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# Development And Upgrading Of Coffee Cultivation, Value Addition, And Community-Based Management Among Tea-Coffee Quality Farmers In Ban Pok Mae On District Chiang Mai Province

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## ABSTRACT

This research aims to generate knowledge and enhance the quality of community-grown coffee beans for specialty coffee evaluation. The study focuses on improving the quality of Arabica coffee and analyzing the return on investment in coffee production, with particular emphasis on post-harvest processing. Additionally, the research examines the coffee supply chain to enhance operational efficiency and develop management systems that optimize the use of available materials and equipment, thereby strengthening the competitiveness of Thai coffee in the broader market. The research sample comprised two groups: (1) 26 local coffee farmers from Ban Pok and 12 regional entrepreneurs, totaling 38 participants; and (2) 100 stakeholders including producers, operators, experts, and consumers engaged through exhibitions, competitions, and trade fairs in Mae On District, Chiang Mai Province, and other regions. Findings indicate that Ban Pok farmers received academic support to promote forest-friendly cultivation practices. Arabica coffee of the Catuaí variety was grown in agroforestry settings, yielding a distinctive flavor profile characterized by notes of chocolate, wildflowers, grains, berries, persimmons, and passion fruit flavor elements uniquely associated with the region. Harvesting and processing are conducted manually, particularly during the midstream phase, when ripened coffee cherries are carefully selected. Farmers sell their produce in two primary forms: (1) fresh coffee cherries and (2) parchment coffee processed using the wet (washed) method. Community capacity-building initiatives led to improved coffee quality, with four individuals successfully achieving specialty coffee certification from the Specialty Coffee Association (SCA). While the Ban Pok coffee supply chain reflects substantial experience and production capability, it still lacks comprehensive value addition through product development and processing, particularly in midstream and downstream operations. There remains a need for quality enhancement through grading and evaluation in alignment with SCA standards, which will facilitate the production of high-quality specialty coffee and strengthen the overall value chain. Project interventions included training programs and capacity-building workshops targeting entrepreneurs involved in all stages of the supply chain upstream, midstream, and downstream. To enhance the market competitiveness of Thai coffee, the project recommends development in five key areas: (1) cultivation improvement and upgrading, (2) refinement of production processes, (3) advanced coffee processing techniques, (4) strategic marketing management, and (5) strengthened community enterprise administration.

**Keywords:** Production Process Enhancement, Specialty Coffee Quality, Coffee Cultivation.

## INTRODUCTION

Thailand currently ranks third in coffee production in Southeast Asia, following Vietnam and Indonesia, and is the 19th largest producer globally. The country cultivates two main coffee species: Robusta and Arabica. Robusta coffee grows well from sea level up to 1,050 meters above sea level and is primarily cultivated in the southern provinces, including Surat Thani, Chumphon, Ranong, Nakhon Si Thammarat, Phang Nga, and Krabi. In contrast, Arabica coffee thrives in highland areas between 800 and 1,500 meters above sea level, where the slower growth rate yields higher-quality beans. This variety is mainly grown in northern Thailand (Office of Agricultural Economics, 2015). In 2022, Thailand had a total of 281,092 rai (approximately 112,437 acres) of coffee plantations, with 259,449 rai (103,737 acres) in active production. Southern Thailand accounts for 73.56% of the total coffee cultivation area. Meanwhile, northern Thailand contributes 25.82% (72,570 rai), but yields a higher productivity rate of 151 kilograms per rai, compared to 145 kilograms per rai in the South making the North the most productive region (Office of Agricultural Economics, 2022). Among the northern provinces, Chiang Mai holds the second-largest coffee cultivation area with 32,688 rai, following Chiang Rai (53,891 rai), and ahead of Nan (12,572 rai) and Mae Hong Son (8,888 rai). Despite being second in cultivated area, Chiang Mai ranks first in yield per rai, indicating its high potential for quality coffee production. This success stems from the Royal Project initiated in 1974 with support from the U.S. Department of Agriculture (USDA) and the Department of Agriculture, which promoted Arabica coffee cultivation as a substitute for opium farming among hill tribes. Today, more than 100,000 households in Chiang Mai are involved in coffee farming. One significant area is Mae On District, including Ban Pok, Ban Mae Lai, Ban Mae Kampong, and Ban Mae Wong. Most coffee in this area is sold as fresh cherries or parchment coffee. The region's high elevation and climate offer ideal conditions for producing premium Arabica beans, attracting attention from both consumers and tourists. "Ban Pok Community Coffee," located in Huai Kaeo Subdistrict, Mae On District, has evolved from its legacy of miang (fermented tea) production, a tradition dating back over 200 years to the Khmu ethnic group. As miang consumption declined, coffee emerged as an alternative cash crop. Initially, farmers focused on quantity over quality, leading to increased household debt and financial risks. Although government agencies and academic institutions supported coffee cultivation, gaps remain in product value addition, mechanization, and knowledge transfer between older and younger generations. Bridging these gaps especially in post-harvest technology, product innovation, and knowledge integration is essential to enhancing productivity and transforming Huai Kaeo into a high-value agro-industrial community. In alignment with Thailand's 13th National Economic and Social Development Plan (2023-2027), enhancing coffee quality requires attention across the value chain from cultivation and harvesting to processing, grading, and storage. Key challenges include high production costs, inconsistent yields, and environmental concerns. To address these issues, a systematic approach that incorporates local wisdom, modern technology, and mechanization is needed to reduce costs and improve the quality of Arabica beans (Pongwiritthon, Kamchai, & Panturee, 2022).

Based on field visits to Huai Kaeo Subdistrict, specifically the coffee-growing area of Ban Pok, and participation in meetings with community enterprises and experts on specialty coffee certification in September 2022, two key issues emerged. First, in order to elevate the standards of community-grown coffee and access higher-value markets, coffee farmers must focus on adopting better cultivation practices. This improvement does not necessarily require additional investment in production inputs but relies instead on practical training, organic forest-based cultivation techniques, and farmer discipline in knowledge creation and record-keeping. These practices can add value throughout the coffee production process from cultivation to distribution—and ensure Ban Pok coffee gains wider recognition. This pathway also creates opportunities for younger generations returning to their hometowns to engage in sustainable community-based tourism and coffee-related enterprises. Second, supply chain analysis of community-based coffee processing highlighted the need to integrate and enhance production knowledge. This includes effective use of machinery and equipment appropriate for smallholder farmers or farmer groups. The community already demonstrates readiness in terms of indigenous knowledge, support from local business operators with SCA-standard production techniques, and full-scale machinery provided by relevant agencies. However, addressing current challenges requires a shift in

mindset: although the cost of producing higher-quality coffee may increase, the return on investment is significantly greater. To ease the transition, it is recommended that farmers begin by allocating a portion of their land to grow specialty coffee—either by upgrading existing coffee plots or converting other agricultural land. This approach reduces financial risk and allows farmers to gradually shift from selling low-value fresh cherry to processing coffee via dry (natural), washed, or honey (semi-washed) methods. These practices increase product value and market visibility. This strategy aligns with Chiang Mai Province's agenda to become a hub for coffee innovation. The goal is to leverage high-quality, forest-grown coffee to integrate the coffee economy with tourism and generate local income. Based on these findings, the research team proposes a study titled: "Development and Upgrading of Coffee Cultivation, Value Addition, and Community Enterprise Management for Quality Tea and Coffee Producers in Ban Pok, Mae On District, Chiang Mai Province." This research aims to enhance coffee cultivation, product value, and the management of local tea-coffee community enterprises. The participatory research model emphasizes living networks and community-led management from upstream to downstream processes. It also focuses on building leadership and operational capacity among group members, with the goal of establishing Ban Pok coffee as a recognized specialty product both domestically and internationally. Ultimately, this will improve local quality of life and economic well-being, while preserving forest ecosystems. The integration of modern concepts and technologies in production and processing is expected to ensure product quality and community-driven growth.

## RESEARCH OBJECTIVES

1. To generate knowledge and improve the quality of community-grown coffee beans for specialty coffee evaluation.
2. To analyze the enhancement of Arabica coffee quality and the return on investment in coffee bean production, with a focus on post-harvest processes.
3. To examine the coffee bean supply chain from production to processing in order to optimize efficiency and propose strategies for managing production systems that maximize the utilization of materials and equipment.
4. To identify the unique characteristics of specialty coffee rooted in the local resources of Ban Pok community.
5. To propose strategies for enhancing the competitiveness of Thai coffee products in the market.

## LITERATURE REVIEW

The Role of Innovation in Community-Based Enterprises and Coffee Value Chains: An Integrated Strategic Approach, Innovation is central to business development, especially for community-based enterprises (CBEs), where product and process innovation—whether incremental or radical enhances competitive capacity and sustainability (Schilling, 2020; Tidd & Bessant, 2020). This is evident in the context of rural coffee-growing communities in Thailand, such as Ban Pok in Chiang Mai, where innovation is not solely technological but embedded in socio-cultural practices, storytelling, and resource optimization. CBEs in Thailand generally evolve through four levels: (1) household enterprises that begin with self-sufficient production and reduce dependency on external markets, (2) community-level enterprises that promote inter-household collaboration, (3) inter-community networks to leverage diverse resources, and (4) enterprises focused on processing surplus produce for added value and external markets. These stages highlight a bottom-up innovation model grounded in local participation and mutual benefit. The Thai coffee value chain, particularly for Arabica beans, serves as a model for successful rural innovation. Value addition involves storytelling, geographical indications (GI), and sustainable farming practices. For instance, Robusta coffee in Chumphon and Krabi provinces has been developed through GI certification, which connects geographical specificity with product quality (Wasana Suwanwijit & Somphong Promsaat, 2015). However, maximizing the benefits of GI requires comprehensive strategies: standardized quality control, cooperative networks among producers, collaborative production planning aligned with market needs, sustainable packaging design, and diversification into digital marketing platforms. The integration of GI strategies within coffee CBEs contributes to greater competitiveness, particularly when producers coordinate production and marketing efforts. This cooperation reinforces trust and brand identity essential in globalized markets where product differentiation based on origin, quality, and sustainability is increasingly valued (Kotler & Keller, 2016). Creating added value is critical in competitive markets. Value can be derived through

product design, process improvements, packaging, and service innovation (Poonlap Thipchatyothin, 2010). The design of packaging, for instance, can reflect local identity while appealing to modern consumers. Branding also plays a crucial role: Kotler and Keller (as cited in Suttaya Somsuk, 2013) define essential brand elements as name, logo, slogan, trademark, packaging, benefits, perceived value, brand personality, and positioning. These elements serve as strategic tools to elevate a product's market presence and emotional connection with consumers. Equally important is the application of the Resource-Based View (RBV) theory, which emphasizes leveraging both tangible (e.g., financial, physical, technological) and intangible (e.g., knowledge, skills, brand reputation) resources to gain sustained competitive advantage (Barney, 2001; Grant, 1991). Organizations capable of optimizing their internal resources especially those that are valuable, rare, inimitable, and non-substitutable can outperform competitors (Kor, Mahoney, & Michael, 2007). In the case of Ban Pok, this includes indigenous knowledge, coffee-processing techniques, and intergenerational skills that are unique and deeply rooted in local identity. Furthermore, CBEs must cultivate dynamic capabilities the ability to adapt, reconfigure, and transform resources in response to changing environments. This aligns with Teece, Pisano, and Shuen's (1997) notion that innovation capacity is not static but must evolve alongside market dynamics and technological advancements. In conclusion, innovation in CBEs particularly in the Thai coffee sector requires an integrated approach that combines local wisdom with modern business strategies. By embedding innovation in production processes, brand development, value creation, and resource optimization, CBEs can strengthen their market competitiveness while preserving cultural identity and ecological sustainability. The RBV framework and innovation theories offer practical guidance for enhancing capabilities, sustaining product differentiation, and achieving long-term success in domestic and global markets.

## METHODOLOGY

This research employed a participatory action research (PAR) design to develop the coffee value chain of the Ban Pok community enterprise, integrating local knowledge with scientific and entrepreneurial practices. Prior to initiating the research, the research team organized a series of stakeholder meetings involving local farmers, community leaders, district agricultural officers, and representatives from the Department of Community Development. The objective was to explain the research process and engage participants as co-researchers, ensuring local ownership and collaborative decision-making throughout. The study was structured into ten key phases. Phase 1 involved analyzing the current context of coffee cultivation in Ban Pok and selecting demonstration plots for conservation-based shade-grown coffee farming.

Phase 2 focused on community participation by organizing meetings with farmers and allied partners to select representatives from the Ban Pok Quality Tea-Coffee Producers' Group for training in processing, roasting, brewing, and cupping. This phase aimed to build capacity and raise the quality standards of local coffee products. Phase 3 entailed the implementation of a hands-on training workshop under the "CSP Green Coffee" initiative. Phase 4 offered technical knowledge on coffee cultivation and post-harvest handling. Phase 5 emphasized skill development in coffee processing, roasting, brewing, and sensory evaluation (cupping). Phase 6 involved enhancing productivity in existing farms through three practices: (a) pruning, (b) rejuvenation or stump pruning, and (c) soil improvement based on soil analysis data. Phase 7 provided advanced knowledge transfer on processing methods Wet/Wash, Honey, and Dry Processes focusing on value creation for coffee beans. Phase 8 sought to improve production and processing practices through iterative community feedback. Phase 9 conducted a supply chain analysis of Ban Pok's coffee to identify bottlenecks and opportunities for market integration. Phase 10 concluded with formulating strategic recommendations to enhance the competitiveness of Thai coffee products in domestic and global markets.

**Population and Sample**, the research targeted two primary groups. The first comprised 26 local coffee farmers and 12 regional entrepreneurs, totaling 38 participants. The second group included 100 individuals consisting of coffee producers, entrepreneurs, industry experts, and consumers from Mae On District and other regions. This second group participated in exhibitions and coffee product contests, providing valuable feedback for evaluation.

**Research Instruments**, A variety of qualitative and quantitative instruments were used to ensure comprehensive data collection, 1) In-depth Interviews were conducted with stakeholders, including institutional partners supporting the Ban Pok community enterprise. 2) Focus Group Discussions were held with committee members and key partners to explore shared challenges and opportunities for development. 3) Public Forums were organized using Spider Web Analysis and Business Model Canvas tools, facilitating structured dialogue on community needs, problem-solving strategies, and developmental directions. 4) Stakeholder Brainstorming Meetings were held to solicit multi-perspective insights. 5) Questionnaires were administered to training participants to gather feedback on knowledge acquisition and satisfaction.

Data Analysis, the data analysis combined qualitative and quantitative techniques. Content analysis and thematic synthesis were employed to interpret findings from interviews, focus group discussions, and public forums. Quantitative data from the questionnaires were processed using standard statistical software. Descriptive statistics including frequency, percentage, and standard deviation were used to analyze participant responses and assess the effectiveness of the interventions. This integrated methodology emphasizes co-creation, capacity building, and continuous improvement aligned with community needs. The participatory and iterative nature of the research ensures not only scientific rigor but also social relevance and local applicability, which are critical in community-based development (Chevalier & Buckles, 2019; Chambers, 1994).

## RESULTS

**The research results according to the first objective, which aims to create knowledge and improve the quality of community coffee beans for the evaluation of specialty coffee quality**, found that

**Table 1:** Table showing the results of soil analysis for all 4 samples

| Test list | Unit | Sample area | | | |
|---|---|---|---|---|---|
| | | **Area representative** | **Area Parcel 1** | **Area Parcel 2** | **Area Parcel 3** |
| Available phosphorus | mg/kg | 0.68 | 0.47 | Non detected | 0.22 |
| Moisture | % | 20.10 | 19.61 | 21.19 | 20.34 |
| pH | - | 4.51 | 4.90 | 5.52 | 4.55 |
| total nitrogen | % | 0.40 | 0.40 | 0.51 | 0.39 |
| Soil exchangeable K | mg/kg | 106 | 259 | 352 | 151 |

The results from that area and the soil samples collected in the coffee-growing area of Ban Pok (table 1) were taken at a concentration of 0-15. The samples collected in that area met the standard (1.4-1.5). The components of production may be due to the soil characteristics in the Ban Pok area. By examining all four samples, the research findings revealed a concentration (moisture) of 20.10%. This is because when farmers apply fertilizers with high nitrogen content and concentration, it does not cause Arabica coffee to have a certain amount of soil and the main components of fertilization, especially urea fertilizers, which make the soil more acidic. Therefore, the use of red soil, lime, or dolomite can lead to excessive fertilization beyond the necessary acidity-alkalinity conditions of the soil.

Farmers should be encouraged to select fertilizers with nutrient ratios that are appropriate for the local context to avoid unnecessary cost increases. When farmers apply fertilizers with high nitrogen and potassium levels, there is no response from Arabica coffee because the soil already has sufficient nitrogen and potassium. Applying fertilizers, especially urea, which increases soil acidity, may require soil pH adjustment using lime or dolomite, leading to excessive fertilization and unnecessary cost increases.

**Analysis of Arabica Coffee Quality Improvement and Production Returns with Emphasis on Post-Harvest Processes**

This section presents an analysis of the production returns from Arabica coffee cultivation among farmers in Ban Pok, highlighting the critical role of post-harvest processes in enhancing coffee quality and profitability. The cost structure of coffee production is divided into variable and fixed costs. Variable costs include expenditures on agricultural inputs and operational activities such as purchasing farming tools and equipment, repairing nursery facilities, buying coffee seedlings, fertilizers, fuel, transportation, harvesting labor, and pest control chemicals. In contrast, fixed costs encompass agricultural land rental, construction costs of nurseries, and interest expenses on investments in agricultural equipment. Table 2 summarizes the detailed costs and returns associated with coffee production for the Ban Pok coffee group. Understanding this cost composition is vital for identifying efficiency improvement areas, particularly during the post-harvest stage, which includes processing, drying, roasting, and packaging. These stages significantly influence the final coffee quality and market value, thereby affecting farmers' net returns. Improvements in post-harvest handling not only elevate coffee quality by reducing defects and preserving desirable flavors but also enhance product consistency, which is crucial for meeting specialty coffee standards. Enhanced processing techniques, such as wet/wash, honey, and dry methods, contribute to differentiating products in competitive markets and command premium prices. Moreover, integrating efficient logistical and quality control systems reduces losses and waste, directly impacting profitability. Therefore, investment in training and technology transfer related to post-harvest management is an essential strategy to maximize returns for Arabica coffee farmers in Ban Pok. This analysis underscores that a thorough understanding of both variable and fixed costs, combined with targeted improvements in post-harvest processes, forms the foundation for sustainable coffee production that aligns with higher quality standards and improved economic outcomes (Damayanthi & Jayasinghe, 2019; International Coffee Organization, 2021).

**Table 2:** Production Costs and Returns of Ban Pok Coffee Group (Unit: THB per Rai)

| **Cost Item** | **Cost (THB)** | **Percentage (%)** |
|---|---|---|
| Variable Costs | | |
| - Agricultural Tools & Equipment | 350 | 3.07 |
| - Nursery Repairs | 20 | 0.18 |
| - Coffee Seedlings | 66.66 | 0.59 |
| - Fertilizers | 6,416.66 | 56.45 |
| - Fuel | 1,615 | 14.21 |
| - Transportation | 160 | 1.41 |
| - Harvesting Labor | 1,433.33 | 12.61 |
| - Pest Control Chemicals | 333.33 | 2.93 |
| **Total Variable Costs** | 11,366.67 | 99.71 |
| Fixed Costs | | |
| - Nursery Construction | 33.33 | 0.29 |
| **Total Fixed Costs** | 33.33 | 0.29 |
| **Total Production Cost** | 11,400 | 100 |
| Average Yield (kg/rai) | 332.33 | |

| Cost Item | Cost (THB) | Percentage (%) |
|---|---|---|
| Average Selling Price (THB/kg) | 137.39 | |
| Total Revenue (THB/rai) | 45,659.89 | |
| Net Profit (THB/rai) | 34,359.89 | |

Analysis of Economic Returns and Supply Chain Enhancement in Ban Pok Arabica Coffee Production, This study investigates the economic returns and supply chain efficiency of Arabica coffee production in Ban Pok, emphasizing post-harvest management and value chain optimization. Economic Returns from Coffee Cultivation, The total income generated from coffee cultivation in the Ban Pok community amounts to approximately 1,369,800 baht. This income is derived from an actual cultivated area of 172 rai, averaging 5.733 rai per farmer. The average yield per rai stands at 332.33 kilograms, totaling 9,970 kilograms for the entire area. Coffee is sold at an average price of 137.39 baht per kilogram, leading to an average revenue of 45,660 baht per rai. Production costs average 11,400 baht per rai, resulting in a net profit of about 34,360 baht per rai. The data reveal several key economic aspects 1) Production Efficiency, The total average production cost of 11,400 baht per rai is primarily composed of variable costs (99.707%), indicating operational flexibility and adaptability. The average yield of 332.33 kilograms per rai demonstrates relatively high production efficiency, while the selling price per kilogram is substantially above the cost per kilogram (137.39 baht vs. 34.30 baht). This disparity translates into a stable net profit margin, reflecting robust economic opportunities for producers. 2) Cost Management, Fertilizer costs constitute the largest expense, accounting for 56.451% of variable costs. This underscores the critical role of nutrients in sustaining coffee quality and yield. However, opportunities may exist to reduce fertilizer-related costs through innovations such as optimizing fertilizer formulations or integrating organic alternatives. Fuel (14.208%) and harvesting labor (12.609%) are the next significant expenses. Cost reduction strategies could include adopting more efficient machinery or refining harvesting techniques to lower labor intensity and expenses. Notably, fixed costs are minimal (0.293%), which favors scaling production without significantly increasing overhead burdens. 4) Potential for Revenue Growth, increasing yield per rai by enhancing cultivation practices could reduce the average cost per kilogram and boost overall profits, provided costs do not escalate proportionally. Furthermore, refining marketing strategies by emphasizing premium product lines or value-added coffee brands may enable higher selling prices. Expanding market access to higher-value retail or export channels with strong purchasing power could also enhance revenue streams. 5) Supply Chain Analysis and Production System Development, To address Objective 3, the study analyzed the supply chain of coffee bean production in Ban Pok, focusing on improving production efficiency and strategic management of resources and equipment throughout the chain. The analysis highlights the need to improve product quality through standardized grading aligned with the Specialty Coffee Association (SCA) protocols. Implementing such grading allows for categorizing coffee quality to meet specialty coffee market demands, elevating the reputation and price potential of Ban Pok coffee. To promote quality enhancement along the entire supply chain, the research project facilitated a series of capacity-building activities. These included training and skills development for stakeholders involved at every stage: upstream (cultivation), midstream (processing and roasting), and downstream (marketing and sales). This comprehensive approach addresses all five key components of the coffee value chain, ensuring integrated improvements from farm to consumer. Improving supply chain management through such multi-level interventions is expected to maximize the efficient use of materials and equipment, reduce wastage, and enhance product consistency. These measures ultimately strengthen the competitiveness of Ban Pok coffee in both domestic and international markets. Enhancing the Arabica Coffee Value Chain in Ban Pok Village, The study focused on analyzing and improving the Arabica coffee production process in Ban Pok Village, Chiang Mai Province, with a specific emphasis on the post-harvest value chain and community-based sustainability. The research findings are organized into four key components of the coffee value chain: cultivation, harvesting, processing, and roasting. 1) Shade-Grown Coffee Cultivation and Plot Management, The initial stage emphasized the evaluation and improvement of coffee plots under shade cultivation. Researchers collaborated with local farmers, agricultural experts, and community leaders to assess soil conditions, plot management, and production challenges. Farmers adapted recommended practices such as selective pruning, weed control, and soil management to enhance plot productivity. To develop the community's coffee cultivation sustainably,

future strategies were proposed. These included implementing varietal trials of Chiang Mai 80, Chiang Rai 1, and Chiang Rai 2 coffee strains, conducting soil analysis for optimized fertilization, and maintaining year-round activity logs. Improved recordkeeping on planting, pruning, fertilization, irrigation, pest monitoring, and harvest practices was emphasized to achieve consistent quality and prepare for specialty coffee certification (Specialty Coffee Association, 2020). 2) Harvesting Ripe Coffee Cherries, In recent years, farmers have faced labor shortages, particularly among aging households, affecting harvest capacity. The mountainous terrain further limits mechanization, resulting in inconsistent harvests and ungraded cherry collection. Consequently, a significant portion of the coffee is sold unprocessed at low prices, dictated by external buyers. The lack of local grading and collective marketing mechanisms limits community bargaining power and economic returns (FAO, 2021). The study identified key problems: (1) absence of grading, (2) fragmented sales channels, and (3) reliance on selling fresh cherries without value addition. Addressing these issues is essential for improving incomes and ensuring the viability of coffee farming in Ban Pok. 3) Coffee Processing and Intermediate Product Development, While Ban Pok possesses natural advantages for producing high-quality coffee due to its highland microclimate, community-level processing capacity remains underutilized. Some equipment, such as de-pulpers from Royal Project initiatives, has not been regularly used due to inefficiency, high operating costs, and insufficient training. Coordination with other user groups was proposed to maximize equipment usage through shared leasing models. Pilot innovations, such as briquette charcoal and coffee extract production for cosmetics, were also explored but have not yet achieved practical uptake. These projects often rely on external researchers and lack long-term integration into community enterprises. In contrast, development efforts in areas like marketing, group governance, and post-harvest handling have proven more impactful. However, the limited presence of next-generation leaders poses a challenge for knowledge transfer and enterprise continuity. 4) Coffee Roasting and Cultural Identity, Though roasting infrastructure exists, its utilization is minimal due to limited economies of scale and high transportation costs associated with remote locations. Industrial roasters are often underused or inefficient for small batch roasting. A promising direction emerged from a community-based enterprise “Tamnan Ban Pok” which uses traditional earthenware pot roasting methods. This culturally significant approach not only preserves indigenous knowledge but also presents an opportunity for tourism-linked branding and experiential learning (International Trade Centre, 2020). If promoted strategically, traditional roasting could enhance the identity of Ban Pok’s coffee and attract specialty buyers and tourists alike. Activities such as clay pot roasting demonstrations and “shade-grown coffee brewing under the canopy” could enrich the visitor experience and open new income channels. **Marketing and Brand Development of Ban Pok Community** Coffee, 1) Marketing Practices and Challenges, Ban Pok's community-based coffee marketing primarily involves selling unprocessed products, such as coffee cherries and parchment coffee, to local middlemen. Individual farmers often sell directly in fresh cherry form or engage in early-stage contract sales due to financial and labor shortages, limiting their capacity for value-added processing. As a result, most coffee is sold outside formal community enterprise structures, weakening bargaining power. Notably, Ban Pok produces up to 50 tons of coffee cherries annually. Processed coffee products are currently marketed only within the local district, particularly at tourism hotspots in Huay Kaew Subdistrict. Promotion efforts rely on government-organized trade fairs, video media campaigns, and limited online platforms such as Facebook and Shopee. However, these efforts remain fragmented and lack sustained implementation. **2) Collaborative Brand and Identity Development**, A joint initiative by researchers, local entrepreneurs, and community members identified the following key outcomes, 2.1) Coffee Identity: Ban Pok coffee possesses a distinctive floral aroma derived from wild forest flowers and is cultivated under forest canopy without deforestation. The community comprises three sub-villages: Pok Nok, Pok Klang, and Pok Nai. These were unified under a shared brand identity named "Three Pok Coffee." 2.2) Logo Design, A combination logo was developed, symbolizing the coffee’s quality, origin, and connection to community heritage. The design integrates images of coffee beans, the Ban Pok highland landscape, and cultural elements, conveying the narrative of sustainable, forest-grown coffee. 2.3) Product Innovation Using Coffee By-products, To add value to leftover coffee grounds, the community co-developed the following products, Coffee Soap: Enriched with antioxidants and vitamins (A, D, E, B3, B5), the soap offers skincare benefits like exfoliation, hydration, and brightness enhancement. It reflects the community's wellness-oriented identity. Coffee Scrub: Made from spent grounds, this product gently exfoliates and nourishes skin while minimizing irritation compared to synthetic scrubs.

The scrub also includes natural brightening agents. 3) Brand Exposure and Community Events, Ban Pok coffee was promoted at several high-profile exhibitions, Royal Project Doi Teen Tok Center, Chiang Mai International Exhibition and Convention Centre, National Agriculture Day Fair at Mae Hia Agricultural Research Center, Chiang Mai University. An Open House event titled "Sip Coffee, Explore the Forest in Ban Pok" was organized to introduce the brand to broader audiences and tourists. The event featured booths, roasting demonstrations, and guided farm tours. Dignitaries and media coverage helped amplify visibility. 4) Specialty Coffee Identity and Heritage, The specialty status of Ban Pok coffee is defined through five dimensions. 5) Physical Geography: High-altitude cultivation at 1,200 meters above sea level with ideal soil pH (5.5–6.5), natural shade, and cool climate. Environmental Stewardship: Recognized for sustainable resource management and awarded for excellence in low-carbon highland development. Product Quality: Rigorously processed coffee has expanded into specialty drip and freeze-dried products. Cultural Legacy: Initiated by a royal project under King Rama IX in 1981, coffee cultivation was integrated with miang gardens to protect forests. Processing Excellence: High care from cherry harvesting to roasting results in distinctive coffee with notes of chocolate, wildflowers, berries, and passionfruit. 6) Brand Communication Strategy, Brand Identity: "Ban Pok Coffee – Father's Coffee, Grown in Mother's Forest." Positioning: A premium, sustainable, specialty coffee reflecting local heritage. Messaging: Storytelling emphasizes environmental preservation, heritage, and highland terroir. Channels: Social media (Facebook, IG, TikTok), packaging QR codes, SEO, café collaborations, and participation in coffee fairs.
7) Capacity-Building Recommendations, Cultivation: Implement hand-drawn mapping for farm planning, promote solar drying, encourage organic fertilizers, and coordinate bulk purchasing. Production: Train farmers in CSP green coffee standards and roasting aligned with SCA guidelines. Processing: Optimize use of existing machines and extend roasting services to nearby communities. Marketing: Highlight awards (e.g., ICP Thailand Evaluation 2023 – Rank 7), use storytelling, and expand to national and international markets. Enterprise Management: Address aging leadership and organizational gaps by fostering trust, transparency, flexibility, and shared governance. These findings support the long-term competitiveness of Ban Pok coffee in premium domestic and global markets through a unique blend of quality, sustainability, and cultural heritage.

## DISCUSSION

The findings of this study highlight the multi-dimensional approach needed to enhance the quality and value chain of Arabica coffee production in Ban Pok Village, Chiang Mai Province. Drawing on soil analysis, cost-benefit evaluations, post-harvest processing practices, and branding initiatives, this research illustrates how scientific and community-based strategies intersect to create sustainable development in specialty coffee cultivation.

**1. Soil Composition and Fertilization Practices.** The soil analysis across four parcels of land revealed significant variability in pH, moisture, and nutrient content factors known to influence coffee growth and flavor profile (Boreux et al., 2016). Notably, the pH values ranged from 4.51 to 5.52, which falls below the optimal range (5.5–6.5) for Arabica coffee cultivation (International Coffee Organization [ICO], 2021). This acidity can be attributed to the overuse of nitrogen-based fertilizers such as urea, which, while supporting plant growth, contributes to increased soil acidity and long-term fertility issues. Despite sufficient levels of total nitrogen and potassium, the observed phosphorus levels were considerably low (as low as non-detectable in Parcel 2), which may constrain root development and cherry maturation (DaMatta et al., 2007). The study recommends context-sensitive fertilization, combining soil amendment practices like lime or dolomite application to regulate pH, with balanced nutrient management tailored to actual soil deficiencies. These practices are critical to prevent over-fertilization, reduce input costs, and enhance soil health for sustained coffee productivity.

**2. Economic Returns and Cost Structure.** The financial analysis revealed a robust profit margin, with an average net return of 34,359.89 THB per rai, supported by a relatively high average yield of 332.33 kg/rai and a selling price of 137.39 THB/kg. Variable costs constituted nearly all (99.71%) of total production expenses, indicating significant flexibility in resource allocation. Fertilizer costs alone made up over 56% of the variable costs, reinforcing their centrality to production efficiency. Yet, this also indicates potential areas for optimization through the integration of organic inputs or more precise application methods (Damayanthi & Jayasinghe, 2019). While fixed costs remain minimal, their low proportion creates opportunities for scalable growth. Nonetheless, labor shortages particularly for

harvesting pose ongoing challenges. This is consistent with broader trends in rural agrarian communities in Southeast Asia where aging populations and migration contribute to labor constraints (Food and Agriculture Organization [FAO], 2021).

**3. Post-Harvest Processing and Quality Enhancement.** The research underscores the post-harvest phase as a pivotal determinant of coffee quality and value. Techniques such as wet/wash, honey, and dry processing were highlighted for their role in preserving flavor, reducing defects, and aligning with specialty coffee standards set by the Specialty Coffee Association (2020). The relatively underutilized processing infrastructure in Ban Pok, such as depulpers and roasting machines, reflects both technical inefficiencies and a lack of coordinated management, resulting in missed opportunities for value addition. Importantly, the integration of community-based processing and shared equipment leasing models may help address these gaps. Training programs in grading, drying, and roasting tailored to SCA protocols—are essential not only to improve consistency and marketability but also to enable local certification efforts that would increase access to premium specialty coffee markets (ICO, 2021).

**4. Supply Chain Optimization and Value Chain Development**

A core contribution of this study lies in its examination of the coffee value chain—from cultivation through processing to marketing—and the identification of bottlenecks and opportunities across each stage. Fragmentation in sales channels and the dominance of fresh cherry sales to external buyers dilute community bargaining power and hinder long-term sustainability. Community-based enterprises like "Tamnan Ban Pok" represent promising models for vertically integrated operations, linking production with branding and retail (International Trade Centre [ITC], 2020). The introduction of a shared brand identity, "Three Pok Coffee," and the emphasis on shade-grown, floral-scented coffee reflect a shift toward place-based branding rooted in cultural and environmental narratives. This aligns with recent scholarship highlighting the importance of terroir and storytelling in specialty coffee marketing (Wilson & Zepeda, 2022). Moreover, product diversification through coffee by-products such as soap and scrubs introduces a wellness dimension, further broadening market potential.

**5. Community Empowerment and Sustainability.** Despite the successes, the study identifies Persis. Tent challenges in leadership succession, technical training, and market access. Capacity-building efforts must focus not only on production techniques but also on enterprise governance, youth engagement, and digital literacy to ensure continuity and adaptability in a dynamic market. Strengthening social capital and institutional trust among community members is vital to foster collaborative governance, innovation diffusion, and long-term resilience (Pretty, 2003). Ultimately, Ban Pok's coffee development illustrates a convergence of environmental stewardship, cultural preservation, and market innovation. The synergy between scientific soil management, strategic post-harvest practices, and culturally embedded branding provides a replicable model for other upland coffee-growing communities in the Global South. Investments in training, infrastructure, and institutional linkages—supported by inclusive policies can catalyze a transition from subsistence farming to high-value specialty coffee enterprises.

## CONCLUSION

This study offers a comprehensive evaluation of Arabica coffee production in Ban Pok Village, highlighting the interrelated factors of soil management, economic sustainability, post-harvest practices, value chain enhancement, and cultural branding. By integrating agronomic, economic, and socio-cultural perspectives, the research contributes to a deeper understanding of sustainable rural enterprise development in upland coffee-growing communities. Soil analysis revealed acidic pH levels and inconsistent nutrient availability, particularly phosphorus deficiencies, which may hinder optimal coffee growth and bean quality. These findings indicate a need for tailored soil fertility strategies that balance organic and inorganic inputs while minimizing soil acidification risks. Such practices could enhance bean quality and reduce unnecessary input costs. Economically, the study found that Ban Pok farmers attained notable profitability, with net returns exceeding 34,000 THB per rai. Nevertheless, a high dependence on variable inputs, especially fertilizers and labor, signals areas for improvement. Collective purchasing, eco-friendly farming methods, and enhanced labor efficiency are recommended for cost reduction and resilience. Post-harvest innovation emerged as a key driver of value addition. Techniques such as improved drying, roasting, and processing aligned with SCA standards boost coffee quality and marketability. Traditional roasting methods, like earthenware pot roasting, also reinforce cultural identity and open tourism-related income streams. The creation of community brands, such as "Three

Pok Coffee," illustrates the power of collective enterprise in strengthening market presence and pricing leverage. However, aging leadership, limited marketing capacity, and digital gaps pose ongoing challenges. The Ban Pok model demonstrates a holistic approach to coffee development that blends environmental stewardship, cultural heritage, and market innovation. Its lessons are broadly applicable to sustainable coffee development across similar highland regions.

## RECOMMENDATIONS

Based on the research findings, several key recommendations are proposed to strengthen the sustainability, productivity, and market competitiveness of Arabica coffee production in Ban Pok Village. **1) Soil and Fertility Management,** Local authorities and agricultural extension agents should prioritize regular soil testing and promote the use of site-specific fertilization plans. Integrating organic amendments such as compost and biochar with targeted inorganic inputs can help address phosphorus deficiencies and mitigate soil acidification, thereby improving plant health and bean quality. **2) Input Cost Optimization and Resource Sharing**, To reduce production costs and increase efficiency, collective procurement of fertilizers, fuel, and tools is recommended. Establishing farmer cooperatives or input-sharing schemes would enable economies of scale and reduce the financial burden on smallholders. **3) Post-Harvest Innovation and Quality Control**, Farmers should be trained in post-harvest handling aligned with Specialty Coffee Association (SCA) protocols to enhance coffee consistency and meet specialty market standards. Investment in solar drying systems, moisture meters, and roasting equipment would further improve product quality and reduce waste. **4) Youth Engagement and Leadership Succession**, Programs that engage younger generations in coffee farming, enterprise management, and digital marketing are vital to ensure continuity. Leadership training and mentorship programs can build governance capacity and preserve community-based knowledge. **5) Brand Development and Digital Marketing**, the "Three Pok Coffee" identity should be further promoted through professional packaging, storytelling, and expansion to e-commerce platforms. Strategic partnerships with cafés, tourism operators, and government programs can enhance visibility and create diversified income streams. These recommendations aim to create a resilient and value-driven coffee production system that aligns with both local culture and global specialty coffee expectations.

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