



## The Study of Lemon Supply Chain: A Case Study of Pasutara Farm, Suan Phueng District, Ratchaburi

Darunee Watnakornbuncha<sup>\*1</sup>, Alongkorn Muangwai<sup>2</sup>, Noppadol Amdee<sup>1</sup> and Tongtang Tonglim<sup>1</sup>

<sup>1</sup>Department of Industrial Technology Management, Faculty of Industrial Technology, Muban Chombueng Rajabhat University, Ratchaburi province, Thailand

<sup>2</sup>Department of Logistics Engineering, Faculty of Industrial Technology, Pibulsongkram Rajabhat University, Phitsanulok, Thailand

<sup>\*</sup>Corresponding author, E-mail: d.watnakornbuncha@gmail.com

### Abstract

The research of “The study of lemon supply chain: a case study of Pasutara farm, Suan Phueng district, showing Ratchaburi was a qualitative research, and the objectives were: 1) to study and analyze the supply chain of agricultural products: lemons, in Suan Phueng district, Ratchaburi province and 2) to use as a guideline of supply chain management for agricultural products: lemons in Pasutara farm, Suan Phueng district, Ratchaburi province. The instruments used for data collection were observation, and in-depth interview of the administrator, and keymen of Pasutara farm, including data from secondary sources. The qualitative analysis tools were content analysis, value chain analysis, SWOT analysis on the lemon supply chain in Pasutara farm.

The research results revealed that agricultures in Suan Phueng district used their production factors; cutting-branch, from the provinces nearby such as Phetchaburi, Nakhon Pathom and Suphanburi. Popular varieties grown were Eureka, Lisbon Meyer and Assamese that they used the lemon branches from cutting and cleft grafting. The most popular lemon products were fresh lemons. However, the analysis results show that there are chances for agricultures and start-ups, who are interested in growing lemon by using SWOT analysis, as the guideline and plan to develop supply chain management of lemon, by following Pasutara farm’s structure. Moreover, the result of the value chain, supply chain management and SWOT in this research would guide lemon farmers in Ratchaburi, and the owner of Pasutara farm on how to reduce their costs and times, and improve for the more capital-intensive production process, after learning from each stream in the value chain.

**Keywords:** *Lemon, Supply Chain, Value Chain*

### 1. Introduction

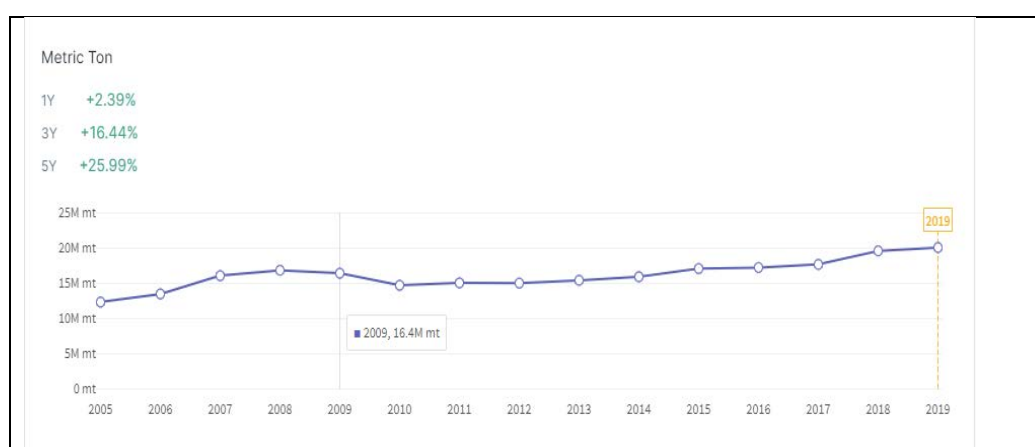
Provinces in the western part of Thailand, such as Tak, Kanchanaburi, Ratchaburi, Phetchaburi, and Pachuab Khiri Khan, are the industrial region of agricultural processing products. Since, it is the area of agricultural production factors, and they grow sugar cane, cassava, rice, pineapple, etc. It’s suitable for growing agricultural plants, as a result, there are various kinds of them. In addition, propagation has been developed proper plants for this region. Not only propagation is being developed, but the value-added of the plant is in that process also. Hence, the production line is finally expanded continuously.

Ratchaburi is one of the provinces in the western region of Thailand. There are various agricultures and agricultural industries. Agriculturers in Ratchaburi have taken some proper plants, to grow steadily more and more, and all of those plants have become the economic crops in this province. The new economic crops in Ratchaburi are Ban Kha pineapple, golden banana, avocado, and lemon. Lemon is the economic crop of Citrus-Lime, and it’s new for Thai agriculturers, but it is one of the world’s economic crops. Thailand is the 19<sup>th</sup> of lemon producer in the world. There are 3,331,000 rais growing lemon, and lemons are produced, approximately, 115,038 tons. Over the periods of B.E. 2559-2560, the world lemon products have grown about 3-5% annually. Table 1 shows that the world lemon products have grown continuously, year by year, from B.E. 2557-2562. It has grown about 5%. Figure 1 shows that the quantity of world lemon products has grown continuously since B.E.2548.

**Table 1** World Lemon Products during B.E. 2557-2562

Year	Quantity of Lemon Products (million Metric Tons)
2014	15.90
2015	17.05
2016	17.21
2017	17.65
2018	19.57
2019	20.04

Source: Food and Agriculture Organization of the United Nations, 2021

**Figure 1** Quantity of world lemon products since 2005

Source: Food and Agriculture Organization of the United Nations, 2021

Pasutara Farm is located in Suan Phueng district, Ratchaburi, the organic farm without a chemical in agriculture. The owner of started her business by buying land in B.E. 2556, planned for growing lemon trees in B.E. 2558, and grew them in B.E. 2559. Pasutara farm's area is about 43 rais (68,800 m<sup>2</sup>). It's sufficient cultivation. It initially started to grow lemon and rosemary by using branches from Phetchaburi in 1 rai (1,600 m<sup>2</sup>). This was the beginning of learning and making area improvements, including collecting data on both the advantages and disadvantages of these two types of plants. They have used manure and organic fertilizer to improve the soil and plants, so the organic and natural stuff matter on the farm. It was about three months of soil improvement, and they expanded one more rai to grow lemon. After growing the first crops for about 8 months, a new lot of fresh products came out. The products were good and bigger than the normal products growing. The farm administrator thought of fruit processing so that it adds more value to fresh lemons, therefore, she started stem cutting from mature lemon branches, and used these cutting branches to grow in the farm, bit by bit. Nowadays, there are more than 1,200 lemon trees in Pasutara farm, and they can be harvested the whole year, especially from November – February. Moreover, the farm has got more income from selling lemon cutting branches together with lemon processing. (Pasutara Farm 1, B.E. 2564)

The researcher realized that the production activity was flowing, from Pasutara farm's lemon processing and supply chain management from upstream, midstream and downstream, including the overlap of the upstream supply chain, that were all going smoothly, from its farm management. Therefore, the researcher has started to study supply chain management of lemon, in Pasutara farm, in Suan Phueng district, Ratchaburi province, as a case study that the result could be used, as a guideline to develop supply chain management more efficiently.



## 2. Objectives

The objectives of the study were

- 1) To study and analyze the supply chain of agricultural products; lemons, in Suan Phueng district, Ratchaburi province.
- 2) To use it as a guideline of supply chain management for agricultural products; lemons in Pasutara farm, Suan Phueng district, Ratchaburi province.

## 3. Materials and Methods

This research used materials and methods as the followings:

### 3.1 Research Design

This research is qualitative research, that is designed to study and to analyze the supply chain of agricultural products: lemon, in Suan Phueng district, Ratchaburi province, in order to use the result, as a guideline of supply chain management, for agricultural products: lemons in Pasutara farm. The researcher initially started to collect data from secondary data sources for lemon cultivation, value chain of lemon supply, lemon supply chain and lemon supply chain management of agriculturists, at the Suan Phueng district, Ratchaburi province, especially at the Pasutara farm. The scope of this research was the area, only in Suan Phueng district, Ratchaburi province, in the Pasutara farm, and the scope of production was only lemon.

### 3.2 Research Instruments

The instruments, which is used in this research to study supply chain, and lemon supply chain management in Suan Phueng district, Ratchaburi province, were the observation of lemon farm in the region, in the secondary data such as documents and reports, and an unofficial interview. The interviews were made with three keymen who work in Pasutara Farm: the owner, production manager and marketing manager. These people are individuals, who are knowledgeable about the lemon farm and have experience of more than ten years. They are the expertise of each field. The topics of the interview were set on the methods of lemon supply chain management on the farm.

### 3.3 Research Analysis

After finishing data collection of both secondary data and primary data sources, all data will be analyzed by using content analysis, value chain analysis, SWOT analysis and, finally supply chain management analysis of Pasutara farm.

## 4. Results and Discussion

The results of the study and analysis of lemon supply chain: a case study of Pasutara farm, Suan Phueng district, Ratchaburi province, revealed as the followings:

### 4.1 Supply chain management of lemon in Suan Phueng district, Ratchaburi province

Lemon has been a new economic crop grown in Ratchaburi area, particularly in Suan Phueng district area. Agriculturists in that area have increasingly grown lemons, and some farms are well known in the region and for the whole country, such as Timberland Farm and Fruit Resort, CORO Field, and Pasutara Farm. (Pasutara Farm 1, B.E. 2564). The overview of activities of lemon supply chain management in Suan Phueng district has been divided into three parts, that are upstream, midstream and downstream activities. All activities of the lemon supply chain have shown as below:

4.1.1 Upstream activities – Activities that are about raw materials for lemon cultivation, and the beginning of lemon supply chain management in Suan Phueng district, Ratchaburi province. The major raw materials are as follows:

- 1) Lemon cutting branch – Agriculturists in Suan Phueng district have cultivated more lemons in their farms by using cutting branches from provinces nearby, such as Phetchaburi, Suphanburi and Nakhon Pathom. The average price of lemon branch is about 70-120 Baht a branch, and it depends on the quantity and varieties. The popular varieties grown in Suan Phueng district are Eureka, Lisbon, Meyer and Assamese.



2) Fertilizers – Agriculturists have used various types of fertilizers to nourish lemon trees that are animal feces manure, chemical substance or combination.

3) Insecticide and herbicide – There are not many of insects that harm lemon trees gradually and individually. Diseases and insects that harm lemon trees and fruits are Canker, rotten roots and stem, rice trips and fruit flies. Agriculturists normally use both typical ways and chemical substances, that are different in costs and consequences.

4.1.2 Midstream activities – Activities that have been done after the upstream activities that are cultivation, nourishment and harvesting (Pasutara Farm 2, B.E. 2564) are as follows:

1) Cultivation – Agriculturists have to prepare the area to plant lemon trees, both outdoors and indoors. Use strong cuttings to grow in well-prepared holes, and separate each tree about 3-4 meters. Soil that is suitable for lemon trees should be mold, and each bottom should not be deep that is less than 15 inches.

2) Nourishment – Since lemon trees can produce lemon fruits the whole year, agriculturists should nourish them by watering once a day or every two days, disking and fertilizing every 10-15 days, cutting branches, and spraying regularly.

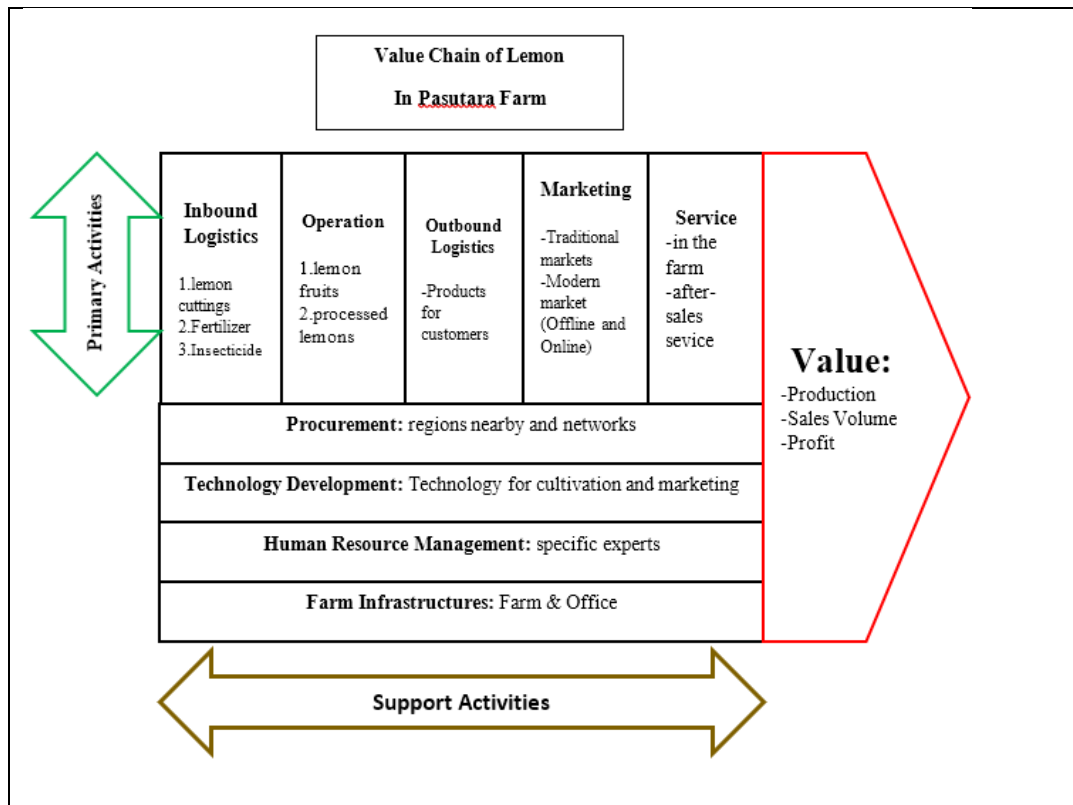
3) Harvesting – Lemon trees produce lemon fruits for the whole year, it's about 350-500 lemons each tree annually. It depends on lemon varieties and nourishment. Furthermore, agriculturists have to know how to pick fresh lemons suitably, because lemons in one tree have different appearances. Thus, agriculturists have to learn how to pick the proper lemon fruits, if not they will lose their incomes.

4.1.3 Downstream activity – This is the last activity of the lemon supply chain. But there is an overlap in this stage because fruit processing occurs in this stage, and it becomes the midstream activity. So does lemon processing. Eighty percent of agriculturists in Suan Phueng district likely sell fresh lemons as production factors to other producers, and the rest make lemon processing, for various kinds of lemon products (Pasutara Farm 3, B.E. 2564).

#### *4.2 Development of Lemon Supply Chain Management in Pasutara Farm*

The following content is about the details of lemon supply chain development in Pasutara farm, it consists of value chain analysis, supply chain management and SWOT analysis.

4.2.1 Value chain analysis of lemon production in Pasutara farm has been shown in Figure 2, which explains primary activities and support activities of the lemon value chain. Value chain development is to feature prominently in development programming, aiming at stimulating economic growth and increasing the competitiveness of the agricultural sector (Staritz, 2012). The explanation of the value chain of lemon in Pasutara farm showed as the followings:



**Figure 2** Value Chain of Pasutara Farm

(1) Primary Activities

1) Inbound logistics – Pasutara farm purchased lemon cuttings from lemon farm in Phetchaburi, and grew 200 lemon trees in the farm for 1 rai (1,600 m<sup>2</sup>). Lemon varieties grew was Eureka. At present, the farm has been cultivated in three varieties: Eureka, Lisbon and Assamese. The cultivation methods are cutting branch and top-working branch which provide stronger stem than seed propagation.

2) Operation – Pasutara farm started their lemon cultivation, by using 200 lemon-cutting branches. After growing this set completely, they went on starting plant propagation by hardwood cutting. Finally, they have completed 43 raises with 1,500 lemon trees within three years. The first set of lemon trees started fruiting after 8-12 months, it firstly produced 100-200 fresh lemon fruits each tree, annually. But when the farm learns to grow and nourish by using organic substances, the quantity of lemon fruits has increased continuously, and produced, on average, 400-500 fruits each tree a year. Moreover, the farm has expanded the production line, not only lemon-fresh fruits, but also lemon-cutting branches and lemon-processing products.

3) Outbound logistics – Products that have been made in Pasutara farm have been sent to customers in many ways, for example, to send directly to wholesalers, retailers and customers. Pasutara farm has two channels of marketing that are traditional and modern trade, both offline and online methods. The farm has collected customers' information, and distributed all products by using its own and transportation agencies.

4) Marketing – Marketing activity is much more important than before since lemon markets for fresh fruits and lemon-processing products are highly competitive. The marketing plan has to be made clearly and strategically to fulfill the market's needs. The farm has set the product prices as the price leader with mixed markets; traditional and modern markets, offline and online markets by many channels of promotion.



5) Service – Service is the value-added activity for the supply chain. It is intangible but significant. Therefore, customers' information is the core source for Pasutara farm, to provide the appropriate products and improve new products in the future.

(2) Support Activities

1) Procurement – Pasutara farm has looked for all quality raw materials and other production factors from reliable sources for cultivation and lemon processing, for example, lemon cutting branches from Phetchaburi, and also honey from Chiang Mai.

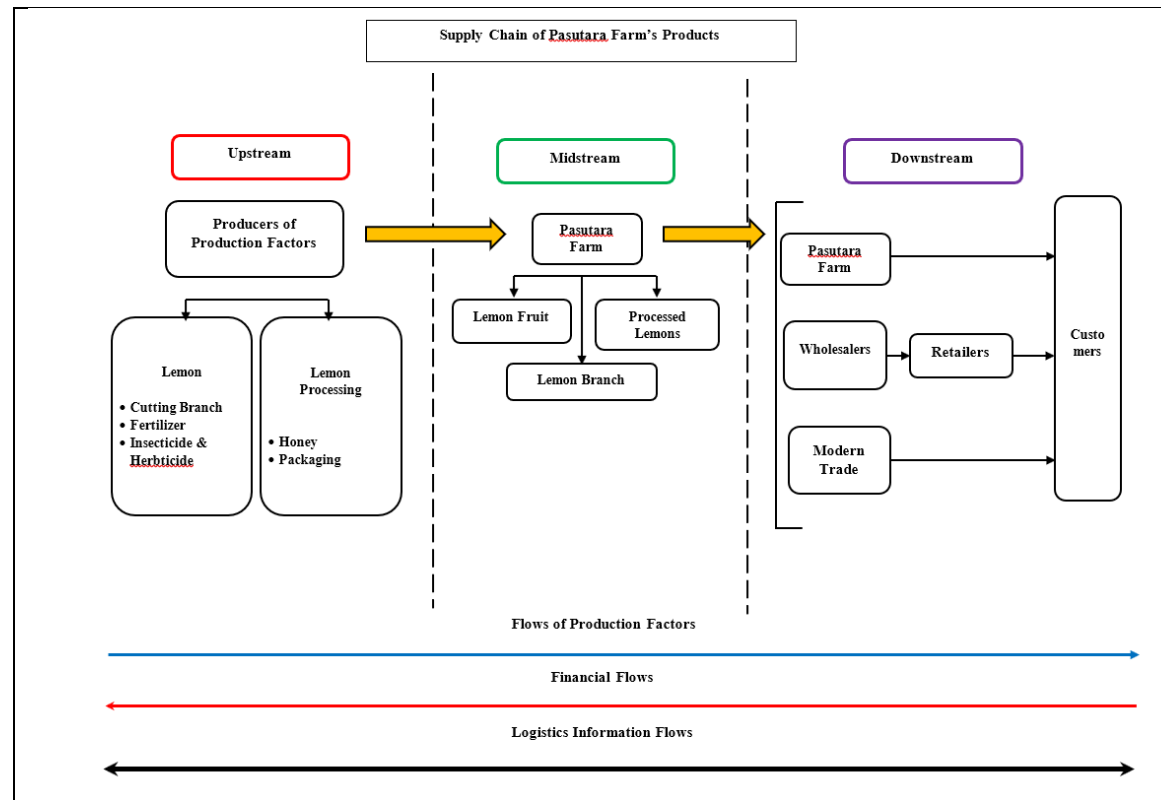
2) Technology development – With 43 rais, Pasutara farm has to provide technology for cultivation and production, only labor-intensive production is not enough. The farm has set the watering system and fruit processing, in order to reduce labor costs. In addition, using organic fertilizer, insecticides and herbicides is an alternative in the farm, and it shows that the costs are less than using chemical fertilizer, insecticide and herbicide, and it is safer. At present, the proportion of labor and technology in Pasutara farm is about 7:3.

3) Human resource management – Since labor-intensive production is still the main factor, so to develop and train workers is necessary. Some process needs skilled labors, i.e. lemon processing for various kinds of lemon products. This activity has to support other activities in primary activities; operation, marketing and service as well, therefore, Pasutara farm recruits some experts to work in it. In the future, there is a plan to set the R&D department to develop more cosmetic products, made of lemons, so some specific workers will be hired.

4) Infrastructure – Pasutara farm is located close to Pachee river, and the water from this river can support for watering lemon trees for the whole year. Products of the farm can be delivered to customers everywhere through the main roads, and it is far from Ratchaburi, only 63 kilometers, and from Bangkok about 160 kilometers. It is quite convenient to travel and deliver products. In the near future, after the COVID-19 pandemic stops, the farm plans to expand its market to Myanmar.

(3) Value – As the primary activities and support activities are integrated with Pasutara farm's supply chain, the results show that there are 3 parts, which are production, and the sales volumes and profits, have increased their values, consequently. There are three kinds of production; fresh lemon fruits, lemon-processing products for food and beverage, and lemon cosmetics. The sales volumes have increased year by year, so does profit.

4.2.2 Supply chain of Pasutara Farm's products – As value chain of the farm showed reasonable consequences in the end. However, it should explain further about supply chain management that it will help understand the whole idea of supply chain clearly. Supply chain management is an important platform to achieve collaboration between trade partners. It helps better control of product quality and safety, reduction of production losses, better demand management, reduction of transaction costs, technology sharing and access to capital, and collaborative knowledge exchange among chain partners (Dani, 215). A case study of supply chain management of Pasutara farm has revealed the results of it, as shown in Figure 3: Supply Chain of Pasutara Farm's Products.



**Figure 3** Supply Chain of Pasutara Farm's Products

Supply chain management of Pasutara farm's products will be explained in summary by three topics: flows of production factors, financial flows, and logistics information flows, as the followings:

(1) Flows of Production Factors – The production factors of Pasutara farm flow through upstream, midstream and downstream and can be divided into two periods; the beginning period and the improvement period. In the beginning period, Pasutara farm got production factors from outsources and can be explained in value chain before, until the farm could expand lemon cultivation by themselves and grew fully in the farm. The improvement period started when lemon cultivation has improved in the whole area and the farm can produce the organic lemons self-sufficiently. Eventually, the farm can produce many kinds of processed lemon products. The first product of lemon processing is slice honey lemon and slice lemon in honey, and at the end, there is one by-product: lemon honey. All of them can be sold. It shows that the midstream is expanded by-products, and more complicated in supply chain management, especially 4P's in marketing: product, price, place and promotion. Lemon products distribute to customers, in three ways that are a direct way in the farm, and by postal from online purchasing, wholesales and retails.

The flows of production factors of Pasutara farm have concluded that the supply chain management of the farm is under self-sufficient organic method without chemical substances. Besides, Pasutara farm has produced lemon products under the Thai and international standards, such as FDA standard, Halal, GMP and HACCP, from upstream through downstream activities.

(2) Financial Factors – The activity that concerns the capital of the farm backwards to the upstream, and the money is currently at each stream as well. The longest financial flows start customers back to the outsources of production factors.

(3) Logistics Information Flows – Each activity is full of data and information, and they are useful for Pasutara farm. It flows back and forth and can be managed for improvement processes of technology,





logistics and supply chain management. It helps to increase the efficiency of economic competition also (Srisawat, 2017), therefore all logistics information enables to be collected, is identified and analyzed to increase their lemon supply chain efficiently and effectively. The results show by the customers' feedback, that they buy regularly and comment through Pasutara farm's channels, at the farm and on Facebook. The information helps to produce efficiently that can reduce costs of production, approximately 15-20%, to get into the proper sizes of lemons for sales and production, and produce new types of lemon products, such as lemon powder, lemon shampoo, lemon soap and other cosmetics. Therefore, logistics information from the supply chain is very useful to all, who may concern with this platform and should be used practically.

4.2.3 SWOT Analysis – It is a framework used to evaluate a company's competitive position and to develop strategic planning. It consists of strengths, weakness, opportunities, and threats, and assesses internal and external factors, as well as current and future potential (Grant, 2020), Table 2: SWOT Analysis of Pasutara farm's lemon products show strengths, weaknesses, opportunities, and threats of the farm, including strategies.

**Table 2** SWOT Analysis of Pasutara farm's lemon products

<b>Strengths</b>	<b>Weaknesses</b>
1. The location and surrounding of the farm is suitable for lemon cultivation; Pachee river and the climate. 2. Capital factors: sources for investment and technology 3. New product development has worked out continuously in various kinds of products. 4. The farm gains business network for capital and marketing. 5. Pasutara brand is well known and reliable. 6. Lemon processing products are under Thai and international standards.	1. It is very hard and complicated to analyze the logistics information. 2. The integration of work is not efficient and well-managed.
<b>Opportunities</b>	<b>Threats</b>
1. Market expansion is possible in the future if the farm can be supported from government sector. 2. Product development can be promoted by private and government sectors.	1. It is affected by COVID-19 situation that makes some plans slow down. 2. It's the risk for new luxurious products to launch in the world market, since the world consumption is lowered and is down by spreading of COVID-19.

SWOT analysis of Pasutara farm can indicate the ways to make some strategies for supply chain management and its business. The strategies suggested the farm are:

1. the farm should clarify the lemon product attributes and features, including lemon benefits for food, beverage, and cosmetic products, and make the differentiation of each product.
2. the farm enables to go on setting the premium price, and later the market because the consumption of the upper-class market is affected less than others, by spreading of COVID-19.
3. online channel should be used more on various platforms to promote direct sales of lemon products.
4. SMEs, BOI and other government departments of foreign trade promotion are a network that the farm should connect with, and expands its lemon supply chain network.





## 5. Conclusion

The supply chain management of lemon is a specific platform and helpful to the agriculturists, who are interested in lemon cultivation and lemon processing production. The demand for lemon is still higher than the supply in Thailand, for example, lemon jam can be made of Thai lemons but its costs of production and prices in the market are quite high, therefore fresh lemons have been used to make other products that can be more valuable (Chanmuang, 2018). Hence, the ones who are interested in the lemon business should learn and understand the supply chain management and value chain of lemon from the upstream through downstream activities, including the flows of production factors, finance, and logistics information. A case study of Pasutara farm is beneficial to understand the whole chain of lemon supply. The study has guided the lemon farmers to see each part of the lemon stream, then they could apply for lowering the costs of production, improving their efficiency of cultivation, and using more capital-intensive process for their upstream and midstream, for example, using AI technology for harvesting lemons, and for their downstream by expanding their market to the new target customers, such as online customers. Eventually, promotion and support from the government sector are as well necessary for them.

## 6. Acknowledgements

This research was made possible through the objectives with the useful interviews from three keymen of Pasutara farm: the owner, the purchasing manager and the marketing manager. Finally, I would like to thank the advisers, who reviewed and gave some recommendations throughout this research.

## 7. References

- Srisawat, B. (2017). Information Technology and Logistics. Paper presented at the International Research Conference 4<sup>th</sup>, Research Institute of Khampangpet Rajabhat University, Thailand.
- Dani, S. (2015). *Food Supply Chain Management and Logistics: From Farm to Fork*. London, UK: KoganPage.
- Grant, M., (2020). Strength, Weakness, Opportunity, and Threat (SWOT) Analysis. Retrieved on January 6, 2021, from <http://www.investopedia.com/terms/s/swot.asp>
- Pasutara Farm 1. (2021). Interview the owner at Pasutara farm, Suen Phueng district, Ratchaburi province. Miss Darunee Watnakornbuncha. January 10, 2021.
- Pasutara Farm 2. (2021) Interview purchasing manager at Pasutara farm, Suen Phueng district, Ratchaburi province. Mr. Thanat Orarnrakthum. January 17, 2021.
- Pasutara Farm 3. (2021) Interview marketing manager at Pasutara farm, Suen Phueng district, Ratchaburi province. Mr. Paramin Watnakornbuncha. January 17, 2021.
- Staritz, C. (2012), *Value Chains for Development: Potentials and Limitations of Global Value Chain Approaches in Donor Interventions*, Austrian Research Foundation for International Development, Vienna.
- Chanmuang, W. (2018). Tips for Agriculturists. Retrieved on January 15, 2021, from [www.rakbankerd.com/agriculture/highlight-view.php?id=103&s=tbheight=](http://www.rakbankerd.com/agriculture/highlight-view.php?id=103&s=tbheight=)
- Food and Agriculture Organization of the United Nations. Retrieved on January 15<sup>th</sup>, 2021, from <http://www.tridge.com/intelligences/lemon/production>