STRENGTHENING RURAL ECONOMIES THROUGH BIO-CIRCULAR-GREEN INNOVATION IN RICE AND SILK VALUE CHAINS: A PARTICIPATORY MODEL FROM NORTHERN THAILAND

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ABSTRACT

This study explores the integration of Bio-Circular-Green (BCG) innovation into rice and silk value chains to strengthen grassroots economies in northern Thailand. Utilizing a participatory action research framework, the research engaged Isan-Lanna farming communities in Chiang Rai province to develop a localized, sustainable model that enhances supply chain coordination, fosters value-added production, and improves digital marketing capacities. The study applied supply chain management (SCM), the Business Model Canvas (BMC), and innovation diffusion theory to co-create solutions with farmers across upstream, midstream, and downstream processes. Key outcomes include the design of cluster-based production planning, the creation of culturally rooted value-added products, and the implementation of digital branding strategies that reflect local identity and environmental values. The findings demonstrate how place-based innovation, community participation, and strategic capacity-building can drive rural economic transformation in line with the Sustainable Development Goals (SDGs). This research offers a replicable model for integrating agricultural innovation and cultural entrepreneurship within rural development frameworks.

Keywords: Rural Economy, Value Chain Innovation, Bio-Circular-Green (BCG) Model, Community Enterprise, Sustainable Agriculture

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INTRODUCTION

The COVID-19 pandemic (2020-2022) had a profound impact on rural communities across Thailand, particularly in Northern Thailand, especially in Chiang Rai province, where prolonged restrictions disrupted agricultural production and local economies. Despite longstanding efforts by the Thai government to promote sustainable agricultural development, many initiatives failed to gain lasting traction. Farmers often encountered challenges related to shifting policy priorities, lack of consistent support, and limited access to practical guidance, resulting in skepticism and diminished motivation to adopt sustainable farming practices. The scarcity of local agricultural leaders further hampered broader implementation, hindering the formation of a robust grassroots economic foundation.

In response to these challenges, recent development strategies have focused on empowering local communities to utilize indigenous knowledge and natural resources in driving community-based enterprises. Programs such as "One Tambon One Product" (OTOP) and the promotion of community enterprises aim to foster value-added production and strengthen localized supply chains. These approaches have been implemented widely in northern Thailand under the framework of the Sustainable Development Goals (SDGs). However, the COVID-19 pandemic severely disrupted these efforts, causing income loss from tourism and depressed prices for agricultural products—particularly affecting smallholder producers.

One such community is located in Chiang Saen District of Chiang Rai Province, where a group of farmers—known locally as *Isan-Lanna*—has developed a distinctive cultural and agricultural identity. The term *Isan-Lanna* refers to ethnic Lao-speaking communities who migrated from northeastern Thailand (Isan) and settled in northern Thailand (the Lanna region) decades ago. These farmers rely on rice cultivation—mainly Jasmine 105 and Santal 6 varieties—and have sustained a supplementary silk production tradition based on mulberry cultivation and hand-weaving. While previously supported by cultural tourism and local markets, the pandemic led to a sharp decline in revenues, with many producers reverting to selling raw materials instead of finished products due to reduced demand, weak branding, and lack of digital capabilities.

The research area presents a strong sense of cultural identity and social cohesion, but faces constraints in product development, branding, and market access. Most producers continue to depend on middlemen due to limited digital literacy, lack of standardized packaging, and underdeveloped communication strategies. These challenges highlight the need for integrated interventions that combine sustainable supply chain management, value-added innovation, and digital marketing transformation.

This study adopts a participatory action research framework to co-develop a sustainable model for grassroots agricultural enterprises focused on rice and silk production. Specifically, it seeks to 1) strengthen the upstream production base in line with the SDGs, 2) develop value-added innovations in the midstream supply chain, and 3) enhance product identity and digital marketing capabilities. Drawing on the Bio-Circular-Green (BCG) economic model and the Business Model Canvas (BMC), the study aims to transform community enterprises into resilient actors within the rural economy, capable of adapting to market dynamics and contributing to inclusive and sustainable development.

LITERATURE REVIEWS

This study integrates several theoretical frameworks and practical concepts to support the development of sustainable community-based agricultural enterprises. One of the core concepts is Supply Chain Management (SCM), which refers to the integrated planning and control of all elements involved in sourcing, production, and distribution. According to Christopher (1998) and Mentzer (2001), SCM encompasses three levels—basic, extended, and ultimate—focusing on optimizing the flow of goods, services, and information. The study applies SCM principles

to enhance upstream and midstream agricultural activities, ensuring process continuity, stakeholder collaboration, and strategic alignment throughout the supply chain.

Production management is another vital element, addressing the planning, control, and execution of manufacturing processes. The theoretical foundation includes the 4M framework (Man, Machine, Material, Method), production capacity planning, and process design tools such as flow diagrams and value stream mapping (VSM). These frameworks help local farmer groups streamline operations, reduce waste, and improve product quality to meet evolving consumer demand and sustainability targets.

To guide business strategy development, the Business Model Canvas (BMC) is employed. This framework includes nine building blocks, such as customer segments, value propositions, channels, and revenue streams (Osterwalder & Pigneur, 2010). BMC is used to help farmer groups identify key activities, partners, and cost structures, enabling them to visualize and iterate on sustainable business models tailored to local contexts.

The study also emphasizes innovation and product development. Drawing from Rogers' (1995) theory of innovation diffusion, the research explores the factors influencing innovation adoption, such as relative advantage, compatibility, complexity, trialability, and observability. The research also incorporates the innovation development cycle—from ideation to commercialization—as discussed by Tushman and Nadler (1996), Hart (1999), and Thai scholars. This supports the transformation of traditional agricultural practices into value-added enterprises through community-driven innovation.

Lastly, the study leverages concepts related to product identity, branding, packaging, and digital marketing. Kotler and Keller (2012) and Aaker (2014) define branding as the creation of symbolic associations that add emotional and functional value to products. The branding process involves target market identification, brand design, and brand communication. In tandem, effective packaging design is essential for market competitiveness and consumer engagement. These branding strategies are aligned with the promotion of local identity and differentiation in niche agricultural markets, particularly through digital platforms.

RESEARCH METHODOLOGY

This study employed a mixed-methods research design, integrating both quantitative and qualitative approaches within a participatory research framework. The methodology was further reinforced by action research principles to ensure tangible outcomes and stakeholder engagement. The integration of diverse methods aimed to address the complex nature of community-based agricultural development and to foster innovation across the supply chain.

Population and Sample

The research was conducted among members of two occupational groups in Yonok subdistrict, Chiang Saen district, Chiang Rai province: rice farmers and mulberry-silk producers. Specifically, participants were drawn from two communities—Ban San That (Moo 4) and Ban San That Mai Pattana (Moo 9)—which had demonstrated organizational readiness, shared goals, and high levels of group cohesion. The population in this study consisted of 105 rice farmers from the Ban San That Community Enterprise and 62 silk farmers. The total sample size was set at 100 participants, comprising 50 members from the rice farming group and 50 from the silk farming group. Voluntary sampling was employed to select participants

Research Instruments

A variety of tools were developed to suit the participatory action research activities conducted at different stages of the agricultural supply chain. Data collection methods included structured questionnaires, observation checklists, evaluation forms, and semi-structured focus group questions. Activities included: 1) development of an upstream business model linking the agricultural supply chain; 2) midstream innovation for product value addition; 3) downstream development of product identity and digital marketing; 4) monitoring and synthesizing data

from sub-projects; 5) stakeholder workshops; and 6) public communication of research findings.

Instrument Validity and Reliability

For qualitative data, semi-structured interviews were developed based on the operational contexts of upstream, midstream, and downstream activities. For quantitative data, the questionnaire was constructed based on a synthesis of relevant literature and pilot-tested to ensure content validity. The questions addressed contextual operations across all stages of the supply chain and were measured using a six-point Likert scale ranging from 0 (not applicable) to 5 (strongly applicable).

Data Collection and Analysis

Data collection was conducted by the researcher in collaboration with local leaders, ensuring accuracy and community involvement in each activity. For qualitative analysis, content analysis was used to identify recurring themes and interpret stakeholder narratives. For quantitative analysis, data were processed using statistical software. Descriptive statistics—such as frequencies, percentages, means, and standard deviations—were used to summarize the data. Inferential statistics, including Pearson's correlation coefficients and multiple regression analysis, were applied to examine relationships and predictive effects among key variables. For interpretation of data, Mean scores were interpreted on a six-point scale, with values categorized as: very low (1.00-1.80), low (1.81-2.60), moderate (2.61-3.40), high (3.41-4.20), and very high (4.21-5.00). Correlation coefficients were interpreted using Hinkle's (1998) framework, with values ranging from very weak to very strong relationships. The study was conducted over a 12-month period, from October 1, 2023, to September 30, 2024.

RESEARCH RESULTS

This study employed a participatory action research framework to develop sustainable models for agricultural community enterprises in Chiang Saen district, Chiang Rai province, focusing on rice and silk production by Isan-Lanna farmer groups. The research was structured around three main objectives: developing an upstream supply chain model, fostering midstream value-added innovation, and building downstream product identity and digital marketing capabilities. The findings are presented in alignment with each objective.

Development of an Upstream Supply Chain Model

The research found that both rice farmers and mulberry-silk producers in the study area operated within fragmented supply chains lacking systematic integration. Initial assessments revealed inconsistencies in production planning, duplication of effort, and inefficiencies in labor and resource allocation. In response, the research team collaborated with community members to co-design an upstream business model tailored to local conditions.

The model emphasized cluster-based production planning, coordinated input management (e.g., seeds, organic fertilizers), and application of GAP (Good Agricultural Practices) standards. Participatory mapping of production areas enabled the optimization of land use, while group decision-making processes enhanced transparency and accountability. Notably, farmers reported improved confidence in crop planning and reduced cost variability. The model also fostered stronger inter-household cooperation, especially among returning migrant laborers who contributed to both planning and production. By formalizing operations through the community enterprise structure, the group strengthened its ability to engage with external stakeholders, including agricultural extension offices and potential buyers.

Midstream Innovation for Product Value Addition

A key challenge among the target groups was the limited capacity for value-added production. For rice farmers, post-harvest handling was primarily oriented toward raw grain sales with minimal differentiation. Similarly, silk producers often sold raw silk or unfinished textiles due to lack of design capabilities and market insight. Through a series of workshops and co-creation

sessions, the research facilitated the introduction of midstream innovations that emphasized traditional knowledge blended with modern consumer preferences.

The rice group developed new products such as herbal rice crackers, rice flour snacks, and ready-to-cook rice kits. Each product line incorporated unique branding elements reflecting the cultural heritage of the Isan-Lanna identity. Meanwhile, the silk group engaged in co-design sessions that resulted in premium silk accessories—such as scarves, handbags, and home décor—drawing on local weaving patterns and natural dye techniques. These innovations allowed both groups to position their products within higher value market segments. Participants noted a sense of pride in being "product creators" rather than mere producers, leading to greater group cohesion and entrepreneurship orientation.

Development of Product Identity and Digital Marketing Communication

Prior to the intervention, both groups lacked a clear brand identity and had limited engagement with digital marketing. Packaging was basic, storytelling was minimal, and access to consumer markets was mediated by traders and middlemen. The research introduced capacity-building activities focusing on brand positioning, packaging design, product photography, content creation, and digital storytelling. Farmers received training in using social media platforms (e.g., Facebook Pages, TikTok, Line OA) to promote their products and interact with customers.

As a result, both the rice and silk groups created distinctive brand identities that reflected their community's heritage, ecological values, and production standards. Packaging was redesigned using eco-friendly materials and included QR codes linking to digital content. Pilot sales through online channels showed measurable improvements in product visibility and customer interaction. Moreover, participants began to adopt the language of branding—speaking of "target markets," "value propositions," and "user experience"—reflecting a conceptual shift from subsistence to strategic enterprise. This transformation demonstrated the potential of digital communication not only as a marketing tool, but also as a vehicle for rural self-expression and economic inclusion.

In sum, the research successfully achieved its objectives by facilitating the design of a locally appropriate, scalable model of supply chain development. It strengthened community innovation capacity, enhanced cultural product value, and enabled market access through digital means. These outcomes suggest that a participatory, integrated approach combining agricultural systems thinking, business model innovation, and digital literacy can be a powerful strategy for rural revitalization and sustainable development.

DISCUSSION & CONCLUSION

The findings of this study reveal the multifaceted impact of an integrated, community-based approach to agricultural innovation and enterprise development. The results confirm that participatory action research, when grounded in local knowledge and supported by appropriate theoretical frameworks, can lead to meaningful change in rural livelihoods. This discussion analyzes the findings in relation to key theories and prior research, focusing on supply chain integration, innovation diffusion, business model development, and digital marketing in rural contexts.

Supply Chain Integration and Grassroots Empowerment

The development of the upstream business model aligns with existing literature that emphasizes the importance of supply chain coordination in enhancing productivity and market access (Mentzer et al., 2001; Christopher, 1998). In this study, the use of participatory mapping and cluster-based planning reflects the application of decentralized supply chain logic adapted for smallholder settings. The outcome supports Tanit Sorat's (2007) view that trust, transparency, and collaboration among stakeholders are crucial to achieving supply chain efficiency in rural communities.

Moreover, the empowerment of returning migrant workers as active participants in production planning highlights the importance of social capital in grassroots economic development. This echoes findings by Pretty (1995) and Chambers (2008), who argue that inclusive participation contributes to community resilience and innovation. By transforming passive beneficiaries into co-creators of value, the model demonstrated how supply chain thinking can be localized to suit cultural and organizational realities of rural Thailand.

Innovation Diffusion and Cultural Adaptation

The success of midstream innovations in both the rice and silk sectors illustrates the relevance of Rogers' (1995) theory of innovation diffusion. Key attributes—such as trialability, observability, and relative advantage—were clearly present in the product development process. Participants expressed increased willingness to adopt new practices once they observed tangible benefits and peer validation. This aligns with findings from studies in Southeast Asia, where cultural validation and communal learning have been found to accelerate innovation uptake (Simpson & Hall, 2020).

Furthermore, the combination of traditional knowledge (e.g., natural dyes, local rice varieties) with modern consumer trends (e.g., health food, minimalist design) illustrates the principle of "glocalization" in rural innovation. Rather than abandoning tradition, participants adapted it to new market contexts, resulting in hybrid products that carried both economic and cultural value. This process supports Hart's (1999) notion of "base-of-the-pyramid" innovation, where underserved communities can create inclusive, sustainable value propositions using locally available resources.

Business Model Innovation and Strategic Thinking

The use of the Business Model Canvas (BMC) provided a structured platform for community members to engage in strategic business thinking—something traditionally lacking in rural production groups. As noted by Osterwalder and Pigneur (2010), the BMC facilitates visualization of how value is created, delivered, and captured. In this study, community members were able to identify new customer segments, redefine value propositions, and establish clearer revenue models. This reflects a cognitive shift from producer-oriented thinking to market-oriented entrepreneurship.

Interestingly, the BMC also served as a tool for internal dialogue and group alignment. Members began to articulate shared goals, negotiate roles, and evaluate trade-offs. This social function of the BMC—beyond its strategic use—parallels findings by Zott and Amit (2011), who argue that business models can act as boundary-spanning mechanisms that connect internal and external stakeholders in enterprise development.

Digital Communication and Market Democratization

Perhaps the most transformative result emerged from the downstream activities in branding and digital marketing. Prior to the project, participants viewed social media as peripheral or inaccessible. After training and hands-on implementation, digital platforms became central tools for storytelling, customer interaction, and brand building. This finding reinforces the growing body of research showing that digital communication can democratize market access for rural producers (Donner et al., 2021; World Bank, 2022).

The successful development of online content, including branded videos and interactive posts, also underscores the role of digital literacy in reducing rural-urban market asymmetries. As Aaker (2014) emphasizes, emotional branding and narrative identity are key to customer loyalty. In this case, the ability to articulate a product's origin, cultural meaning, and environmental sustainability through digital media created a differentiated position in competitive markets. This not only expanded income opportunities but also gave participants a renewed sense of pride in their heritage.

Systemic Transformation through the BCG Framework

Finally, the integration of the Bio-Circular-Green (BCG) economic model into the research provided a holistic pathway for systemic transformation. By embedding ecological consciousness into production, promoting circular practices (e.g., reusing byproducts), and adopting green branding, the community enterprises aligned themselves with the Sustainable Development Goals (SDGs). The case demonstrates that rural innovation is not merely about technology adoption but about redesigning systems to be regenerative, inclusive, and place-based. This affirms UNDP's (2021) assertion that localizing sustainability frameworks is key to equitable development.

In summary, the study illustrates how participatory, multi-dimensional interventions can simultaneously elevate economic outcomes, cultural expression, and environmental awareness in rural settings. The findings contribute to broader debates on sustainable rural transformation and offer practical insights for replicating similar models in comparable contexts.

While the participatory model presented in this study offers replicable strategies for rural innovation, its applicability is inherently influenced by the cultural, economic, and environmental specificities of Northern Thailand. Therefore, adaptation to other contexts may require recalibration of community dynamics, resource availability, and institutional support systems.

Recommendations

Based on the findings and their broader implications, the study offers three tiers of recommendations: 1) community-level strategies for enterprise development, 2) policy-level interventions to support rural innovation, and 3) directions for future academic research.

1) Community-Level Recommendations

To sustain and build upon the success of the integrated model, local agricultural groups should institutionalize internal learning mechanisms such as peer mentoring, participatory planning, and periodic review of business practices. Farmer groups are encouraged to formalize roles in supply chain governance, including roles for youth and returning migrants, to diversify leadership and ensure continuity. Regular workshops on financial literacy, cost control, and product differentiation should be organized within the enterprise structure to develop adaptive business capacity.

Moreover, there is a need to embed digital marketing practices as part of everyday operations. Community members who have acquired digital literacy should serve as "digital champions" to support peers in managing content, monitoring customer feedback, and optimizing digital platforms. Developing a content calendar and maintaining consistent brand storytelling across platforms can reinforce consumer trust and brand identity.

In terms of production, the promotion of green practices such as organic farming, biodegradable packaging, and circular product development (e.g., rice husk reuse, silk dye waste management) should be scaled. These practices not only enhance environmental outcomes but also offer new value propositions to environmentally conscious consumers.

2) Policy and Institutional Recommendations

At the policy level, relevant government agencies—including the Ministry of Agriculture and Cooperatives, Department of Agricultural Extension, and the Community Development Department—should consider supporting community enterprises with long-term development grants, not merely short-cycle funding. Policies should prioritize "soft infrastructure" development: farmer training, digital literacy programs, and access to design and branding services.

A national database of community-based products with verified geographic indication (GI), local identity certification, or sustainability credentials could be developed to support market recognition and protection against imitation. Additionally, micro-financing mechanisms tailored for community enterprises should be made more accessible, with less stringent requirements and support for first-time entrepreneurs.

Academic institutions and vocational colleges in the region should be encouraged to form service-learning partnerships with community groups to provide ongoing technical support in design, marketing, and data analytics. This institutional engagement would foster two-way learning and local capacity building while aligning with university social responsibility goals.
Lessons from successful rural innovation policies in countries such as Vietnam and South Korea—where integrated agricultural clusters and government-supported innovation hubs have driven rural transformation—could be contextualized for the Thai setting. Establishing regional rural innovation centers that combine agricultural extension services with design and digital marketing incubators is one potential model.

3) Recommendations for Future Research

While this study demonstrated the benefits of integrated supply chain and digital innovation in two occupational groups, future research should explore its applicability in other types of community enterprises, such as fruit processing, herbal products, or crafts. Comparative studies across provinces or ethnic groups may reveal context-specific challenges and opportunities.
In addition, longitudinal research should be conducted to track the long-term impact of such models on household income, gender roles in entrepreneurship, and community resilience. It would also be valuable to investigate the role of artificial intelligence and data analytics in supporting rural supply chain decisions, product customization, and market prediction.
Lastly, a more in-depth inquiry into the cultural dimensions of branding—how local narratives, symbols, and identity influence consumer perception—could enrich the academic literature on indigenous innovation and rural marketing strategy.

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