OPPORTUNITIES AND CHALLENGES OF TOMATO SUPPLY CHAIN MANAGEMENT IN THAILAND*

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Abstract

This article explores the opportunities and challenges of tomato supply chain management in Thailand. Tomato is an important vegetable crop for both fresh consumption and food processing, and it is a key source of income for many small farmers, especially in the northern and northeastern regions. In 2024, tomato production in Thailand was mainly based on small-scale farming, with limited land size per household and strong dependence on seasonal and climate conditions. The tomato supply chain includes many actors, such as farmers, collectors, community enterprises, wholesalers, processors, retailers, and consumers. Transportation and logistics are essential parts of this system; however, inefficiency, high costs, and weak coordination often reduce overall supply chain performance. This article applies the concept of agricultural supply chain management to analyze the current production situation, supply chain structure, and the main opportunities and challenges facing the tomato sector in Thailand. The findings show that major challenges include high production costs, pest and disease problems, heavy use of chemical inputs, limited access to

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modern farming technology, weak compliance with food safety standards, poor post-harvest handling, lack of cold chain systems, and unequal bargaining power between farmers and middlemen. These issues lead to high post-harvest losses, unstable prices, and low income security for small farmers. At the same time, several important opportunities are identified. Modern production technologies, such as greenhouse farming and controlled production systems, can reduce climate risk and support year-round production. Digital tools can improve information sharing, production planning, and logistics management. In addition, food safety standards, processing, value addition, branding, and stronger cooperation through farmer groups and contract farming can help increase product value and improve income distribution. Overall, improving tomato supply chain management is essential for enhancing efficiency, sustainability, and farmer income in Thailand.

Keywords: Tomato supply chain, Agricultural supply chain management, Smallholder farmers, Logistics efficiency, Thailand

Introduction

Tomato is an important vegetable crop in Thailand. It is used for fresh consumption and for processing in the food industry. Tomato farming creates income for many small farmers, especially in the northern and northeastern regions. In 2024, the total tomato planting area in Thailand was about 40,823 rai, with around 11,283 farming households (Department of Agriculture, 2024a). The average farm size was small at about 3.57 rai per household. Total national tomato production was about 139,569 tons (Department of Agriculture. (2024b). Processing tomatoes accounted for a larger share than fresh tomatoes. This situation shows that tomatoes are an important economic crop, but production is still based on small-scale farming. Thailand also depends on tomato imports

in some years, which reflects limits in domestic supply and supply chain efficiency

The tomato supply chain in Thailand includes farmers, collectors, community enterprises, wholesalers, processors, and retailers. Transportation and logistics play a key role in this chain. Pattamadilok et al. (2015) noted that transportation cost is one of the main expenses in agricultural supply chains. Inefficient routing and poor coordination increase fuel cost and product loss. A case study of cherry tomatoes in northern Thailand found that improved routing could reduce distance and fuel cost by more than 2 percent (Department of Agriculture. (2024d). This shows that better supply chain management can improve efficiency and farmer income (Yosying et.al., 2022). However, many tomato farmers still rely on traditional marketing channels and middlemen, which limits their bargaining power and profit.

Tomato production and supply chains also face many challenges. Farmers face high input costs, pest and disease problems, and strong seasonal effects. In Thailand, tomato production is concentrated in the cool season. More than 70 percent of national output is harvested between January and March (Department of Agriculture, 2024a). Production is very low in the rainy season. This seasonal pattern creates price fluctuation and supply instability. Postharvest loss is another serious issue due to poor handling, lack of cold storage, and weak logistics systems. Similar problems are found in tomato supply chains in other developing countries (Pattamadilok et al, 2015). These challenges reduce competitiveness and increase risk for farmers and small enterprises.

Although many studies discuss tomato production or logistics separately, there are still important gaps in the literature (Rosset, Rice & Watts, 1999; Siasakul et al., 2006; Rugchat, 2019; Lekhavat & Sanium, 2024). Limited research focuses on the full tomato supply chain in Thailand, especially the link between production, logistics, and market access. There is also little discussion on how

small farmers and community enterprises can improve coordination and reduce risk under changing market conditions. Issues such as value addition, sustainable standards, and digital supply chain tools are often mentioned but not deeply analyzed in the Thai context. Therefore, this paper aims to explore both opportunities and challenges of tomato supply chain management in Thailand. It seeks to provide insights for farmers, policymakers, and agribusiness stakeholders to support a more efficient and sustainable tomato supply chain. Therefore, this article aims to analyze the opportunities and challenges of tomato supply chain management in Thailand. The article reflects the current situation and proposes academic and policy-based approaches that can be used to improve the efficiency and sustainability of the tomato supply chain.

Agricultural Supply Chain Management

A Short Introductory of Supply Chain Management

Supply chain management can be defined as the coordinated management of activities and processes that move products from original suppliers to final consumers through a network of organizations (Davis, 1993). Lambert & Cooper (2000) explain that supply chain management integrates key business processes such as procurement, production, logistics, and information sharing across firms in order to create value for customers and stakeholders. This concept also emphasizes strategic coordination and cooperation among suppliers, manufacturers, and customers to improve efficiency, reduce cost, and enhance overall performance (Mentzer et al., 2001). Power (2005) note that supply chain management is not limited to physical product movement but also includes the flow of information and financial resources, which are important for decision making and coordination across organizations. In addition, supply chain management describes the management of upstream and downstream activities, from raw material sourcing to final delivery, with the aim of reducing uncertainty

and improving reliability in complex production systems (Yusuf & Soediantono, 2022). Therefore, supply chain management can be described as a comprehensive and integrated approach that connects multiple organizations, aligns their activities, and supports effective planning and control to achieve better operational performance and customer satisfaction in dynamic business environments.

Supply chain management plays an important role in modern business because it connects all activities from suppliers to final consumers. Scholars explain that firms no longer compete as single organizations, but they compete as supply chains (Lambert & Cooper, 2000). Supply chain management helps firms coordinate production, transportation, and information sharing across different partners. This coordination reduces delays and improves efficiency in delivering products to customers. In agricultural products such as tomatoes, supply chain management is important because products are perishable and sensitive to time. Effective management helps reduce post-harvest loss and improves product quality during transportation and storage (Khedr, 2024). Therefore, supply chain management supports stable product flow and better market access for farmers and traders.

Another important role of supply chain management is cost reduction and performance improvement. Scholars note that supply chain costs account for a large part of total business costs, so even small improvements can lead to large financial benefits (Power, 2005). Supply chain management helps reduce unnecessary inventory, transportation costs, and production waste. It also supports better planning and forecasting by sharing information across the supply chain. In the tomato supply chain, poor planning can cause oversupply or shortage in markets. Effective supply chain management helps balance supply and demand, which leads to fair prices for farmers and stable income (Soori,

Arezoo & Dastres, 2023). As a result, supply chain management improves economic efficiency across the whole system.

Supply chain management also plays a key role in coordination and integration among supply chain members. Scholars explain that supply chain management focuses on cooperation, trust, and information sharing between suppliers, producers, and distributors (Yusuf & Soediantono, 2022). This integration helps reduce uncertainty and improves decision making. When supply chain members work separately, problems such as delays, quality issues, and price instability often occur. In the tomato supply chain in Thailand, farmers, collectors, wholesalers, and retailers often lack coordination. Supply chain management helps align their activities and goals. This alignment improves transparency and strengthens long-term relationships among supply chain actors.

So, supply chain management supports risk management and resilience in uncertain environments. Scholars note that supply chains face many risks such as demand fluctuation, transportation disruption, and climate change (Soori, Arezoo & Dastres, 2023). Supply chain management helps firms identify risks and prepare response plans. In agriculture, risks are higher because production depends on weather and natural conditions. Effective supply chain management helps reduce the impact of these risks through better planning, diversification, and information sharing (Khedr, 2024). For the tomato supply chain in Thailand, strong supply chain management can help farmers and businesses adapt to market changes and external shocks. Therefore, supply chain management plays a critical role in supporting sustainability and long-term development of agricultural supply chains.

Concept of Agricultural Supply Chain Management

Agricultural supply chain management is defined as the management of activities that move agricultural products from farms to final consumers through

a connected system of actors and processes (Ganeshkumar, Pachayappan & Madanmohan, 2017). Caro et al. (2018) explain that this system includes input supply, production, processing, storage, transportation, and distribution, which must be planned and controlled together to ensure efficiency and food safety. Bhat et al. (2022) is noted that agricultural supply chain management focuses on coordination among farmers, processors, distributors, retailers, and consumers in order to manage the flow of products, information, and money across different stages of the chain. This coordination helps reduce delays, lower costs, and minimize food loss, which are common problems in agricultural systems, especially for perishable products such as tomatoes. Ada (2022) also describes agricultural supply chain management as an important tool for improving transparency, product quality, and overall performance in the agricultural sector, because it links all stakeholders and supports better decision-making.

Agricultural supply chain management refers to the coordination of activities from farm production to final consumption. It includes input supply, farming, harvesting, processing, storage, transportation, and distribution. Gatahi (2020) explain that agricultural supply chains involve many actors such as farmers, collectors, processors, wholesalers, retailers, and consumers. These actors are connected through flows of products, information, and money. Effective agricultural supply chain management helps reduce food loss, improve product quality, and increase efficiency across the system (Sharma et al., 2023). In the context of agri-food products, supply chain management is more complex because products are perishable and sensitive to time, temperature, and handling conditions. Poor coordination can lead to high post-harvest losses and unstable income for farmers. Therefore, agricultural supply chain management focuses on integration, coordination, and value creation across all stages of the chain.

Sustainability is a key concept in agricultural supply chain management. Nayal et al. (2022) note that agri-food supply chains must balance economic performance, environmental protection, and social well-being. Sustainable agricultural supply chain management aims to reduce waste, lower environmental impacts, and ensure fair returns for farmers and workers. Supplier relationships and sourcing practices play an important role in sustainability because farming activities directly affect water use, soil quality, and emissions. Studies highlight that sustainable supplier selection and long-term collaboration can improve supply chain resilience and performance (Ada, 2022). When sustainability principles are applied, agricultural supply chains can better respond to climate risks, market uncertainty, and policy pressure. This approach also supports food security and long-term agricultural development.

Digital technology has become increasingly important in agricultural supply chain management. Technologies such as the Internet of Things, blockchain, big data, and artificial intelligence help improve information sharing and traceability. Mukherjee et al. (2022) explain that digital tools allow real-time tracking of products from farm to consumer. This improves transparency, food safety, and trust among supply chain actors. Blockchain technology, for example, creates tamper-proof records that reduce fraud and information gaps (Sharma et al., 2023). Digital integration also helps reduce delays, manage inventory, and improve forecasting. However, adoption remains limited in many developing countries due to high costs, lack of skills, and weak infrastructure. As a result, digital transformation in agricultural supply chains is uneven and still developing.

Despite its importance, agricultural supply chain management still faces many challenges. Scholars point out problems such as fragmented supply chains, many intermediaries, poor coordination, and weak logistics systems (Yadav et al., 2024). These issues increase costs and reduce efficiency. External shocks such as pandemics and climate change further increase supply chain risks. Research shows that advanced technologies like artificial intelligence can help manage

risks by improving decision-making and supply chain visibility (Bhat et al., 20122). However, small farmers and small firms often lack access to these technologies. This creates gaps between large and small actors in the supply chain. Therefore, agricultural supply chain management research highlights the need for inclusive policies, capacity building, and appropriate technology adoption to improve overall system performance and sustainability.

In conclusion of the section, agricultural supply chain management is a comprehensive approach that focuses on coordinating activities from farm production to final consumption in order to improve efficiency, quality, and sustainability. It connects many actors, including farmers, input suppliers, processors, distributors, retailers, and consumers, through the flow of products, information, and financial resources. Effective management helps reduce food loss, control costs, and improve product quality, which is especially important for perishable agricultural products such as tomatoes. Agricultural supply chains are complex and face many risks related to weather conditions, market fluctuation, logistics, and external shocks. Good coordination and integration among supply chain members can reduce these risks and improve transparency and decision making. Sustainability is also a key part of agricultural supply chain management, as it supports long-term economic performance, environmental protection, and social well-being. In addition, digital technologies provide new opportunities to improve traceability, information sharing, and efficiency, although access and adoption remain limited for small farmers. Overall, strong agricultural supply chain management is essential for improving competitiveness, resilience, and sustainability in agricultural systems, particularly in developing country contexts.

Production Situation and Structure of the Tomato Supply Chain in Thailand

Production Situation of the Tomato Supply Chain in Thailand

Tomato production is an important part of the agricultural sector in Thailand. Tomatoes are grown both for fresh consumption and for processing in food factories. The production system mainly depends on smallholder farmers in many regions of the country. Department of Agriculture (2024a) reported that, in 2024, the total tomato planting area in Thailand was about 40,823 rai. This area included tomatoes grown for processing at about 25,288 rai and tomatoes grown for fresh consumption at about 15,535 rai. The average planting area per household was around 3.57 rai, which shows that tomato farming in Thailand is mostly small-scale production (Department of Agriculture, 2024). These figures reflect the important role of family farmers in supplying tomatoes to the domestic market and processing industry.

In terms of production outcomes, tomato cultivation in Thailand shows clear differences between processing tomatoes and fresh tomatoes. In 2024, the total national tomato output was about 139,569 tons. Processing tomatoes accounted for around 100,156 tons, while fresh tomatoes accounted for about 39,413 tons (Department of Agriculture, 2024b). The harvested area was slightly lower than the planted area due to climate conditions, pests, and production risks. Average yield also varied by type. Processing tomatoes had a higher average yield per rai than fresh tomatoes, which reflects the use of specific varieties and production practices designed for factory supply (Thailand Development Research Institute, 2010). These production conditions show that the tomato supply chain in Thailand is strongly linked to factory demand, seasonal production patterns, and the capacity of small farmers to manage costs and risks in the production stage.

Yosying et al. (2022) studied on tomato farmers in the northeastern region of Thailand report that most tomato growers are female farmers. The average age of tomato farmers is about 54 years, which shows that tomato production relies heavily on middle-aged and older farmers. Most farmers have a primary school education level, and only a small number have higher education. This education level limits farmers' access to advanced production knowledge and new technologies. Tomato farming is often a family activity, and labor mainly comes from household members. The average tomato planting area per household is about 3.10 rai, which confirms that tomato farming in Thailand is dominated by small farms rather than large commercial farms.

In terms of economic characteristics, tomato farmers in Thailand earn moderate income from tomato production. Research of Yosying et al. (2022) shows that the average annual income from tomato farming is about 62,806 baht per household. Farmers usually grow tomatoes once per year and follow seasonal production patterns. Most farmers buy seeds from local traders and often reuse the same production areas every year. This practice helps reduce costs but may increase risks related to soil quality and pests. Farmers commonly sell tomatoes to middlemen rather than directly to markets or factories. This situation reduces farmers' bargaining power in the supply chain. Many tomato farmers express a strong interest in producing safe or low-chemical tomatoes to protect consumer health and reduce production risks. These demographic and economic characteristics show that tomato farmers in Thailand face challenges related to aging, low education, small farm size, and limited market power. These factors strongly influence the efficiency and sustainability of the tomato supply chain in Thailand.

The tomato supply chain in Thailand operates through different channels based on the type of product. Fresh tomatoes and processing tomatoes follow different paths from farmers to final users. For processing tomatoes, farmers

mainly produce under informal or semi-contract arrangements with factories. Most processing tomatoes are sold directly to processing factories or through local collectors who deliver tomatoes to factories. National data show that, in 2024, processing tomatoes accounted for about 100,156 tons of total production, or more than 70 percent of total tomato output. Almost all good-quality processing tomatoes are sent to factories, while only a small share is sold in local markets. This channel is short and focuses on large volume and stable demand. Farmers depend strongly on factory prices and delivery schedules, which reduces price risk but limits farmers' bargaining power (Butsalee et al., 2025).

For fresh tomatoes, the supply chain is longer and more complex. Fresh tomatoes are mainly sold through middlemen, local wholesale markets, and retail markets, such as fresh markets and supermarkets. In 2024, fresh tomatoes accounted for about 39,413 tons, or around 28 percent of total tomato production (Department of Agriculture, 2024b). Studies of Yosying et al. (2022) and Butsalee et al. (2025) show that about 98 percent of fresh tomatoes with good quality are sold to traders or middlemen, while low-quality tomatoes are used for animal feed or left in the field. This channel involves many actors, including farmers, collectors, wholesalers, retailers, and consumers. Prices in this channel change by season and market demand. Farmers often face price fluctuation and weak market information. These different supply chain channels show that tomato production in Thailand is divided clearly between factory-oriented production and market-oriented fresh consumption. This structure creates both opportunities for stable demand and challenges related to price risk and coordination in the tomato supply chain.

Structure of the Tomato Supply Chain in Thailand

The tomato supply chain in Thailand can be divided into three main levels: upstream, midstream, and downstream (Meniga, 2014; Poapongsakorn, Chokesomritpol & Pantakua, 2019; Yosying et al., 2022; Butsalee et al., 2025)

Upstream Level

The tomato supply chain in Thailand starts at the upstream level with tomato farmers and farm input providers. Most tomato farmers are smallholders who cultivate tomatoes on small plots of land and depend on family labour. Tomato production is concentrated in some regions, such as the northern and central parts of Thailand, where climate and water access are suitable. Many farmers grow tomatoes as a seasonal crop, especially in the cool season, because tomatoes are sensitive to high temperature and pests. Yosying et al. (2022) found that community-based production is common, where farmers group together to improve bargaining power and reduce cost. In one community enterprise case, 17 tomato farms supplied cherry tomatoes to a local collection centre, with a total production of more than 200,000 kilograms over five months (. The average pickup per farm per day ranged from about 1,000 to 1,800 kilograms. This shows that upstream production is fragmented but can generate a large volume when farms are combined through collective action.

At the upstream level, farmers also rely on input suppliers for seeds, fertilisers, chemicals, and basic technology. Improved tomato seeds and farming knowledge are often provided through contract farming or support from agribusiness firms and community enterprises. This structure helps control quality and quantity from the farm level. Thailand has a long history of tomato production linked to processing and fresh markets, which supports stable upstream demand. The food value chain literature explains that upstream actors, such as farmers and farmer groups, play a key role in supplying raw materials to the rest of the chain. However, many farmers still face limits in capital, storage, and transport. As a result, tomatoes are usually sold quickly after harvest to reduce loss. The upstream structure of the tomato supply chain in Thailand is therefore characterised by small-scale farmers, seasonal production, reliance on collective systems, and close links with local collection centres and buyers.

Midstream Level

The tomato supply chain in Thailand has a clear structure that links farmers to markets through several midstream actors. The midstream level mainly includes community enterprises, collectors, processors, wholesalers, and transport operators. Lekhavat & Sanium (2024) found that community enterprises play an important role in collecting tomatoes from small farmers and preparing them for the next stage of the chain. Evidence from the Mae Chui community enterprise shows that tomatoes are first collected from many farms and brought to a central depot for grading and screening. During the period from May to September 2023, about 204,531 kilograms of cherry tomatoes were collected from 17 farms and handled by the community enterprise. These tomatoes were transported using four-wheeled trucks with a capacity of about 3,000 kilograms per truck. This process shows that the midstream level manages large volumes of products and acts as a key coordination point between farmers and markets. Scholars note that this type of collective handling helps small farmers access markets and reduces individual transaction costs.

At the processing and distribution stage, the midstream level also includes basic processing, packaging, and delivery to wholesale and retail markets. After grading at the depot, tomatoes are delivered to markets in nearby provinces such as Nakhon Pathom and Suphan Buri. Butsalee et al. (2025) present the data from the same case indicate that around 81,950 kilograms of tomatoes were delivered to markets during the study period, with a total delivery distance of about 17,887 kilometers. However, the midstream operations still face efficiency problems, such as low truck capacity use and high fuel costs. Total fuel costs for transportation were reported at more than 34,000 baht during the period. These issues reflect broader challenges in Thailand’s food value chains, where logistics and coordination at the midstream level are often weak and costly. Scholars explain that improving logistics, coordination, and route planning

at this stage can increase efficiency and reduce losses in vegetable supply chains (Pattamadilok et al., 2022; Yosying et al., 2022; Butsalee et al., 2025).

Downstream Level

At the downstream level, the supply chain mainly includes wholesalers, retailers, food processors, and final consumers. Fresh tomatoes are distributed through traditional channels such as local markets, wholesalers, and wet markets, which still play an important role in domestic consumption. Many small retailers buy tomatoes from wholesale markets early in the morning and sell them directly to consumers on the same day. This short distribution chain helps maintain freshness but also creates high price fluctuation. Studies show that traditional channels still dominate the vegetable market in Thailand, especially in provincial areas, where small traders and wet markets handle a large share of fresh produce (Poapongsakorn, Chokesomritpol & Pantakua, 2019). In some community enterprise cases, tomatoes are first collected at a local depot before being sent to retailers, which helps reduce transaction costs and improve coordination in delivery.

Modern downstream channels have expanded rapidly in recent years, especially through supermarkets, convenience stores, and food processing industries. Supermarkets require stable supply, standard quality, and food safety certification, which has changed the structure of the tomato supply chain. Processed tomato products such as tomato paste, juice, and canned tomatoes are mainly sold through modern trade and export markets. Data from community enterprise case studies show that, over a five-month period, more than 80,000 kilograms of tomatoes were delivered from a local depot to markets, with total transport distances exceeding 17,000 kilometers, which reflects the high logistical intensity at the downstream level (Butsalee et al., 2025).

In conclusion of the section, the production situation and structure of the tomato supply chain in Thailand reflect a system that is strongly based on

smallholder farmers, seasonal production, and clear separation between fresh and processing tomato channels. Tomato farming is mainly small-scale, with limited land size, aging farmers, and moderate-income levels, which affects productivity, technology adoption, and bargaining power. Production is closely linked to factory demand for processing tomatoes and to market demand for fresh tomatoes, creating different levels of risk and stability for farmers. The supply chain structure shows a clear flow from upstream farmers, through midstream collectors, community enterprises, and processors, to downstream markets, retailers, factories, and consumers. Community enterprises and collectors play an important role in linking fragmented farm production to markets, but they also face challenges related to logistics cost, coordination, and efficiency. At the downstream level, traditional markets still dominate fresh tomato distribution, while modern trade and processing industries are growing and require higher standards. Overall, the tomato supply chain in Thailand provides stable demand and income opportunities, but it also faces structural challenges related to small farm size, limited farmer capacity, price fluctuation, and logistics inefficiency, which affect the long-term efficiency and sustainability of the supply chain.

Opportunities for Developing the Tomato Supply Chain in Thailand

Despite many challenges, the tomato supply chain in Thailand has strong development opportunities (Meniga, 2014; Poapongsakorn, Chokesomritpol & Pantakua, 2019; Rugchat, 2019; Bhat et al., 2022; Yosying et al., 2022; Kamkankaew et al., 2025; Lekhavat & Sanium, 2024; Butsalee et al., 2025)

Modern Technologies for Tomato Farming

Thailand has a hot climate that causes many problems for tomato farming. Tomatoes grow very well during the winter season. However, the production of tomatoes goes down in the summer and the rainy season. The

high temperatures and humidity are not suitable for the plants. These conditions also cause more pests and diseases to attack the crops. Rain is a major issue because it causes fungal diseases and makes the fruits rot. Modern agricultural technologies can solve these problems. Farmers can use greenhouse systems to control the environment. These structures protect the tomato plants from heavy rain and harmful insects. This control allows farmers to grow tomatoes all year round. It reduces the risks related to the climate. As a result, farmers can have stable production and better profits.

Digital technologies provide another great opportunity for the tomato supply chain. Modern food supply chains rely on Information and Communication Technology (ICT). These digital tools help farmers and businesses manage their operations better. For instance, the Internet of Things (IoT) is a very useful technology. Research shows that using IoT systems can increase the amount of tomatoes produced by a significant level. These technologies also improve the flow of information between farmers and buyers. They provide quick data that helps with planning. This allows farmers to control the quality and quantity of their products. Therefore, applying these digital tools increases production efficiency. They make the supply chain more effective and successful.

Standardizing Production for Safer Consumption

Currently, tomato farmers in Thailand face many problems with pests and diseases, which forces them to use a large amount of chemical pesticides. This heavy use of chemicals increases the cost of production and can damage the quality of the soil over time. Moreover, it is dangerous for the health of the farmers themselves. Research shows that many farmers want to change their methods. They want to grow tomatoes that are free from toxic residues because they want to be safe and reduce their expenses. To solve this problem, farmers need support to reach food safety standards, such as Good Agricultural Practice (GAP) or organic farming standards. Government agencies and private companies

can help by training farmers. For example, contract farming systems can transfer new technology and knowledge to small farmers. Also, when farmers work together in groups or community enterprises, they can help each other follow these strict rules and lower the cost of checking quality.

This improvement in production methods fits perfectly with the changing needs of Thai consumers. As people in Thailand earn more money, they care more about their health and food safety. This trend is very strong among young people and the middle class in cities. They are willing to pay a higher price for vegetables that are safe and organic. This behavior follows an economic idea called Bennett's Law, which states that people buy higher-quality food when their income rises. Supermarkets and modern stores are the main places that sell these premium tomatoes. However, consumers still worry about chemicals because some products with safety labels still have residues. Therefore, building trust is very important. If farmers can produce tomatoes that truly meet safety standards, they can sell their products to these modern markets. This creates a great opportunity for farmers to increase their income and make their business sustainable.

Promoting Processing and Branding

Thailand has a great opportunity to improve the tomato industry through processing. Farmers often grow too many fresh tomatoes. This makes the price go down, and farmers lose money. We can solve this problem by changing fresh tomatoes into other products. For example, farmers can make dried tomatoes or tomato preserves. This adds value to the raw vegetable. Factories also play a big role in this process. They turn fresh tomatoes into tomato juice and tomato paste. Some companies even make special tomato paste for customers in Japan. Local communities can also invent new things. A group of farmers in Bann NaNgoi used tomatoes to make soap. This shows that processing helps farmers get more income from their crops.

Creating brands is also very important for the tomato supply chain. Branding helps customers trust the product. It also makes the product special in the market. Farmers can join together to build community brands. For instance, the farmers in Bann NaNgoi created a community enterprise to sell their goods. This helps them manage their products better. Modern markets like supermarkets want products with good brands. Brands show that the food is safe and has high quality. Customers are willing to pay a higher price for these trusted brands. Thailand can also build a national brand for its tomato products. This will help Thai tomatoes compete better in the world market.

Strengthening Cooperation in Tomato Supply Chains

The tomato supply chain in Thailand needs better cooperation systems. Many farmers currently work alone. They are small and have little power. They cannot negotiate prices well. A good solution is the formation of farmer groups. Farmers can join together to form cooperatives or community enterprises. For example, the community in Ban Nangoi formed a group to produce safe tomatoes. This group helps members manage production. They can buy seeds and fertilizers together. This lowers their costs. Another system is contract farming. This is an agreement between farmers and companies. The company provides technology and inputs. The farmers grow tomatoes for the company. The company promises to buy the produce. This gives farmers a guaranteed market. These systems make the supply chain stronger.

These cooperation systems also create direct market linkages. In the old system, farmers sell to many middlemen. The middlemen take a lot of the profit. Direct linkages help farmers sell straight to factories or supermarkets. This reduces the number of middlemen. Farmers get a higher price for their tomatoes. This creates a fairer distribution of benefits. The farmers have more bargaining power. They can talk to buyers as a large group. They can ask for fair prices. Contract

farming also helps with risk. It shares the risk between farmers and buyers. Strong cooperation leads to better income for small farmers. It helps the whole tomato industry in Thailand grow.

In conclusion of this section, the tomato supply chain in Thailand has strong opportunities for development despite existing challenges. The use of modern farming technologies, such as greenhouses and controlled production systems, can help farmers reduce climate risks and produce tomatoes throughout the year with more stable output and income. Digital technologies also provide important opportunities by improving information flow, production planning, and efficiency across the supply chain. Standardizing production through food safety systems and safer farming practices can respond to rising consumer demand for healthy and chemical-free food, especially in urban markets and modern retail channels. At the same time, promoting tomato processing and value-added products can reduce price problems caused by oversupply and help farmers and communities earn higher income from their produce. Branding at both community and national levels can further increase consumer trust and market competitiveness. Finally, strengthening cooperation through farmer groups, community enterprises, and contract farming can improve bargaining power, reduce costs, share risks, and create more direct market linkages. Together, these opportunities support a more efficient, fair, and sustainable tomato supply chain in Thailand.

Challenges of Tomato Supply Chain Management in Thailand

The challenges of tomato supply chain management in Thailand can be summarized into several issues. (Meniga, 2014; Poapongsakorn, Chokesomritpol & Pantakua, 2019; Rugchat, 2019; Yosying et al., 2022; Lekhavat & Sanium, 2024; Sharma et al., 2023; Kamkankaew et al., 2025; Yadav et al., 2024; Butsalee et al., 2025)

Production Constraints in Tomato Farming

One major challenge for tomato supply chain management in Thailand is the high cost of production. Farmers spend a lot of money to grow their crops because they depend on external inputs. They cannot produce essential items themselves and must buy them from other sellers. For example, they need to purchase seeds, chemical fertilizers, and pesticides. The cost of these materials is often very high. In addition, tomatoes are sensitive plants. They easily get diseases and are attacked by insects, especially in Thailand's humid weather. As a result, farmers must use a large amount of chemicals to protect their fields. This heavy use of chemicals significantly increases the daily cost of farming. Furthermore, labor costs are rising. Farmers need to hire workers to clear weeds and harvest the produce because they do not have enough machinery. This financial burden makes it difficult for small farmers to make a good profit.

Another significant problem is the lack of appropriate knowledge regarding production technology. Many farmers in Thailand still use traditional methods to grow tomatoes. They often lack the skills to use modern technology that could help them reduce costs. for instance, many growers do not follow Good Agricultural Practices (GAP). They feel that the GAP rules are too complicated and difficult to follow. Consequently, they continue to use chemicals incorrectly. Moreover, farmers often plant tomatoes in the same land for many years without resting the soil. This causes the soil quality to become poor or degraded. Because they do not have the right technical knowledge to improve the soil, they try to solve the problem by adding even more chemicals. This damages the environment and the long-term productivity of the farm. Without access to better technology and proper training, farmers struggle to produce high-quality tomatoes efficiently.

Quality and Safety Standards

The second main challenge is the issue of quality and safety standards. Many tomato farmers in Thailand are small-scale growers who face serious problems with pests and plant diseases. To solve these problems and keep their production high, these farmers often use a large amount of chemical pesticides and fertilizers. However, they often lack the proper knowledge to use these chemicals safely. Research shows that farmers use many different groups of chemicals to control insects and weeds, which can lead to unsafe chemical residues left on the tomatoes. Because of this intense chemical use, it is difficult for many farmers to meet important food safety standards, such as Good Agricultural Practice (GAP). Without these certificates, the tomatoes are often considered unsafe for consumers, and this creates a big barrier for the whole industry.

This lack of quality standards limits where farmers can sell their products. The tomato market in Thailand is divided into two parts: the traditional market and the modern market. Modern buyers, like big supermarkets and food processing factories, have very strict rules about size, color, and chemical safety. For example, factories will only buy tomatoes that meet their specific quality grades, while supermarkets require safety guarantees. Since many small farmers cannot meet these high requirements, they cannot sell to these high-value markets. Instead, they must sell their goods in local wet markets where prices are much lower and the quality is not checked as strictly. This situation prevents farmers from earning more money and stops the supply chain from improving.

Logistics and Post-Harvest Management Issues

Third, there are logistics and post-harvest management problems. Tomatoes are highly perishable products that rot very quickly in Thailand’s hot climate. The main issue is the lack of proper storage facilities, such as cold rooms or a "cold chain" system, which keeps the temperature low from the farm to the market. Most small farmers and local collectors do not have these cooling

systems because they are expensive. As a result, the tomatoes lose water and freshness very fast after they are picked. When the storage is not good, the quality of the product goes down before it even reaches the customers. This leads to a large amount of waste, which means the farmers have fewer tomatoes to sell and make less money.

In addition to storage, the transportation system in Thailand has many weaknesses. The supply chain relies heavily on trucks for road transport, which takes a long time and has high costs. The way tomatoes are packed for travel is often poor; for example, farmers may use simple plastic bags or baskets that are stacked on top of each other. This bad packaging causes the tomatoes to get crushed and damaged during the trip. Furthermore, the routing for trucks is often not efficient, which increases fuel costs and travel time. Because of these logistics problems, there are large post-harvest losses, sometimes up to 50-60 percent for fresh vegetables, which greatly reduces the income of the farmers.

Imbalance of Power and Market Structure

The market structure for tomatoes in Thailand creates a difficult situation for farmers because they depend heavily on intermediaries. Most tomato growers are small-scale farmers who cannot sell their products directly to factories or consumers. Instead, they must sell to middlemen who operate in their local area. For instance, research in the Northeastern region shows that farmers often purchase seeds from these middlemen and are then obligated to sell the harvest back to them. This type of trade is part of a traditional supply chain, where buying and selling happen on the spot without long-term planning. Consequently, farmers are disconnected from the real market demand and lack control over where their tomatoes go.

This dependency leads to a significant lack of bargaining power for the farmers, resulting in unfair income distribution. Farmers invest a lot of money in production costs, such as expensive fertilizers, seeds, and labor. Despite these

high costs, they cannot negotiate the selling price and must accept the price set by the traders. The middlemen possess more market information and can control the profits, while farmers earn less relative to their hard work and investment. Although some farmers try contract farming to fix this, problems with unfair agreements still occur. Therefore, the income is not shared equally along the supply chain, leaving farmers with the lowest financial return.

In conclusion of this section, tomato supply chain management in Thailand faces several serious challenges that affect efficiency, farmer income, and long-term sustainability. High production costs, heavy dependence on external inputs, and rising labor expenses place strong financial pressure on small farmers. Limited knowledge of modern production technology and poor soil management further reduce productivity and increase chemical use, which harms both the environment and farm sustainability. Quality and food safety standards are another major challenge, as many farmers cannot meet strict requirements for modern markets and processing factories, forcing them to sell in low-price traditional markets. Logistics and post-harvest management problems, such as the lack of cold storage, inefficient transportation, and poor packaging, lead to high levels of product loss and reduced product quality. In addition, the tomato market structure is characterized by an imbalance of power, where farmers depend heavily on middlemen and have weak bargaining power, resulting in unfair income distribution. Together, these challenges limit the development of the tomato supply chain in Thailand and highlight the need for better technology access, stronger coordination, improved logistics systems, and fairer market arrangements to support small farmers and strengthen the overall supply chain.

Implementations for Tomato Farmers and Entrepreneur

1) The tomato farmers and entrepreneurs should improve farm production management through better planning and simple technology use.

Farmers should plan planting time carefully to match market demand and climate conditions. This planning helps reduce oversupply in the peak season and shortage in the off-season. Farmers can use simple tools such as farm calendars and basic record keeping to control costs and yields. Entrepreneurs who work with farmers should support production planning by sharing market information and expected demand. When farmers know what quantity and quality the market needs, they can reduce waste and improve income stability. This implementation helps farmers manage risks related to climate and price fluctuation in a practical way.

2) Farmers and entrepreneurs should focus on improving quality and food safety standards step by step. Farmers should reduce excessive chemical use and follow basic Good Agricultural Practice guidelines. They can start with simple actions such as proper chemical dosage, safe harvesting time, and clean handling after harvest. Training from government agencies or private firms can help farmers understand these practices more clearly. Entrepreneurs should support farmers by providing clear quality requirements and simple checking systems. When farmers can meet basic safety standards, they can access better markets such as supermarkets and processing factories. This approach improves consumer trust and increases product value without creating high pressure on small farmers.

3) Tomato farmers and entrepreneurs should improve post-harvest handling and logistics management. Farmers should use better harvesting methods and basic packaging to reduce damage during transport. Simple plastic crates or boxes are better than bags because they protect tomatoes from pressure. Entrepreneurs and community enterprises can invest in shared facilities such as small cold rooms or shaded storage areas. Better coordination of transport routes can reduce fuel cost and delivery time. When logistics are improved, post-harvest loss can be reduced and product quality can be

maintained until reaching the market. This implementation directly increases the amount of tomatoes that can be sold and raises farmer income.

4) Farmers and entrepreneurs should strengthen cooperation through groups and community enterprises. Farmers should join together to form farmer groups or cooperatives to increase bargaining power. Group action allows farmers to buy inputs at lower prices and sell products in larger volumes. Entrepreneurs can work directly with these groups instead of dealing with many individual farmers. This cooperation improves coordination in production, collection, and delivery. It also helps farmers gain better access to training, technology, and financial support. Strong cooperation creates a fairer supply chain and reduces farmer dependence on middlemen.

5) The tomato farmers and entrepreneurs should develop simple value addition and market-oriented strategies. Farmers can work with entrepreneurs to process surplus tomatoes into basic products such as dried tomatoes or sauces. This reduces losses during periods of low fresh market prices. Entrepreneurs should support branding at the community level to show product origin and safety. Clear labels and simple stories about the farm can increase consumer trust. Farmers should also learn basic marketing skills to understand customer needs. This implementation helps farmers and entrepreneurs move beyond raw product selling and supports long-term sustainability of the tomato supply chain in Thailand.

Policy Recommendations

1) The government should invest more in farmer training and practical extension services for tomato production. This action is important because tomato farming in Thailand is mostly small-scale. Small farms often have limited capital and limited access to new knowledge. Many farmers also face high input costs, pest and disease pressure, and soil degradation from repeated planting.

Therefore, the Ministry of Agriculture and related agencies should expand training on pest control, soil management, and climate-smart practices. Training should focus on simple steps that farmers can follow in real farms. The government should also support access to greenhouses and protected farming systems, especially for production in the rainy season and hot season. This support can reduce seasonal shortages and price fluctuation because more than 70 percent of tomato output is harvested in January to March. The government should provide low-interest loans or matching grants for small farmers and community enterprises to buy basic equipment. Public research centres should also develop suitable tomato varieties and share them with farmers. This policy can improve yield and quality and reduce production risk. It can also strengthen the upstream part of the supply chain and improve stability for both fresh and processing tomato channels.

2) The government should improve the system of food safety standards for tomatoes, especially Good Agricultural Practice (GAP) and low-chemical production. Many small farmers use a large amount of chemicals because tomatoes are sensitive to pests and diseases in Thailand's humid climate. This problem affects farmer health and consumer trust. It also limits market access because modern markets and processors require strict safety and quality control. Agricultural supply chain management aims to reduce loss, improve quality, and create value across the system, and strong coordination is needed for this goal. Therefore, agencies should simplify the certification process and provide step-by-step support at the farm level. Field officers should help farmers keep records, follow safe chemical use rules, and pass audits. The government can also support group certification for cooperatives and community enterprises. This approach can reduce the cost per farmer. In addition, the government should increase residue testing and public communication to build consumer trust. This is important because consumers are more concerned about health and safe

vegetables. If the certification system becomes practical for small farmers, more farmers can sell to supermarkets and higher-value channels. This policy can also reduce the gap between traditional and modern markets and support safer tomato supply chains.

3) The government should invest in cold chain infrastructure and better post-harvest handling systems for tomatoes. Tomatoes are highly perishable, and losses increase when storage and transport are weak. Studies in developing country contexts also show that poor handling and weak logistics increase post-harvest loss and reduce competitiveness. In Thailand, many small farmers and collectors do not have cold rooms, proper packaging, or grading facilities. As a result, tomatoes lose freshness quickly and get damaged during transport. The government should build shared packhouses, cold rooms, and collection centres in key production areas. These facilities should be managed by cooperatives, local governments, or community enterprises with clear rules. The policy should also support better packaging standards to reduce bruising. Transport operators should receive guidance on loading, stacking, and temperature control. In addition, routing and delivery planning should be improved to reduce fuel cost and distance. Evidence from northern Thailand shows that better routing can reduce distance and fuel cost by more than 2 percent. This saving can be meaningful when transport happens every day in peak season. Therefore, related agencies should promote logistics training and provide simple digital tools for route planning and delivery coordination. This policy can reduce loss, lower costs, and increase income for farmers and midstream actors.

4) The government should reduce the dependence on middlemen and improve bargaining power for farmers and community enterprises. Many farmers still sell through traditional channels and must accept prices set by traders. This problem is serious because small farmers already face high costs and limited capital. Supply chain management highlights the importance of cooperation, trust, and information sharing across actors to reduce uncertainty and improve

performance (Mentzer et al., 2001; Power, 2005). Therefore, the government should promote farmer groups, cooperatives, and community enterprises as key market actors. These groups can collect products, grade quality, and negotiate better prices. The government should also support fair contract farming frameworks for processing tomatoes. Contract farming can provide stable demand, but contracts must be transparent and fair for farmers. Agencies should issue simple contract guidelines and provide dispute support services. In addition, the government should improve market information systems. Farmers need clear price data and demand forecasts, especially because tomato supply is seasonal and prices fluctuate. Digital tools can support real-time information sharing and traceability, which improves transparency in agri-food chains (Sharma et al., 2023; Nayal et al., 2021). If farmers and small enterprises can access market data and direct linkages to factories, supermarkets, and institutional buyers, they can reduce risk and improve income distribution.

Conclusion

This article concludes that tomato supply chain management in Thailand plays a very important role in supporting farmer income, food security, and agricultural sustainability, but it still faces many serious challenges. Tomato production in Thailand is mainly based on small-scale farmers with limited land, aging labor, and moderate-income levels. Production is strongly seasonal, with most output harvested in a short period, which causes price fluctuation and supply instability. High production costs, heavy dependence on chemical inputs, pest and disease problems, and rising labor costs create strong pressure on farmers and reduce profitability. In addition, many farmers lack access to modern production knowledge and technology, which limits productivity and increases long-term environmental risk. Quality and food safety standards are another major barrier, as many small farmers cannot meet strict requirements for modern

markets and processing factories, forcing them to sell in low-price traditional markets. Logistics and post-harvest management problems further weaken the supply chain, as poor storage, weak cold chain systems, inefficient transportation, and unsuitable packaging cause high product loss and reduced quality. The market structure also shows an imbalance of power, where farmers depend heavily on middlemen and have weak bargaining power, leading to unfair income distribution along the chain. Despite these challenges, the tomato supply chain in Thailand has strong opportunities for development. Modern farming technologies such as greenhouses and protected cultivation can help reduce climate risks and support year-round production. Digital tools can improve information flow, planning, and coordination across supply chain stages. Food safety standards and safer production practices can respond to growing consumer demand for healthy food and open access to higher-value markets. Processing, value addition, and branding can reduce losses from oversupply and increase income for farmers and communities. Stronger cooperation through farmer groups, community enterprises, and fair contract farming can improve bargaining power, reduce costs, and share risks more equally. Therefore, improving tomato supply chain management requires integrated action from farmers, entrepreneurs, and policymakers. With appropriate support, coordination, and technology adoption, the tomato supply chain in Thailand can become more efficient, fair, and sustainable in the long term.

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