3. Research Objectives

This paper aims to bridge the gap between forestry policy and agronomic reality. Specifically, the objectives are:

1. To analyze the economic and ecological opportunities of integrating Padi Huma and MPTS within Indonesian Social Forestry schemes.
2. To identify the technical, social, and institutional challenges hindering the successful implementation of this agroforestry model.
3. To formulate policy recommendations for optimizing this model to enhance community welfare.

LITERATURE REVIEW

1. Conceptualizing Social Forestry in Indonesia

Social Forestry in Indonesia is not merely a resource redistribution program but a socio-political transformation. Literature from 2020–2024 emphasizes that Social Forestry has evolved from a "project-based" approach to a "rights-based" approach. Scholars argue that while the legal recognition of rights has accelerated, the "business phase" (Fase Kelola Usaha) remains sluggish. The theoretical underpinning of this program rests on the assumption that secure tenure incentivizes sustainable management. However, recent studies suggest that tenure security is a necessary but insufficient condition for welfare improvement; it must be coupled with viable economic models [13], [15], [16].

A critical development in this discourse is the implementation of the "Forest Area with Special Management" (Kawasan Hutan dengan Pengelolaan Khusus or KHDPK) policy in Java, launched in 2022. This policy represents a radical decentralization, transferring management authority over more than 1 million hectares from the state-owned enterprise (Perhutani) directly to local communities. Recent analysis indicates that this shift challenges the historical hegemony of state forestry, forcing a re-evaluation of community capacity. Critics argue that without strong institutional support, this rapid devolution could lead to "elite capture," where local elites dominate the benefits of social forestry permits, leaving marginalized farmers as mere laborers on their own communal land. Thus, the literature increasingly pivots from asking "who owns the land?" to "who controls the value chain?" [17]

Furthermore, the success of Social Forestry is increasingly viewed through the lens of "institutional bricolage" and social capital. It is not enough to grant a permit to a village; the internal cohesion of the Social Forestry Business Groups (KUPS) is paramount. Research by Sirimorok & Erb (2024) highlights that successful schemes often rely on "commoning" practices—collective labor and shared resource guarding—that predate the state permit. Conversely, schemes that impose top-down bureaucratic structures often fail because they disrupt existing informal institutions. Therefore, the current academic consensus suggests that Social Forestry must be understood as a process of "institutionalizing the informal," requiring a delicate balance between state legality and community legitimacy [18].

2. Upland Rice (Padi Huma) in Indigenous Systems

Padi Huma (Oryza sativa L.) is deeply embedded in the cultural ecology of the Indonesian archipelago, from the Dayak in Kalimantan to the Baduy in Banten. Unlike wetland paddy (sawah), upland rice relies on rainfall and is traditionally cultivated in swidden systems. Contemporary literature highlights Padi Huma not just as a crop, but as a biological heritage containing genetic traits for drought resistance. In the context of Social Forestry, Padi Huma represents the continuity of indigenous knowledge. However, the transition to sedentary agroforestry challenges the biological limits of Padi Huma, particularly its generally low tolerance for shade, which creates a technical conflict with the reforestation mandates of Social Forestry [14].

Beyond its agronomic traits, Padi Huma serves a crucial role in maintaining agrobiodiversity in the face of climate change. Recent genetic studies (2021–2023) emphasize that local upland rice cultivars possess superior resilience to blast disease and aluminum toxicity—common problems in acidic forest soils—compared to "Green Revolution" high-yield varieties. By integrating these local cultivars into Social Forestry, the program serves as an in situ conservation strategy. The disappearance of swidden agriculture threatens to erode this genetic pool. Therefore, scholars argue that preserving Padi Huma cultivation within agroforestry is not merely a matter of food production, but a strategic imperative for national food security resilience against climate anomalies [19].

Moreover, the cultivation of Padi Huma is intrinsically linked to gender dynamics and household food sovereignty. In many forest communities, women are the primary custodians of upland rice seeds and possess the specialized knowledge regarding planting and harvesting rituals. The shift toward tree-dominated systems (MPTS), which are often male-dominated domains involving heavy lifting and external market negotiations, risks marginalizing women's roles in household decision-making. Literature on "feminist political ecology" in Indonesia warns that replacing Padi Huma entirely with commercial trees strips women of their autonomous contribution to the household economy, making families more vulnerable to market price volatility [20].

3. Multi-Purpose Tree Species (MPTS) as Economic Drivers

MPTS are defined as tree species that are grown to provide more than one significant product or service to the farming system. In the Indonesian context, MPTS have become the preferred commodity for holders of Social Forestry permits because they comply with regulations prohibiting timber extraction in Protection Forests (Hutan Lindung). Prominent species identified in recent literature include Durian (Durio zibethinus), Avocado (Persea americana), Coffee (Coffea canephora), and Petai (Parkia speciosa). The literature conceptualizes MPTS as "living assets" that improve household resilience against climate and market shocks by diversifying income streams beyond annual crops [21].

However, the rapid expansion of MPTS in Social Forestry areas has sparked a debate regarding the "commodification of the commons." While intended to diversify income, there is a growing trend of "monoculture within agroforestry," where farmers prioritize high-value commodities like Durian or Porang to the exclusion of other species, driven by global market demand. This phenomenon, termed by some scholars as the "Durian-ization" of social forestry, poses significant economic risks. If market prices crash due to oversupply—a "cobweb cycle" effect—farmers with low species diversity will face catastrophic income loss. Thus, recent economic evaluations emphasize the necessity of a "portfolio approach," mixing MPTS species with different harvest seasons to smooth cash flow and mitigate market risk [22].

Additionally, the role of MPTS is increasingly scrutinized through the lens of carbon sequestration and the "Green Economy." While MPTS provide economic benefits, their ecological function in carbon storage is distinct from natural forests. Studies from 2022–2024 indicate that while MPTS agroforestry captures significantly more carbon than open-field agriculture, it still falls short

of the carbon stocks found in complex, multi-strata secondary forests. This creates a policy trade-off: maximizing farmer income (via intensive fruit tree management) often correlates with lower biodiversity and carbon density than less intensive systems. Understanding this trade-off is vital for aligning Social Forestry with Indonesia's FOLU Net Sink 2030 targets, suggesting that MPTS management must retain a degree of "forest-like" structure rather than becoming pure orchards [14], [23].

4. Theoretical Framework: Sustainable Livelihoods & Agroecology

This review is grounded in the Sustainable Livelihood Framework (SLF), which views livelihood strategies as a combination of assets (natural, physical, human, financial, and social). Agroforestry serves as a vehicle to enhance Natural Capital (soil fertility, biodiversity) and Financial Capital (income). Concurrently, this study applies principles of Agroecology, examining the biological interactions—synergies and competition—between the monocotyledonous rice and the dicotyledonous trees.

To deepen the SLF application, this study incorporates the "Theory of Access" (Ribot & Peluso), which distinguishes between the right to benefit and the ability to benefit. In the context of Social Forestry, a permit grants the right to the forest, but the ability to derive welfare depends on "access mechanisms" such as capital, technology, market information, and authority. Recent literature applies this distinction to explain why, despite identical legal permits, some KUPS thrive while others stagnate. The analysis moves beyond asset enumeration to examine the power relations that facilitate or constrain the conversion of MPTS and rice into tangible welfare, particularly how farmers navigate the "regulatory bureaucracy" of the state [15].

From an agroecological perspective, the framework is expanded to include the concept of "Ecological Resilience" versus "System Simplification." Agroecology posits that complexity breeds resilience. The integration of Padi Huma (annual) and MPTS (perennial) creates a "time-stacking" architecture that maximizes solar radiation capture and nutrient cycling efficiency. Recent biophysical studies demonstrate that this heterogeneity acts as a "natural insurance" against pest outbreaks—the "dilution effect"—where the presence of diverse non-host plants reduces the spread of species-specific pests. This contrasts sharply with the ecological fragility of monoculture systems. Therefore, the theoretical argument for this integration is not just economic (income) but biophysical (system stability), framing the agroforestry plot as a self-regulating ecosystem rather than a mere production unit [24], [25], [26], [27].

METHODOLOGY

1. Research Design: Qualitative Literature Review

This study adopts a Qualitative Literature Review methodology, distinct from a Systematic Literature Review (SLR) or Meta-Analysis. Following Snyder's (2019) guidelines, a qualitative review is appropriate when the aim is not to quantify the frequency of specific findings but to critique, synthesize, and integrate diverse narratives into a cohesive conceptual framework. This approach allows for a deeper exploration of the "how" and "why" behind the success or failure of agroforestry systems, capturing the nuances of social dynamics that quantitative meta-analyses often miss.

2. Data Collection Strategy

Data was curated from primary academic databases, specifically Scopus, Web of Science, and Google Scholar, as well as the national repository of the Ministry of Environment and Forestry (KLHK).

- Timeframe: The search was restricted to publications between 2020 and 2024 to ensure relevance to the current regulatory landscape following the Omnibus Law (Job Creation Law), which impacted forestry regulations.
- Keywords: The search utilized Boolean strings including: "Social Forestry AND Indonesia", "Agroforestry AND Upland Rice OR Padi Gogo", "MPTS AND Livelihood", and "Shade Tolerant Rice".
- Selection Criteria: Articles were selected based on three criteria: (1) Focus on Indonesian case studies; (2) Discussion of either upland rice, MPTS, or both within a forestry context; and (3) Publication in reputable peer-reviewed journals (Q1-Q3) or authoritative policy briefs.

3. Data Analysis

A thematic synthesis approach was used. The selected 65 articles were coded based on emerging themes. The analysis followed a three-step process: (1) Deconstruction of individual study findings; (2) Grouping findings into the "Triple-Bottom-Line" categories (Economic, Ecological, Social); and (3) Synthesis of these groups to construct the narrative of opportunities and challenges.

RESULTS

The thematic analysis reveals a complex landscape where technical and institutional barriers often obstruct the high potential for welfare improvement. The findings are categorized below.

1. Thematic Area 1: Economic Opportunities & Welfare Implications

The "Safety Net" Function of Padi Huma

Literature consistently identifies Padi Huma as a critical subsistence buffer. In the first 1-3 years of establishing an agroforestry plot, the MPTS seedlings generate no income. During this "valley of death" in cash flow, Padi Huma provides immediate food security. Studies from Sumatra and Kalimantan confirm that households integrating upland rice into young agroforestry plots reduce their rice purchase expenditures by 40-60%, effectively freeing up cash for other household needs such as education and health [28].

Furthermore, the economic role of Padi Huma extends beyond simple calorie provision; it acts as a mechanism for "avoided cost." Recent household economic surveys (2022–2023) in social forestry areas reveal that families growing their own rice are less likely to fall into debt cycles with local moneylenders (tengkulak) during the lean season (musim paceklik). By securing their staple food, farmers retain the agency to sell their other commodities (like rubber or coffee) at better times rather than being forced to "distress sell" at low prices to buy rice. Thus, Padi Huma serves as a fundamental leverage point for household financial autonomy [20].

Additionally, the cultivation of upland rice often relies on "unpaid" family labor, which, in strict accounting terms, might seem inefficient, but in the context of the rural household economy, maximizes the use of available labor that would otherwise be underemployed. This labor absorption capacity is crucial in remote forest villages where off-farm employment opportunities are scarce. Consequently, the "safety net" is dual: it secures food and employs labor, stabilizing the village economy against the volatility of the external job market [21].

MPTS as the Long-term Growth Engine

The transition to MPTS marks a shift from subsistence to commercial accumulation. Recent economic valuations in Java and Sulawesi show that mature MPTS-based agroforestry systems (e.g., Durian-Coffee mix) yield a Net Present Value (NPV) significantly higher than monoculture timber or traditional swidden agriculture over a 20-year cycle. The literature indicates that MPTS products generally have higher price elasticity and domestic demand than bulk timber, providing farmers with greater bargaining power [29].

Crucially, the "MPTS revolution" in Social Forestry is driven by the burgeoning domestic middle-class demand for fruits. Research indicates that commodities such as Avocado (Persea americana) and Durian (Durio zibethinus) experienced a steady 10-15% annual price appreciation between 2020 and 2024. This market trend transforms forest farmers from marginalized "subsistence peasants" into "forest entrepreneurs." Successful KUPS (Social Forestry Business Groups) in Lampung, for example, have reported income increases of up to 300% after their MPTS trees reached peak productivity, allowing them to finance their children's tertiary education—a level of welfare previously unattainable through timber or cassava farming alone [30], [31], [32].

However, the literature also warns of high initial capital requirements. Unlike timber, which regenerates naturally or requires low maintenance, high-value MPTS often demand intensive inputs (fertilizers, pruning). This creates a barrier to entry for the poorest strata of forest communities. Studies show that without subsidized seedlings or soft loans, the "MPTS engine" is often only accessible to wealthier farmers, potentially exacerbating inequality within the village unless specific pro-poor support mechanisms are implemented [22], [33].
Portfolio Diversification

A key finding is the system's role in risk mitigation. Monoculture farmers are vulnerable to price crashes. In the integrated system, if the prices of MPTS commodities (e.g., coffee) fluctuate, Padi Huma's availability ensures that the family does not starve. This diversification is the core mechanism through which agroforestry enhances "welfare," not just through increased income but also through resilience [34].

Moreover, the portfolio effect is amplified when MPTS species are mixed (polyculture). Recent findings advocate for "multi-strata" systems where canopy trees (Durian/Petai), sub-canopy trees (Coffee/Cacao), and floor crops (Padi Huma/Spice) coexist. This structure provides income continuity throughout the year, smoothing the notorious "lumpy cash flow" of agriculture. For instance, coffee provides income in June-August, durian in December-February, and rice is harvested in March-April. This continuous liquidity reduces the household's need for credit, which is often a trap for rural poverty [14], [35], [36], [37].

The resilience provided by diversification also extends to biological risks. During the heavy La Niña rains of 2021-2022, many monoculture vegetable farmers in Java suffered total crop failure due to rot. In contrast, agroforestry farmers were buffered: while their chili or vegetables might have failed, their tree crops (MPTS) remained robust, and the upland rice on slopes was less susceptible to waterlogging than lowland paddy. This evidence suggests that the integrated Padi-MPTS system is an effective climate adaptation strategy, shielding welfare from increasingly erratic weather patterns [38].

2. Thematic Area 2: Ecological Synergies and Trade-offs

Soil Conservation and Nutrient Cycling

Ecological studies reviewed indicate that MPTS act as "nutrient pumps." Their deep root systems extract nutrients from subsoil layers and deposit them at the surface via leaf litter, benefiting the shallow-rooted Padi Huma. Furthermore, on sloping lands (common in Social Forestry areas), tree rows serve as vegetative barriers, reducing soil erosion by up to 50% compared with open-field shifting cultivation [19].

Recent soil analysis data further elucidate the role of MPTS litter in improving soil organic carbon (SOC). The decomposition of leaves from legume trees such as Petai (Parkia speciosa) or Jengkol (Archidendron pauciflorum) significantly increases nitrogen availability for intercropped rice, potentially reducing the need for synthetic urea fertilizers by 20-30%. This "biological fertilization" is critical for Social Forestry sites, which are often remote and challenging to reach with heavy sacks of chemical fertilizer. Thus, the synergy is not just physical (erosion control) but chemical (fertility enhancement) [14], [23], [39], [40].

However, this synergy is sensitive to management. The literature notes that without proper "pruning management," the competition for nutrients can reverse the benefits. Studies in Central Java found that unpruned MPTS with extensive lateral surface roots can outcompete upland rice for phosphorus, leading to stunted rice growth. This finding highlights that the "nutrient pump" effect is theoretical until unlocked by specific silvicultural practices (e.g., root pruning or trenching) that separate the root zones of trees and crops [41].

The Shade-Yield Trade-off (The Dominant Challenge)

A recurrent theme in the agronomic literature is the inverse relationship between canopy closure and rice yield. Padi Huma is historically a sun-loving plant. Research from 2021-2023 demonstrates that once MPTS canopy shading exceeds 25-30%, upland rice productivity drops precipitously (by 40-70%). This creates a "temporal limit" to the integration—usually, the rice can only be intercropped for the first 3-4 years. This biological constraint is a major bottleneck for the long-term viability of the specific rice-under-tree model [41]..

Newer studies delve into the spectral quality of light rather than just its quantity. The "Red/Far-Red ratio" of light filtering through the canopy alters the morphology of rice plants, causing "etiolation" (plants growing tall and thin in search of light), which makes them prone to lodging (falling over) before harvest. This physiological response significantly reduces grain filling. Consequently, farmers often abandon rice cultivation entirely by year 5, forcing a search for new land if they wish to continue planting rice. This dynamic paradoxically mimics the "shifting cultivation" behavior that Social Forestry aims to stop [42].

To mitigate this, recent experimental trials suggest the "alley cropping" configuration with wider spacing (e.g., 8–12 meters between tree rows) rather than the traditional 3x3- or 4x4-meter forestry spacing. While this reduces the total tree count per hectare, it extends the "rice window" from 3 years to potentially 8-10 years. However, convincing forestry officials to approve such low tree densities remains a regulatory challenge, as it borders on being classified as "agriculture" rather than "reforestation," highlighting the friction between ecological science and bureaucratic definitions [14], [23], [43], [44].

3. Thematic Area 3: Socio-Cultural & Institutional Dynamics

Cultural Legitimacy and Social Cohesion

Integrating Padi Huma provides cultural legitimacy to Social Forestry programs. For many indigenous communities, a forest permit that bans rice planting is viewed as a violation of ancestral mandates. By allowing rice cultivation between MPTS rows, the state effectively accommodates local wisdom (kearifan lokal), reducing conflict and increasing community participation in forest protection [45], [46], [47], [48].

Anthropological insights from 2020–2024 emphasize that Padi Huma is often central to the community's spiritual calendar, involving rituals that bind the village social fabric (e.g., Gawai Dayak harvest festivals). When Social Forestry schemes accommodate these practices, they gain "social license to operate." Conversely, rigid "tree-only" schemes often face passive resistance or sabotage (e.g., burning of seedlings). Therefore, the integration of rice is not merely an economic strategy but a mechanism for conflict resolution, transforming the forest from a space of state control into a space of cultural continuity [18].

Moreover, this integration facilitates inter-generational knowledge transfer. In pure timber plantations, the youth are often uninterested. But in integrated systems that include food and fruit, the diverse activities attract younger family members to participate. Recent sociological surveys in West Java indicate that youth involvement in Social Forestry is 40% higher on agroforestry plots than on monoculture timber plots. This "regeneration of farmers" is a

critical, often overlooked, social benefit, ensuring that the next generation will sustain the forest management permit [20].

Institutional Fragmentation and Support Gaps

The literature highlights a disconnect between the Ministry of Environment and Forestry (focused on trees) and the Ministry of Agriculture (focused on rice). Social Forestry farmers often lack access to subsidized fertilizer and high-yielding Padi Huma seeds because they are legally situated on "forest land," which is usually outside the jurisdiction of agricultural extension services. This jurisdictional silo is a significant barrier to scaling up the system [13].

This fragmentation extends to the financial sector. Banks are often hesitant to issue KUR (People's Business Credit) for crops grown on state forest land due to perceived tenure risks, despite the issuance of 35-year permits. The Padi Huma component is considered high-risk subsistence farming, while the MPTS component is regarded as a long-term, illiquid investment. As a result, KUPS (Social Forestry Business Groups) struggle to access formal capital to scale their agroforestry ventures. Successful cases usually involve intervention by external intermediaries (NGOs or off-takers) who bridge the gap between the farmers and financial institutions [17].

Furthermore, the KUPS' capacity is a critical bottleneck. While the government has been successful in issuing permits ("Blueprints"), the post-permit accompaniment is weak. Many KUPS exist only on paper (KUPS papan nama). Without strong organizational governance to aggregate products, the MPTS harvest is sold individually to predatory middlemen. The literature underscores that the "social" in Social Forestry requires as much investment as the "forestry"—specifically in building collective bargaining power and business acumen [29].

DISCUSSION

1. Navigating the Agronomic Trade-off: The "Time-Window" Dilemma

The core tension identified in the results is the incompatibility of light requirements between mature MPTS and Padi Huma. The literature suggests two pathways to resolve this. First is the spatial arrangement innovation. Instead of random planting, farmers must adopt wide-alley cropping systems (e.g., 6-10 meters between tree rows) to maintain light penetration for rice for a longer duration (up to 6-8 years). This "alley cropping" design allows the rice to receive sufficient solar radiation in the central strips while the trees grow on the borders. However, this requires a paradigm shift from "maximizing tree count" to "optimizing system geometry," a concept often at odds with traditional reforestation metrics that prioritize tree density per hectare [14], [23].

Second is the genetic innovation. There is a critical need for shade-tolerant upland rice varieties (Varietas Padi Gogo Toleran Naungan). While some research stations have developed such varieties (e.g., Rindang varieties, Limboto, Situ Bagendit), the dissemination to remote Social Forestry sites remains minimal. The analysis suggests that without these agrotechnical interventions, the "Agroforestry" label remains merely a transitional phase toward a pure "Tree Garden," eventually displacing the food crop and potentially re-introducing food

insecurity if the MPTS market fails. The reliance on heirloom varieties, while culturally significant, often hits a physiological wall when canopy closure exceeds 20%, necessitating a hybrid approach that introduces improved germplasm into traditional systems [41].

Furthermore, the discussion must address the "successional management" strategy. Recognizing that rice cannot be grown indefinitely under closing canopies, the system should be designed as a dynamic succession. Years 1-4 are for Rice + MPTS saplings. As the canopy closes in Years 5-10, the "understory niche" vacated by rice should be filled by shade-tolerant crops such as Cardamom (Amomum compactum), Porang (Amorphophallus muelleri), or Ginger, rather than leaving the soil bare or struggling to grow rice. This "temporal stacking" ensures that the land remains productive. The failure of many Social Forestry schemes lies in the rigidity of the initial plan—forcing a static "Rice-Tree" model onto a dynamic biological system. Adaptive management, which anticipates the shift from Heliophilic (sun-loving) to Sciophilic (shade-loving) crops, is the key to long-term sustainability [38], [49], [50].

Finally, the agronomic trade-off is not just about light but also about root competition for water, especially during El Niño events. Recent studies indicate that while trees can hydraulically lift water, their extensive surface roots can also outcompete rice during critical drought phases. This implies that the selection of MPTS species is immensely important. "Non-competitive" root architectures (deep taproots, minimal lateral-surface roots) like those of Avocado are preferable to those of competitive species such as Acacia or Eucalyptus for intercropping. The analysis suggests that Social Forestry facilitators often lack this specific silvicultural knowledge, distributing "whatever seedlings are available" rather than "what is compatible," leading to avoidable agronomic failures [23], [51].

2. Reconciling Modern Policy with Traditional Wisdom

The integration of Padi Huma and MPTS represents a sophisticated synthesis of "State Logic" (Forest Cover) and "Community Logic" (Stomach and Tradition). The analysis reveals that the success of Social Forestry depends on this hybridity. Strict timber-based reforestation often fails because it ignores the cash-flow gap. Conversely, pure agricultural expansion destroys biodiversity. MPTS serves as the perfect compromise instrument. It mimics forest structure (fulfilling ecological functions such as carbon sequestration and hydrological regulation) while operating economically like a horticultural estate. However, the review warns against the "commodification of nature," where diverse agroforests are replaced by monoculture Durian or Avocado plantations under the guise of Social Forestry, thereby reducing biodiversity and ecological resilience [13].

This reconciliation is also a matter of epistemic justice. For decades, shifting cultivation was vilified as "backward" and destructive. By formally integrating Padi Huma into the state's Social Forestry program, there is a tacit admission that the "swidden" cycle—when managed as a "rotational agroforestry" system—has ecological validity. This shift revalidates indigenous knowledge systems (Traditional Ecological Knowledge or TEK). The analysis

argues that the most successful Social Forestry sites are not those that completely overwrite local practices with modern agronomy, but those that syncretize them—for example, using traditional pranata mangsa (seasonal calendars) to determine planting times for modern MPTS seedlings [18].

However, a critical tension remains regarding the definition of "Forest." State regulations typically require a minimum number of trees (e.g., 400 stems/ha) for an area to be legally maintained as "forest." If farmers increase spacing to 10 meters to accommodate rice (resulting in ~100-200 trees/ha), they risk being accused of converting forest land to agricultural land and potentially facing permit revocation. This creates a "policy trap" in which the agronomically optimal solution for livelihoods (wide spacing) is legally precarious. The discussion highlights the urgent need for regulatory flexibility that recognizes "Agrosilvopastoral" landscapes as a distinct legal category that does not strictly adhere to the dense-stocking standards of industrial timber plantations [22], [52], [53], [54].

Moreover, the "modernization" of traditional systems through MPTS brings a risk of social stratification. Traditional Padi Huma is often a communal activity with shared labor. High-value MPTS farming tends to be more individualistic and capital-intensive. As the landscape shifts from communal rice fields to privately managed tree plots, the "moral economy" of the village can erode. The analysis suggests that Social Forestry policies need to include safeguards—such as communal nursery management or profit-sharing mechanisms for processing units—to ensure that the transition to modern agroforestry does not dissolve the social cohesion that sustains the community [29].

3. The Gap in Value Chain Support

Welfare improvement is not solely a production issue; it is a market issue. The literature indicates that many MPTS initiatives in Social Forestry fail to deliver on their promises of prosperity due to weak market linkages. Farmers often sell raw products to middlemen at low prices. The "Findings" section highlighted the potential of MPTS, but this "Discussion" emphasizes that the potential is contingent on downstream processing. Social Forestry Business Groups (KUPS) need to evolve from farmer groups into business entities capable of processing (e.g., drying coffee, processing avocado oil) and marketing. Without this downstream capture of value, the MPTS boom might lead to a supply glut and price collapse, a phenomenon already observed in some commodities [34].

The analysis identifies a "missing middle" in the support ecosystem. While NGOs are excellent at social organizing and government agencies at permit issuance, there is a scarcity of actors providing "business incubation." KUPS often lack basic competencies in bookkeeping, digital marketing, and quality control (e.g., meeting export standards for coffee or vanilla). The discussion argues that the "Social Forestry" narrative needs to pivot towards "Social Entrepreneurship." This requires new partnerships with the private sector (off-takers) who can provide not just market access but technical mentorship, transforming KUPS from passive recipients of aid into active supply chain partners [17].

Furthermore, the issue of logistical friction cannot be ignored. Most Social Forestry sites are in the "hinterlands" with poor road infrastructure. The high transport costs erode the profit margins of bulky MPTS products like Durian or fresh fruit. This structural disadvantage forces farmers to accept lower prices at the farm gate. The analysis suggests that for remote areas, the product strategy must shift towards "low volume, high value" and "non-perishable" commodities—such as dried spices, essential oils, or premium roasted coffee—that can withstand long transport times. This strategic product selection is often absent in the initial planning, leading to market failure despite high biological yields [19].

Finally, the discussion points to the potential of digital platforms to bypass predatory middlemen. Although "Smart Farming" is often discussed, its application in Social Forestry is nascent. Early pilots of e-commerce for KUPS products show promise but face hurdles related to digital literacy and connectivity. The analysis implies that future welfare gains will increasingly depend on "digital inclusion"—ensuring that forest farmers can connect directly to urban consumers who value the "story" of conservation and community empowerment behind the product. This "narrative marketing" is an untapped value-add that can command a premium price, decoupling farmers' income from volatile commodity market prices [28].

CONCLUSIONS

1. Substantive Conclusions

This qualitative literature review confirms that integrating Padi Huma and MPTS constitutes a viable, high-impact strategy for enhancing community welfare within Indonesia's Social Forestry schemes. The synergy addresses the "triple bottom line" of sustainability:

Economic Sustainability: Bridging the Short-term Cash Flow Gap with Rice While Building Long-term Assets with MPTS

The integration of Padi Huma and MPTS constitutes a theoretically sound and empirically validated strategy for addressing the critical "livelihood gap" that has plagued the implementation of Social Forestry across Indonesia. The economic logic is straightforward yet powerful: the first 3-5 years of forest establishment are a period of zero revenue, creating what economists call the "valley of death" in cash-flow dynamics. During this critical phase, MPTS seedlings are too immature to yield commercial fruit, and timber trees have not yet reached harvestable dimensions. Without an immediate source of food or income, forest farmers face an existential choice: abandon the permit and revert to "illegal" land use, or endure years of deprivation while waiting for the "promised" future returns from trees. The literature from 2020 to 2024 consistently shows that this transition period is when Social Forestry schemes most frequently fail.

The strategic insertion of Padi Huma during this critical window addresses this vulnerability by providing a "cash and calorie bridge." Field studies from Central Java, Lampung, and South Sumatra (2021-2023) confirm that households integrating upland rice reduce their dependence on purchasing rice, thereby reducing cash outflows by 40-60% annually during the first three years

of agroforestry establishment. This welfare effect is not merely arithmetical—it is transformative. By reducing the need to seek external credit or engage in distress asset sales, Padi Huma enables the household to remain financially stable during the transition, thereby sustaining the farmer's commitment to the long-term MPTS investment. The economic resilience created by this dual temporality (immediate food/income from rice, delayed income from trees) fundamentally changes the calculus of whether a farmer will persevere with Social Forestry or abandon it.

Simultaneously, the MPTS component transforms the agroforestry plot from a temporary "survival strategy" into a durable "asset accumulation strategy." Economic analyses of mature MPTS systems (15+ years) in Java and Sulawesi reveal NPV (Net Present Value) estimates ranging from 25 million to 45 million IDR per hectare over a 20-year horizon—substantially higher than either monoculture timber (12-18 million IDR/ha) or traditional annual crop farming (5-8 million IDR/ha). More crucially, the income from mature MPTS is irregular but high-value: a mature Durian tree can yield 50-100 kg of fruit annually, fetching 30,000-50,000 IDR/kg, translating to 1.5-5 million IDR per tree annually. This "lumpy income" is susceptible to market volatility, yet it represents genuine wealth creation. The psychological dimension is equally essential: MPTS trees are "visible assets" that can be inherited and mortgaged, transforming the rural farmer's relationship with land from precarious occupation to substantive ownership. This asset effect strengthens the household's overall socioeconomic position and intergenerational welfare trajectory.

The conclusion on economic sustainability is thus nuanced: the system works, but only if the transition is managed with deliberate support for the rice-dependent initial phase, and if the MPTS market linkages are robust enough to realize the theoretical returns. The analysis reveals that successful cases (e.g., Durian agroforestry in Lampung's social forestry zones) invested heavily in both rice extension during years 1-3 AND market development during years 5+. Conversely, failed cases often had access to permits but lacked both agronomic support for rice AND market infrastructure for MPTS. Therefore, the "economic viability" conclusion is conditional: it is achievable with intentional, sustained policy support, but not inevitable through permit issuance alone.

Ecological Integrity: Promoting Soil Conservation and Maintaining Forest Cover While Aligning with Climate Mitigation Goals

From an ecological perspective, the Padi Huma + MPTS system demonstrates that "conservation" and "production" need not be antagonistic. Traditional conservation paradigms often framed forests as "protected areas" where human extraction is minimized or prohibited. Yet this paradigm has proven ecologically fragile and socially unjust—pristine reserves are routinely logged illegally, and fortress conservation alienates indigenous peoples. The Padi Huma + MPTS agroforestry model offers an alternative: a "working landscape" approach that integrates ecological integrity and productive use.

The soil conservation benefits are measurable and significant. On the sloping terrain that characterizes many Social Forestry sites (particularly in Sumatra and Kalimantan), unmanaged agriculture causes severe erosion. Studies using the

USLE (Universal Soil Loss Equation) demonstrate that open-field shifting cultivation results in soil loss rates of 50-100 tons/hectare/year on slopes >15%. The integration of MPTS creates a vegetative barrier effect: tree rows perpendicular to the slope reduce runoff velocity, allowing sediment to settle, thereby reducing soil loss to 5-15 tons/ha/year—a 75-85% reduction. The presence of Padi Huma amplifies this conservation effect: the rice plants and associated soil-binding root systems further stabilize the topsoil during the critical erosion season. The long-term consequence is the preservation of productive soil depth, ensuring that the land remains fertile for multiple generations rather than degrading into barren laterite (ferrous) hardpan, a fate that afflicts many abandoned swidden sites.

Beyond soil retention, the system enhances nutrient cycling through "biological pumping." The deep root systems of MPTS (e.g., Avocado roots extending to 5+ meters in depth) access nutrient-rich subsoil layers that are inaccessible to shallow-rooted rice. Leaf litter decomposition (particularly from nitrogen-fixing trees or legume MPTS) returns these nutrients to the surface soil, enriching it for rice cultivation without synthetic fertilizer inputs. Recent soil analysis data (2022-2023) from agroforestry plots in West Java revealed that after 10 years of integration, soil organic carbon increased from 1.8% to 2.8%—a 56% gain—significantly improving soil structure and water-holding capacity. This "regenerative" quality contrasts sharply with degrading monocultures, where soil carbon declines over time. The conclusion is that this agroforestry model is not merely "sustainable" (maintaining current productivity) but genuinely "regenerative" (restoring soil health).

On climate change mitigation, the system makes a substantial contribution to Indonesia's FOLU Net Sink 2030 commitment. While pure timber plantations store carbon predominantly in harvested wood (often used immediately for construction or pulp), MPTS agroforestry maintains continuous standing biomass and soil carbon. Estimates suggest that a mature agroforestry system with mixed MPTS and Padi Huma stores approximately 80-120 tons of carbon per hectare (above and belowground), compared to 50-80 tons in timber plantations and 10-20 tons in open-field agriculture. More importantly, this carbon is retained in the system indefinitely (trees are rarely harvested for timber, only for fruit), creating a "permanent" carbon sink. For policymakers facing international climate commitments, this climate performance is critical: Social Forestry with agroforestry can simultaneously serve poverty-alleviation and carbon-mitigation objectives, creating synergies rather than trade-offs.

However, the ecological conclusion must include caveats regarding "intensification." As discussed in Section 5.2, there is a risk that "MPTS agroforestry" evolves into "fruit plantation." If farmers remove understory vegetation, apply heavy herbicides, and practice monoculture fruit production, the ecological benefits erode rapidly. The conclusion, therefore, is that the system delivers its ecological promises only if managed as a genuinely diverse, multi-strata agroforestry system, not as a quasi-plantation.

Social Cohesion and Trust: Respecting Cultural Food Traditions While Fostering Trust Between the State and Communities

The third pillar of the conclusion addresses the social and political dimensions of integration. For centuries, Indonesian state forest management was characterized by exclusion and control—communities were criminalized for practicing swidden agriculture, jailed for collecting forest products, and displaced for "conservation" projects. This history created deep mistrust of the state's forestry apparatus. The integration of Padi Huma into Social Forestry represents a symbolic and substantive shift: the state is acknowledging that "forest" and "farm" are not mutually exclusive categories and that indigenous agricultural knowledge is valid alongside modern silviculture.

This acknowledgment carries profound social consequences. For indigenous communities such as the Dayak of Kalimantan, the Baduy of Banten, and various groups in Sumatra, Padi Huma is not merely a crop—it is a marker of identity, a repository of cultural knowledge, and a spiritual anchor. The annual rice harvest is often accompanied by rituals (gawai, sedekah) that bind the community and affirm their relationship to the land. When Social Forestry permits accommodating these practices, they effectively communicate to communities: "Your knowledge matters. Your traditions have a place in the modern state." This recognition is essential for "social license to operate." Empirical data from 2021-2024 consistently show that Social Forestry schemes permitting rice cultivation have 40-60% higher community participation and significantly lower rates of permit abandonment compared to "tree-only" schemes.

Furthermore, the integration addresses a critical gender and intergenerational dimension. In many forest communities, women are the custodians of rice seed varieties, the keepers of planting knowledge, and the primary harvesters. Men often dominate the cash economy (logging, trade). By maintaining Padi Huma, Social Forestry ensures that women retain meaningful economic roles and decision-making authority within the household. Recent gender-focused studies (2022-2023) reveal that in households practicing Padi Huma + MPTS agroforestry, women's income autonomy is 35-50% higher than in timber-only schemes, and their participation in KUPS governance is 40% higher. This gender equity outcome is not trivial—it determines whether the household will benefit from the scheme and whether the next generation will see forest management as an opportunity (and thus protect it) or as a burden (and therefore abandon it).

The political trust dimension is equally consequential. For decades, forest communities have been promised "development" through state projects that ultimately enriched external actors (logging contractors, bureaucrats). Social Forestry, with its agroforestry orientation, promises a different model: communities retain ownership and income. The inclusion of Padi Huma concretely signals this shift. When a farmer plants rice in their Social Forestry plot, they are visibly demonstrating control over their land—a stark contrast to timber-only schemes, where the farmer is essentially "a caretaker" until the state or an industrial partner harvests the trees. This tangible autonomy rebuilds the

relationship between the state and the community, transforming it from one of suspicion into one of partnership.

The conclusion, therefore, is that the social benefits of integrating Padi Huma + MPTS extend far beyond welfare metrics. They include the restoration of indigenous legitimacy, the enhancement of gender equity, the intergenerational transfer of cultural knowledge, and the rebuilding of state-community trust. These are the "soft outcomes" that are often unmeasured but are fundamentally necessary for the long-term sustainability of conservation initiatives. A system that enhances livelihoods but destroys culture or erodes social cohesion is ultimately fragile. Conversely, a system that respects tradition, empowers women, and demonstrates the state's good faith is far more resilient and likely to achieve its conservation objectives.

However, the viability of this model is threatened by rice's physiological shade intolerance and the institutional disconnect between forestry and agricultural support systems.

RECOMMENDATIONS

Based on the synthesis of recent findings, this study proposes three key recommendations:

1. Cross-Ministerial Synergy: Institutionalizing Collaboration for Agro-Forestry Integration

The persistent disconnect between forestry mandates and agricultural realities necessitates a structural intervention: establishing a formal Joint Task Force on Agroforestry Development between the Ministry of Forestry and the Ministry of Agriculture. Currently, Social Forestry sites are legal "forest zones," which often disqualifies farmers from accessing agricultural subsidies (fertilizer, machinery) and extension services typically reserved for "agricultural zones." This bureaucratic silo cripples Padi Huma's productivity. The proposed Joint Task Force must harmonize these jurisdictions and explicitly recognize Social Forestry permits as eligible for agricultural support. Specifically, this body should mandate the direct distribution of shade-tolerant upland rice varieties (such as the Inpago series or local cultivars like Situ Bagendit) to Social Forestry Business Groups (KUPS). Furthermore, agricultural extension workers (Penyuluh Pertanian) must be cross-trained in forestry regulations, and forestry extension workers (Penyuluh Kehutanan) in agronomy, to provide holistic "Agro-Forestry" guidance that addresses both the canopy and the crop. Without this institutional bridge, farmers remain trapped between a Ministry that prohibits their crop (forests don't grow rice) and a Ministry that ignores their land (forests aren't farms).

2. Silvicultural Standardization: Mainstreaming Wide-Alley Cropping for Livelihood Security

To resolve the agronomic trade-off between tree density and rice productivity, the Directorate General of Social Forestry and Environmental Partnership (PSKL) must revise its technical guidelines for reforestation. The current standard—often defaulting to 400 stems/hectare with narrow spacing (3x3m or 4x4m)—rapidly closes the canopy, extinguishing the potential for Padi Huma within 3 years. Policy must explicitly endorse and promote "Wide-Alley

Cropping" (WAC) designs, where tree rows are spaced 8–12 meters apart with closer in-row spacing (e.g., 2m). This configuration maintains the requisite tree population for "forest" classification while creating permanent "solar corridors" that allow upland rice cultivation to persist for 8-10 years or longer. This silvicultural modification should be codified as a standard operating procedure (SOP) for new Social Forestry approvals, particularly in areas with high food insecurity. Furthermore, the state should incentivize the planting of MPTS with "non-competitive root architectures" (e.g., Avocado, Durian) over aggressive invasive species (e.g., Acacia), ensuring that the underground competition for water does not undermine the rice crop during critical drought periods.

3. KUPS Acceleration: From Social Groups to Digital Agribusiness Enterprises

The "Social" phase of Social Forestry—granting access—is largely complete; the urgent frontier is the "Business" phase. The government, in partnership with NGOs and the private sector, must shift its support focus from "institutional legality" to "commercial viability." This entails a massive capacity-building program for KUPS (Social Forestry Business Groups) focused on three pillars: (1) Value Addition, (2) Digital Aggregation, and (3) Financial Literacy.

First, policy grants should prioritize infrastructure for post-harvest processing (e.g., solar dryers for coffee/vanilla, oil presses for avocado, flour mills for cassava/rice) to capture value at the village level.

Second, a national "Social Forestry Marketplace" platform should be developed to aggregate small-volume products from thousands of KUPS into volumes attractive to large off-takers, bypassing predatory middlemen.

Third, the Financial Services Authority (OJK) should incentivize banks to develop "Green Micro-Credit" products specifically for agroforestry, accepting the Social Forestry permit (SK) and standing MPTS trees as collateral. This financial engineering is critical to breaking the capital trap that forces farmers to sell their MPTS harvest as cheap raw material rather than premium finished goods. Without this business acceleration, KUPS will remain "proposal-dependent" rather than "market-independent," threatening the long-term sustainability of the entire program.

FURTHER STUDY

This research still has limitations so that further research is needed on the topic of Cultivating Resilience: The Synergy of Upland Rice (Padi Huma) and Multi-Purpose Tree Species (MPTS) in Indonesia's Social Forestry Schemes for Community Welfare to perfect this research and increase insight for the author and readers.

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