Asian Journal of Agriculture and Rural Development
Volume 16, Issue 1 (2026): 26-38

Participation framework for building farm households' capacity in Chiang Mai province agri-food system

Jureerut Somboon[a]
Thi Phuoc Lai Nguyen[b†]
Vilas Nitivattananon[c]
Ekbordin Winijkul[d]

[a,b,c]*Department of Development and Sustainability, School of Environment, Resources and Development, Asian Institute of Technology, Pathum Thani, 12120, Thailand.*
[d]*Department of Water Resources and Environmental Engineering, School of Engineering and Technology, Asian Institute of Technology, Pathum Thani, 12120, Thailand.*

† phuoclai@ait.asia *(Corresponding author)*

Article History
Received: 21 August 2025
Revised: 12 December 2025
Accepted: 24 December 2025
Published: 29 January 2026

Keywords
Agri-food supply chains
Farm households
Farming systems
Livelihood security
Value chain governance
Value-adding activities.

ABSTRACT
Farm households are critical actors in the agri-food system; however, they frequently encounter systemic challenges, affecting their livelihood security. This study investigates farm households in Chiang Mai, Thailand, aiming to identify system components, operational patterns, and value creation across diverse farming systems. Integrated approaches, including the agri-food supply chain framework, Porter's Value Chain Model, and profit margin calculations, were employed. The findings indicate the dominance of the single-crop cultivation system, which yielded the highest profit margins. Traditional management influences farm households to purchase inputs from retailers and heavily relies on intermediaries for sales, with limited engagement in value-adding activities. Infrastructure deficits, such as inadequate cold storage, contributed to post-harvest losses. Although mixed farming offers diversification benefits, it incurs high operational costs. These findings provide critical actionable insights for farm households and inform agri-food businesses to refine collaborations, policymakers to build resilient and effective interventions, and researchers for future studies. The data collection period, coinciding with widespread animal disease outbreaks (African swine fever, Lumpy skin disease) and a flood in the province, resulted in limited representation of livestock and freshwater fishery systems. This situational constraint was mitigated by applying a weighted proportional analysis based on the actual farm household distribution.

Contribution/Originality: This study is original for simultaneously investigating multiple farming systems and products to capture a broad agri-food context. It applies simple, integrated approaches that encourage farm household participation, filling a critical gap in existing literature that often uses complex methodologies focused narrowly on a single system or product.

DOI: 10.55493/5005.v16i1.5851
ISSN(P): 2304-1455/ ISSN(E): 2224-4433
How to cite: Somboon, J., Nguyen, T. P. L. ., Nitivattananon, V., & Winijkul, E. (2026). Participation framework for building farm households' capacity in Chiang Mai province agri-food system. *Asian Journal of Agriculture and Rural Development, 16*(1), 26–38. https://doi.org/10.55493/5005.v16i1.5851

1. INTRODUCTION

Farm households are the initial producers of the agri-food system at the agricultural production stage, yet frequently encounter significant risks and pressures due to limitations, leading to limited participation and facing disadvantages in the system (Blake et al., 2019; Hassan, Jajja, Asif, & Foster, 2021; Ørtenblad, Larsen, Bruun, & Ortiz-Gonzalo, 2023). These include a low level of education, restricted market interaction, soft bargaining power, limited technology access, structural barriers to land certification, constrained financial resources, and minimal product differentiation, thereby reducing opportunities for value addition and hindering market channel access.

Achieving sustainable agri-food systems is a central global policy objective. In Thailand, the government's Thirteenth National Economic and Social Development Plan (2023-2027) formally incorporates this promotion. However, farm households that are crucial employees in Thailand's agriculture sector continue to confront persistent challenges (Chankrajang, 2015; Charoenratana & Shinohara, 2018; Feder, 1987). These challenges contribute to the sector's relatively low GDP contribution, recorded at 8.81% of the national total (Ministry of Commerce, 2024).

Consequently, enhancing farm households' capacity is fundamental for promoting sustainable agri-food systems, especially for small-scale farmers in low- and middle-income countries, including upper-middle-income nations like Thailand, which remain largely marginalized. A comprehensive understanding of farm households' characteristics, management practices, and current value creation is crucial for analyzing the existing challenges. Methods, for instance, socioeconomic assessments (Adugna & Goshu, 2010), the knowledge, attitude, and practice (KAP) model (Liao, Nguyen, & Sasaki, 2022), and supply chain analyses (Gardas, Raut, Cheikhrouhou, & Narkhede, 2019) can be used to investigate farm households' contexts. However, these methods often focus on isolated agricultural systems, such as specific crops, livestock, or aquaculture, or employ a single analytical lens. Farm households' contexts are complex, involving multiple systems and products, including crop cultivation, livestock, aquaculture, and agroforestry. Therefore, a singular approach is often insufficient, and an integrated approach may better address this complexity.

This study integrates supply and value chain analyses, including profit margin calculation, to examine diverse farming systems and address the identified research gap. The integrative approaches help to identify location-specific challenges, which cooperate with farm households to achieve these objectives.

(1) To investigate the characteristics and patterns of farming systems across different years.

(2) To identify farm households' supply chain components and classify operational activities in the farm households' value chain.

(3) To examine value creation across different farming systems.

(4) To propose a participation framework for building and enhancing farm households' capacity in the agri-food system and to suggest effective interventions.

The participation framework proposes integrative approaches that can be applied to work with farm households to help them identify persistent challenges and lead to finding actionable interventions to build farm households' capacity. Ultimately, this framework can be scaled to other farm contexts in different regions.

2. LITERATURE REVIEW

This review synthesizes key concepts of the agri-food supply chain (AFSC) and value chain (VC) to establish the analytical framework necessary for understanding farm households' operations. This highlights that these integral frameworks can help to identify supply chain components, management patterns, operational activities, and value creation. However, a critical review of their application reveals significant gaps that limit comprehensive analysis and hinder the enhancement of farm household participation and capacity building towards a sustainable agri-food system.

The Agri-food Supply Chain (AFSC) is a fundamental concept for identifying and elucidating stakeholder relationships and management patterns within agri-food business chain networks (Campanhola & Pandey, 2019; Tsolakis, Keramydas, Toka, Aidonis, & Iakovou, 2014; Van Der Vorst, Da Silva, & Trienekens, 2007). Additionally, the AFSC helps to identify that the main challenges in agricultural supply chains typically arise at the production, post-harvesting, processing, and marketing stages. These require further analysis, such as factors affecting the AFSC's efficiency, which might rely on effective management of land, labor, capital stock, and human capital, including the management of information flow and stakeholders' collaboration.

Value Chain (VC) is widely used to examine agri-food business chains. Trienekens (2011) and Barrett, Reardon, Swinnen, and Zilberman (2022) used VC to study agri-food and agricultural value chains in developing and low- and middle-income countries, highlighting constraints, value addition processes, network structures, and governance mechanisms. These insights informed options for upgrading and transitioning value chains. Additionally, Hassan et al. (2021) conducted action research through in-depth engagement with small-scale farmers in the potato value chain in Pakistan. Their findings revealed that cultivation and sales practices significantly influence crop yield, cost structure, and profitability, suggesting guidelines for recrafting and streamlining the value chain.

Despite the utility of AFSC and VC, a critical synthesis of existing literature reveals two main gaps. Firstly, there is a lack of integration of these analytical frameworks to examine diverse farming systems simultaneously. Secondly, most literature typically focuses on a narrow, single product, particularly economic crops (e.g., rice, maize) or specific livestock (e.g., dairy cattle, swine). For example, Blake et al. (2019) focused on the animal feed maize supply chain, and Ørtenblad et al. (2023) examined vegetable-producing smallholders through a cabbage case study. Locally, previous agricultural studies in Chiang Mai primarily addressed farmers' behaviors concerning chemical use, cost reduction strategies, and general farm management practices, often employing complex methodologies that inhibit farm households' understanding and capacity to participate (e.g., Liawruangrath, Khuankaew, & Thapinta, 2021; Thapinta, Liawruangrath, & Khuankaew, 2022).

A lack of integrated analytical approaches, a narrow focus, and overly complex methods still do not achieve the objective of encouraging farm household participation and capacity building. Therefore, this study attempts to address these gaps by employing simple, integrated analytical frameworks designed specifically to capture the broad context of farm households in the rural agri-food system to enhance their participation and capacity building.

3. MATERIALS AND METHODS

This study employed a mixed-methods approach, combining qualitative and quantitative data. Qualitative data were collected through semi-structured interviews with 54 farm households from different farming systems, utilizing the agri-food supply chain (Tsolakis et al., 2014) and Porter's Value Chain (Porter, 1985) frameworks to analyze the data. Quantitative data were obtained from survey questionnaires with farm households (N=412), employing percentage descriptive statistical analysis to illustrate farming systems characteristics and patterns. Profit margin calculations were used for value-added analysis.

3.1. The Case Study: Chiang Mai Province

Chiang Mai Province, located in northern Thailand (Figure 1), was selected due to its distinctive landscape, significant agricultural production for the national economy, and diverse farming systems, practices, and products. This provides a robust context for understanding farm household characteristics and patterns. Notably, Chiang Mai exhibits substantial agricultural production across crop cultivation, livestock farming, and freshwater fisheries, predominantly undertaken by farm households (National Statistical Office, 2015). However, farm households here face several obstacles hindering sustainable agriculture, potentially impacting overall agri-food system sustainability.

To capture regional heterogeneity and ensure representativeness, this study strategically focused on five districts within Chiang Mai: Sanpathong, Mae On, Omkoi, Chiang Dao, and Fang. These were purposively selected based on their diverse geographical locations, varying altitudes and climates, and coverage spanning the northern to southern parts of Chiang Mai. The socio-economic heterogeneity, including variations in ethnicity and principal agricultural outputs, influences local farming systems and practices. This purposive selection ensures a representative reflection of the distinctive and diversified agricultural production of the province.

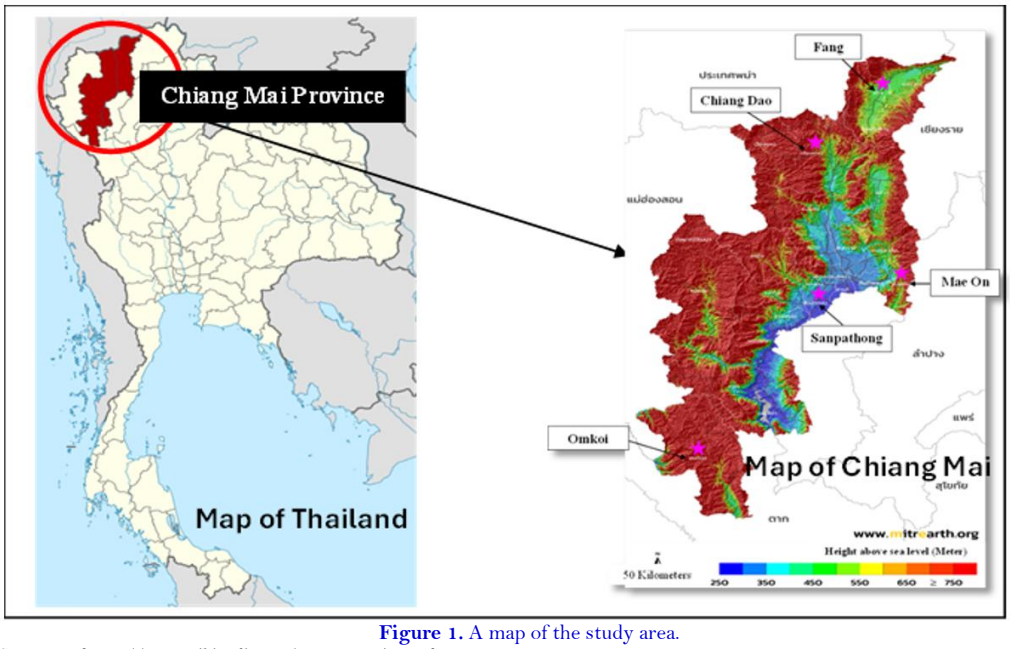


Figure 1. A map of the study area.

Source: https://en.m.wikipedia.org/ & www. mitrearth.org

3.2. Data Collection

Data was collected from both primary and secondary sources. Secondary data were obtained from the Chiang Mai Agricultural Census 2013 (National Statistical Office, 2015). Primary data were collected through a survey questionnaire and semi-structured interviews with farm households representing various agricultural farming systems (single system of crop cultivation, livestock, and freshwater fisheries, including mixed systems) across the five selected districts in Chiang Mai province. The sample size for the survey questionnaire was determined using an estimation of the mean with 30 preliminary trials of farm households, employing the following formula (1).

$$n = \frac{4Z^2\sigma^2}{W^2} \quad (1)$$

When

Confidence interval 99%, Z = 2.58.

W = Units total in width.

σ = The standard deviation of the population.

The average of farm households' income was used for the sample size calculations, with units total in width (W) = 7,990 units, and the standard deviation of farm households' income in the population (σ) = 31,432. Thus, the required sample size was calculated as n = 412 farm households. Multi-stage sampling, comprising simple random and cluster sampling, was used for sampling selection.

$$n = \frac{4\ x\ 2.58^2 x\ 31{,}432\text{^}2}{7{,}990\text{^}2} = 412 \text{ farm households}$$

A survey collection and semi-structured interviews, conducted from September to December 2022 by a researcher and five assistants, with support from local leaders. Semi-structured interviews with 54 farm households used a purposive approach to gain deeper insights into farm households' contexts.

3.3. Data Analysis

Stage 1: Investigating Farming Systems' Characteristics and Patterns.

Percentage descriptive statistics were utilized to analyze Chiang Mai's farming systems characteristics and patterns, using data from the Chiang Mai Agricultural Census 2013 (National Statistical Office, 2015) and quantitative survey results.

Stage 2: Supply and Value Chain Analysis.

Stakeholders and components within farm households' supply chains, as well as their value chain activities, were identified and analyzed using the agri-food supply chain framework (Tsolakis et al., 2014) and Porter's value chain model (Porter, 1985).

Stage 3: Evaluating Value Creation.

Value creation across different farming systems was examined through profit margin calculations, beginning with data normalization to ensure robust analysis. Ultimately, the overall profit margin was weighted based on the proportion of farm households in each system relative to the total sample size.

The profit margin was calculated using the following formula.

$$\%\ \text{Profit Margin} = \frac{[(Revenue - Cost)]}{Revenue} \text{ x } 100 \qquad (2)$$

Stage 4: Developing a Participation Framework.

This final stage involved developing a participation framework for farm households to foster insights and identify their key challenges.

Content analysis was employed to elaborate on quantitative survey data and qualitative semi-structured interview data, which helps systematically identify contextual information.

4. RESULTS AND DISCUSSION

4.1. Chiang Mai's Farming Systems Characteristics and Patterns

Farm households primarily employ single or mixed farming systems. Survey data from 2022 revealed that single-crop cultivation was the most prevalent system (64.6% of the farm households surveyed), followed by mixed systems of cultivation and livestock (14.3%) and single livestock systems (9.7%). A comparison of these 2022 findings with data from the Chiang Mai Agriculture Census of 2013 (National Statistical Office, 2015) indicated that most farm households maintain consistent farming systems over time, showing no significant shifts (Figure 2).

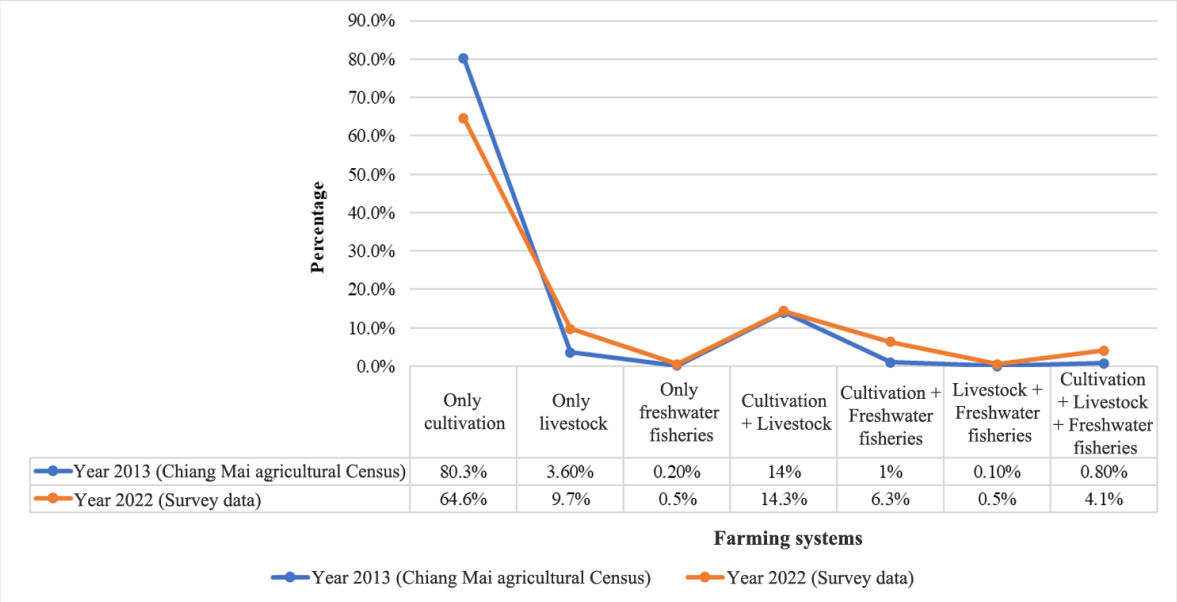


Figure 2. The agricultural production farming systems trend in Chiang Mai in different years.

Source: The year 2013 data was compiled from the Chiang Mai Agricultural Census 2013.
The 2022 data were collected through a survey questionnaire.

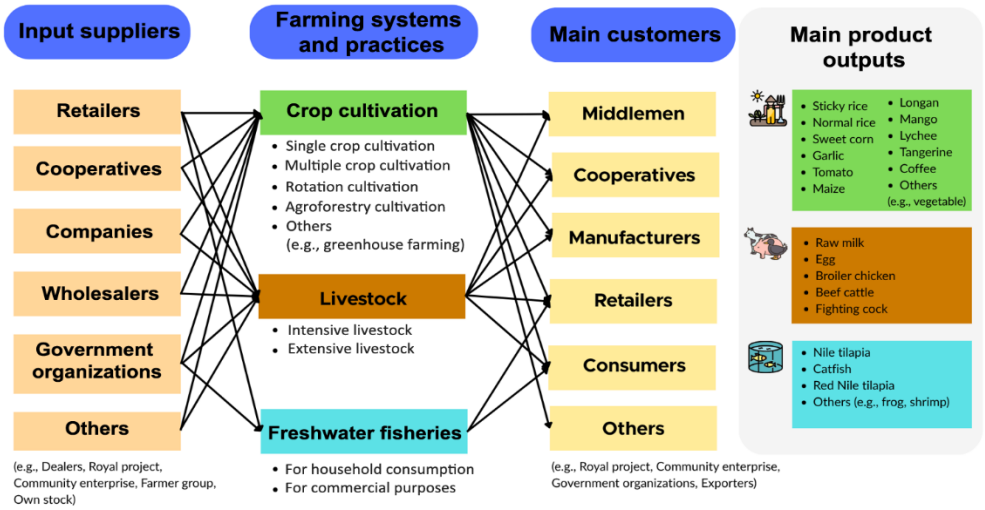
This persistence is primarily attributed to the strong prevalence of ancestral farming systems and practices, a finding that aligns with Thibet (2018). Several factors contribute to this continuity. The advanced age of household heads significantly limits motivation for changing farming systems and practices, aligning with observations of aging farmer populations in prior research (Faysse, Aguilhon, Phiboon, & Purotaganon, 2020; Ji, Hu, Zhu, & Zhong, 2017). Adherence to traditional farming systems and practices is particularly evident among Indigenous farm households that have a strong sense of origin attachment (Ba, Wang, & Wang, 2023; Das et al., 2012; Dey & Sarkar, 2011; Hamadani et al., 2021; Kaewploy, Aquino, & Phonpakdee, 2018; Mukherjee, 2012). These farm households are commonly deeply rooted in generations of local wisdom, cultural beliefs, and traditional knowledge (Setboonsarng & Gilman, 1998; Trakansuphakorn & Kampholkul, 2010). The reduced labor force impacts the adoption of new systems. Furthermore, semi-structured interviews and earlier studies reveal insights into the limitations influencing decisions to maintain original systems and practices: financial constraints; scarcity of knowledge, information, skills, and techniques for new operations; limited access to technologies and market channels; agricultural product price volatility; pests and animal diseases; and climate variability (Kazmi, Ghafoor, Chaudhry, & Khan, 2014; Oyetunde-Usman, Olagunju, & Ogunpaimo, 2021). These factors contribute to a lack of confidence in transitioning. Conversely, some farm households expressed satisfaction with current farm operations, productivity, and revenue, aligning with the findings of Faysse et al. (2020). Consequently, they reported no immediate plans to adopt new farming systems.

4.2. Supply and Value Chain Analysis

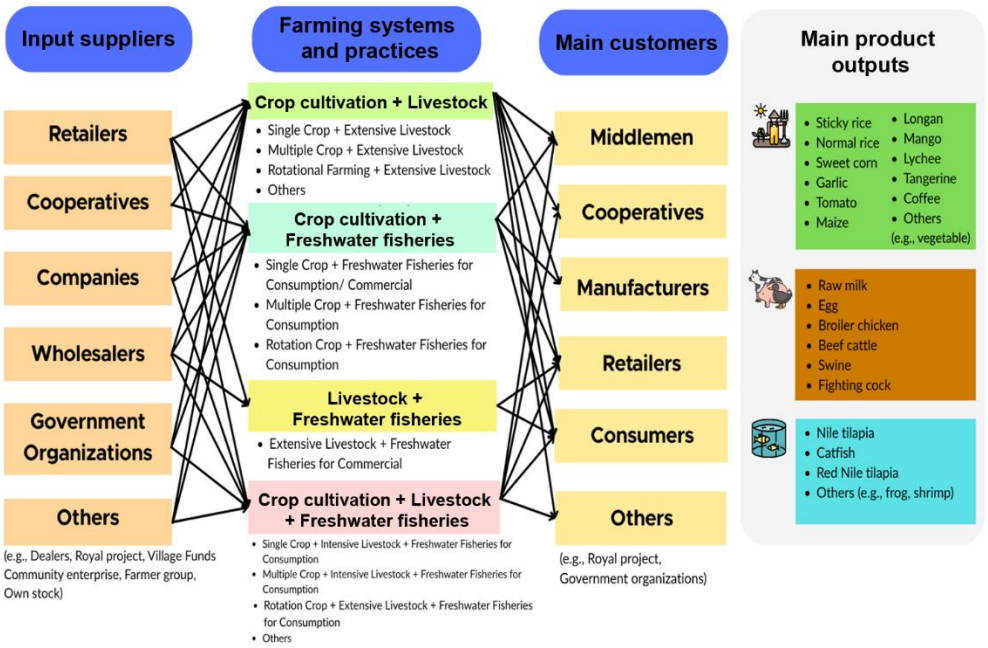
4.2.1. Agri-Food Supply Chain of Farm Households in Chiang Mai

Farm households' system components were identified using the agri-food supply chain analysis (Figures 3a and 3b). The analysis indicates that farm households predominantly employ farming practices and management methods inherited across generations. Diverse farming systems necessitate distinct input materials based on their specific agricultural activities. This aligns with findings from the National Statistical Office (2015) and previous research on economic crops in Chiang Mai, such as tangerine, longan, garlic, and rice (e.g., Kusano, 2019; Liawruangrath et al., 2021; Thapinta et al., 2022). Retailers were the predominant suppliers for farm households across all farming system types, consistent with Ørtenblad et al. (2023), due to the easy accessibility of agro-retailer shops widely distributed within local communities. Farm households often purchase inputs in small quantities due to financial constraints, despite higher retail prices (Office of Agricultural Economics, 2024). Cooperatives and government organizations also play a significant role as suppliers. Additionally, some farm households purchase inputs from wholesalers and dealers, primarily observed in contract farming arrangements. Product diversification across different farming systems was limited, particularly for crops, with farm households predominantly cultivating similar crops (e.g., sticky rice, longan, and mango). A limited variety of products leads to oversupply and negatively impacts their revenue. Additionally, supply chain analysis shows a continued dominant engagement with traditional markets, relying heavily on intermediaries, notably middlemen (Endo, 2014; Kusano, 2019; Ørtenblad et al., 2023; Wongprawmas, Canavari, & Waisarayutt, 2015) who typically dictate product prices, leaving farm households with limited negotiation power. Some farm households sold to cooperatives (e.g., rice, raw milk, eggs) at guaranteed prices. Moreover, some farm households are under contract farming (e.g., maize, swine, broiler chicken), whose production must follow standard regulations, and product prices are determined by contracting companies. Supply chain analysis also shows an emerging trend: some groups of farm households are beginning to actively seek alternative markets, such as direct sales to consumers through local markets and online platforms, to avoid perceived unfair trade conditions.

These findings are consistent with previous studies in lower-middle-income developing countries such as Pakistan (Hassan et al., 2021) and other ASEAN countries, including other areas in Thailand (Kusano, 2019; Ørtenblad et al., 2023; Wongprawmas et al., 2015). Farmers face similar challenges: disadvantages, limited negotiation power, external dependence, and restricted market access. Furthermore, the analysis reveals a persistent lack of robust collaboration among stakeholders across supply chains, significantly impacting overall efficiency.



3a



3b

Figure (3a) (3b). Stakeholders and key components in the agri-food supply chain across the different farming systems
Source: Extracted from field data survey, 2022.

4.2.2. Value Chain of Farm Households in Chiang Mai

Value chain analysis classifies general operations and value-added activities within the farm households' value chain (Figure 4). The analysis indicates that farm households' value chain primarily focuses on general operational activities, a pattern also observed in the studies of Wei and Zhang (2004) and Hassan et al. (2021). Conversely, there is limited emphasis on value-added activities, as evidenced by the small proportion of farm households involved in activities such as food processing, packaging, and chilled storage. Typically, these value-added activities are conducted by other stakeholders, a phenomenon also highlighted in previous research (Concepcion et al., 2004; Ørtenblad et al., 2023; Wheatley & Peters, 2004; Wongprawmas et al., 2015; Woods, 2003). This highlights that traditional management focusing on general agricultural production more than adding value to commodity products significantly influences operational patterns in farm households' value chains (Singgih & Woods, 2003).

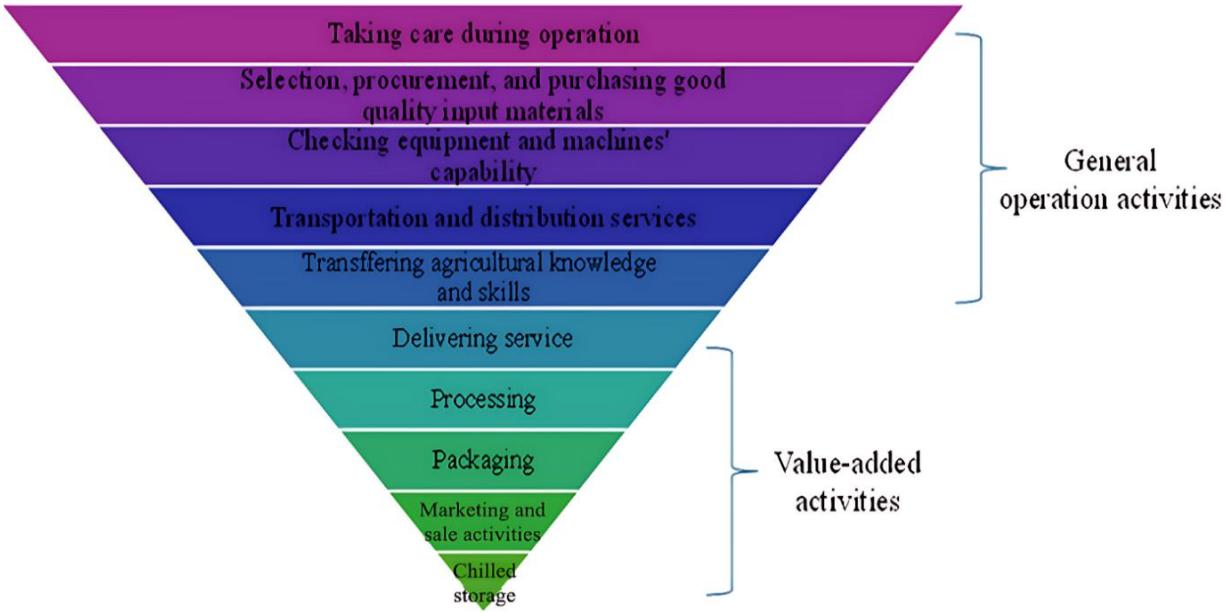


Figure 4. The classification of general operations and value-added activities in the farm households' value chain.
Source: Extracted from field data survey, 2022.

Semi-structured interviews highlighted that some farm households engage in basic value-added activities, specifically food processing, which are primarily for household consumption. Scaling up the production of processed food products into high-value items is constrained by the need for improved practices and techniques (Oktaviani, 2004; Wheatley & Woods, 2003). Packaging development is also crucial for adding value, but it still lacks engagement from

farm households (Chau, Wei, Truyen, Rankin, & Russell, 2004; Setyadjit et al., 2004; Wei, Adar, Woods, & Suheri, 2003). Furthermore, farm households lack marketing and sales skills. Delivery services have still emerged only among farm households actively engaged in direct sales to consumers. Finally, farm households lack essential infrastructure support, particularly chilled storage (Van Der Vorst et al., 2007). They mostly face financial limitations in accessing chilled warehouses, leading to frequent post-harvest problems, which result in reduced profitability for farm households (Brennan, 2004; Concepcion et al., 2004; Wheatley, Best, Peters, & Connell, 2004; Yanrong & Wei, 2004). Additionally, the application of technology for agricultural production (e.g., automatic watering systems, automatic milking machines, automatic feeding systems, automatic sorting belts) remained limited to a small group of farm households.

4.3. Value Creation Across Different Farming Systems

Descriptive statistics, specifically the standard deviation, indicated that initial income data exhibited a non-normal distribution (Table 1), necessitating a normalization approach to ensure validity before profit margin calculation.

Table 1. Average net income across the different farming systems before data normalization.

Farming Systems (N = 412)	AVG. Revenue (Baht/Year)	AVG. Operation Costs (Baht/Year)	AVG. Net Income (Baht/Year)	Std. Deviation
Single system of cultivation (n=266)	78,793.26	54,135.97	24,657.30	117,397.54
Single system of livestock (n=40)	1,113,608.75	798,392.10	315,216.65	714,961.72
Single system of freshwater fisheries (n=2)	2,500.00	28,112.50	-25,612.50	39,580.30
Mixed system of cultivation and livestock (n=59)	143,416.92	118,668.81	24,748.10	177,738.62
Mixed system of cultivation and freshwater fisheries (n=26)	103,545.88	45,067.65	58,478.22	115,120.47
Mixed system of livestock and freshwater fisheries (n=2)	48,791.50	5,287.50	43,504.00	43,262.21
Mixed system of cultivation, livestock, and freshwater fisheries (n=17)	95,254.85	64,839.12	30,415.74	75,136.22

Source: Field data survey, 2022.

Following data normalization, the sample size was adjusted from 412 to 344 farm households due to the exclusion of outliers. This normally distributed dataset was then utilized for value creation analysis through profit margin calculation (Table 2). A weighted profit margin accounted for the varying proportion of households in each farming system, which potentially influences the overall profit margin calculation.

Table 2. Profit margin across the different farming systems after the data normalization.

Farming Systems (N = 344)	AVG. Revenue (Baht/year)	AVG. Operation Costs (Baht/year)	AVG. Net Income (Baht/year)	Std. Deviation	Weight	% Profit Margin
Single system of cultivation (n=238)	48,514.59	40,641.69	7,872.90	45,171.52	0.69	11.23
Single system of livestock (n=17)	39,849.41	93,768.47	-53,919.06	70,542.79	0.05	-6.69
Single system of freshwater fisheries (n=2)	2,500.00	28,112.50	-25,612.50	39,580.30	0.01	-5.96
Mixed system of cultivation and livestock (n=48)	81,236.31	82,551.56	-1,315.25	58,684.61	0.14	-0.23
Mixed system of cultivation and freshwater fisheries (n=22)	64,985.94	39,855.41	25,130.53	48,760.26	0.06	2.47
Mixed system of livestock and freshwater fisheries (n=2)	48,791.50	5,287.50	43,504.00	43,262.21	0.01	0.52
Mixed system of cultivation, livestock, and freshwater fisheries (n=15)	57,935.50	48,951.00	8,984.50	45,240.74	0.04	0.68

Source: Field data survey, 2022.

The weighted profit margin calculation revealed that the single cultivation system, most prevalent in the study, yielded the highest percent profit margin at 11.23%. This implies that the proportion of farm households engaged in specific farming systems influenced the overall profit margin. Conversely, single livestock (-6.69%), single freshwater fisheries (-5.96%), and mixed cultivation and livestock systems (-0.23%) all exhibited negative profit margins. Value creation analysis further revealed that profit margin was not solely determined by total revenue, due to total revenue

fluctuating with market prices, aligning with Faysse et al. (2020). High operation costs relative to low selling prices also negatively impacted farm households' income and profit margins. In addition, the intermediary-centric market highlights middlemen's influence on farm households' income and margins (Cifra, Lee, Vizcarra, & Camaro, 2022; Pokhrel & Thapa, 2007; Rahayu, Dewi, & Abid, 2021). These findings are consistent with other studies conducted in South and Southeast Asia (Khushk, 2001; Lantican, 1997; Thapa, Koirala, Gill, & Thapa, 1995). However, farm households' income and profit margin distribution vary based on local contexts (e.g., counties, regions).

4.4. Developing a Participation Framework for Building the Capacity of Farm Households in the Agri-Food System

This research develops a participation framework (Figure 5) that proposes integrative approaches to working with farm households, leading to enhancing their capacity. It begins with an in-depth investigation of the farming systems and practices, facilitating an inclusive understanding of their inherent characteristics and patterns. Additionally, the framework suggests integration approaches of the agri-food supply chain framework with the value chain model and coordinating with profit margin calculations. The integration approaches provide contextual insight into the challenges faced by farm households. They consistently face persistent adherence to traditional management, insufficient support for value-added activities, and a limited focus on high-value products compared with raw commodities (Campanhola & Pandey, 2019; Hassan et al., 2021; Van Der Vorst et al., 2007). Thus, farm households' capacity in the agri-food system depends on system characteristics and practices, supply chain management, and value chain operations. Accordingly, the framework identifies potential interventions to strengthen farm households' ability to improve the agri-food system from the initial producers.

The framework's key contribution is integrating analysis approaches to facilitate seeking efficiency interventions through farm household participation. This study suggests that interventions in agricultural policy should align with the specific local contexts (Greer, 2005) and farm households' characteristics and practices, considering supply and value chain management performance to enhance efficiency and value creation. Furthermore, agricultural policy should encompass several dimensions, including price, production, environment, rural development, and social conditions. The European Model of Agriculture (EMA) exemplifies an agricultural policy that underlines farmer participation, recognizing their significant role in the agri-food system (Brouwer, 2004).

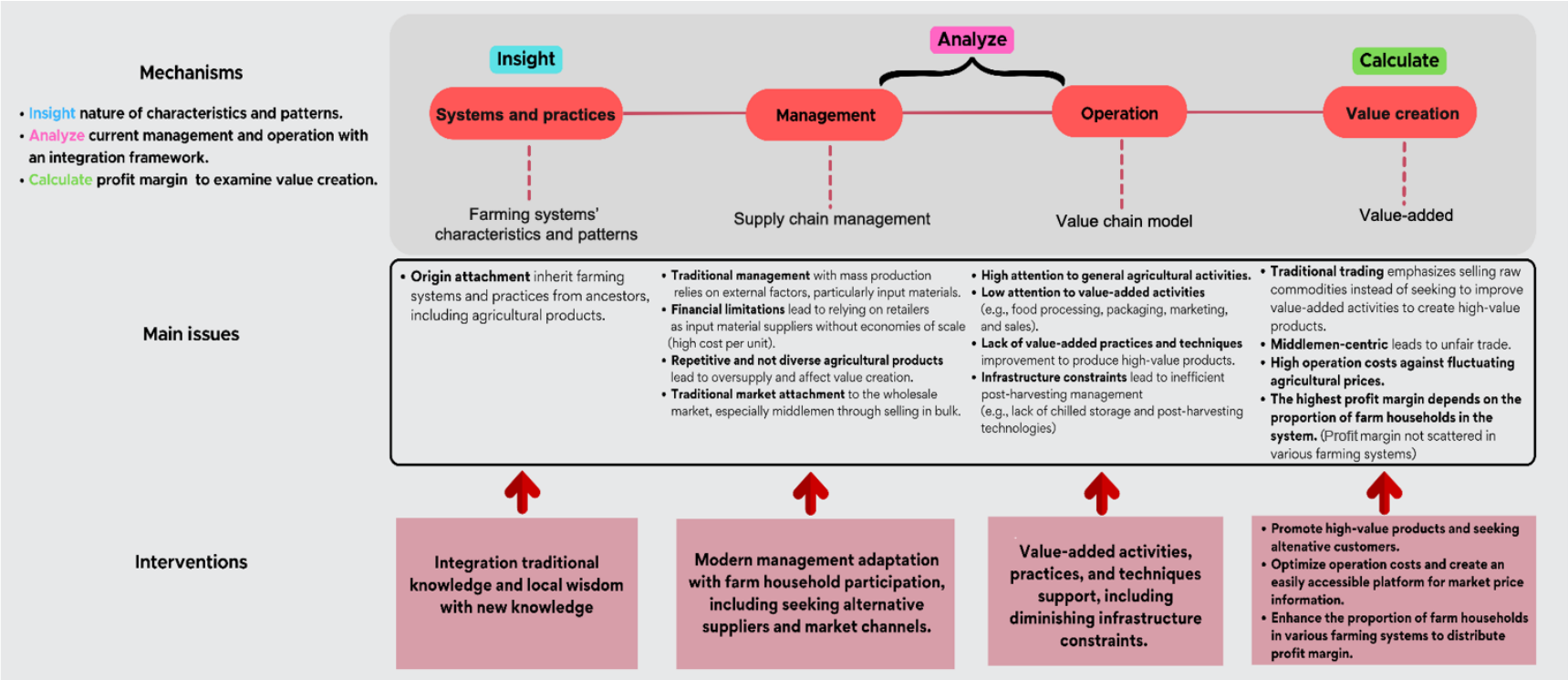


Figure 5. A participation framework for building farm households' capacity in the agri-food system.

5. CONCLUSION

This study cooperates with farm households to develop a participation framework, integrating multiple analytical approaches for crucial insights into farm households' performance and capabilities, including their challenges, facilitating the suggestion of appropriate interventions synchronized with local contexts.

The findings indicate that farm households in the study area predominantly adhere to farming systems and practices inherited from previous generations.

The primary factors influencing their decision not to transition include the age of household heads, origin attachment (e.g., indigenous farm households), labor force reduction, financial constraints, knowledge and skills conditions, and limited access to technologies and market channels.

Supply chain analysis implies that farm households are typically trapped in traditional management, which mostly relies on external factors, notably input materials that are predominantly purchased from retailers, which induce high operating costs. Moreover, they rely heavily on intermediaries, particularly on middlemen, for selling raw commodity products. Output products of farm households' supply chain are often repetitive, leading them to face oversupply issues and falling prices of agricultural products. Traditional management influences operational activities in the value chain. It can be observed that farm households frequently concentrate on general operational activities when compared to value-added activities.

Low attention to value-added activities is caused by issues such as a scarcity of practices and techniques and financial barriers to accessing essential infrastructure (e.g., chilled storage and automatic machines). A value creation analysis reveals two key challenges for farm households: volatile agricultural prices, which reduce revenue, and high operational costs, which diminish net income and profitability. A contributing factor to these issues is a lack of improvement in value-added activities to produce high-value products. This analysis further suggests that profitability is not distributed equitably among different farming systems but is instead predominantly captured by a single-crop cultivation system, a practice most households engage in. To summarize, the key factors influencing farm households' capacity encompass internal factors, particularly struggles in traditional management and resource conditions (e.g., financial, input materials, and family labor), and external factors, especially market price fluctuations and intermediaries' influence.

These factors cause farm households to remain marginalized and disadvantaged within the rural agri-food system. Therefore, enhancing their capacity, including supply and value chain performance, particularly through improved management patterns, is essential. These insights provide a basis for farm households' capacity-building interventions within rural agri-food systems.

(1) Integrating traditional knowledge and local wisdom with contemporary knowledge to enhance the efficiency of farming systems.

(2) Adopting modern management to improve traditional supply chains and seeking fair-trade stakeholders, including expanding market channels.

(3) Supporting the development of value-added activities and infrastructure to promote high-value products.

(4) Optimizing farm households' operational costs (e.g., implementing measures to control input material prices).

(5) Encouraging farm households to diversify into various farming systems to distribute value creation across a broader range of agricultural activities.

Post-COVID-19 data collection revealed significantly lower farm household revenue while operational costs remained relatively stable, negatively impacting income and causing deficit profit margins across systems. This aligns with government reports (e.g., Office of Agricultural Economics). These contextual insights are vital for formulating effective bottom-up agricultural policy, beginning with understanding farm household context and capacity building at the agri-food system's initial stage.

5.1. Limitations and Future Research

This study provides context and actionable insight into farm households in Chiang Mai. However, its scope presents certain limitations.

Firstly, the data collection period was affected by significant external shocks, notably widespread animal disease outbreaks (African swine fever and Lumpy skin disease) and a provincial flood. These constraints resulted in limited representation of livestock and freshwater fisheries systems.

Secondly, while reliance on primary survey data for operational costs, revenue, income, and profit margins introduces potential reporting bias, this limitation was partially mitigated by cross-validating key findings against official government reports (e.g., Office of Agricultural Economics).

Thirdly, given the purposive selection of five diverse districts in Chiang Mai, Thailand, the generalizability of the findings should be carefully considered within this specific socio-economic and geographical context.

Future research should build upon this framework by exploring other factors influencing farm households' capacity through hypothesis testing and advanced statistical models, and expanding the geographical scope to confirm these patterns across regional agri-food systems.

Funding: This study received funding from the Royal Thai Government Fellowships (RTG) and the AIT Scholarships, which were allocated through the Asian Institute of Technology, Thailand (grant number 202008003011).
Institutional Review Board Statement: The Ethical Committee of the Asian Institute of Technology (AIT), Thailand has granted approval for this study on 14 September 2022 (Ref. No. RERC 2022/015). Informed consent was obtained from all participating farm households before data collection through a survey questionnaire and semi-structured interviews.
Transparency: The authors state that the manuscript is honest, truthful, and transparent, that no key aspects of the investigation have been omitted, and that any differences from the study as planned have been clarified. This study followed all writing ethics.
Competing Interests: The authors declare that they have no competing interests.
Authors' Contributions: All authors contributed equally to the conception and design of the study. All authors have read and agreed to the published version of the manuscript.
Disclosure of AI Use: The author used Gemini (Version 2.5 Flash) to edit and refine the wording of the Introduction and Literature Review. All outputs were thoroughly reviewed and verified by the author.

REFERENCES

Adugna, B. T., & Goshu, G. (2010). Integrating aquaculture with traditional farming system: Socioeconomic assessment in the Amhara Region, Ethiopia. *Ecohydrology & Hydrobiology, 10*(2-4), 223-230. https://doi.org/10.2478/v10104-011-0010-y

Ba, Q.-X., Wang, H.-Z., & Wang, M.-H. (2023). Agrobiodiversity, social institutions, and indigenous farming practices: A case study of the Rukai in Wutai, Taiwan. *Human Ecology, 51*(6), 1127-1140. https://doi.org/10.1007/s10745-023-00463-4

Barrett, C. B., Reardon, T., Swinnen, J., & Zilberman, D. (2022). Agri-food value chain revolutions in low-and middle-income countries. *Journal of Economic Literature, 60*(4), 1316-1377. https://doi.org/10.1257/jel.20201539

Blake, D. J., Thiengburanathum, P., Thiengburanathum, P., Friend, R. M., Doherty, B., & Thankappan, S. (2019). Looking at complex agri-food systems from an actor perspective: The case of Northern Thailand. In Advances in food security and sustainability. In (Vol. 4, pp. 33-65). Netherlands: Elsevier.

Brennan, D. (2004). *Public policy issues in supply-chain management. In Agriproduct Supply-Chain Management in Developing Countries: Proceedings of a Workshop Held in Bali, Indonesia, 19–22 August 2003*, ACIAR Proceedings No. 119, ACIAR, Australia.

Brouwer, F. (2004). *Sustaining agriculture and the rural environment: Governance, policy, and multifunctionality*. United Kingdom: Edward Elgar Publishing.

Campanhola, C., & Pandey, S. (2019). Chapter 33 – Agrifood systems. In Sustainable food and agriculture: An integrated approach (pp. 305–330). Academic Press/Elsevier. https://doi.org/10.1016/B978-0-12-812134-4.00033-9

Chankrajang, T. (2015). Partial land rights and agricultural outcomes: Evidence from Thailand. *Land Economics, 91*(1), 126-148. https://doi.org/10.3368/le.91.1.126

Charoenratana, S., & Shinohara, C. (2018). Rural farmers in an unequal world: Land rights and food security for sustainable well-being. *Land Use Policy, 78*, 185-194. https://doi.org/10.1016/j.landusepol.2018.06.042

Chau, N. M., Wei, S., Truyen, V. T., Rankin, M., & Russell, I. (2004). *Getting farmers to work together: the experiences of mango growers in the Mekong Delta region of Vietnam*. Paper presented at the Agriproduct Supply-Chain Management in Developing Countries, Proceedings of a Workshop Held in Bali, Indonesia, 19–22 August 2003, ACIAR Proceedings No. 119.

Cifra, M. U., Lee, J. M., Vizcarra, C. M., & Camaro, P. J. (2022). The influence of marketing margins, production cost, and labor productivity on farmers' welfare: A regression analysis. *UJoST-Universal Journal of Science and Technology, 1*(2), 145-181.

Concepcion, S., Montiflor, M., Hualda, L. T., Migalbin, L. R., Digal, L. N., Rasco, E. T., & Rola-Rubzen, F. M. (2004). *Farmers' misconceptions about quality and customers' preferences: contributing inefficiencies to the vegetable supply chain in southern Mindanao*. Paper presented at the Agriproduct Supply-Chain Management in Developing Countries. Proceedings of a Workshop Held in Bali, Indonesia, 19–22 August 2003, ACIAR Proceedings No. 119.

Das, A. D., Ramkrushna, G., Choudhury, B., Munda, G., Patel, D., Ngachan, S., . . . Manoj Kumar, M. K. (2012). Natural resource conservation through indigenous farming systems: wisdom alive in North East India. *Indian Journal of Traditional Knowledge, 11*(3), 505-513.

Dey, P., & Sarkar, A. K. (2011). Revisiting indigenous farming knowledge of Jharkhand (India) for conservation of natural resources and combating climate change. *Indian Journal of Traditional Knowledge, 10*(1), 71-79.

Endo, G. (2014). The key role of intermediaries in Thailand's fresh food distribution system. *The International Review of Retail, Distribution and Consumer Research, 24*(5), 544-563. https://doi.org/10.1080/09593969.2014.967363

Faysse, N., Aguilhon, L., Phiboon, K., & Purotaganon, M. (2020). Mainly farming… but what's next? The future of irrigated farms in Thailand. *Journal of Rural Studies, 73*, 68-76. https://doi.org/10.1016/j.jrurstud.2019.12.002

Feder, G. (1987). *Land ownership security, farm productivity, and land policies in Thailand* (Vol. 66). United States: Agriculture and Rural Development Department, Operational Policy Staff, World Bank.

Gardas, B. B., Raut, R. D., Cheikhrouhou, N., & Narkhede, B. E. (2019). A hybrid decision support system for analyzing challenges of the agricultural supply chain. *Sustainable Production and Consumption, 18*, 19-32. https://doi.org/10.1016/j.spc.2018.11.007

Greer, A. (2005). *Agricultural policy in Europe*. United Kingdom: Manchester University Press.

Hamadani, H., Rashid, S. M., Parrah, J. D., Khan, A. A., Dar, K. A., Ganie, A. A., & Ali, A. (2021). Traditional farming practices and its consequences. In Microbiota and Biofertilizers, Vol 2: Ecofriendly Tools for Reclamation of Degraded Soil Environs. In (pp. 119-128). Cham: Springer International Publishing.

Hassan, S. Z., Jajja, M. S. S., Asif, M., & Foster, G. (2021). Bringing more value to small farmers: A study of potato farmers in Pakistan. *Management Decision, 59*(4), 829-857. https://doi.org/10.1108/MD-12-2018-1392

Ji, Y., Hu, X., Zhu, J., & Zhong, F. (2017). Demographic change and its impact on farmers' field production decisions. *China Economic Review, 43*, 64-71. https://doi.org/10.1016/j.chieco.2017.01.006

Kaewploy, N., Aquino, U., & Phonpakdee, R. (2018). The people's participation on the indigenous serrated mud crabfattening practices in La-ngu district, Satun Province, Thailand. *International Journal of Agricultural Technology, 14*, 1315–1326.

Kazmi, T., Ghafoor, A., Chaudhry, A. A., & Khan, S. E. (2014). Farmers beliefs about indigenous farming practices and sustainable agricultural development. *Pakistan Journal of Agricultural Research, 27*(1), 1-7.

Khushk, A. M. (2001). Marketing of vegetables and fruits in Pakistan: problems and constraints. Report of the APO Seminar on Marketing of Vegetables and Fruits held in Islamabad from 4-9 October 1999, Marketing of Vegetables and Fruits in Asia and the Pacific. In (pp. 81–97). Tokyo: Asian Productivity Organization

Kusano, E. (2019). *Food value chain in ASEAN: Case studies focusing on local producers.* Retrieved from https://www.researchgate.net/publication/338990243

Lantican, J. M. (1997). *Market prospects for upland crops in the Philippines.* Indonesia: CGPRT Center.

Liao, X., Nguyen, T. P. L., & Sasaki, N. (2022). Use of the knowledge, attitude, and practice (KAP) model to examine sustainable agriculture in Thailand. *Regional Sustainability, 3*(1), 41-52. https://doi.org/10.1016/j.regsus.2022.03.005

Liawruangrath, P., Khuankaew, C., & Thapinta, J. (2021). Upstream supply chain management of agricultural products in Peri-Urban area: Case study of Tumbon Nong Phueng SaraPhi, Saraphi District, Chiang Mai Province. *Panyapiwat Journal, 13*(2), 148-161.

Ministry of Commerce. (2024). *Thailand's agriculture sector challenges.* Thailand: Ministry of Commerce.

Mukherjee, D. (2012). Resource conservation through indigenous farming system in hills of West Bengal. *Journal of Crop and Weed, 8*(1), 160-164.

National Statistical Office. (2015). *2013 agricultural census Chiang Mai Province.* Thailand: National Statistical Office.

Office of Agricultural Economics. (2024). *The main categories of Thailand's agricultural products.* . Thailand: Office of Agricultural Economics.

Oktaviani, R. (2004). *Indonesia's strategic agricultural commodities in meeting the WTO agreement.* Paper presented at the Agriproduct Supply-Chain Management in Developing Countries. Proceedings of a Workshop Held in Bali, Indonesia, 19–22 August 2003, ACIAR Proceedings No. 119.

Ørtenblad, S. B., Larsen, M. N., Bruun, T. B., & Ortiz-Gonzalo, D. (2023). Smallholder participation in modernising agri-food value chains in Thailand: The role of traditional markets. *The European Journal of Development Research, 35*(6), 1419-1439. https://doi.org/10.1057/s41287-023-00587-9

Oyetunde-Usman, Z., Olagunju, K. O., & Ogunpaimo, O. R. (2021). Determinants of adoption of multiple sustainable agricultural practices among smallholder farmers in Nigeria. *International Soil and Water Conservation Research, 9*(2), 241-248. https://doi.org/10.1016/j.iswcr.2020.10.007

Pokhrel, D. M., & Thapa, G. B. (2007). Are marketing intermediaries exploiting mountain farmers in Nepal? A study based on market price, marketing margin and income distribution analyses. *Agricultural Systems, 94*(2), 151-164. https://doi.org/10.1016/j.agsy.2006.08.004

Porter, M. E. (1985). *Competitive advantage: Creating and sustaining superior performance.* United States: Free Press.

Rahayu, H. S. P., Dewi, M., & Abid, M. (2021). *Analysis of marketing margins and farmers' shares on corn in Sigi Regency.* Indonesia: Central Sulawesi.

Setboonsarng, S., & Gilman, J. (1998). Alternative agriculture in Thailand and Japan. *Asia-Pacific Journal of Rural Development, 8*(1), 71-86. https://doi.org/10.1177/1018529119980104

Setyadjit, S., Dimyati, A., Lokollo, E. M., Kuntarsih, S., Basuki, R. S., Hidayat, A., & Woods, E. J. (2004). *Analysis of the constraints to banana industry development in Indonesia using the supply chain concept.* Paper presented at the Agriproduct Supply-Chain Management in Developing Countries, Proceedings of a Workshop Held in Bali, Indonesia, 19–22 August 2003. ACIAR Proceedings No. 119.

Singgih, S., & Woods, E. J. (2003). *Banana supply chains in Indonesia and Australia: Effects of culture on supply chains.* Paper presented at the Agriproduct Supply-Chain Management in Developing Countries, Proceedings of a Workshop Held in Bali, Indonesia, 19–22 August 2003. ACIAR Proceedings No. 119.

Thapa, G. B., Koirala, G. P., Gill, G. J., & Thapa, M. B. (1995). *Constraints on agricultural marketing in Nepal.* Kathmandu: Winrock International.

Thapinta, J., Liawruangrath, P., & Khuankaew, C. (2022). Supply chain cost study of longan cultivation in Peri-Urban Area: Tumbon Nong Phueng, Yang Noeng and Saraphi, Saraphi District, Chiang Mai Province. *Journal of Humanities and Social Sciences Thonburi University, 16*(2), 63-75.

Thibet, A. (2018). Factors affecting farmers' adaptation on sustainable orange production in Fang District, Chiang Mai Province. Master's Thesis, Faculty of Agriculture, Chiang Mai University.

Trakansuphakorn, P., & Kampholkul, T. (2010). Knowledge and practice on rotation farming of Pgaz K'Nyau (Karen) people, Hin Lad Nai community in Northern Thailand. In Towards an alternative development paradigm: Indigenous peoples' self-determined development. In (pp. 249-329). Philippines: Tebtebba Foundation

Trienekens, J. H. (2011). Agricultural value chains in developing countries a framework for analysis. *International Food and Agribusiness Management Review, 14*(2), 51-82. https://doi.org/10.22004/ag.econ.103987

Tsolakis, N. K., Keramydas, C. A., Toka, A. K., Aidonis, D. A., & Iakovou, E. T. (2014). Agrifood supply chain management: A comprehensive hierarchical decision-making framework and a critical taxonomy. *Biosystems Engineering, 120*, 47-64. https://doi.org/10.1016/j.biosystemseng.2013.10.014

Van Der Vorst, J. G., Da Silva, C. A., & Trienekens, J. H. (2007). *Agro-industrial supply chain management: concepts and applications.* FAO Agricultural Management, Marketing and Finance No. 17. Food and Agriculture Organization of the United Nations.

Wei, S., Adar, D., Woods, E. J., & Suheri, H. (2003). *Improved marketing of mandarins for East Nusa Tenggara in Indonesia, agriproduct supply-chain management in developing countries.* Paper presented at the Proceedings of a Workshop Held in Bali, Indonesia, 19–22 August 2003, ACIAR Proceedings No. 119.

Wei, S., & Zhang, Y. (2004). *Supply-chain management and the 'one dragon' approach: Institutional bases for Agro-industrialisation in China, agriproduct supply-chain management in developing countries.* Paper presented at the Proceedings of a Workshop Held in Bali, Indonesia, 19–22 August 2003. ACIAR Proceedings No. 119.

Wheatley, C., Best, R., Peters, D., & Connell, J. (2004). *Supply-chain management and agro-enterprise development: CIAT's approach in Southeast Asia. Agriproduct Supply-Chain Management in Developing Countries.* Paper presented at the Proceedings of a Workshop Held in Bali, Indonesia, 19–22 August 2003. ACIAR Proceedings No. 119.

Wheatley, C., & Peters, D. (2004). *Who benefits from enhanced management of agri-food supply chains?. Agriproduct supply-chain management in developing countries.* Paper presented at the Proceedings of a Workshop Held in Bali, Indonesia, 19–22 August 2003, ACIAR Proceedings No. 119.

Wheatley, C., & Woods, E. J. (2003). *The benefits of supply-chain practice in developing countries–conclusions from an International Workshop. In: Agriproduct supply-chain management in developing countries.* Paper presented at the Proceedings of a Workshop Held in Bali, Indonesia, 19–22 August 2003, ACIAR Proceedings No. 119.

Wongprawmas, R., Canavari, M., & Waisarayutt, C. (2015). A multi-stakeholder perspective on the adoption of good agricultural practices in the Thai fresh produce industry. *British Food Journal, 117*(9), 2234-2249. https://doi.org/10.1108/BFJ-08-2014-0300

Woods, E. J. (2003). *Supply-chain management: Understanding the concept and its implications in developing countries. In: Agriproduct supply-chain management in developing countries.* Paper presented at the Proceedings of a Workshop Held in Bali, Indonesia, 19–22 August 2003. ACIAR Proceedings No. 119.

Yanrong, Z., & Wei, S. (2004). *The Melon value chain in Gansu Province, Western China: Benefits to growers from improved disease-control practices. Agriproduct Supply-Chain Management in Developing Countries.* Paper presented at the Proceedings of a Workshop Held in Bali, Indonesia, 19–22 August 2003, ACIAR Proceedings No. 119.