The Analysis of Garlic Supply Chains in Agriculture to Transportation to The Factory

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Abstract

This research studied the supply chain of fresh garlic plantation in the north of Thailand. The main objective of the study was to analyze the production of fresh garlic in supply chains from agriculture to transportation to factory. Present fresh garlic production was determined and analyzed to reduce production cost of farmers. Start with collecting necessary information from farmers in Pai District, Mae Hong Son; Li District, Lamphun; Mae Wang District, Chiang Mai; Samoeng District, Chaing Mai. Then SCOR model concept was applied. After that, the comparison among costs, profit, and production quantity and quality were conducted. The data from interview were analyzed by qualitative and quantitative techniques.

The results of the study showed the costs of production in Pai District, Li District, Mae Wang District, Samoeng District, are 23848, 28133, 26092, 27106, bath per rai(1 rai = 0.16 hectare) respectively. In terms of profit the amounts are 49024, 47392, 25714, 24532, baht per rai, respectively. Regarding to production limitations, it can be found that farmers faced 3 production problems i.e.; a large amount of chemical fertilizers usage, shortage of labor force and inefficient utilization of pesticides. The results from this research suggested some possible ways to improve supply chain performance of fresh garlic production.

Keyword : Garlic, Supply chain, SCOR Model, Cost analysis

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Introduction

Garlic is one of Thailand’s economic plants which takes total 65,695 rai of plantation area in the country (year 2017). Most of the plantation area is in the northern part of Thailand which is about 65,101 rai, including 24,967 rai in Chiang Mai, 17,176 rai in Mae Hong Son, Phayao 6,939 rai, Lampang 4,865 rai, Tak 4,131 rai and Lamphun 3,272 rai and that makes 69,504 tons of country total product, according to the data from Office of Agricultural Economics, year 2017. Moreover, Thailand has reached to the 16th most garlic producing country with the production capacity at 0.75 percent. China ranked in the first place for producing 12,750 million tons per year, followed by India (645 million tons) and South Korea (375 million tons) (Department of Agriculture 2016). Most of garlics are used for consumption within the country, for households and food processing industry, paste and sauces factories, for instance. 80 percent of produced garlic is used as fresh product while the other 20 percent is used as processed garlic, for example, pickled garlic, fried garlic, powdered garlic, and extracted garlic. However, Thailand exports garlic and its products 500 - 1,000 tons per year, and imports those 20,000 – 50,000 tons per year to fulfill the consumption need at 173,00 tons a year.

Garlic is one of economic plants and is in the highly sensitive list that can uncertainly change. For example, in 2014, the garlic price reached the lower point. That started from the price of fresh garlic was not high enough, therefore, the farmers did not want to sell the product right after the harvest and held the product to sell in a better price. Some farmers had to sell the product in the price as it was to cover their daily expenses. Ones who waited to sell when the price reaches up had to loan money from illegal loans with the hope that the price would increase in the near future. Furthermore, import garlic from other countries, both legal and illegal, is one of the reasons that the selling price in the country was not proper. This agrees to the research of Shuman (2007) that says, the garlic plantation area in America decreased from 40,000 acre to 25,000 acre which can produce 60 million pounds of garlic each year. But in America, the consumption of garlic each year is about 300 million pounds while the plantation area in California was lessened apparently. The study showed that both fresh and dried garlics were immensely imported from China to America. There is also the research of Kanokporn Meekaew (2010) says that, garlic is part of the agriculture field and is one of economic plants that form the stability for agriculturists since the past. Therefore, agriculturists planted more of garlic for trading and that led to oversupply in the market which causes price fluctuation and might lead to the lower price of the garlic. This became the reason why the government had to limit the garlic producing capacity within the country and also its plantation area. Since 2002 until recent time, the demand of garlic is more than the products that has in the country, which causes the excess demand in Thailand, so the country has to import garlic from China under the condition of free trade agreement and some from the illegal imports from different parts of Thailand. In addition, garlic imported from China costs less than Thai garlic, which means the price of Thai garlic would not get higher even the demand of the product were increased. This directly affects agriculturist who plant garlic.

From the issue, the filed that relates to producing garlic has been improved in order to increase the ability to stay and compete in the market. For example, firstly, to improve the way of producing garlic by improving its
gene and put the required qualities into it, such as, the garlic type can give more product, has short harvesting time, durable in any environment and disease, the product has expected color, size and taste as the market needs. The Horticultural Research Institute has been taking up the matter in order to improve the garlic types but the process could not help as much as expected, because to improve plant varieties need at least 10 – 15 years, and now the process in on the improvement of the varieties (The Horticultural Research Institute 2015). Secondly, to put garlic into processing progress that follows the purpose of the Subcommittee for tuber crops has supported the researches of garlic and its products for increasing its value in the market. Garlic itself can be processed into many products, such as, dried garlic, garlic oil, pickled garlic, powdered garlic. And there are also many researches that are related to processed garlic. For example, the research of Passorn Leabwan (2015) studied about the eatable coating substances for extend the time for keeping garlic, by coating to peeled garlic in four substance; Alginate, Agar, Carrageenan, and Carboxymethyl cellulose at 1 percent concentration by weight per capacity. The study found that Agar can best slow down the lose of weight and change in internal color of garlic. Wilaisri Limpapayom and others (2012) has improved the processing progress to increase garlic value, by producing garlic oil in the form of gel capsule and other processed products in order to make the supplements and essential substances. Start from bringing garlic from Kan Taralak district, Sisaket Province, to use in the research. Researcher examined the active compounds and found that there are ones that can be used for making products. The research shows the solution to price problem by processing garlic into other products. Thirdly, to develop the garlic supply chain by using the tools to analyze the faults and leads to decreasing garlic cost while increase the profit. Compared all 3 solutions, the development of garlic supply chain is considered to be the most suitable way to solve problem since it takes less time than improving the varieties of garlic. Moreover, it is also the way to study the whole system of garlic, since the beginning, sprouts, producing progress, sources used during the plantation, its transportation after harvest, and gather the key information to analyze by using the tools and proceed to find the better solutions.

Literature about Instruments in the Supply Chain Study

Juthamart Netpanya (2013) studied about increasing the ability of logistic and supply chain of fresh strawberry in Chiang Mai. The study used Bor Kaew sub-distict, Sa Moeng district as a case study, and also created the indicator to evaluate the capability of strawberry supply chain; The supply chain operations reference model. There was also the evaluation form to see the capability of supply chain and to use that evaluation in the further examination. The purposes of the study were to analyze and increase ability of logistics and strawberry supply chain in Chiang Mai. In this case, the concept of SCOR Model was used to evaluate the capability of the relevant factors; agriculturist, middleman, the company representative. Chaiyut Wong-Atchareeya (2004) has studied the SCOR Model for taking the knowledge about management of supply chain to apply on the export progress of dried longan, based on the study of the exportation of agricultural goods in Khong River area. The result was the supply chain that dried longan export companies use in this current time.
and has evaluated each company’s progress ability and compared. The research is to study the whole progress and to improve each step of it for the good of the company.

**Literature review about supply chain and logistics**

Prakit Sukkhim (2010) studied about ability of the management of garlic logistics system before being in supermarkets by the garlic agriculturist cooperative, Fang sub-district, Chiang Mai Province. The purpose of the research was to evaluate the management capability of logistics system, compared with the ratio of net profit and sales. The research also suggests ways to improve and manage logistics system, to help it become more effective. The researcher interviewed people who are related in the field and also compare and analyze the results to the standard of Federation of Thai Industries. For evaluating the logistics system, it is to evaluate both the management of cost, time, credits, and the possibility of the project. After that, researcher used SWOT Analysis to analyze the result of the cooperative and found that the cost of inventory management and wage are in the higher level, compared to others but gain the credibility less than average standard. For the operating result, the ratio of net profit compared to sales was negative when selling product to the private companies. Furthermore, the SWOT Analysis the researcher used showed that the cooperative has weakness of the quality of goods and time management. Even in the future the demand of the consumers might reach up but there is still the matter of lack of labors and fluctuating price. Therefore, there should be less steps and less producing progress. The report for every cost should also be established and divided in category for the use of planning production and marketing.

**Literature review about reducing cost**

Wajana Ar-nu (2013) studied mangosteen supply chain by examining the agricultursis in Chan Ta Buri province. The research found that the cost of mangosteen caused by the agriculturist is 18.59 baht per kilogram, plus the cost by the middleman is 3.91 baht and plus 5.34 baht per kilogram by the retailer. There is also the suggestion in the research about the way to decrease the cost of mangosteen is to decrease the waste along its transportation.

**Literature review about analyzing cost of production and cost of logistics in supply chain**

Pradee Nueagchop (2017) studied about production and logistics cots from agriculturist who plant Melientha suavis, Ban Mor district, Sara Buri province. The research shows that, logistics cost in the plant is 6.89 baht per kilogram and there is the production cost for 17.33 baht per kilogram. That means producing the plant will cost 24.22 baht per one kilogram. The researcher found that the logistics cost occurred before transportation is delivery cost and high wage. Therefore, the researcher suggests that decreasing the cost by applying the concept ECRS. The research particularly focuses on C: Combine as to gather the work load of
staff and the product in the center. This can decrease the wage from 6.89 baht to 5.79 baht and makes the total cost from 24.22 to 23.12 baht, so the cost was 4.54 percent reduced.

Research Methodology

This research is about analyzing garlic producing cost from agricultural field to factory. The researcher has determined the operation into 5 steps, as following details.

1. **Advanced Planning and preparation**

   In this step, the researcher will plan how the research should operate and how much time they should take in each step, along with studying about garlic producing progress and related theories.

2. **Create questionnaire**

   Creating a questionnaire to use as a tool to gather the information from the sample group follows the principle of supply chain operations reference: SCOR-Model. The model is to define the delimitation and content for studying, and also the gathering of information, including planning, source preparation, production progress, delivery, and repatriation. There are also other issues, such as, quantity and quality of the product, the producing cost; logistics cost and total cost. The researcher will use the information taken from 2 different times; garlic planting season in 2017 and 2018.

    | Types of cost          | operation details and expenses                                                                 |
    |------------------------|-----------------------------------------------------------------------------------------------|
    | 1. Cost of Production  |                                                                                               |
    | - Fixed Cost           | - rent, Agricultural equipment depreciation cost                                               |
    | - Variable Costs       | - materials and tools using in plantation, wage other expenses, such as, electricity, tap water phone bills and agricultural tools repairing cost, etc. |
    | 2. Logistics Costs     |                                                                                               |
    | - Transportation cost  | - cost of transportation equipment                                                            |
    |                        | - insurance fee for transportation equipment                                                   |
    |                        | - interests from purchase the equipment                                                        |
    |                        | - cost of equipment maintenance                                                               |
    |                        | - cost of import transportation                                                              |
    |                        | - cost of export transportation                                                              |
    |                        | - cost of reverse transportation                                                              |
    |                        | - cost of wage for transportation                                                             |
    |                        | - Costs related to keeping product                                                            |
    |                        | - cost of keeping space                                                                       |
- cost of inventory services
- cost of risks of inventory
- cost of wage to keep and take care of inventory

3. Total Costs
- total cost of production and logistics

3. Agriculturist survey for collecting information

Target population and sample group

Target population
Since the sample group is very large and is separated in different areas, so it was difficult to do the survey and proceed the communication. There was also the limitation of budget. Therefore, the researcher uses purposive sampling in order to study supply structure and differences of the chains, including garlic production cost in each place, as following,

Agriculturist
1. 10 Garlic agriculturists, Pai district, Mae Hong Son province
2. 10 Garlic agriculturists, Lee district, Lamphun province
3. 10 Garlic agriculturists, Mae Wang district, Chiang Mai province
4. 10 Garlic agriculturists, Sa Moeang district, Chiang Mai province

Middleman
1. 2 middlemen, Pai district, Mae Hong Son province
2. 2 middlemen, Lee district, Lamphun province
3. 2 middlemen, Mae Wang district, Chiang Mai province
4. 2 middlemen, Sa Moeang district, Chiang Mai province

Company’s representative
1. 1 representative from transportation company, Pai district, Mae Hong Son province
2. 1 representative from transportation company, Lee district, Lamphun province
3. 1 representative from transportation company, Mae Wang district, Chiang Mai province
4. 1 representative from transportation company, Sa Moeang district, Chiang Mai province

4. Collecting information from interviews to analyze and find the solutions

Analyze the information given from the interview and study about structure management and operation system of garlic supply chain, compare with costs, profit of the product. The statistics used is descriptive statistics, including finding the average number, percentage, along with the information analysing by using SWOT system to find strengths, weaknesses, opportunities, and struggles in agriculturists in each place. After that, it is to find the solution to the problems.
Research result

Creating the model in refer to operation of supply chain was to collect the data that will lead to the knowledge of 5 steps of the operation in supply chain, as following, 1. plan, 2. source, 3. make, 4. delivery, and 5. return.

1. Plan

Agriculturist will plan the whole progress of operation before plantation. Since planting garlic needs the advanced preparation, so the agriculturist must prepare the sprouts in February. Agriculturist who plant garlic by its dried form will buy garlic since November and do the harvest in February. To prepare the materials for plantation, such as, fertilizer, pesticide, fuel for pump, depends of the qualified quantity and time. Except rice straws which are the very essential material for plantation as they will be used to cover the garlic field to protect it from the sun. Agriculturist has to carefully plan out the operation to manage the material in efficient amount, for if the rice straws were not enough to cover, garlic might be destroy from the sun.

The common struggles are when agriculturists want to proceed the plantation in their own field at the nearly same time and want to harvest before others could. The following situation is the lack of labor and agriculturist were not aware of making the report that has the details of plantation, such as, costs, problems, weather. They assume that it was a little complicated and do not see much benefit from that.

2. Source

The research found out that the agriculturist from four areas purchase materials, such as, fertilizer, pesticide, from nearby stores. Besides, the agriculturist in each area has the different way to prepare the garlic sprout. Agriculturists in Pai district and lee district use fresh garlic for the plantation and the sprouts were purchase from other nearby agriculturists. Furthermore, the agriculturists in Mae Wang and Sa Moeng districts purchase the garlic from companies under the trading contract. They will be taking the sprouts to plant in the field first and they do the payment after taking the product to sell to the company.

3. Make

To prepare garlic variety by using raw garlic, agriculturist needs to have a place for hanging garlics in order to let them dry out while waiting for the right time of season to come before start the plantation. There are 5 steps of the preparation. 1. cut garlic from its stem 2. peel the shelth 3. peel the cloves 4. seperate the cloves and 5. take out the rotten ones. On the other hand, the agriculturists who plant garlic using dried garlic do not need to hang the garlics, so when the right season for plantation has come the agriculturists can directly take garlic to use. Some tend to use labors for peeling out the garlic shelth because they assume that using machine might not be the best way for garlic skin. Although, some prefer to use mchine because the lack of labors and the matter of time. Most of the plantation area are sandy soil, so there will be the soil preparation at the end of October by watering the area every 5 - 7 days. Since the garlic plantations are mostly located lower than water source, it is convenient to pipe water into the land. If the area was higher than water source, they need to pump up water into the field. After the first plantation has started for 100 - 120 days, it will be the time for harvest, and
all agriculturist will be in need of labors for harvesting. Some agriculturists who sell fresh garlcs will set up the place right at their field to sell garlcs to middleman, who has been waiting to buy. Some agriculturists who sell dried garlcs will hang their garlcs in the storage, waiting for them to dry before selling them. About labors, agriculturist who have the large plantation field will hire labors in every step of the producing operation. The ones who have about 2 - 3 rais will keep that as a family business. Agriculturists with high experiences will get the good products while having the low cost of producing.

The problem found in every surveyed district is diseases of garlic, as agriculturists tend to use chemical fertilizer, pesticides, growth hormones and they all cost a very high price.

4. Delivery

In tranportation, the researcher found that agriculturists in Pai district will sell garlcs when they are fresh, by selling to the middleman immediately after harvest. It means the agriculturists will not have to expenses about transportation, same as agriculturists in Lee district. Some agriculturists will sell green raw garlcs in order to use money to cover their daily expenses. They, too, do not need to provide any transportation fee. Agriculturists in Mae Wanf district and Sa Moeng district sell dried garlcs so they have to cover the transportation cost.

5. Return

The researcher found that in all 4 areas, there is no return of the product.

Efficiency of Garlic Supply Chain Management

1. Results from data collection by farmer interviews

From interviews with 20 farmers, the following information was as follow; farmers in Pai district, Li district, Mae Wang district, Samoeng district who have experienced from garlic cultivation for 25 years, 11 years,10 years ,and 7 years respectively. Most of farmers have both their own areas and rent more areas from their family and neighbors (65.00%). Farmers in Pai district, Li district, Mae Wang district, Samoeng district have the average of areas for garlic cultivation is 10.4 rais, 3.5 rais, 1.5 rais, 4 rais, respectively. Recognition Group Discussion about knowledge of farmers and the area of farmers is sandy loam (100%).The breed that most farmers plant is Pai District Local Breed (70.00%) used seeds of 100-120 kilograms per rai. All farmers use organic fertilizers such as bat dung, cow dung, but only for the first time, and they will harvest products at the age of 100-120 days. From the experience of farmers who could harvest 2,000-5,000 kilograms per rai (fresh garlic), that in 2017 they had ever harvested at the average of 2555 kilograms per rai. Costs of cultivation and the average costs of farmers in Pai district, Li district, Mae Wang district, Samoeng district are as follows; 23,848, 28,133, 26,092, and 27,106 baht per rai respectively, and costs of garlic cultivation are as follows; 7.95, 9.38, 15.65, 12.55 baht per kilogram respectively.
Table 1. Yields and average cost

<table>
<thead>
<tr>
<th></th>
<th>A.Pai</th>
<th>A.Li</th>
<th>A.Mae Wang</th>
<th>A.Samoeng</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average cost (Baht/rai)</td>
<td>23,848</td>
<td>28,133</td>
<td>26,092</td>
<td>27,106</td>
</tr>
<tr>
<td>Average yield (Kg/rai)</td>
<td>3,000</td>
<td>3,000</td>
<td>1,667</td>
<td>2,160</td>
</tr>
<tr>
<td>Cost (Baht/Kg)</td>
<td>7.95</td>
<td>9.38</td>
<td>15.65</td>
<td>12.55</td>
</tr>
</tbody>
</table>

Table 2. The production and logistics cost

<table>
<thead>
<tr>
<th>Production and Logistics Cost (Baht/Kg)</th>
<th>A.Pai</th>
<th>A.Li</th>
<th>A.Mae Wang</th>
<th>A.Samoeng</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production Cost</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fixed cost</td>
<td>0.2</td>
<td>0.5</td>
<td>0.5</td>
<td>0.4</td>
</tr>
<tr>
<td>Variable cost</td>
<td>7.5</td>
<td>8.43</td>
<td>15.05</td>
<td>11.95</td>
</tr>
<tr>
<td>Total</td>
<td>7.7</td>
<td>8.93</td>
<td>15.05</td>
<td>12.35</td>
</tr>
<tr>
<td>Logistics Cost</td>
<td>0.25</td>
<td>0.45</td>
<td>0.1</td>
<td>0.2</td>
</tr>
<tr>
<td>Total Costs</td>
<td>7.95</td>
<td>9.38</td>
<td>15.65</td>
<td>12.55</td>
</tr>
</tbody>
</table>

2. Structure of garlic supply chain in surveyed areas

Figure 1. Supply Chain Structure
Structure of garlic supply chain in Pai and Lee districts are similar. The agriculturists use the garlic from Pai, using other support materials from nearly stores. After that, when due to the harvest time, they will sell garlics to broker. Finally the broker will hire the transport company to take the product to the processing factory.

Structure of garlic supply chain in Mae Wang and Sa Moeang are also similar. Agriculturists will get the garlcs from the selling group while the funding is firstly provided by the processing factory. The factory will get the fund back once the products arrive at their factory. Agriculturists who sell dried garlics will wait until the proper time before taking the product to sell at the trading point, before the representative of the group will take all product to the transport company and proceed to the processing factories.

SWOT Analysis

Strengths
- Agriculturists in Pai has at least 25 years of experience so they are very professional as same as laborers who work for them.
- Agriculturists in Pai are in the nearest area of garlic varieties.

Weaknesses
- Agriculturists in four districts are facing the problem of diseases of garlic and lack of knowledge.
- Agriculturists in Lee district get very few of the production as they have less experience, only one year. They also have the most problem of rotten garlic. Moreover, laborers in the area have low skill of the work.
- Agriculturists in Mae Wang and Sa Moeang districts sell dried garlics. That brings higher cost of the expenses after harvesting. Furthermore, there is also risk of rotten garlics when keeping them too long.

Opportunity
- Agriculturists in Mae Wang and Sa Moeang districts get garlics and fertilizers from company and they can do the payment after they have the product ready to sell.
- Agriculturists in Pai have examined the soil by the buying company provided them the examination. They will inform the result to agriculturists, and will also provide the agriculturist the peeling machines as well.
- Garlic buying factories in Pai had brought the sample soil to examined and report back to agriculturists, and will also provide the agriculturist the peeling machines as well.

Threats
- There are off-season rain so there will be chances that garlic might get diseases. Agriculturists might have to waste money on pesticide.
- Agriculturists do not have machines to cover people’s work, so the producing cost is high.
Suggestions

1. There should be the training course for garlic agriculturists about plantation preparation, how to properly store garlic after harvesting, how to appropriately use the substances to reduce the cost of producing.

2. To support agriculturists to examined their soil so they will know what minerals and substances are in the soil.

3. To encourage agriculturists establishing themselves as a group, for exchanging thoughts, knowledge and techniques about producing operation, costs, profits in each time and season. Moreover, the agriculturists with the better ways of operation can set up the example for others.

4. There should be support for agriculturists to use bio-fertilizer instead of the chemical ones, including the way to apply more natural materials instead of using rice straws, as they are expensive.

5. To encourage agriculturists to be aware of the importance of cost and profit report.

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