Sustainability in Agricultural Supply Chain: Lesson Learned from a Large-Scale Agricultural Extension Project of Orange in Maesin District, Si Satchanalai, Sukhothai Province

Siriwan Kitchot[1*], Andrew Lyons[2] and Iain Reid[3]

[1*]Faculty of Business, Economics and Communications, Naresuan University, Thailand

[2]School of Management, University of Liverpool, United Kingdom

[3]Faculty of Business and Law, Manchester Metropolitan University, United Kingdom

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Abstract

This article aimed to examine sustainability within the agricultural supply chain, focusing on a collaborative project in orange supply chain implemented by a farmer extension group in Maesin, Si Satchanalai, Sukhothai province, Thailand. This study employed a qualitative research method, utilizing a semi-structured interview guide based on the three dimensions of sustainability (Economic, Social, and Environmental) and Actor-Network Theory (ANT). Thematic analysis was subsequently used to analyze the interview data and understand the actual sustainability of the agricultural extension project. The findings showed – Even with continuous support from the government policy in the collaborative large-scale agricultural extension project, the strong group leadership was instrumental in sustaining the group, particularly in retaining its members. High member participation is a key factor for sustainable development and the overarching sustainability of the group, which allows it to achieve five of the 17 Sustainable Development Goals (SDGs). This research was limited to a case study of only one of the seven groups involved in the orange farming extension collaborative project in Maesin, Sukhothai Province. The article fills the research gap by demonstrating the government's efficiency and sustainability in funding, using the agricultural extension project as a case study and applying Actor-Network Theory (ANT) and the Sustainable Development Goals (SDGs). Given the complexity and varying characteristics of agricultural supply chains for different fruits, the findings may not be generalizable to all types of farming collaborative projects. The practical implication is that understanding the group's key operational factors provides valuable guidelines for sustaining the group and achieving the Sustainable Development Goals (SDGs) in similar collaborative extension projects in other areas.

The findings offer guidelines for improving the efficiency and sustainability of the large-scale agricultural extension project by revealing previously undocumented real-world practices by Actor Network Theory (ANT) and Sustainable Development Goals (SDGs).

Keywords: 1) Sustainability 2) Agricultural Supply Chain 3) Collaboration Project 4) Community Enterprise 5) Actor-Network Theory (ANT)

[1*] Assistant Professor, Department of Business Administration; E-mail: siriwanw@nu.ac.th (Corresponding Author)

Introduction

Sustainability has become a global concern, particularly in the business and agricultural sectors. According to the World Commission on Environment and Development (1987, p. 43), it refers to development that meets present needs without compromising the ability of future generations to meet theirs. The main dimensions of sustainability comprise economic, social, and environmental aspects. In the agricultural supply chain, farmers play a crucial role as upstream stakeholders who influence all subsequent stages of production and distribution.

Grouping of farmers contribute not only reduction of risk but also they can support each other. Farmer group can be strong and has potential to operate and negotiate to stakeholders including suppliers, intermediates and customers. Moreover, the group can be supported from private and government. There are Cooperative (Israel, 2022, p. 69) and government sector involving in the chain in important specific matters. Farmer groups and cooperative can reach to small holder farmers which can help to increase the revenue and decrease poverty to farmers and people in the community (Ma, Marini and Rahut, 2023, pp. 683-684; Padjung 2018, p. 012057) under the regulation and policy monitoring by government. Referred to the agricultural supply chain from the origin of products to the consumers or from farm to table, there are main stakeholders as following; suppliers, farmers, middlemen/intermediaries/traders, manufacturers, wholesalers, retailers and consumers. Farmer groups are key actors to sustain development in agricultural sector in terms of reaching to large number of smallholder farmers, revenue increasing, capability building as well as quality of life of rural households improving (Ma, Marini and Rahut, 2023, p. 683)

Large scale agricultural extension project was promoted and facilitated by the collaboration among government and stakeholders to build up capability of small size of farmers group in cooperating and managing in operation based on farmer-centered management to improve quality and yield, and reduce cost in sourcing and optimizing technology to reduce cost in marketing and increase efficiency in production (Department of Agricultural Extension, Ministry of Agriculture and Cooperatives, 2023). The large scale agricultural extension project is implemented since 2016. The project is under supporting by the government which aims to motivate farmers in group forming and strengthen the group including production of crops, livestock, and fishery products, and to jointly manage production and sales, ensuring a stable market. Moreover, to enable farmers to reduce production costs and increase yield per unit, as well as ensure products meet quality standards, through the integrated efforts of government and private agencies. From a preliminary study focusing on the efficiency of funding by government agents, the authors identified the research question: 'What is the key to sustaining a community enterprise (a group truly run by the people), and how can it be strengthened within the context of ANT and the SDGs?

There are many stakeholders or actors in Agricultural commodity supply chain which

are composed of suppliers in seeds and pesticides, landlords, farmers, workers (in field/farming), collectors, traders, manufacturers, wholesalers, retailers, and consumers.

Agricultural supply chain is very difficult to manage because it depends on many uncertainty factors including cultivation seasonality, climate change, price fluctuation, demand seasonality, nature and risk of each plant. Usually, agricultural industry is high risk but low return. As the intense competition, the single farmer in cultivation to distribution is not the solution. The community enterprise is the way to strengthen group of farming.

Many groups successfully achieved the goals of the project, for example: Mango in Si Nakhon, Sukhothai Province which can cooperate and collaborate with private sector and become community enterprise to supply mango to the big company and the product was put on the shelves in the convenient stores around Thailand. Thus, Mango in Si Nakhon community enterprise becomes company which can earn a lot of money. While many groups failed to sustain their operations due to various challenges, this research aimed to analyze the factors contributing to the success of a strong group, thereby providing key findings for policy development.

The Maesin district in Si Satchanalai, Sukhothai Province is recognized for its fertile soil that enhances the distinctive flavor of its oranges. According to the Department of Agricultural Extension, Ministry of Agriculture and Cooperatives (2024), Maesin is officially certified for the geographical indication "Maesin Orange," confirming its local identity and quality. The large-scale agricultural extension project brings together smallholder farmers to collaborate in cultivation and management. The total cultivation area covers approximately 4,096.75 rai, involving seven farmer groups that collectively produce 200,000 to 300,000 tons of oranges annually. This initiative has strengthened community-based production, improved farmers' income, and reduced production costs.

Seven collaborative project groups operate within the large-scale agriculture extension system project in Maesin, as shown in Table 1.

As shown in Table 1, the seven agricultural extension project groups in Maesin, Si Satchanalai, Sukhothai Province are presented with their respective locations, farmer participation numbers, and cultivation areas.

Table 1 Seven groups of Agricutural extension project (Orange) in Maesin, Si Satchanalai, Sukhothai Province

	Group name	Moo.	Number of members	Area of cultivation (Rai)
1	Prang Yai Tangerines Maesin district, Si Satchanalai, Sukhothai Province	24	53	800
2	Prang Yai Tangerines-Nothern of Maesin district	2	47	472

	Group name	Moo.	Number of members	Area of cultivation (Rai)
3	Prang Yai Safety Tangerines farming Ban Mae-Tang	25	39	527.5
4	Prang Yai Maesin Orange Pattana	12	57	607.5
5	Prang Yai Tangerines Kaset Rung Rueng	1	30	672.25
6	Prang Yai Tangerines Pattana Acheep Orange farming, Maesin district	4	50	682.5
7	Prang Yai Orange farm Kaona Pattana Maesin	21	30	335
	Total		306	4,096.75

Source: Department of Agricultural Extension, Ministry of Agriculture and Cooperatives, 2024

This research selected a robust group, "Prang Yai Tangerines Maesin district, Si Satchanalai, Sukhothai Province," as a case study to demonstrate enterprise sustainability and establish a best practice model for the large-scale agricultural extension project. The orange enterprise in Maesin serves as an excellent model for community enterprises. This article aimed to examine sustainability within the agricultural supply chain using a case study of a collaborative project in orange supply chain implemented by a farmer extension group in in Maesin district, Si Satchanalai, Sukhothai Province. The analysis was conducted through the lens of Actor-Network Theory (ANT) and the Sustainable Development Goals (SDGs). Moreover, the findings provide a guideline for policy-makers to sustain the community enterprise.

Literature review

1) Sustainability in Agricultural supply chain:

Agricultural supply chain is complicated because of uncertainty of climate change and supply fluctuation. Moreover, uncertainty in demand and supply side could be reach to the price of products.

Sustainability in the agricultural supply chain is composed of three pillars (Purvis, Mao and Robinson, 2019, p. 681): Environmental, Economic, and Social. These three pillars provide a framework for understanding sustainable development. The Environmental dimension focuses on managing natural resources and minimizing pollution. The Economic dimension concentrates on ensuring long-term economic health and stable livelihoods without the depletion of natural or human capital. The Social dimension focuses on ensuring equity in human rights and promoting community well-being. The United Nations (UN, n.d.) originally established 17 Sustainable Development Goals (SDGs) as part of the 2030 Agenda for Sustainable which were adopted by all UN Member States in 2015. The seventeen goals including 1) No Poverty: End poverty in all its forms everywhere. 2) Zero Hunger: End hunger, achieve food security and improved nutrition, and promote sustainable agriculture. 3) Good Health and Well-being: Ensure healthy lives and promote well-being for all at all ages. 4) Quality Education: Ensure inclusive and equitable quality education and promote lifelong learning opportunities. 5)

Gender Equality: Achieve gender equality and empower all women and girls. 6) Clean Water and Sanitation: Ensure availability and sustainable management of water and sanitation for all. 7) Affordable and Clean Energy: Ensure access to affordable, reliable, sustainable, and modern energy. 8) Decent Work and Economic Growth: Promote sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work. 9) Industry, Innovation and Infrastructure – Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation. 10) Reduced Inequality: Reduce inequality within and among countries. 11) Sustainable Cities and Communities: Make cities and human settlements inclusive, safe, resilient, and sustainable. 12) Responsible Consumption and Production – Ensure sustainable consumption and production patterns. 13) Climate Action: Take urgent action to combat climate change and its impacts. 14) Life Below Water: Conserve and sustainably use the oceans, seas, and marine resources. 15) Life on Land: Protect, restore, and promote sustainable use of terrestrial ecosystems, manage forests sustainably, combat desertification, and halt biodiversity loss. 16) Peace, Justice and Strong Institutions: Promote peaceful and inclusive societies, provide access to justice, and build effective, accountable institutions. And 17) Partnerships for the Goals: Strengthen the means of implementation and revitalize the global partnership for sustainable development.

This research applied Actor-Network Theory (ANT) to identify the stakeholders in the upstream agricultural supply chain, focusing on the processes prior to food production and/or delivery to consumers. The author focused in large scale agricultural extension project, orange farming in Maesin, Si Satchanalai, Sukhothai. The project could be reached the goals of sustainability and derive the lesson learned from practicing sustainability scope.

2) Actor-Network Theory

Actor-Network Theory (ANT) (Latour, 1997, pp. 1-2; O'Doherty, 2019, pp. 39-40) is a social theory that treats both human and non-human entities (e.g., technologies, policies, climate conditions) as actors within a network. These actors are interconnected and shape each other's roles, behaviors, and influence. The key idea is that agency is distributed-machines, tools, standards, and institutions are just as important as farmers, corporations, or regulators.

Callon (1986, pp. 203-205) identified the Translator as the most vital human figure because they execute the process of Translation, which involves aligning the disparate interests of all actants in a network. This process unfolds through four sequential moments: problematization, interessement, enrollment, and mobilization. The successful management of these essential links is what temporarily establishes the 'Translator' as the obligatory passage point (OPP), or the network's linchpin.

ANT can be applied to the agricultural supply chain (Compagnucci, Lepore, et al., 2022, p. 101700) as follows; human actors can be Farmers, Agribusinesses, Regulators, Consumers, NGOs/Activists and Logistics providers. Non-human actors can be certification

standards (e.g., Fairtrade, Rainforest Alliance), Blockchain and traceability systems, Environmental conditions (e.g., drought), Sustainability metrics and audits, Legislation (e.g., EU deforestation law) and Algorithms/AI for demand forecasting.

ANT can be applied to understand the roles of actors including human and non-human in the orange supply chain as large scale agricultural extension project "Prang Yai Tangerines Maesin district, Si Satchanalai, Sukhothai Province" as a case study.

In summary, this research aimed to reveal the factors driving sustainability in the agricultural supply chain, using Actor-Network Theory (ANT) to analyze the orange agricultural extension project in Maesin district, Si Satchanalai, Sukhothai Province.

3) Previous research in Agricultural Extension Projects:

The prior research in developing agricultural extensionists, Taveevong, Phusadee and Phanphet (2024, pp. 11-17) identified core attributes such as knowledge, skills, and attitudes that are critical for effective service delivery, especially during conceptual and goal-setting phases. The successful of promoting the agricultural extension projects come up with the performance of the officers which Kueatung and Prapruit (2022, p. 245) assessed the performance of extension officers in promoting small and micro community enterprises (SMCEs) in southern Thailand. The study found that effective knowledge transfer, coordination with stakeholders, and demographic characteristics influenced officer performance. Not only the successful in promoting small and micro community enterprises effect from performance of officers involving the extension project, but also the model of extension project is an important condition. Tailangka Sricharoen and Thongsri (2024, pp. 252-255) proposed an integrated model for high-value agricultural extension in Pathum Thani, emphasizing irrigation, land use planning, and collaborative marketing efforts. Moreover, the area of extension project is another condition to efficiency for promoting agricultural extension project. Phadungphat, Yooprasert and Sanserm (2024, p. 133) introduced an area-based agricultural extension model tailored to cassava farming in northeastern Thailand. The model focused on knowledge dissemination by extension officers to improve yield efficiency.

The agricultural extension is a crucial pathway for alleviating rural poverty (Anderson and Feder, 2004, pp. 41-43). The agricultural extension project which providing knowledge, enhancing resource management skills, and building beneficial partnerships to the community enterprise empower farmers, allowing them to diversify their income sources and achieve more sustainable development outcomes.

The key findings of Ma, Marini and Rahut, (2023, pp. 685-686) which specified that farmers group contribute to sustainable development in terms of reaching smallholders farmers, bargaining power, revenue increasing capability building, eventually meet the economic, social and environment dimensions of sustainability. The findings can enable sustainability policies aimed to support farmers' organizations at the society root.

Agro-Tourism is an alternative to add value of the agricultural products of farmer group, Phumrungruang and Baconguis (2020, pp. 75-76) explored agro-tourism initiatives in northern Thailand as a form of agricultural extension. These programs provided practical learning experiences through cultural integration and farming demonstrations. Many potential areas of the agricultural extension project can learn from the good practice or best practice Agro-Tourism to develop the program based on resource of the project. In additions, the communication technology and social media can increase accessible for customers which Sensomboon, Bilmanoch and Taphowtong (2024, pp. 227-229) examined the effectiveness of the Department of Agricultural Extension's Facebook page in reaching farmers. High user satisfaction and engagement highlighted social media's role in modern extension work. Another research employed technology to improve the communication, Suebsombut, et al. (2022, p. 364) developed Smart Agriculture via Chatbots LINE application to support farmers with real-time agricultural information and irrigation control. The tool received high satisfaction ratings, indicating digital technology's potential in extension services.

The sustainability of an agricultural extension project relies not only on technology transfer or resource allocation but profoundly on the leadership style adopted (Wang, et al., 2025, p. 1474602). The results from Wang, et al (2025, p. 1474602) provided empirical evidence that Servant Leadership cultivates a loyal, adaptive workforce by addressing farmers' developmental needs and nurturing a sense of belonging. The overall conclusion is that integrating ethical governance, emotional support, and technology-driven guidance can sustainably elevate agricultural productivity while retaining talent within China's emerging agricultural entities.

Methodology

This research employed a qualitative methodology using a semi-structured interview guide developed from the principles of sustainability and Actor-Network Theory (ANT). The interview questions were reviewed by experts to ensure validity and alignment with the research objectives. During the preliminary study of the orange supply chain, one representative group out of seven was identified for in-depth analysis. Three key informants were selected for direct interviews focusing on the group's profile, activities, and operational evidence. Thematic analysis was conducted to identify success factors and challenges related to collaboration, operation, and management. The lessons learned about the group's operational sustainability were summarized using ANT in relation to the Sustainable Development Goals (SDGs). The unit of analysis was the group "Prang Yai Tangerines Maesin district, Si Satchanalai, Sukhothai Province".

Rationales for the single case study are included 1. There is continuity of activities and grants supported by the government and local agents. 2. The group selected as the case study continues to operate successfully, maintaining the same mission as before, even though the former leader passed away last year. 3. High participation exists among members. and 4. The group's capital has been growing until now.

Three key informants from this group were selected based on their readiness to provide information, as they are the committees that serve as the management board of the group.

The research employed a two-stage qualitative approach, beginning with a single-informant interview with the group's leader (or president). This was followed by a focus group interview that included three selected committee members." The questions posed during the interviews explored three primary thematic areas: a. Group history b. Group operation and activities c. Performance and sustainability (in economic, social, and environmental terms). Sample questions were: 'What was the history of the group?' and 'What were the group's activities at the beginning?'.

Thematic analysis was employed to identify the key success factors and challenges related to collaboration, operation, and management. In both the individual interviews and the focus group, the authors noted instances where the informants' non-verbal cues (such as facial expressions and gestures) suggested potential discrepancies or hesitancy regarding the information they provided. This analysis was framed by Actor-Network Theory (ANT) and the Sustainable Development Goals (SDGs). The lessons learned regarding the group's operational sustainability, as summarized using ANT, are presented in relation to the relevant Sustainable Development Goals (SDGs). The unit of analysis is the group/organization, “Prang Yai Tangerines Maesin district, Si Satchanalai, Sukhothai Province”.

Results

Profile of the good practice group

A case study is the group names “Prang Yai Tangerines Maesin district, Si Satchanalai, Sukhothai Province”. The group was established in 2017 with 53 members who are farmers specializing in Maesin oranges. Initially, the local government motivated farmers to establish a group by gathering members to secure funding and support from the extension project, aligning with the government's policy to strengthen farmers. The policy implementation included knowledge transfer in the areas of marketing, cultivation, fertilization, pest control, and related product development. Since its establishment, the group's activities and revenue have continually expanded.

Table 2 Profile of informants

	Informant	Gender	Age	Year of Participation in the group	Position/Role in the group	Remark
1	Informant 1	Male	63	2017	President	The retired village headman
2	Informant 2	Male	46	2017	Vice President	Current village headman
3	Informant 3	Male	46	2017	Committee in Information	Current Member of the Subdistrict Administrative Organization

Source: Data from interviewing (Thaotearmwong, personal communication, September 12, 2025)

As presented in Table 2, all informants were male and have participated since 2017 (at the beginning). All three serve as key actors, holding the positions of President, Vice President, and Committee in Information in the group.

The following section presents evidence collected from the Community Enterprise case study over a five-year period.

Table 3 The Community Enterprise Case Study: 5-Year Review

	Group	2020	2021	2022	2023	2024
1	Number of members (person)	53	53	52	52	51
2	Asset value (growth%)	10%	10%	10%	20%	10%
3	Capital value (growth%)	10%	10%	20%	10%	10%
4	Profit sharing (Earning per share) (growth%)	3%	3%	3%	3%	3%

Source: An internal report and committee interviewing of Prang Yai Tangerines Maesin district, Si Satchanalai, Sukhothai Province, 2024.

The key observations from the Table 3 are as follows:

The observations below summarize the performance metrics of the community enterprise from 2020 to 2024:

1) Membership

Number of Members: The enterprise started with 53 members (same amount as beginning in 2017) in 2020 and 2021. Membership saw a slight, gradual decline, remaining at 52 in 2022 and 2023, and ending with 51 members in 2024.

2) Financial growth

1) Asset Value: Asset value growth was stable at 10% for 2020, 2021, 2022, and 2024, with a significant increased to 20% growth in 2023.

2) Capital Value: Capital value generally grew by 10% (2020, 2021, 2023, and 2024), with a peak growth of 20% in 2022.

3) Profit Sharing

Profit Sharing (Earning per share): The growth rate for profit sharing was consistently maintained at 3% across all five years, from 2020 to 2024.

Activities and operation

Upon its establishment, the group initially functioned as an intermediary to collect and sell oranges from its members. Moreover, the group has a facility that houses a machine for cleaning and size-sorting oranges, allowing them to generate income. The group generates its own revenue from cleaning and sorting services provided to both members and non-members. The business model operates as a cooperative community enterprise, with members receiving profit shares based on their shareholdings. Because the group is well-established, it received external funding for cultivation machinery. The local government agency recognizes this group's strength and potential to bolster the community's economy; consequently, the agency consistently promotes and provides funding support

to the group. Currently, the group can provide the loan to members. The group leaders are monitoring balance account of each member for the loan and account receivable. The loan was designated for input costs, including fertilizer, chemical insecticide, and investment in machinery or equipment. Any member who fails to pay the loan as specified in the contract is subject to review by the committee in an official meeting, where a decision is made regarding disciplinary action or a warning.

3) Internal actors and external actors in upstream agricultural supply chain of Maesin orange: Roles of the actors with ANT

The Actor-Network Theory (ANT) analysis, summarized in Table 3, demonstrates that the sustainability of the community enterprise relies on the successful mobilization of both human and non-human actors in focal roles, as detailed below:"

The sustainability of the community enterprise is best understood as a successfully mobilized and stabilized network of both human and non-human actors. The table clearly identifies the key internal and external forces driving the project.

1. Internal Human Actors (The Prime Movers)

The committee members and general members serve as the primary internal drivers of the network's stability.

1.1) President (The Translator): This actor's role is central to the ANT process of translation. The President is responsible for Leading activities and is the main Representative to coordinate with government agents. Crucially, the remark highlights their focal role in "translation the president is responsible for leading activities and serving as the main representative for coordination with government agencies."

1.2) Vice President & Committees: "These actors serve as 'the Management Team' and 'Team Supporters'. They ensure continuity by assisting the Chairman and implementing group decisions.

1.3) Cashier: Acts as a specialized monitoring and control mechanism, ensuring the financial non-human actor (money) "Operate[s] in the right direction" of the group.

1.4) Members: Their role is essential for Enrolment, acting as "Good followers" who participate in activities, thereby validating the network's structure and purpose.

2. Internal Non-Human Actors (The Resources)

Non-human actors are mobilized and managed by the human actors to sustain the enterprise.

2.1) Activities of the group: These are the visible results that "drive the activities and sustain the group."

2.2) Share: Represents the Initial capital (financial non-human actor) required for the network to start operating.

2.3) Cleaning and size-sorting machinery: This is a technical non-human actor funded by the government. Its focal role is to generate revenue (cash inflow) through service charges, directly contributing to the enterprise's economic stability.

3. External Actors (The Enrolling Forces)

External actors, primarily government and academic entities, hold the Power for the budgeting and are critical sources of resources and legitimacy.

3.1) Policy by local government agencies & Academic institutions: Both hold the "Power for the budgeting," signifying their crucial role as resource providers.

3.2) Government officers & Academician: These human actors are focused on "Seeking grant recipients in accordance with government policy," meaning they are the external point of contact that the Chairman must successfully enroll to secure funding and knowledge transfer.

In summary, the Table 2 demonstrates that the Chairman acts as the Obligatory Passage Point (OPP), successfully translating external abstract goals into internal tangible actions, thereby enrolling the necessary resources and actors (human and non-human) to achieve a stable and sustainable collective.

The results from the data analysis are shown in Figure 1.

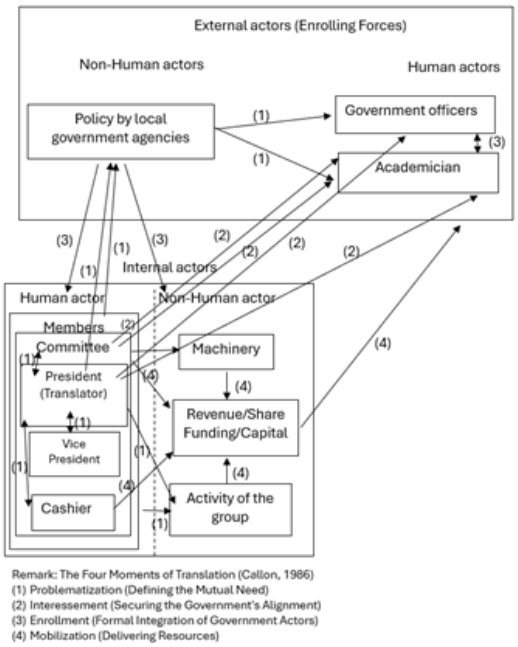

Figure 1 Diagram of the result with Actor Network Theory (ANT)

4) Lesson Learned from a case study in the context of SDGs

According to the context of a case study of a large scale agricultural extension project as “Prang Yai Tangerines Maesin district, Si Satchanalai, Sukhothai Province” operated for eight years and the members in the group is stable as 53 members. The evidence suggests that this group demonstrates both continuity and a strong tendency toward sustainability. The group members and committee strengthen the group. The results showed that the performance of the group enhance members revenue from profit sharing which affect to circulation of money within the community and contributes to an improved quality of life for its residents.

Contribution to Sustainable Development Goals (SDGs)

Out of the 17 Sustainable Development Goals (SDGs), the community enterprise case study demonstrates contributions toward seven specific goals:

1. Economic and Social Goals

• **SDG 1 (No Poverty):** The enhanced profit-sharing mechanism within the group serves as a direct intervention to increase members' income, which is projected to help alleviate poverty among the participants.

• **SDG 2 (Zero Hunger):** The successful financial performance of the community enterprise, resulting in higher revenue and monetary circulation, directly correlates with improved food security, aiming to reduce instances of hunger within the Maesin community.

• **SDG 3 (Good Health and Well-being):** Increased community revenue and the implementation of standardized cultivation practices ensure that members can afford nutritious food and necessary medical care, contributing to overall health and well-being.

• **SDG 8 (Decent Work and Economic Growth):** The collective initiatives enhance decent work opportunities and stimulate local economic growth, providing a viable livelihood that limits the necessity for residents to migrate to urban centers for employment.

2. Environmental and Supply Chain Goals

• **SDG 11 (Sustainable Cities and Communities):** Ensuring sustainability across the agricultural supply chain secures the safe delivery of food from the farm to consumers' tables, which is a key component of sustainable food systems that support community resilience.

• **SDG 12 (Responsible Consumption and Production):** The enterprise's certification under Good Agricultural Practices (GAP) signifies the community's adherence to environmentally sound farming methods, thereby contributing to sustainable resource management and minimizing environmental impact.

• **SDG 13 (Climate Action):** Given the natural suitability of the Maesin area for orange cultivation, farmers benefit from a reduced need for costly fertilizers. This inherent advantage lowers the dependence on chemical inputs and reduces associated environmental hazards, effectively supporting climate-resilient agriculture.

Supported by government knowledge and fundamental funding, the Maesin community enterprise successfully attained sustainability. Many government-supported projects are currently running.

The key success factors as Human Actors and Non-human actors identified from the case study are as follows:

1. Enterprise Sustainability and Success Factors (Internal Non-human actors)

The case study showed that the enterprise's financial standing has significantly improved, with current funding levels surpassing initial project amounts. This growth is largely driven by a strong and effective committee that successfully leads and manages the enterprise, enabling it to become a successful best practice model for other community enterprises. Furthermore, the group’s financial improvement has not only strengthened its economic resilience but also created positive social and environmental impacts. The reinvestment of profits into community development and the

adoption of environmentally friendly cultivation practices demonstrate the group's commitment to long-term sustainability beyond economic success.

2. Management and Mindset (External and Internal Human actors)

The enterprise's management is continuously monitored by officers (external human actors) from supporting government agencies to ensure accountability and efficiency. Crucially, the President and Management Team or committee (internal human actors) operates with a resilient mindset that underscores its commitment to long-term sustainability: "If other enterprises without government support can survive and sustain their businesses, an enterprise with government support should not only survive but also achieve long-term growth." This proactive mindset not only ensures operational stability but also fosters continuous learning and adaptation among members, which are essential for maintaining sustainability and competitiveness in the evolving agricultural sector.

3. Participation (internal human actor) and Influence

Member participation is the key success factor for the enterprise, making it robust enough to attract and merit support from both private and public sector projects. As the committee successfully accepts and implements all activities from government-backed projects, the strengthened enterprise gains the necessary influence to attract and effectively negotiate with government agencies for future support and collaboration. Additionally, the results indicate that active participation among members not only enhances collective decision-making but also contributes to improved productivity and long-term group stability. The involvement of members in planning and implementation processes fosters a sense of ownership, which is crucial for maintaining sustainable operations within the community enterprise.

The lessons derived from the case study of the large-scale agricultural extension project in Maesin offer a valuable guideline for improving project efficiency and achieving sustainability.

Conclusion

This study, titled "Sustainability in Agricultural Supply Chain: Lesson Learned from a Large-Scale Agricultural Extension Project of Orange in Maesin District, Si Satchanalai, Sukhothai Province," aimed to examine sustainability within a collaborative, community-led orange supply chain. The research sought to determine how the enterprise maintains efficient funding and strengthens its capacity to meet the Sustainable Development Goals (SDGs) across social, economic, and environmental perspectives.

The investigation utilized a qualitative approach, employing semi-structured interviews, observations and focus group, and thematic analysis for data collection. Actor-Network Theory (ANT) was employed as the theoretical framework to analyze the complex relationships and interactions driving the enterprise's operations and outcomes.

The sustained operation of the Maesin enterprise serves as a potent model, revealing three critical success factors:

1. Strategic Translation: The President is the core actor, successfully translating the government's abstract goal of 'efficient funding' into the tangible community goal of 'sustainable local income generation.' This act, central to Actor-Network Theory (ANT), demonstrates the power of human actors to successfully enroll non-human government resources into the local network.

2. Mindset and Management: The enterprise's stability is secured by a strong management team with a resilient, proactive mindset, ensuring operational stability and continuous learning.

3. Active Participation: Robust and consistent member participation is the most crucial internal driver, fostering collective capability and enabling the group to attract further government and private-sector support.

In summary, the Maesin enterprise proves that a strong, self-sustaining community enterprise can not only operate independently but also amplify its growth under supportive government funding. This case study offers a best practice guideline for future agricultural extension projects, illustrating the vital role of strategic human actors in stabilizing a complex, sustainable network.

Discussion

The Agricultural Extension Project represents a government policy designed to support and strengthen farmer groups in rural areas, primarily by allocating resources that include knowledge and skills (as highlighted in the Canvas summary). The findings of this research—using the Maesin project as a case study—demonstrate that this project successfully achieved its core goal. This success, in which extension services led to positive outcomes like improved group capability and self-reliance, aligns with the long-standing understanding in development literature regarding the contribution of agricultural extension to sustainable development (e.g., Anderson and Feder, 2004, pp. 41-44).

The findings showed that farmers are crucial to the food supply chain (Anggraeni, Handayati and Novani (2022, p. 3281) , farmer group as the case study, Maesin orange “Prang Yai Tangerines Maesin district, Si Satchanalai, Sukhothai Province” is a good practice for a strong group and became cooperative. Eight years of farmer group can proof that this group serves as a model for effective agricultural extension projects, demonstrating that a community enterprise with strong leadership and committees has the potential to build collective group capability. Evidence showed that participation among leadership and members is a key success factor of farmers group which is similar to Jansoot, Pinkaew and Whankaew (2025, p. e255345). The findings confirmed that enhanced participation among the members significantly strengthens the group's capacity, thereby enabling it to secure funding from both government and private sectors. The research results was similar to the findings of Ma, Marini and Rahut (2023, pp.683-684) which showed that farmers group contribute to sustainable development and achieve economic, social and environment dimensions. However, while Ma, Marini and Rahut (2023, pp.683-700) focused on a farmer's organization, this research, which employed Actor-Network

Theory (ANT), focused on all entities and found that the President is the most important actor to enhance member participation within the group. The results found sustainability in the case study across the Economic and Social dimensions, encompassing profit-sharing, higher revenue and monetary circulation, local economic growth, and sustainable food systems that support community resilience. In the Environmental dimension, the case study demonstrated adherence to environmentally sound farming methods by achieving Good Agricultural Practices (GAP) certification. This certification signifies a commitment to sustainable resource management, minimal environmental impact, and aligns with the natural suitability of the Maesin area for orange cultivation.

The findings from the research showed that Actor-Network Theory (ANT) identified the President of the extension group in Maesin as the critical actor and translator. These findings are similar to the results of Wang, et al. (2025, pp.1-13), whose study used a different method. Wang, et al. (2025, p.11) found that the President of the extension group, who exhibits servant leadership, is a critical mediator for improving productivity through resource allocation and member motivation.

From ANT, the result similar to Compagnucci, Lepore et al. (2022, p.101700) showed that orange agricultural supply chain can be applied to farmer group in Maesin as a case study because there are many actors in the network or supply chain including human; academician, president and members of the group and non-human actors; policy by local government agencies and academic institutions.

The results of the study indicate that a specific internal human actor—the President—serves as the primary Translator of the network. This finding aligns with Callon's (1986, p.203) framework, which identifies the Translator as the critical actant who initiates and sustains a network through the four moments of Translation (problematization, interessement, enrollment, and mobilization). The committee and farmer members are the successfully enrolled human actants who provide the necessary collective agency for sustaining the agricultural extension project. This internal strength is crucial, as the enterprise faces significant challenges from powerful external non-human actants, such as uncertainty and fluctuation in weather and supply.

The findings highlight those empowering rural farmers through resource allocation directly enhances the group's capability, enabling it to establish itself as an independent community enterprise. This self-reliance ultimately leads to increased revenue, decreased costs, and an improved quality of life in the rural community. The findings can lead to sustainable development outcome which was implied by Anderson and Feder (2007, pp. 53-56) in the contribution of agricultural extension.

This approach demonstrates that strengthening farmer groups is a direct path for government agencies to enhance sustainable development achievement, a key global agenda. The sustainability of the agricultural supply chain, composed of the three pillars (Environmental, Economic, and Social), is supported by the enterprise's performance across seven of the 17 Sustainable Development Goals (SDGs):

• Economic and Social: The case study contributes to SDG 1 (No Poverty), SDG 2 (Zero Hunger), SDG 3 (Good Health and Well-being), SDG 8 (Decent Work and Economic Growth), and SDG 11 (Sustainable Cities and Communities).

• Environmental: The case study demonstrates progress toward SDG 12 (Responsible Consumption and Production) and SDG 13 (Climate Action).

To effectively achieve the Sustainable Development Goals (SDGs) globally, the focus must be placed on strengthening the upstream agricultural supply chain, as this area holds a significant impact on sustaining both humanity and the planet.

The results indicated that internal human actors—specifically the committee and farmer members—are the major internal drivers for sustaining the agricultural extension project, even though external non-human actors, such as uncertainty and fluctuation in weather and supply, significantly impact the group's survival. The findings showed that empowering rural farmers by allocating resources to farmer groups can enhance the group's capability. This empowerment will ultimately lead to sustainable development. The farmer group can establish itself as an independent community enterprise, which would eventually lead to increased revenue, decreased costs, and an improved quality of life in the rural community. The findings showed that the government agencies can enhance sustainable development achievement—a key global agenda—by strengthening farmer groups. This action would eventually contribute to the attainment of Sustainability in the agricultural supply chain is composed of three pillars (Purvis, Mao and Robinson, 2019, p.681): Environmental, Economic, and Social with seven of the 17 Sustainable Development Goals (SDGs). In perspective of Economic and Social from the case study, it can achieved included SDG1-No Poverty, SDG2- Zero hunger, SDG 3- Good health and Well-being, SDG 8-Decent Work and Economic Growth and SDG 11-Sustainable Cities and Communities). In perspective of Environment, the case study achieved SDGs included SDG12-Responsible Consumption and Production and SDG13-Climate Action. To achieve the Sustainable Development Goals (SDGs), focusing on the upstream agricultural supply chain is essential, as this area has a significant impact on sustaining humanity and the planet. Furthermore, future studies should consider a comparative analysis among different agricultural extension projects to explore how contextual factors, such as regional resources and stakeholder engagement, influence the level of sustainability achieved. Such insights would strengthen policy recommendations and contribute to a more comprehensive understanding of sustainable agricultural development in Thailand.

Managerial Implication: Implication for Policy and Practice

Despite the government's current policy to strengthen community enterprises in rural areas to improve the quality of life, the findings suggest two primary implications for government agencies to achieve this goal:

Leadership and Resource Allocation: Given that the President is the key actor in directing the community enterprise and operationalizing government objectives, funding

support should be strategically allocated to groups led by individuals demonstrating effective leadership.

Sustaining Participation: Recognizing that member participation is crucial for long-term sustainability, government initiatives should focus on developing programs that foster engagement and collaboration among members to solidify the enterprise's foundation.

Limitation

The primary limitation of this research stems from its data collection methodology, which relied on interviews with only three key informants from a single community enterprise. Consequently, the findings may not fully capture the complete range of operational details or diverse perspectives within the group. Furthermore, the information obtained from these informants might present a positively skewed perspective, potentially limiting a completely objective representation of the truth.

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