ผลกระทบของนโยบายข้าวต่อระบบข้าวไทย

นายพิเศษพร วศวงศ์

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาเศรษฐศาสตรดุษฎีบัณฑิต
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Impact of Rice Policies on Thai Rice Industry

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จากการทำวรรณกรรมปริทรรศน์ 3 ส่วน คือ ลักษณะอุตสาหกรรมข้าวไทย ผ่านกรอบการศึกษาที่เรียกว่าห่วงโซ่มูลค่า (Value Chain) นโยบายที่เกี่ยวข้องกับข้าว และเครื่องมือทางเศรษฐศาสตร์ที่ใช้ในการวิเคราะห์เกี่ยวกับนโยบายและอุตสาหกรรมข้าวในปัจจุบัน พบว่า หนึ่ง ระบบอุตสาหกรรมข้าวไทย เริ่มจาก "ชาวนา" นำข้าวเปลือกที่ปลูกได้ไปสู่ "โรงสี" ทั้งขนาด "ใหญ่" และ "เล็ก"ก่อนที่โรงสีจะนำไปสู่ผู้ค้าข้าวทั้ง 2 ประเภท คือ "ผู้ส่งออก" และ "ผู้ค้าข้าวในประเทศ" สอง การกำหนดราคาข้าวนั้นมาจากราคาตลาดโลก โดย ราคาตลาดโลกนั้น ถูกกำหนดจาก จำนวนประชากรโลก รายได้ต่อประชากร และ GDP ของโลก สาม นโยบายข้าวหลักของไทยจากอดีตถึงปัจจุบันที่ส่งผลต่ออุตสาหกรรมข้าวอย่างมีนัยสำคัญ 2 นโยบาย คือ การจำนำ และการประกันราคาข้าว ซึ่งมีความซับซ้อนกว่านโยบายของหลายประเทศ สี่ เครื่องมือที่ใช้ในทางเศรษฐศาสตร์ที่เป็นที่นิยม 3 เครื่องมือ คือ เศรษฐมิติ (Econometric) แบบจำลองดุลยภาพทั่วไป (Computable General Equilibrium) และ โปรแกรมเชิงเส้น (Linear Programming) นั้น เครื่องมือที่เหมาะสมที่สุด คือ โปรแกรมเชิงเส้น เนื่องจาก สามารถตอบโจทย์ที่ซับซ้อนได้ดีกว่า นอกจากนั้น ยังสามารถใช้หาคำตอบเรื่อง ทรัพยากรขาดแคลน (Scarce Resource) และราคาเงา (shadow price) ของทรัพยากรนั้น และสามารถดัดแปลงเพื่อตอบโจทย์ที่เป็นเป้าหมายรวมของสังคมด้วยวิธีการโปรแกรมเป้าหมาย (Goal Programming) ได้ด้วย

การศึกษานี้จึงได้พัฒนา แบบจำลองอุตสาหกรรมข้าวไทย โดย ใช้ โปรแกรมเชิงเส้น โดย อาศัยข้อมูลจากหลากหลายแหล่ง อาทิ สำนักงานเศรษฐกิจการเกษตร ธนาคารเพื่อการเกษตรและสหกรณ์และมูลนิธิ สวค. กรมการข้าว กระทรวงมหาดไทย กรมโรงงาน สมาคมโรงสีข้าวแห่งประเทศ สมาคมผู้ส่งออกข้าวแห่งประเทศไทย ฯลฯ มาใช้ในการพัฒนาแบบจำลอง โดยทำการศึกษาทั้งหมด 7 กรณี ได้แก่ กรณีทั่วไป กรณีจำนำข้าว กรณีประกันราคาข้าว กรณีจำนำข้าวที่มีการคอร์รัปชั่น กรณีประกันราคาข้าวที่มีการคอร์รัปชั่น กรณีโปรแกรมเป้าหมายแบบให้ความสำคัญเท่ากัน (equal priority) และกรณีโปรแกรมเป้าหมายแบบให้ความสำคัญไม่เท่ากัน (unequal priority)

ผลการศึกษาสำคัญ มี ดังนี้ หนึ่ง ที่ดิน ทั้ง ที่ในเขตชลประทาน และนอกเขตชลประทาน เป็นปัจจัยสำคัญที่ขาดแคลน แต่การขยายพื้นที่เพื่อทำเกษตรกรรมนั้นเป็นไปได้ยากในทางปฏิบัติ ข้อเสนอแนะในด้านนี้มีได้เพียง 2 กรณี คือ การเปลี่ยนจากพืชชนิดอื่นเป็นข้าว และการขยายพื้นที่ชลประทานจากพื้นที่นอกชลประทาน ออกไป โดย ราคาเงาของการขยายพื้นที่ชลประทานบนพื้นที่นอกเขตชลประทาน คือ 4,111 บาทต่อไร่ต่อปี สอง ในปัจจุบันชาวนาไม่ได้ตัดสินใจบนหลักคิดที่เหมาะสมที่สุด (non optimized decision) จึงมีรายได้ต่ำกว่าที่ควรเป็น การส่งเสริมให้ชาวนาตัดสินใจบนหลักคิดที่เหมาะสมจึงมีความสำคัญ สาม ในภาพรวมการจำนำข้าวให้กำไรรวมของอุตสาหกรรม (total profit) สูงกว่าการประกันราคาข้าว และกรณีทั่วไป ซึ่งสาเหตุนั้นมาจากลักษณะโครงการที่ทำให้โรงสีขนาดเล็กซึ่งมีอัตราข้าวหักต่ำกว่าโรงสีขนาดใหญ่สามารถซื้อข้าวจากชาวนาที่ไม่ประสงค์รอเงินจากโครงการได้ กล่าวอีกนัยหนึ่งคือกำไรที่มากขึ้นไม่ได้เกิดจากเป้าประสงค์ของนโยบายเป็นหลัก อย่างไรก็ตามในกรณีที่มีการคอร์รัปชั่นพบว่าเมื่อทั้ง 2 นโยบายใช้งบประมาณเท่ากันนั้น การจำนำข้าวกรณีที่นำข้าวจากต่างประเทศมาสวมสิทธิ์นั้น "มีข้าวเข้าโครงการมากกว่ากำลังการสีข้าว ของโรงสีใหญ่ในโครงการ" ส่งผลให้ "ข้าวล้นโกดัง" ซึ่งเมื่อคิดมูลค่าความเสียหายแล้วสูงมาก ทำให้แม้การลักลอบนำเข้าข้าวจะเป็นการเพิ่มผลผลิตข้าวในประเทศไทยทางอ้อม แต่เมื่อหักลบกับความสูญเสียจากข้าวที่ล้นนั้น พบว่า "กรณีคอร์รัปชั่นจากการจำนำข้าว" มีผลกำไรรวมของสังคม "ต่ำที่สุด" ทั้งที่ใช้ งบประมาณเท่ากันทั้ง 4 กรณี ส่วน กรณีโปรแกรมเป้าหมายแบบให้ความสำคัญเท่ากัน (equal priority) และกรณีโปรแกรมเป้าหมายแบบให้ความสำคัญไม่เท่ากัน (unequal priority) ซึ่งใช้ได้ดีในกรณีที่ทุกผู้เล่นในอุตสาหกรรมทำการตัดสินใจร่วมกันนั้น พบว่า กรณีที่ให้ความสำคัญเท่ากันให้ ผลกำไรรวม สูงกว่ากรณีทั่วไป นั่นคือ การร่วมมือตัดสินใจร่วมกันทั้งอุตสาหกรรมจะให้ผลดีกว่าการแยกตัดสินใจ นอกจากนั้นในกรณีที่ให้ความสำคัญไม่เท่ากัน พบว่า ผู้ที่ควรให้ความสำคัญสูงสุดในอุตสาหกรรมนี้ โดยพิจารณาจากกำไรรวมของอุตสาหกรรม คือ ชาวนา รองลงมาคือ โรงสีขนาดเล็ก ผู้ค้าข้าวในประเทศ ผู้ส่งออก และโรงสีขนาดใหญ่เป็นลำดับสุดท้าย

สาขาวิชา เศรษฐศาสตร์ ลายมือชื่อนิสิต .....

ปีการศึกษา 2559 ลายมือชื่อ อ.ที่ปรึกษาหลัก .....

5485902929 : MAJOR ECONOMICS
KEYWORDS: LINEAR PROGRAMMING / THAI RICE POLICIES / GOAL PROGRAMMING / THAI RICE CORRUPTIONS

PISESPORN WASAWONG: Impact of Rice Policies on Thai Rice Industry. ADVISOR: PROF. ISRA SARNTISART, Ph.D., 188 pp.

From the review of literature on the study of the structure of the the value chain of the Thai rice industry , rice polices and the tools used to analyse rice policies. There are four crucial results . Firstly, the system of the Thai rice industry is studied. The system starts with the farmers who sell paddy to both large and small millers, and the millers mill and sell the rice to both exporters and domestic traders. Secondly, the rice price is determined by the world rice market. In addition, the rice price is determined by the population, world income, and world per capita income. Thirdly, the two main rice policies in Thailand involve rice pledging and rice price guarantee, which are more complicated than the policies in other countries. Fourthly, amongst the three main tools for the analysis of rice policies; econometrics, the computable general equilibrium model, and linear programming, linear programming is the most appropriate for this study because it can deal with complicated policies and it can also identify scarce resources and their shadow prices. In addition, linear programming can also be adapted for goal programming.

This study constructs and develops a Thai rice industry model by applying linear programming with data from many sources, including the Office of Agricultural Economics, the Bank of Agriculture and Cooperatives and the Fiscal Policy Research Institute, the Department of Rice, the Ministry of Interior, the Department of Industrial Work, the Thai Rice Millers Association and the Thai Rice Exporters Association. There are seven cases applied in this study; the normal case, the pledging case, the price guarantee case, the pledging case with corruption, the price guarantee case with corruption, goal programming with equal priorities and goal programming with unequal priorities.

The study revealed three main results. Firstly, normal land and irrigated land area are the scarce resources. However, in practice, it is difficult to expand the normal land area. There are two recommendations; changes from other cash crops to rice or to expand the irrigated land area by irrigating non-irrigated land areas. The shadow price of irrigated land that is developed on normal land is 4,111 Baht per rai per year for irrigated land. Secondly, farmers do not optimize their decisions, so their income is less than it could be. Therefore, farm optimization is necessary. Thirdly, the pledging policy yields higher total profit than the price guarantee and normal cases. However, the higher profit comes from a system that gives a chance to small millers who have a lower broken rice rate to purchase more paddy from the farmers who cannot wait for the money from the program. In the corruption case, the study found that when both price guarantee and pledging policies spend the same amount of budget, pledging, which is corrupted by smuggling rice from neighbouring countries caused a huge amount of smuggled rice to enter the market, which exceeded the milled and wasted quantity. Therefore, the pledging with corruption case is the worst. The last two cases represent goal programming with equal priorities and goal programming with unequal priorities. These two cases are appropriate for the case of cooperative decision-making in the industry. The study found that cooperatives, by deciding together, yield a higher total profit than individually decided cases. Moreover, the study also found that the player that should be prioritized first is the farmer, followed by the small millers, the domestic traders, the exporters and the large millers.

Field of Study: Economics Student's Signature .....

Academic Year: 2016 Advisor's Signature .....

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Chapter 1 :Introduction

1.1 Background

Rice is one of the most important products in Thailand and is very important for Thailand in many ways. In terms of economics, it is crucial for both the demand and supply side. On the demand side, rice is the main agricultural product that Thai people consume. In Thailand, 10.6 million tons of rice was consumed in 2015. With a population of 68 million, Thailand consumes on average 156 kilograms of rice per person per year. On the supply side, Thailand is one of the main rice production and exported countries. In 2015, Thailand produced 18.75 million tons of rice and exported around 21 per cent of the world rice market by value. In terms of the labor force, around 40 per cent of the labor force works in the agricultural sector in Thailand, and more than 50 per cent of farmers are rice farmers. In terms of its political impact, since around 20 to 30 percent of the labor force is rice farmers, rice is also very important for politicians. Finally in terms of its social importance, since rice is the main agricultural product, food and source of income for many Thai people, and it also strongly connected with Thai culture and the way of life.

Table 1-1 *:* Thai rice production and Consumption in 2015

	Value
Rice Consumption(million tons)	10.60
Population (millions)	67.96
Rice Consumption per Person per Year (Kg)	155.98
Rice Production (million tons)	18.75
Rice Produced per Person (Kg)	275.9

USDA and World Bank

From past to present, there have been a lot of rice policies implemented in Thailand. Many policies have played vital roles in the Thai rice industry and market.

Some policies are debatable in terms of pros and cons, such as rice premium, rice pledging and price guarantee policies. However, most farmers are still poor despite a lot of money having been spent on rice farming. It can be said that many rice policies have not really helped farmers.

Most of the main policies are debatable. For example, the pledging policy is blamed for huge spending and high levels of corruption, but the supporters argue that most of the farmers preferred and gained from the program. In contrast, the price guarantee program which was claimed by supporters to relieve the farmers' problems, did not involve market intervention .It was claimed by the opposition that farmer did not favour this kind of program .There is consequently, no unanimously accepted policy for the Thai rice industry.

Moreover, most debates are on specific topics, such as budget spending, corruption, and the losers in the program. Policy makers and researchers also rarely study the whole system. For example, the pledging policy is blamed by the opposition parties and media for high spending and corruption, by traders and rice agents for market intervention, and by some economists in regard to the question of Thai rice market power.

It is important to study the details of the whole industry along the value chain, the policies about rice, and to create an appropriate economic model to analyze the policies.

Therefore, the research questions for this study are geared to the study of the impacts of each policy when implemented in Thailand so that appropriate policies can be recommended.

1.2 Objectives

From the background, the objectives of the study are as follows:

- To understand the nature of the Thai rice industry along its value chain
- To gather information and to understand the policies on rice both in Thailand and other countries
- To create an appropriate model (s) for the analysis of the impacts of rice policies in Thailand
- To study the impacts for farmers, millers, traders, and the whole industry on the decisions and profits under the following scenarios
    - Under the normal situation (no corruption)
        - No Government intervention
        - Pledging Scheme
        - Price Guarantee Scheme
    - With Corruption
        - Pledging Scheme
        - Price Guarantee Scheme
    - Goal Programming
        - To solve the social objectives when all parties are equally prioritized
        - To prioritized some parties (unequally weighted)
- To discuss, summarize, recommend or determine the optimal policy for Thailand

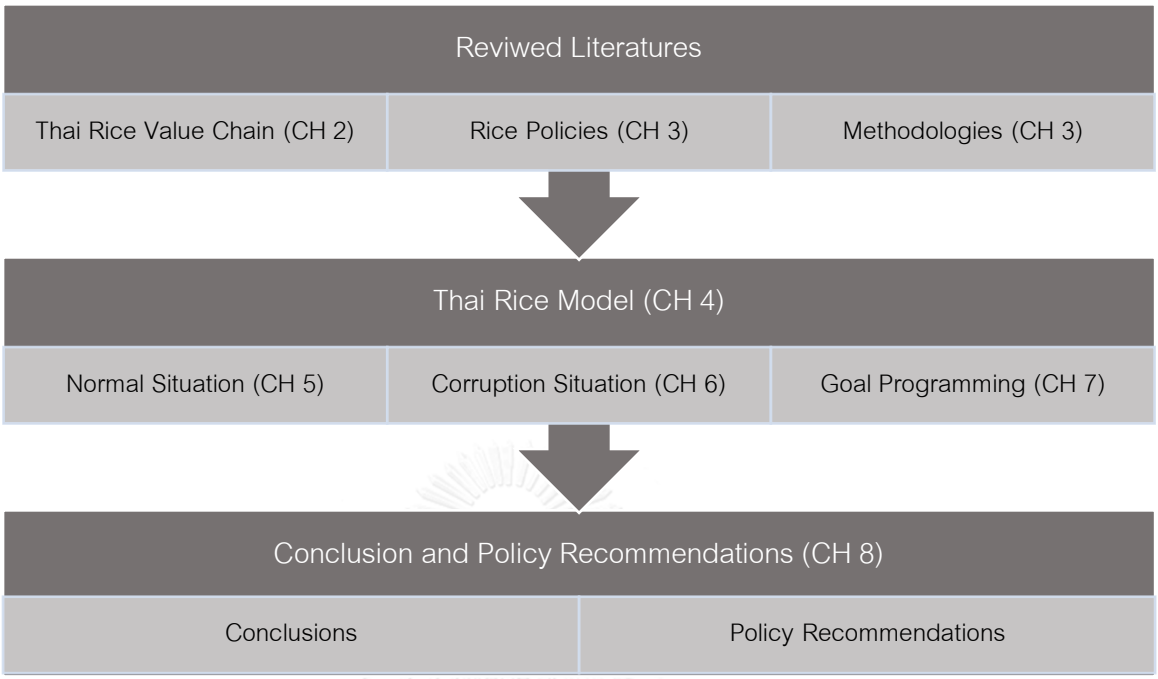
1.3 Scope of the Study

- This study will focus on only the main players in the industry, such as farmers, small millers, large millers, exporters, domestic traders, and the government.
- The main policies studied are the main policies implemented in Thailand after 1990.
- This study focuses mainly on the Thai rice industry
- The data and information applied in this study are current data and information (mostly not older than 5 years)
- Some market conditions such as land and other resource constraints, milling capacity, and market size are controlled

1.4 Study Flow

To achieve the objectives, the study follows the flow shown in figure 1-1. In figure 1-1, the study begins with the review of literature. After that, the study will create a model based on the reviewed literature. Finally, the findings will be concluded and recommendations for policy will be made in chapter 8.

Figure 1-1 :Study Flow

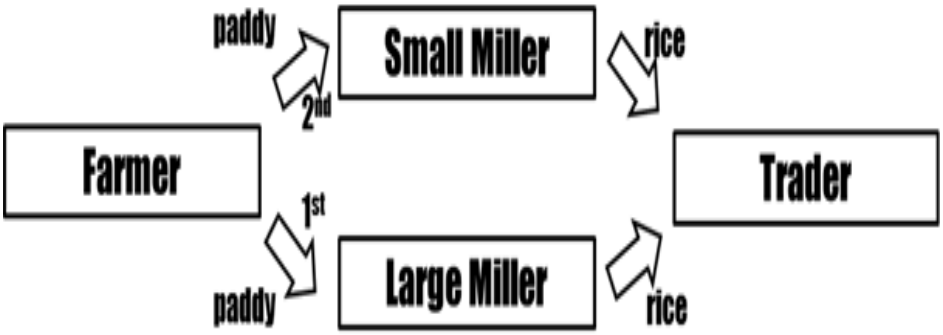


Source :Author

Review of Literature

For the review of literature, there are three separate parts in two chapters. The first part is the review on the Thai rice value chain. This part gathers information about the rice industry, especially the operational process .The Thai rice value chain is presented in chapter 2.

Figure 1-2 :Rice Value Chain



Source: From the study

Note: This brief version of the value chain will be applied in all models in the study

The second part is on rice policies. This part will provide information about the policies applied in Thailand and other countries. In regard to Thailand's policy, the study will focus on the process of policy implementation, which will be applied in the model section. This section is presented in chapter 3.

Finally, the review of literature will be on the methodologies applied in rice policy research.This part focuses on the advantages, disadvantages, and appropriateness of each policy. In the end of the section, the study will outline the optimal methodology for model creation in this study. This part is presented in chapter 3.

Thai Rice Model

With the information obtained from review of literature, the study will create a model based on the rice industry operational process presented in chapter 2 and the policy process implemented in the country by the methodologies applied in other rice policy research presented in chapter 3. The models will also be modified in regard to various cases according to the objectives of the study. For all cases, the study will begin with the assumptions, followed by the model, data, result and discussion sections.

In chapter 4, the basic model used for normal situation (no corruption) and the 'no government intervention' case will be constructed with the data applied in the model. After that, in chapter 5, the model will be applied and analyzed to arrive at a solution in the normal situation of no government intervention, pledging policy, and price guarantee policy cases.

Figure 1-3 :Model Diagram for the normal case with no government intervention

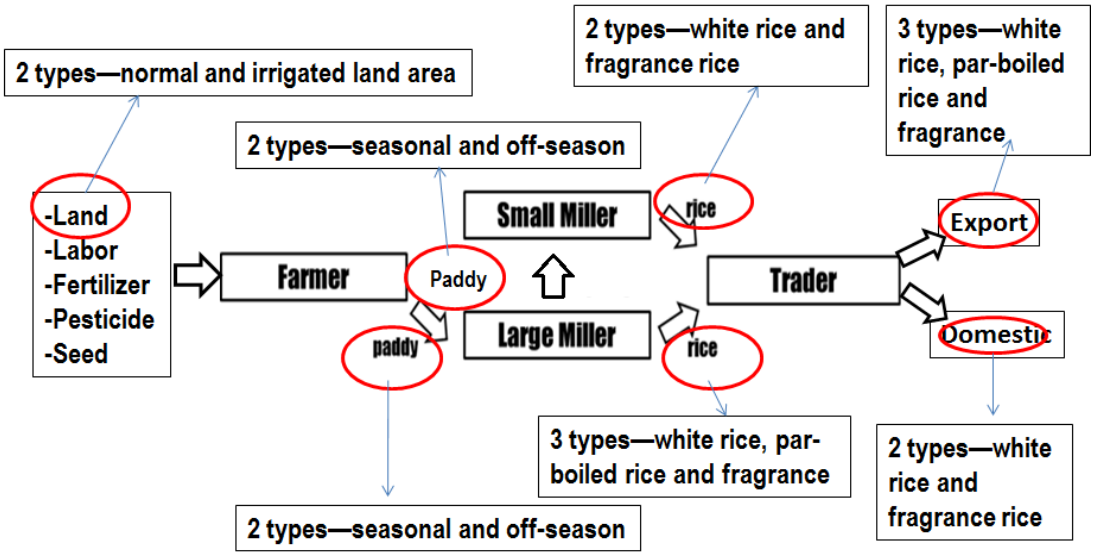


Figure 1-4 :Model Diagram for pledging case

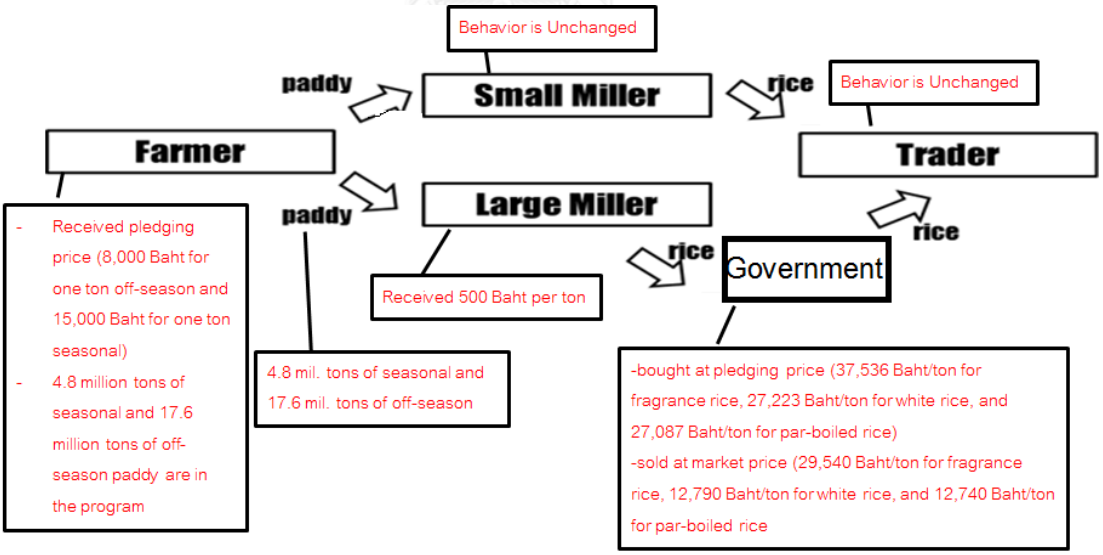
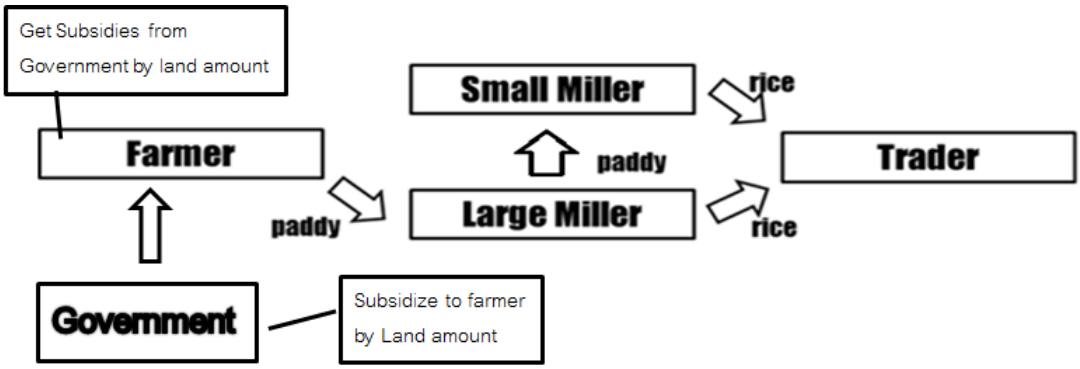


Figure 1-5 :Model Diagram for the Price Guarantee Case



Subsidy Rate = "Different between Guarantee Price and Real Price" X "Yield per Rai" X "Number of Rai"

In chapter 6, the corruption issue will be applied in the cases.The study will analyze the impact of corruption in both the pledging and price guarantee policies.This study will address the impact, prevention, the budget, and the way of detection and compare these two policies.

Figure 1-6 :Model Diagram for Corruption in Pledging Case (Paddy Smuggling)

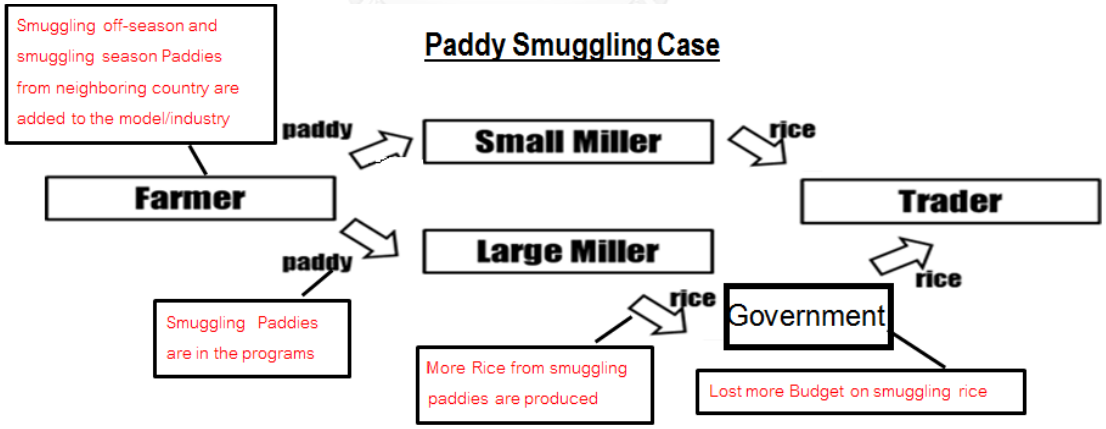
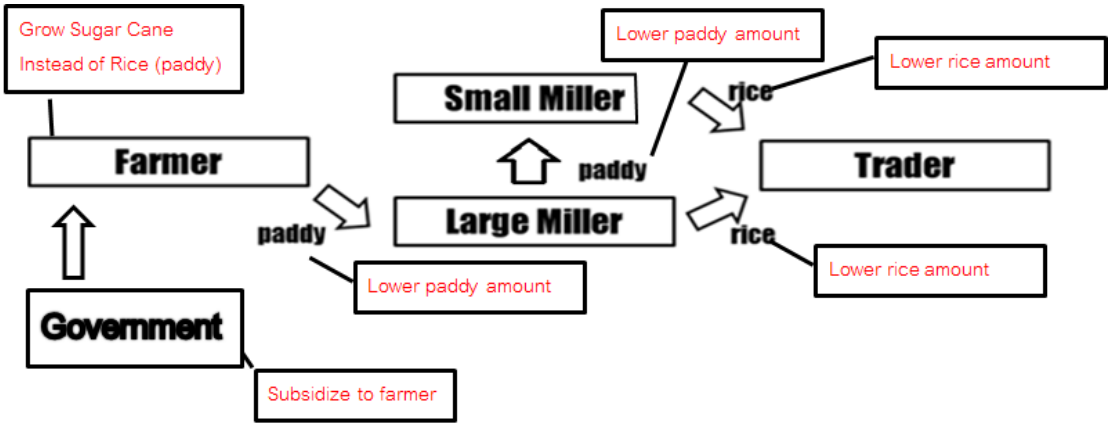


Figure 1-7 :Model Diagram for Corruption in Price Guarantee Case



Finally, in chapter 7, an alternative policy will be studied by using the goal programming method.The goal programming method will be separated into two cases; the equal priority case and the different priority case.The equal priority case aims to optimize the benefit for the whole society and has no priority party. It aims to examine the impact of cooperation compared to individual decision making in the industry. For the different priority case, the study also aims at benefits for the whole society, but there are some prioritized parties. For example, the government might prioritize the farmer in the policy. This part will examine the different impacts of different priorities.

Conclusion and Recommendations

This part will conclude the study and present the findings in the first part of the chapter. In the second part, the findings will be analyzed and discussed and suggestions for policy recommendations will be made. Finally, recommendations will be made in regard to the time period and further studies.

1.5 Benefits of the Study

In regard to the study flow shown in Figure 1.4, the benefits of the study are as follows.

Firstly, the study can enhance understanding about the Thai rice industry and the policies concerning Thai rice production. Although there are some studies on both the Thai rice value chain and Thai rice policies, those studies focused on different topics in the industry. This study can explore, summarize, and conclude new findings.

Secondly, this study attempts to explain the impact of each policy on each party in the Thai rice industry**.** With the model constructed in chapter 4 and the study from chapter 5 through chapter 7, the model can explain the impact of each policy in detail.

Thirdly, with the findings, the study can also assess the appropriateness of each policy applied in Thailand**.** The study can compare the advantage and the disadvantages and make recommendations for each policy. These recommendations can be combined with the recommendations for new and alternative policies to formulate appropriate policies for Thailand.

Fourthly, this study can also recommend new, alternative policies in the country**.** A duel technique can help to increase the value of rice yield, which can support research and development policy.The goal programming method can also be employed to study alternative policies related to cooperation between parties in the industry.

Finally, with the findings and recommendations for both the existing and alternative policies, a policy plan can be made. The recommendations for Thai rice policy plan can be made by combining all recommendations from the study. This plan can support and be applied by Thai rice public policy makers, such as the Ministry of Agriculture and Cooperatives, the Ministry of Commerce and the National Economic and Social Development Board (NESDB).

Chapter 2 :The Value Chain of the Thai Rice Industry

2.1 .Introduction

In the Thai rice value chain, there are three main players with vital roles in the industry. The farmer is the main player in the “upstream” sector of the industry while the miller is the significant operator in the “midstream” sector; the trader is an important player in the “downstream” sector. This chapter will explain all of these parties, in terms of types, products, and processes .In addition, other crucial roles of influencers such as government and agents are also explained. Lastly, the relationship between each party will be described.

2.2 .Farmers

The Thai rice value chain begins with the farmers in the “upstream” of the chain. The task of farmers is to grow paddy and sell it to millers. There are four types of farmer and four steps to grow paddy. The details are explained as follows:

2.2.1 .Types of Farmer

Farmers can be categorized by size and type of land. For size, there are small and large farmers. For land, there are irrigated and non-irrigated land areas. Therefore, there are four types of farmer including small farmers in irrigated land, small farmers in non-irrigated land, large farmers in irrigated land, and large farmers in non-irrigated land.

The small farmer occupies around five to ten rai per family, while the large farmer has a larger land area. Therefore, a large farmer can produce more paddy. However, with less land, a small farmer has more time to take care of his product and can produce a higher yield per rai.

In irrigated land areas, farmers can grow rice more than one time while only one time is possible in a non-irrigated land area. Normally, farmers in irrigated land

areas produce off-season rice while farmers in non-irrigated land areas produce seasonal rice. This is because off-season paddy can be cropped more than two times a year but it needs a lot of water to grow; thus, it can grow only in irrigated land area. However, normally the seasonal paddy is more expensive than the off-season paddy.

In 2013, around 12 per cent of the labor force worked in paddy fields[1]. By applying this ratio to the total labor force of around 40 million in 2015, there were around 4.8 million paddy farmers in the country.

2.2.2 .Types of Paddy

Before 1960, Thailand had barely developed paddy progenies. At that time, there was only seasonal paddy grown one time a year. From 1966, Thailand began to develop more paddy seed by adopting "IR-8" which was introduced by the International Rice Research Institute (IRRI). This paddy can be grown twice per year and provides higher yields than traditional paddy. At the present time, there are hundreds of paddy progenies in the Thai paddy seed market; however, the paddy seed can be separated into two main groups, photosensitive seasonal paddy and non-photosensitive off-season paddy.

In 1960, there was a food crisis. The Rockefeller and Ford Foundation established an organization called the "International Rice Research Institute (IRRI)" to respond to the problem. This organization launched their first experiments in the Philippines in 1966. The first project introduced the rice seed named "IR-8". This rice progeny provided the largest yield in the world at that time. This attracted the attention of rice growers around the world .In Thailand, Worawithaya Panichpatana, a government officer in the Department of Rice, mixed the IR-8 with Leuang-Thong-Na-Prang seed, which generated a new rice seed named "RD 1". "RD 1" is a modification of IR-8, which was developed to be appropriate for the Thai climate. Today, RD rice has been bred to create many progenies. The latest one is RD-47.

[1] National Statistics Office (2014) Labor Force Survey

Mostly, off-season paddy grows faster and provides a better yield. However, off-season paddy needs a lot of water so it needs to be grown in irrigation areas. Moreover, the off-season paddy mostly has more amylase, so the texture is not soft. Consequently, the price is lower than photosensitive paddy.

2.2.3 .Production Processes

There are four main steps to grow rice: land preparation, planting, maintenance, and harvest. All of these steps can be operated by both traditional methods and with machines, which can reduce the labor cost on rice farms.

Land preparation is the first step for growing paddy. Farmers need to prepare the land before the seedling process. This process is to make land appropriate for growing rice. This activity can be performed by employing traditional methods such as buffalo ploughing or by machinery such as tractors and pedestrian-controlled tractors. The normal tractor can work 15 to 40 rai or 2.4 to 6.4 hectares per day[2] whereas with the traditional use of bovine animals only 0.16 to 0.48 hectares per day can be worked since the animal can work for only 5 to 6 hours per day[3] .

Figure 2-1 : .Bovine (Buffalo) with Plough, Tractor, and Pedestrian-Controlled Tractor

Source :Department of Rice, Rice Knowledge Bank, www.brrd.in.th

[2] Department of Rice, Rice Knowledge Bank, www.brrd.in.th

[3]AmmarSiamwala and Wiroj Na Ranong

Seedlings can also be processed by both traditional methods and machinery. The traditional methods can involve both sown seeds and transplanted seedlings. Machinery includes blowing machines and seedling tractors. A sowing machine can work with the rate of 0.8 to 1.28 hectares per hour. The pedestrian-controlled tractor can seed at a rate of 0.24 hectares per day while a normal tractor can seed at a rate of 2.4 hectares per day or 10 times faster than the pedestrian controlled tractor. It can be seen that to seed by sowing is much faster than transplanting; therefore, today not many farmers grow rice by employing the transplanting method.

Figure 2 -2 :Sowing Machine and Pedestrian-Controlled Seedling Machine

Source :Department of Rice, Rice Knowledge Bank, www.brrd.in.th

For maintenance, farmers need three main inputs (excluding labor) which are water, fertilizer, and herbicide/pesticide. Paddy needs a lot of water, so in non-irrigated areas, paddy cannot be grown in the dry season (November to April) and is grown only in the rainy season (May to October). However, in irrigated land areas, farmers can grow off-season paddy all year round. Farmers in irrigated areas normally use pedestrian- controlled tractors to direct water into the farm.

For fertilizer, there are two types the organic and inorganic chemical. Organic fertilizer is much cheaper than chemical fertilizer but a greater quantity is required. The suggestion for fertilizer use is 500-1,000 kilograms of non-chemical fertilizer per rai[4], while only 20-35 kilograms of chemical fertilizer per rais needed. Moreover, organic fertilizer cannot control the amount of main minerals (nitrogen, potassium

[4] 1 Rai is equal to 0.16 hectares

and phosphorus), which is different from the chemical fertilizer. However, the chemical fertilizer harms the fertility of land in the long run. Therefore, the Rice Department[5] recommends using both organic and inorganic fertilizer.

On rice farms, there are both weeds and animals that can harm paddy production. Farmers need herbicides and pesticides to eliminate such attackers. In such processes, farmers can also employ sowing machines to spread fertilizers and other chemicals.

The last process is harvesting. In the past, Thai farmers did it manually mostly with a sickle as a tool, except in the south where farmers used a "krae" as a tool .Today, there are many machines that can be used very effectively for harvesting and threshing. Some machines are used with tractors and some are used individually. For example, a combine harvester-thresher machine can work 0.8 hectares per hour, so if it is used for 10 hours a day, it can work 8 hectares per day.

Figure 2-3 :Sickle, Krae, and Combine Harvester-Thresher Machine

Source :Department of Rice, Rice Knowledge Bank, www.brrd.in.th

As explained above, new highly technological machines can work much more effectively than traditional tools; therefore, the demand for agricultural machinery in the rice industry has grown rapidly in recent decades. Table 2-1 shows that between 2003 and 2006 there were 836,790 tractors used in the agriculture industry, while there were only 66,243 tractors in the industry between 1988 and

[5] Rice Department, "Rice Knowledge Bank", retrieved on 30th September 2016, http://www.brrd.in.th/rkb/

1992. In other words, the demand for tractors has grown by more than 10 times in 15 years .Moreover, many farmers purchased machinery to use not only on their land, but also to provide services to other farmers. For example, the rate for harvesting in Pijit is around 500 baht per rai[6].

Table 2-1 :Number of Machines Used in Thailand's Agricultural Sector

Period	Tractor	Pedestrian Controlled Tractor	Thresher
1978 - 1982	42,267	262,277	16,174
1988 - 1992	66,243	826,089	42,504
2003 - 2006	836,790	4,663,299	154,368

Source :Somporn Iswilanonda, 2011, Thai Rice :Industrial and Market Structural Change

Changes in demand also change the agricultural machinery industry .In 2011, Thailand spent 719 million dollars on imported agricultural machinery while exporting only 301 million dollars. The largest exporters to Thailand are Japan and China, while ASEAN such as Cambodia, Laos and Myanmar are the largest market of Thailand. The top three exported products are tractors, pedestrian controlled tractors and combine harvester-thresher machines. The top three imported products are tractors, combine harvester-threshers and track-laying tractors[7].

It seems that machinery is replacing labor. Recently, there have been some changes in the rural social structure[8]. In many regions of the country, farmers have no need to farm by themselves. They hire somebody with new machinery to farm instead. Therefore, with the introduction of machinery in the farming business, labor

[6]Fiscal Policy Research Institute & Bank of Agricultural and Cooperative (2012) *"A Field Survey on Thailand Rural Financial Landscape"*

[7]TradeMap, UNCTAD

[8]Somporn Iswilanonda, 2011, Thai Rice: Industrial and Market Structural Change and BAAC joined FPRI, 2012, IBID.

has been gradually substituted by machinery; in other words, labor is not an important factor in rice farming anymore.

2.3 .Millers

The miller is “midstream” in the rice value chain process. Millers buy paddy from farmers and mill it into rice. There are two types of miller and they can produce more than two types of rice. The types of miller, rice and processes are as follows.

2.3.1 .Types of miller

At present, there are more than one thousand millers in Thailand. However, they can be separated into two main types of miller, small and large. Small and large millers can be defined by their production capacity. Small millers produce less than twenty tons per day and large millers produce more than 20 tons per day.

Small millers can mill between one and twenty tons of rice per day. With a compact machine, small millers require less labor. Most of them have one to five workers in the rice mill. In addition, they can also mill a small amount of very rare or premium paddy, which has a lower percentage of broken rice (assuming the use of a well-maintained machine and the same type of paddy), which the larger miller cannot.

Large millers have a much greater capacity. They can mill from more than twenty tons per day to more than two hundred tons per day. However, with larger machines large millers require many workers and some technicians to operate and maintenance the machinery. Most large millers operate twenty-four hours a day and seven days a week. Moreover, although they cannot mill small amounts of rare or premium paddy, they can produce par-boiled rice which is popular in African markets.

The Department of Business Development (DBD) regulated the number of millers who requested the right to operate rice mills in 2015. This information shows

a total number of 886 millers in the industry .DIW separates millers into three sizes: small, medium, and large. There were 666 small millers, 152 medium-sized millers, and 68 large millers in the industry.

Compared with 2013, there has been a dramatic drop in the numbers of millers in Thailand. In 2013 there were about 1,097 millers in the country; this, rose to 1,108 millers in 2014, and dropped dramatically in 2015 by 20 per cent. The fall in the number of millers was mostly small and medium-sized millers at 21 and 22 per cent, respectively. The number of large millers increased from 58 to 68 millers in 2015. One of the reasons behind this phenomenon was the pledging policy which was run at that time. In that period, the rice market was booming so many small millers were established. For example, mini milling machines with a capacity of around one ton per day were sold around the country. New millers with new milling machines were established, until the milling capacity exceeded the supply of paddy, (which is shown in chapter 5). This over supply of new machinery led to new millers having no paddy to operate and they could not survive in the market. Consequently, the numbers of millers decreased.

Table 2-2 :Number of Millers between 2012 and 2015

	2013	2014	2015	Changes (%)
Total	1,097	1,108	886	-19%
Small	843	847	666	-21%
Medium	196	187	152	-22%
Large	58	74	68	17%

Source :Department of Business Development

2.3.2 .Types of Rice

The miller's task is to produce rice from paddy .In addition, according to section 2.3.1, large millers can also produce another type of rice called par-boiled rice .Most par-boiled rice is made from off-season rice because the demand for par-

boiled seasonal rice is low. Therefore, there are three main types of rice: seasonal rice, off-season rice, and par-boiled rice.

Seasonal rice is made from milling the seasonal paddy. As stated above, most seasonal paddy has a higher price than off-season paddy. Most seasonal paddy is grown in non-irrigated areas, especially in the Northern and North-Eastern region, and most of them are types of "fragrant rice". This type of rice has a natural fragrant, smelling like "jasmine", and low amylase (a soft texture), so it is also called "Hommali" or jasmine rice. The official name is "Dok Mali 101"[9].

Off-season rice is made from cheaper paddy, which can be grown more than one time a year. This rice provides high amylase, so it has a hard structure and no fragrant smell. Most of this rice comes from "RD" paddy and is sometimes called "white rice".

Par-boiled rice is also made from RD paddy, the same paddy as white rice. However, par-boiled rice is more convenient to cook and retains more nutrition than white rice. This type of rice can be made by steaming the paddy before milling, so it can be produced only by large millers who have steaming machines. It is popular in the African market since it requires no special equipment to cook it.

2.3.3. Production Processes

Small and large millers employ the same processes in their business. There are three main processes: purchasing paddy, making rice, and selling rice. Each process will be explained in this section.

The first process is purchasing paddy. In Thailand, most millers do not buy at the farm gate, but the farmer or rice collector will sell the paddy at the milling factory. Therefore, to reduce the transportation cost, farmers go to the mill that can buy a larger amount of paddy first, which is the large miller. Then, the rest will be sold to small millers. In addition, due to the transportation cost and the rice

[9]Also developed by Panichpatana

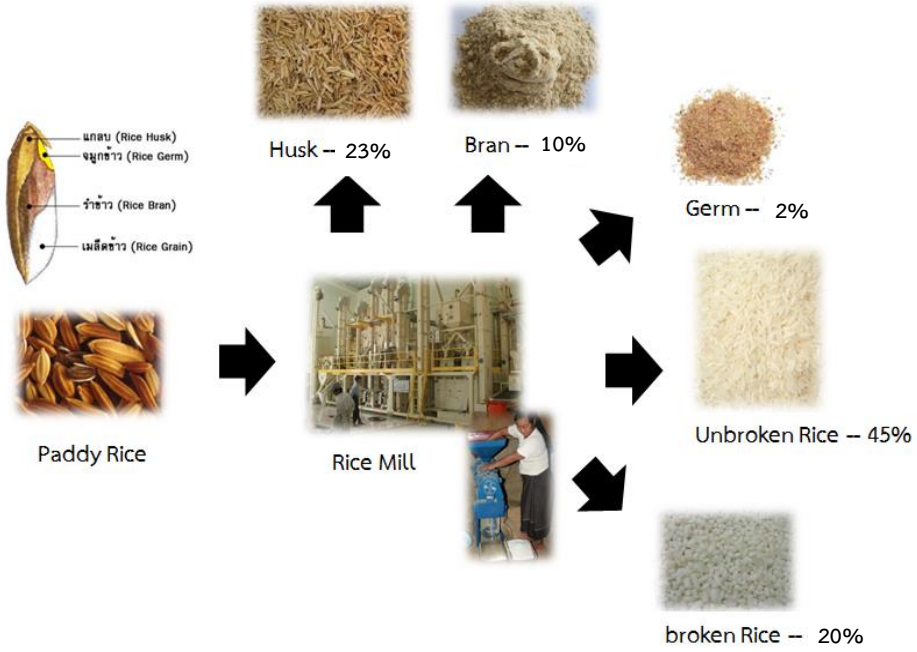
business culture, large millers, who normally have their own territory, do not purchase paddy from outside the area.

The second process is making rice from paddy. In this process, millers can decide which type of rice he will produce. The decision is based on factors such as price, capacity, cost, and market demand which will be explained in chapter 4.

Not all paddy can be used as rice. There are other by-products, which are husk, bran and germ. Around 65 percent of paddy is rice .The rest is husk (23 per cent), bran (10 per cent), and germ (2 per cent). In addition, in the process there is a chance that rice will be broken.From 65 percent of paddy, around 45 percent is unbroken rice while the other 20 percent is broken rice. In other words, the chance of broken rice is around 30 percent. It should be noted that the possibility of broken rice varies according to conditions, such as the paddy, and the machine. The small miller tends to have a lower percentage of broken rice. Kittipong Chaiwongsa (2014) showed that the rate of broken rice for small millers in 2014 was lower than the standard rate that the rice miller association states[10]. It may be because a smaller amount allows more time for the smaller miller to improve their production process.

[10] This production rate will be described in more detail in Chapter 4, section 4.3.

Figure 2-4 :Rice Milling Rate



Source :Adapted from Thai Rice Miller Association

All of the by-products can be sold .Husk can be sold to make energy, both as a briquette for cooking and for use in power plants. Bran can be used as an ingredient for animal food or extracts such as rice bran oil. Germ can be used for very high value-added products, such as cosmetics and wellness industry products . Broken rice is very useful for processed food products, such as rice noodles, pre-cooked boiled rice, and congee.

To make par-boiled rice, the miller needs a steaming machine to steam the paddy before milling. Consequently, not many millers can make par-boiled rice. With expensive machines and more complicated process, more cost is incurred to make par-boiled rice, but the price is higher than white rice.

The last process is to sell rice. Although the miller can sell rice directly to a trader or the market, normally, due to the transportation cost and the economies of scale, millers trade via agents. This kind of agent is called “Yong”, and they specialize in matching millers and traders. The “Yong” will be explained in detail in section 2.5.

2.4 Traders

Traders are the “downstream” in the value chain of the Thai rice industry . There are two main types of trader who operate in different markets .These two types of trader buy rice both directly from the miller and via rice agents .

2.4.1 .Types of traders

Traders can be separated into two types by the market in which they operate. The first market is the domestic market, and the other is the export market . Both markets require different activities and specializations. Therefore, these two types of trader compete in different markets. Even large enterprises that run businesses in both markets have to establish two departments for the domestic and export markets, and separate them completely. Sometimes, they even register different company names.

Table 2-3 :Thai Rice Production, Consumption, Stocked and Export Amount between 2013 and 2016

Unit :million Tons

	2013	2014	2015	2016
Rice Production	20.2	20.46	18.75	15.8
Rice Consumption	10.6	10.7	10.6	10.8
Stocked Rice	12.81	11.9	10.57	6.07
Rice Exports	6.72	10.97	9.78	9.8

Source :World Market and Trade, USDA

Table 2-3 shows the amount of rice production, rice consumption, rice stocked and rice exports between 2013 and 2016. It can be seen that rice production was between 15 million tons and 20 tons per year, while rice consumption (domestic demand) and the export market was around 10 million tons in each market. However, for stocked rice, the highest amount was in 2013 but it then dropped every year to 6.07 million tons in 2016. This phenomenon was a result of the pledging

scheme which was run from 2011 to 2013, since one of the scheme's ideas was to stock rice until the price rises. Unfortunately, the rice price has not risen until now, so the government needed to sell a large amount of rice stock to the market . Therefore, stocked rice decreased dramatically from 2013 to 2016.

For domestic traders, there are many players in the market and the market is competitive. Most of them purchase rice from Yong and sell through retail shops, which sell many rice brands. Therefore, the domestic market is very competitive in terms of price and quality.

For the export market, there are not many players. The top five exporters called the 'five tigers', play a vital role in the market .Their combined market share is around 50 percent of the Thai rice export value. In addition, each tiger has their own market and rarely tries to penetrate or compete with each other in the same market .The five tigers are "NakornLuang Rice Trading", "Asia Golden Rice", "Chaiyaporn Rice Trading", "PhongLarp" and "Thai Fah".

Table 2-4 :Thai Rice Export Destinations

Country	2014		2015		2016 (JAN-MAY)	
	Quantity *(Tons)*	**Value** *(Million Baht)*	**Quantity** *(Tons)*	**Value** *(Million Baht)*	**Quantity** *(Tons)*	**Value** *(Million Baht)*
World	10,969,344	174,851	9,795,781	155,912	4,281,585	66,471
Benin	1,112,602	15,565	805,765	10,240	465,235	5,824
China	734,765	12,364	958,368	16,316	444,321	7,353
Cote D'Ivoire	719,771	8,594	542,923	6,742	357,497	4,651
Indonesia	366,360	5,069	274,481	3,904	334,045	4,674
Malaysia	422,167	5,958	443,169	6,173	266,959	3,611
Cameroon	517,526	6,357	449,297	5,380	245,177	2,885
South Africa	535,645	7,691	568,751	7,592	211,093	2,812
U.S.A.	475,536	14,351	431,719	13,812	189,368	5,472
Philippines	353,044	4,568	821,088	10,080	148,206	1,878
Japan	336,893	4,517	282,613	3,909	140,120	1,908

Source :Information and Communication Technology Center with the Cooperation of the Customs Department

Table 2-4 shows the top 10 destinations for the rice exporters .There are four countries from Africa, including Benin which is the largest buyer; three from ASEAN, and two from East Asia .Benin, Cameroon and Cote D'Ivoire are not the final destinations for Thai rice .These countries are also rice distributors. The actual final destinations are Nigeria and other West African countries. However, in some countries, such as Nigeria, there are rice protection policies, for example, tariff barriers. Therefore, Thai rice exporters have to export via the neighbouring countries which are Benin, Cameroon, and Cote D'Ivoire.

2.4.2 .Rice Trading Processes

For these two markets, the traders have different targets .Exporters sell in bulk while domestic traders target individual consumers. Therefore, their processes are different.

For domestic traders, their process begins by purchasing rice and packing the rice for individual use. Their next process is to contact retail shops in the country and get the necessary licenses such as the Thai FDA and trading license.

Exporters do not need to pack in individual packages from Thailand, although they can also do that. They can sell in bulk and the rice will be repacked in the destination country. Their difficulty is to meet the destination country requirements, especially those with many licenses .However, the key to success is the marketing method to capture the market. For that, advertisement, promotion, and long term relationships are required, as there are not many exporters in the market.

In addition, each market has different tastes .Large markets for Thai rice include Africa, Asia, and Arab countries. African countries prefer par-boiled rice, while Asia consumes both white and fragrant rice. Arabs who earn high per capita income demand more expensive rice, such as Thai fragrant rice, and Indian basmati rice.

2.5. Other players

Other players play a vital role in the Thai rice industry. The first group is paddy and rice collectors. The second group is the government and research institutes. All of the groups will be described in the following section.

Paddy collectors can be separated into four groups: local, non-local, institute, and market. Non-local and local agents are mobile agents who come to buy paddy from the farm gate. Institutes like cooperatives and paddy markets are non-mobile agents where farmers have to come to sell their paddy.

Local and non-local agents charge a margin to buy and sell paddy. Local agents buy paddy from their own area, while non-local agents come from other places. Since non-local agents are from further away, their transportation costs are higher than local agents. Non-local agents have to buy at the same price as local agents, so they need to buy larger amounts to reduce the higher transportation cost problem.

The paddy market used to be popular in the past; however, after a long period of price distortion policy such as the pledging policy, the paddy markets such as “Tha Kao Kamnang Srong” were in deficit and needed to leave the market. At present, only institutions such as cooperatives play a role as a place where farmer go to sell his paddy.

Figure 2-5 shows the Thai paddy market and the market share of each agent . Local agents are the main channel for farmers to sell paddy .Around forty percent of farmers sell their paddy through local agents .The second channel is to sell to millers directly .Thirty-eight percent of farmers sell to millers directly .The other agents are non-local agents who earn 19 percent, and cooperatives earn 5.5 percent of the market share.

Figure 2-5 :Thai Paddy Market

Source: Office of Agricultural Economics

The other type of agent is the rice agent .The rice agent is called “Yong”. The Yong’s task is to match rice millers with trader. The Yong earns around 1 to 2% of trade value as a management fee. The management fee is more economical for both the miller and the trader than finding trade partners on their own.

The Research Institute is very important for the rice industry. It can reduce cost, improve quality and increase yield. There are two types of research institute in Thailand: private and government owned. Most of the research institutes are government bodies. Only a few research labs are run by private companies.

There are two main fields of rice research. The first is on-operation processes. This field of study includes, for example, paddy seed, fertilizer, herbicide, and machinery development. The Ministry of Agriculture and Cooperatives is in charge of paddy field research. For the rice milling process, research under the Ministry of Industry, aims to increase efficiency, for example by reducing the rate of broken rice, by reducing time and cost, and by improving quality.

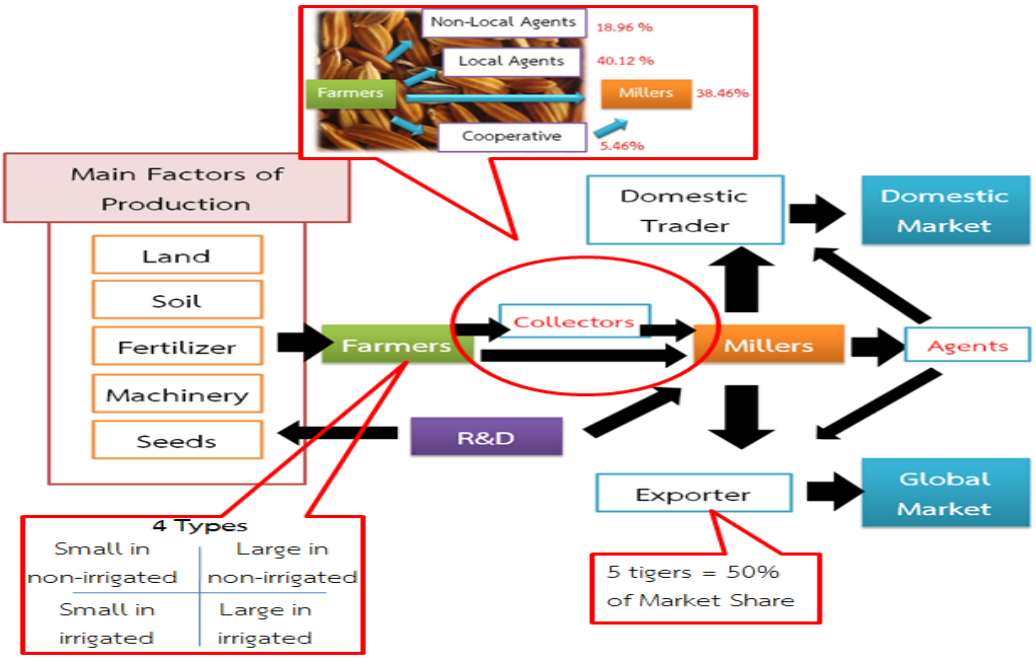
The other field of research is in the area of marketing and economics. There are many types of researcher working in this field. Some researchers work permanently as government officers for the Ministry of Agriculture and Cooperatives or with the Ministry of Commerce. This type of researcher mostly gathers data and information, conducts data and information analysis, and is involved in policy making. The second type of researcher includes those who co-work with the government. The main task of this researcher is to conduct research on government policy. The third type is the researcher who focuses on academic research. Most of these researchers are university professors. The last type works for private companies. Their research focused on private business interests. Most of these kinds of research are for example on market behaviour, demand and supply forecasting, market competition, and other business-related topics.

2.6.The Value Chain of Thai Rice Industry

According to the studies mentioned above and other value chain-related studies such as Somporn Iswilanonda, 2011[11], Agrifood Consulting International (2005) ,Ammar Siamwalaand Wiroj Na Ranong (1990), the Thai rice value chain can be depicted as shown in Figure 2-6

[11]Somporn Iswilanonda, 2011, Thai Rice :Industrial and Market Structural Change

Figure 2-6 :Thai Rice Value Chain



Source :Adapted from SompornIswilanonda (2011), Agrifood Consulting International (2005), and AmmarSiamwala and Wiroj Na Ranong (1990)

Figure 2-6 shows that the rice industry begins with the farmers who grow paddy by employing five main factors of production: land, soil, fertilizer, machinery, and seeds, and they sell their paddy to millers both directly and indirectly by trading through collectors. Millers transform paddy to rice by milling and they then sell it to traders who supply two markets, the domestic and export markets. Millers can sell to traders directly or via agents called "Yong".

Farmers can be separated into four types by their size (small and large) and type of land (irrigated and non-irrigated land). Small farmers normally obtain a better yield per rai than large farmers but gain lower benefit as a result of the smaller quantities and the inability to enjoy economies of scale. On irrigated land, farmers can grow off-season rice, which requires more water than seasonal rice. Although the seasonal rice gets a

higher price, it can be grown only one time a year in contrast to off-season rice, which can be harvested for at least two times a year.

For rice trading, more than 60 percent of paddy is traded via collectors. There are three types of collector: local agents, non-local agents and cooperatives. For Yong, there are many companies that work in this area. The business and the market are very competitive when the agents earn only one percent of the trade value in commission. Although exporters have a very low margin with a very high volume, they can obtain a large profit. For example, there are 5 main exporters called “the five tigers” .Each “tiger” specialises in a particular regional market and controls around 50 percent of the Thai export market.

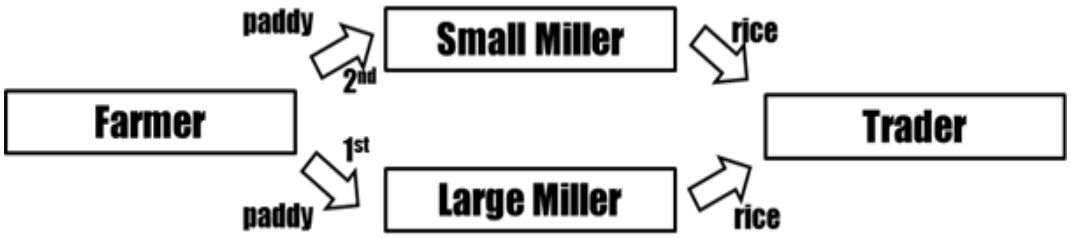
However, it can be seen that this value chain is rather complicated and might not be appropriate for model construction, which will be explained in chapter 4 . Therefore, a shorter and clearer value chain model can be adopted. Figure 2-7 simplifies the value chain to be more convenient and easier to understand .In this figure, the details of the factors of production and types of farmer are included as farmers, and exporter and domestic traders are combined as traders .Both collectors and agents are ignored in the simplified model as they play a minor role and earn only a small margin. In addition, millers are separated into small and large millers since they play different roles in the pledging scheme, which will be explained later.

In addition, large millers can buy paddy before small millers. The rationale is time and cost saving. It saves time and transportation cost for paddy collectors and large farmers to sell paddy in bulk at one place. Therefore, it can be seen that only 5 per cent of paddy is sold via cooperative organizations. In addition, it can be seen from the change in the number of millers between 2013 and 2015 in section 2.3 that only the number of small and medium-sized millers decreased while the number of large millers increased. As a result, the players who are impacted most from paddy shortage problems are smaller millers.

Therefore, this study applied the LP technique for every main player in the Thai rice industry, which consists of the farmers who grow and harvest paddy on their farms, the small and large millers who mill the rice, and the traders who buy the rice

from millers and sell it abroad or domestically. According to the Bank of Agriculture and Agricultural Cooperatives and Fiscal Policy Research Institute BAAC and FPRI (2013) , farmers will sell to large millers before small millers since large millers can buy more paddy, which reduces transportation costs.

Figure 2-7 :Value Chain of the Thai Rice Industry



Source :Author

2.7.Prices Determination

Although the decisions of the players in the rice industry are from the upstream farmer to the downstream trader, the price determination is reversed. According to (AFTC). the Agricultural Future Trading Commission, prices in the rice industry start from the world market price . In the second step, the price in the world market will signal the export price. Thirdly, the domestic market will adopt the price from the export price. After the export price and domestic price are announced or observed, “Yong” or the trader themselves will quote the price to the miller .Finally, the miller will use that price, calculated with their operation cost, and they determine the paddy price which is received by the farmer. AFCT explained the relationship of each stage which is as follows. It should also be noted that Chulaphan, Chen, Jatuporn, and Jiewiriyapant (2012) also explained it; however, in my opinion the AFCT explained it more clearly.

Figure 2-8 :Price Determination Processes

World Price → Export Price → Domestic Price →Miller Wholesale Price → Paddy Price

Source :AFTC

Firstly, the world price is determined mostly by non-domestic factors. In the review of literature, it can be seen that the world rice price is determined by factors such as world GDP and the world population, and it is not determined by the amount of rice. Therefore, the world rice price cannot be controlled.

For the relationship between world price and export price, the export price has to be nearly equal to the world price, since there are many competitors in the market, especially India and Vietnam. So, there are many researches that show that Thailand has no market power on world rice market. Therefore, "the export price is close to the world price" and cannot be controlled by traders.

For the domestic price, the domestic trader has to determine the price based on the export price. AFCT found the relationship at 40.89 plus 0.93 export price Thai Baht per ton .The coefficient (0.93) shows that the domestic price follows the export price. Therefore, these two prices of the traders cannot be controlled

Domestic price = 40.89 + (0.93 x Export Price) Bath per Ton

Although the traders' prices are largely determined by the world price and cannot be controlled, it seems that the miller and paddy price are not strongly related to the world price and can be controlled. For the miller, AFCT found a significantly relationship between the export price and the miller's wholesale price; however, the relationship is only 60 per cent. In addition, the AFCT study also found a lower negation power of the miller to the trader and Yong. The wholesale price is

determined as 60 per cent of export price minus 335.7 Baht per ton. This 40 per cent and 335.7 differences in price shows the low price negotiation power of the miller. AFCT hints that the reason may be because there are much more millers in the industry compared to the number of traders.

Miller's Price = (0.6 x export price) - 335.7 Baht Per Ton

Finally, the paddy price that the farmers received is determined mostly by the miller, since there are many more millers compared to farmers. According to chapter 2: value chain, AFCT and Chulaphan, Chen, Jatuporn, and Jiewiriyapant (2012), miller is the one who determined the paddy price based on the wholesale rice price, which Yong or trader quoted for him, and the reference price from Thai Rice Miller Association, which from the real trading price. With that price, miller will quote the price which farmer can go directly or sell via paddy collectors who finally also sell the paddy to the miller at the quoted price. Therefore, in other words, "paddy price is determined by the price that trader quoted for miller comparing with the operation cost and the power to negotiate with the farmer. AFCT found that miller has more negotiation power than farmer. The wholesale and paddy price related to export price at 60 and 50 per cent relatively. Therefore, miller has more bargaining power than the farmer.

In reality, Chulaphan, Chen, Jatuporn, and Jiewiriyapant (2012) claimed in their research that the price in each level is at equilibrium. This is close to the fact that after the price distortion policy period (pledging policy period) these prices in each stage was quite stable for many years .In addition, the real fragrant rice price (figure 2-9) was similar because

(1) The world price is close to the export price and is uncontrollable
(2) The export price is close to the domestic price and is uncontrollable
(3) Wholesale price is mostly controlled by traders or their agents, not the miller
(4) Paddy price is mostly controlled by millers, not the farmer

Figure 2 9 :Real Fragrance Rice Price in each Stage

Export Price → Domestic Price → Miller Price → Paddy Price

(33,958) (32,000) (29,540) (15,000)

Note : (1) Number in parentheses is price in Baht per ton

(2) This 15,000 Baht per ton is for paddy not the pure unbroken fragrance rice .With this price and by-product price, the cost for miller can be calculated at 27,358 Baht per ton

However, Chulaphan, Chen, Jatuporn, and Jiewiriyapant (2012) and AFCT admitted that the government policy such as pledging policy in the past also impacted paddy and miller prices. In pledging policy, the government and the millers in the scheme announced to buy all paddies from the farmer at the pledging price. With that pledging price, other millers hardly bought any rice at the lower price. Therefore, the market price was an intervention and had to be changed almost to the pledging price.

Nevertheless, export and domestic prices cannot be changed by government policy. Those prices are controlled by world market, which cannot be controlled. Therefore, the real focus is on the wholesale price determination in this situation. In the normal case, millers hardly ever negotiate with traders, since there are many millers compared to traders in the market, but in the pledging case, the government plays the role of a semi monopolist for rice mills. Hence, the bargaining power is changed to the government side not the traders. In addition, the price influenced by the government will also be applied as the benchmark price for the other millers as the market wholesale price.

Unfortunately, instead of transparently and quickly openning the rice bidding, the government at that time decided to stock the rice and expected that the world market price will be increased. The world rice market is proven not to be affectted by stocking rice in many researches and this was an error on the part of the government. Moreover, this bad decision took a very long time until the trader noticed that it was over stocked. Therefore, the bargaining power with traders was lost.

In conclusion, it can be seen that although the export and domestic price cannot be controlled and intervened by the government, the paddy and wholesale price which normally are mostly controlled by miller and trader, respectively, can be controlled and intervened by the government.

2.8 Summary

In this chapter, the value chain of the Thai rice industry is studied to establish basic knowledge for the next chapters. The value chain has been described from farmer to trader in detail. The details will be provided mostly in chapter 4 and chapter 5.

For the Thai rice industry, there are three main players: farmers, millers and traders. Farmers grow and harvest two types of paddy: seasonal and off-season paddy. Large millers have the opportunity to buy rice before small millers. However, both of them can decide the optimal amount of paddy in the rice production process. There are three main types of rice they can produce: fragrant rice, white rice, and par-boiled rice. Finally, traders buy rice from millers and sell to domestic and export markets.

Moreover, it can be seen that the farmer gains the highest value-added (or profit margin per unit) compared to millers and traders .However, there are more than 4.8 million farmers while there are only 886 millers in the country. Therefore, the profit per farmer is much lower than that of the millers and traders.

The next step is to bring this knowledge to set up a model that is appropriate for the research question .In chapter 3, the literature review, the main objectives are presented on (1) understanding the main policy, (2) understanding the techniques applied in rice policy research and (3) deciding on an appropriate technique for this study. In chapter 4, the technique selected in chapter 3 will be applied as a model baded on the knowledge of the rice value cahin provided in this chapter.

Chapter 3 :Literature Review

3.1 .Introduction

Chapter 2 presented the important information about the rice industry along the value chain. The background knowledge about rice was also presented in that chapter. However, chapter 2 did not present the two most important pieces of information in the study: the rice policies and the methodology previously employed in rice studies. The literature on these topics is reviewed in this chapter.

This chapter separates the literature into two topics; the literature on rice policies and that about the methodology of previous rice policy studies. The rice policy study focuses on the topic, types of policy and the results of the policies. The aim of this section and subsequent chapters is to study the impact of each rice policy.

The second half of the chapter focuses on the methodology of rice policies. The review is mostly on the pros and cons of each method and how methodology can be applied in this study. In this chapter, the most appropriate method will then be selected.

3.2 .Literature Review

As mentioned in Chapter 1, rice is a crucial product in Thailand, Asia and the world. There is much literature on rice and the rice industry. However, with regard to the study objectives, only research on the rice market, the rice industry and rice policy is included.

The study is separated into two parts; the literature on types of related research and the literature on the main methodologies applied in rice policy research. The details of the study are as follows.

3.2.1 Related Research on Rice Policies

Due to the importance of rice, many rice policies are applied around the world. In addition, rice production is related to the size of the population in many countries. In many countries, rice is an important consumer product that involves most of the labor force and is a main agricultural product. It can be seen that rice policies affect many people. Therefore, there is much literature on rice policies. In this section (section 3.2.1), the literature is studied and then separated into three types; rice policies, the impact of specific rice policies, and Thai rice policy.

Literature about Rice Policy

Many rice policies have been launched around the world .For example, there are many policies employed to protect domestic rice industries, and many policies for export promotion .It is necessary to begin this section (section 3.2.1) with the literature on the rice policies implemented around the world.

There are many studies about the rice policies implemented around the world .However, the two researches this study focuses on are Manita Rakotoarisoa (2006) and Satimanont, Montien (2006) Rakotoarisoa (2006) is one of the popular papers about rice policies which has been reviewed by many papers .However, in my opinion, Satimanont (2006) described it in a better way than Rakotoarisoa (2006) .First of all Satimanont (2006) provided more details than Rakotoarisoa (2006) The reason is that Satimanont (2006) is a book, while Rakotoarisoa (2006) is a research paper, so Satimanont (2006) describe the policies.in more detail. Secondly, Satimanont (2006) could, in my opinion, categorize the policies in a more useful way for policy makers . Satimanont (2006) categorized the policies in terms of having or not having an allowance from the WTO, while Rakotoarisoa (2006) categorized policy in terms of objectives .

Satimanont (2006) separated policy into three main types :green box, amber box, and special treatments for developing countries .Green box policy is the allowance and support by the WTO to implement, for example, research and development, tariff reduction and the expansion of irrigated areas .Amber box policy

is policy that is not prohibited, but not supported or claimed to be allowed by the WTO .Pledging policy, guarantee policy, and the establishment of a government body to monopolize the market, like BULOG in Indonesia, are examples.Table 3-1shows the example and descriptions of policies in each type as categorized by Satimanont (2006) .

Table 3-1 :Types of Rice Policy by Allowance Level

Amber Box	Green Box	Special Treatment
- Pledging Policy - Price Guarantee Policy	- Research and Development - Service, Analysis, and Advice for Paddy Farmers - Rice Production Promotion - Infrastructure Development	- Soft Loan - Construction of Silo and Warehouse - Establish Paddy Market - Support for Factors of Production

Source :Satimanont (2006) "Rice Under World Trade Organization"

In contrast to Satimanont (2006), Rakotoarisoa (2006) separated the policies into three groups; consumer protection, producer/farmer subsidies and balanced policies .Consumer protection policies, theoretically, should be applied for net importing countries (i.e .those who consume more than they produce). However, many non-main rice producing countries such as the EU, Korea and Taiwan do not apply these policies .Examples of consumer protection policies are low/reduced tariff and non-tariff measures (NTMs) and export tax, such that there is an adequate amount of rice in the domestic market .There are many producer/farmer subsidy policies in the group; for example, direct payments, high tariffs or NTMs, government purchases and export subsidies. The last type of policy is balanced policy .

Rakotoarisoa (2006) gave the example of Badan Urusan Logistik (BULOG) in Indonesia as a case[12] .Table 3-2 shows how Rakotoarisoa (2006) categorized the policies.

Table 3-2 :Rice Policies in Selected Countries

Policy	Country
1. Consumer Protection	
1.1. Reduce Tariff or Other NTMs	Bangladesh and Madagascar
1.2. Export Tax	Argentina
2. Producer/Farmer Subsidy	
Direct Payment	EU and US
High Tariff and NTMs	Japan, EU, Korea, Taiwan, and Nigeria
Government Purchase	Taiwan and Korea
Export Subsidy	India
3.Balanced Policy	
Setting up State Enterprise	Indonesia and Philippines

Source :Rakotoarisoa, 2006, Policy Distortion in the Segmented Rice Market

Literature on the Impact of Specific Rice Policies

After the literature on rice policies has been reviewed, the literature on some specific policy is the focus of this part. It can be seen from literature on rice policies that there are many types of policy, and although some policies have the same objective, the processes that are implemented are different. For example, even though reduced tariff and export tax have the same objective to protect the consumer, the methods of implementation are different. The export tax charges the

[12] Indonesia is one of the countries, including Thailand, which has large numbers of both farmers and consumers .To balance both consumer and producer benefits, Indonesia founded BULOG to manipulate the domestic rice market .According to the law, BULOG is the only enterprise that can both import and export rice in Indonesia; therefore, the domestic market will be monopolized by BULOG .The enterprise called The National Food Authority (NFA) was also founded in the Philippines to function like BULOG.

tax to the domestic exporter, but increased tariff charge tax is levied on foreign importers. Therefore, the study focuses on only one or two policies.

In addition, most research applied only one main tool, so each one chooses policy for the same type of implemented process .For example, although tariff reduction and tariff raised policy have different objectives, the first for consumer protection while the second to support domestic producers, the implemented processes are both 'changes in tariff level'.

The first group of literature on the impact of policy is the study of changes in the tariff level .This literature includes, for example, Caecar Cororaton (2004) Center for Agro-Socioeconomic Research (CASER) (1997). Rizwana Siddiqui (2007), Cororaton (2004), CASER (1997), and Siddiqui (2007), who applied computable general equilibrium (CGE) methods to determine the impact of tariff changes in different countries. Cororaton (2004) (studied the impact of tariff changes in the Philippines; Caser (1997) studied the case of Indonesia and Siddiqui (2007) focused on Pakistan.Unfortunately, other types of policies are rarely researched, except for Thailand which will be explained in the next part .It may be because of the lesser impact of such policies .According to Table 3-2, which presents rice policies in selected countries, most non-tariff policies are applied in non-rice major countries such as Taiwan, Korea, the European Union, and the United States, so those policies do not have much impact unless it is of social interest .

However, there are some studies on the impact of subsidy policy .One of those is Frank Rose (1977) who studied the impact of rice policies in Sierra Leone on farmers and the processing sector .Rose (1977) ran the model for 10 different scenarios .Most of the policies were direct subsidy or technology changes. Rose (1977) found that direct subsidy impacted farmers but not millers. However, technological improvement policy is more effective .Even without subsidy, technological improvement helps farmers in the long run.

Although most of the literature on rice policy is on tariff changes and not on other types of policy, there is much research indirectly related to rice policy. These types of research focus on specific behaviour in specific rice markets, especially on

the impact of price in the rice market .For example, the study on the different impacts of price rise and price reduction can be used to make impact comparisons between tariff reduction and tariff rises .The difference in the impact of price changes along the rice value chain, for example, the price at the farm gate and the retail shop, can also be explained in terms of policy such as subsidy, direct payment, and government purchase .

Literature on Thai Rice Policy

According to Rakotoarisoa (2006), which is shown in table 3-2, most rice policies implemented in countries around the world, are different from Thai rice policies .At present, as a main rice exporter, Thailand applies most policies on farmers and producer support, not on consumer protection, which is different from the past .In addition, rice is the major agricultural product in Thailand, so policies have a very large impact in the country. Consequently, there is much literature on Thai rice policies. This part will begin with the policies applied in Thailand, followed by the literature on it.

There are two main periods of rice policy in Thailand; the period of consumer protection and the period of farmer support. The first period involved consumer protection policy. The government at that time decided to apply export tax, which they called a “premium”, on rice products. From 1950 to 1986, rice premium policies were launched to ensure that the domestic market had sufficient rice for domestic consumption. Moreover, with a larger amount of rice in the domestic market, the domestic price will be lower. Therefore, this policy can ensure that the amount of rice in the domestic market is sufficient and the domestic price will not be high.Therefore, domestic consumers, who are mostly middle to high income people leaving in urban areas, will gain the benefit while farmers, who are mostly lower income people living in rural areas, will get nothing or be even worse off as a result of the lower price

Thanabhan Laiprakorbsab (2011)[13] explained that consumer protection policies that support richer people have been used mainly in non-democratic periods since in this period, middle and high class people had greater power in the political environment .This is different from Thailand in democratic periods .Since farmers represent a large number of voters, when the political system is democratic and the government relies on winning votes, political parties need to launch policy for the benefit of their supporters, who are farmers .Therefore, after 1996, rice premium policies have not been implemented again until now.

After 1996, Thai rice policies have focused on the farmer .Two major policies have been launched, pledging policy and price guarantee policy[14] .The Thai Rak Thai party, which was led by former Prime Minister Thaksin Shinawatra, now called the Pheu Thai party, launched a rice pledging policy .The Democrat party, led by former Prime Minister Abhisit Vejjajiva, launched a price guarantee policy .Although these two policies have the same objective, which is increase farmers' income through price, the implementation was different.

Pledging policy had been implemented since 1981 .The original idea was that most farmers needed to sell the rice when the market price was low because they could not wait until the price was higher .Therefore, the government assisted them by allowing them to pledge their rice .In this policy, the farmers who want quick money can come to the rice millers who join the program and ask them to pledge the rice. With this process, at first, the rice miller will give money to the farmers based on the pledging price .When the price of rice is higher than the pledging price, the farmer can buy the rice back to sell at a higher market price. Therefore, the government at that time pledged the purchase of rice in the low price season with a pledging price that was between the lowest and highest price (higher than the lowest price period but lower than the highest price period).

[13]Thanabhan Laiprakorbsab (2011) "Politics and Rice Policies in Thailand"

[14]Minor policies such as rice seed research, and growing and harvesting techniques are excluded.

However, the pledging policy of Phue Thai was different .A new model of pledging policy was run in 2004, with the pledging price higher than highest price period .Therefore, farmers did not come to get their rice back[15] .With this phenomenon, the government had to stock the rice and sell it later, mostly at a lower price than the pledging price and consequently spent a lot of public money.

Different from pledging policy, price guarantee policy does not involve pledging rice .In a price guarantee policy, the government will set the price guarantee per hectare and limit the number of hectares per farmer .For example, if farmer "A" has a 10 hectare rice farm and the government estimates that 1 hectare can yield 1/10 tons and the price in that year should be 10,000 Baht per ton, then the government guarantees at 1,000 Baht per hectare .Therefore farmer "A" is guaranteed to earn 10,000 Baht in this year .After that, the government will pay the difference between the guarantee price and the actual price based on the estimated amount of rice production (which is calculated from the number of hectares). For example, assuming that the actual market price is 8000 Baht per ton, the government can estimate that the farmer will get only 8,000 Baht per hectare (8,000x 1/10 x10 =8,000 Baht). Then the government has to pay 2,000 Baht per hectare to subsidize the farmer.This policy is claimed to cost less than the pledging policy . However, this policy was not widely accepted by farmers due to many problems, especially the more complicated process[16] and the smaller amount of government support.

Since these two policies were run by different main political parties in Thailand, and the policies impacted farmer and most Thai people, there is much literature on them. Many Thai Economists, in particular, Ammar Siamwala and Nipon

[15]Office of Agricultural Economics (Cholbur), (2009), Analytical Comparison between Pledging and Price Guarantee Policies

[16] IBID and Thailand Development Research Institute (2011) Recommendations for the Development of Rice's Price Guarantee Policy

Poapongsakorn (2011)[17] do not agree with pledging policy and support price guarantee policy. Ammar and Nipon (2011) commented on three main issues which were:

- **policy distribution**: from their research, it was found that middle income and rich farmers gained more benefit from the pledging policy than poor farmers
- **government budget and the ability to sell rice stock**: since the government has poor methods to sell rice, the rice in stock cannot be sold. Then the government has no budget to run the scheme or implement other valuable policies such as infrastructure development.
- **high yield but low quality:** since this policy does not grade rice, farmers want to produce more rice without consideration to quality.

However, there is some support for pledging policy from both economists and non-economists for example Niti Iewsiwong (2011) and Pichit Likitkijsomboon (2011) Pichit (2011) replied to Ammar and Nipon (2011) that

- It is normal that the poor farmer, which Ammar and Nipon (2011) defined as a farmer whose income from pledging was less than 200,000 Baht, has less benefit than middle income and rich farmers because they have less land and product. However, they still have a very high benefit per head and this benefit is higher than a price guarantee policy

[17]Ammar Siamwala and Nipon Poapongsakorn (2011) reply to "Change Thailand with Pledging Policy" by Nithi Iewsiwong

- For the government budget, though it seems that the government needs to spend as much as 300,000 million Baht for the whole program, this amount is only 6 percent of the public debt. In particular, if we compare it to the 1.1 trillion Baht government spending on Bangkok International Banking Facilities (BIBF) in 1997, this amount is very small.
- Though pledging policy makes farmers care only about quantity but not quality, there is no evidence that price guarantee policy is any differentin terms of quantity and quality.

However, it can be seen that these two arguments are opinions which are not necessarily based on qualitative research and empirical data .However, there is some quantified research on the policies, especially the pledging policy, which will be explained as follows.

It seems that no quantified research supports the pledging policy .First is Puapongsakorn, et.al (2014) who claimed the inappropriateness of the program . Puapongsakorn, et.al (2014) applied economic model about rice market and the welfare cost to study and found that "although the farmer earn 560 billion Thai Baht from the program, most of the profit comes to the large farmer, the total welfare is lost for 123 billion Thai Baht .In addition, Puapongsakorn, et.al (2014) also found that the program created the lost from corruption at 84.5 billion Thai Baht[18] .

Itthipong Mahathanaseth (2014) also claimed inappropriateness . Mahathanaseth (2014) studied one of the core ideas of the over pledging price

[18] Although focused on similar topics, this studyis differentfrom Puapongsakorn, et.al (2014). Puapongsakorn, et.al (2014) used the economics welfare model to explain the impact of pledging policy, however, this study applied the operation research method. This study focused on many other conditions in rice industry, especially for the different decision between large and small miller which will be changed, due to the pledging program, while Puapongsakorn, et.al (2014) does not focused. Many conditions omitted out by Puapongsakorn, et.al (2014) are taken into this study. Therefore, this study yield a different result from Puapongsakorn, et.al (2014)

program, which is market power .The Pheu Thai government observed that in 2011 Thailand had 27 percent of the world rice market share, so they thought they could control the price via the pledging program. However, Mahathanaseth (2014) found that the idea was incorrect since Thai rice has no market power in many rice markets. Therefore, Mahathanaseth (2014) concluded that overall, Thailand should not have launched the over pledging price program, except in some rice and other markets . Mahathanaseth (2014) found some market power for fragrant rice in some markets and for par-boiled rice in the African market. Hence, Mahathanaseth (2014) recommended the policy to be applied only for certain specific types of rice.

The only research about the impact of rice pledging which did not indicate the inappropriateness of the program was Chulaphan, Jatuporn, Chen, and Jiewiriyapant (2012). Chulaphan, Jatuporn, Chen, and Jiewiriyapant (2012) analyzed the long run equilibrium relationship between farm gate, wholesale, retail and export prices in Thailand and found that the largest impact of farm gate price is on export prices followed by wholesale prices. Therefore Chulaphan, Jatuporn, Chen, and Jiewiriyapant (2012) concluded that exporters would suffer most from producer support policy in Thailand. Therefore, it can be seen that although Chulaphan, Jatuporn, Chen, and Jiewiriyapant (2012) did not suggest the inappropriateness of the program, they did not support the policy because the study is on the individual party impact, not the overall economic impact.

3.2.2 .Related methodologies on Rice Policy Study

Econometrics

One of the most popular tools applied in economics research is the econometric model .In rice study, there are also many econometric models that are applied .Two main research questions on Thai rice using econometric models were studied at different periods of time: the study of rice demand and the study of rice market behaviour.

In the period before 1981, there was much research on rice demand. Wute Erawan (2006)[19] reviewed much literature on rice demand, especially those employing econometric models. Erawan (2006) found from the literature that rice demand depends on rice price, market income, the population, the exchange rate, and the volume of rice production.

However, most literature that identified the significance of price on rice demand was before 1981, such as Atikul (1976), Daly (1973) and Ramangkura (1976). Most literature after 1981 found relationships with other variables, especially income, the population, and the exchange rate, for example, Hossain (2000), Langley (2000), Regmi and Gehlhar (2001), and Erawan (2006). However, in the literature review of Erawan (2006), the insignificant relationship between rice price and rice demand in literature after 1981 was not explored although his study, which applied an econometric model, also found no relationship between them.

It seems that the latest rice demand studies found strong relationships between rice demand and non-price factors, such as income and population .In other words, there is no market power for Thai rice .Therefore, the rice market strategy is not “stock”, “speculate” and “sale”, but uses other strategies, such as marketing promotion, yield and quality improvement .Hence, the next period investigates rice market behaviour.

Different from rice demand study, rice market behaviour not only affects demand, but also other variables .In addition, this type of study is not only focused on the magnitude of the relationship, but also on the direction and impact differences at different stages of rice production.These kinds of methods are for example price transmission studies.

Price transmission is the method used to study the impact on all main sectors along the value chain .However, price transmission is focused mainly on how one price change impacts other prices.

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[19]Wute Erawan (2006) Demand, Price and Competitive Strategy for Thai Hom Mali Rice in the Global Market, Dissertation, Ramkhamhaeng University.

The Basic Idea

Price transmission has been employed to study the impact along the value chain through price-based mechanisms, for example, to see the impact of export rice price change on the paddy price at the farm gate .Therefore, this model is based on law of one price, which states that the price of the same product in different markets should be equal at equilibrium .For example, Kasperse and Foyn (2010)[20] used the law of one price to construct the model as

$$P_{1t} = \alpha + \beta P_{2t} + \varepsilon_t$$

Where

P_{1t} and P_{2t} =price of the same product in market "1" and "2" at period "t"

α = transaction cost

β =degree of price transmission (β =1 mean law of one price is perfectly occurred)

ε =error term

The model can be modified into another form, subject to the appropriateness of the research questions, for example, Cudjoe, Bresinger, and Diao (2009)[21] modified it by adding transportation cost as

$$P_{1t} = P_{2t} + T$$

Where, "T" =transportation cost

[20]Kasperse and Foyn (2010) did not directly use this model but adapted this simple model into Vector Auto Regressive form (VAR) in their study.

[21]Cudjoe, Bresinger, and Diao (2009) did not directly apply this model but adapted it into logarithmic form.

Many economists believe that prices are not related in linear form, so they modified it into a log-linear form .For instance, Robles (2011) estimated the elasticity of the transmission effect by employing moving average first difference regression in the model

$$dln(P_t) = \alpha + \beta_0 dln(P_t^*) + ... + \beta_n dln(P_{t-n}^*) + \gamma_0 dln(E_t) + ... + \gamma_n dln(E_{t-n}) + \varepsilon_t$$

Where

P_t =domestic price in period "t"

P_t^* =international price in period "t"

E_t = exchange rate in period "t"

ε_t = error term

How it is applied in Rice Analyses

As stated above, price transmission indicates only the impact of one price change on another price along the value chain .In price transmission study, there are four tests generally applied to answer four main questions, as follows.

- **Co-integrated test** .This test tests whether price "A" really has an impact on price "B" .If not, price distortion may be possible.

For this test, there are four methods popularly applied which are Johansen, Maximum Eigen Value, the Error Correction Method (ECM), and the Vector Error Correction Method (VECM). ECM was used by for example, by Imai, Gaiha and Thapa (2008), Kasperse and Foyn (2010), and Chulaphan, Jatuporn, Chen, and Jiewiriyapant (2012). However, the most popular method is VECM since it can answer other questions, such as speed adjustment .Minot (2010), for example, applied VECM to analyse the price transmission impact as follows.

$$\Delta \ln(P_t^d) = \alpha + \theta[\ln(P_{t-1}^d) - \beta \ln(P_{t-1}^w)] + \delta\Delta(P_{t-1}^w) + \rho\Delta \ln(P_{t-1}^d) + \varepsilon_t$$

where

P_t^d =domestic price at period "t"

P_{t-1}^w =world price at period "t-1"

Δ = difference operator such as $\Delta \ln(P_t^d) = \ln(P_t^d) - \ln(P_{t-1}^d)$

Therefore, "β" is the long run elasticity of price transmission, "θ" is the speed of adjustment, "δ" is the short run elasticity, and "ρ" is the impact of domestic price changes on the price in the next period.

- **Magnitude test** :This test tests how much price "A" impacts price "B".

The magnitude test requires stationary testing .For stationary testing, there are 5 methods popularly applied which are the Dickey-Fuller test (DF), the Augmented Dickey-Fuller test (ADF), the Philips-Perron test (PP), the General Least Square (GLS), and the Johansen trace method .However, the most popular approach is ADF, which can test the magnitude later with OLS, VECM, Wald, and Moving Average (MA) methods.

- **Direction test** :This test tests whether changes in the price of "A" impact the price of "B" and "C" equally. If not, who will it affect most?

The most famous method is the Granger Casualty test .Some research on rice price direction include, for example, Ghafoor and Aslam (2012), Kilima (2006), Cudjoe, Bresinger, and Diao (2009), and Chulaphan, Jatuporn, Chen, and Jiewiriyapant (2012).

- **Asymmetry test** :This test tests which magnitude is greater for "B" when the price of "A" increases or decreases.

For the asymmetry test, the Houck approach, ECM, and Threshold Autoregressive (TAR) can be applied .For example, Aguiar and Santana (2002) applied the Houck approach by separating price into two groups, decrease in price (P_d) and increase in price (P_i) and then constructed the equation as:

$$P_{rt} - P_{r0} = \alpha_{0t} + \alpha_1(\sum_{j=1}^{t} \Delta P_{ij}) + \alpha_2(\sum_{j=1}^{t} \Delta P_{dj}) + \varepsilon_t$$

Where

$P_{rt} - P_{r0}$ =change in price of "r"

ΔP_{ij} =increase in price of any "j" that is related to the price of "r"

ΔP_{dj} =decrease in price of any "j" that is related to the price of "r"

Therefore, if the null hypothesis "$\alpha_1 = \alpha_2$" is rejected, it can be concluded that there is asymmetry .

Findings

Since rice problems are different in each country, and price transmission can usually answer only four main questions, economists need to answer the question via the price transmission method indirectly. For example, to assess the impact of government rice export policy on farmers, economists need to assume that the policy will impact export prices at a certain level and how much that will impact paddy prices at the farm gate.

A good example is Chulaphan, Jatuporn, Chen, and Jiewiriyapant (2012) who analyzed the long run equilibrium relationship between farm gate, wholesale, retail and export prices in Thailand and found that the largest impact of farm gate price is on the export price followed by the wholesale price. Therefore Chulaphan, Jatuporn,

Chen, and Jiewiriyapant (2012) concluded that exporters would suffer most from producer support policy in Thailand.

It can be seen that the price transmission method can explain the impact of rice policy only to a limited degree. Moreover, it cannot explain some other important variables, for example, quantity. Therefore, it cannot determine whether farmers will be wealthier when their paddy prices are increased if the changes in the demand for paddy are not solved.

It can be seen that although an econometric model can be applied in various Thai rice research questions, one model can answer only few questions. For rice policy, an econometric model is applied to answer specific questions. In particular, when Thai government changes the policy to a more complicated policy such as pledging and price guarantee policies, the econometric model can only answer very specific questions related to the policy.

A good example is Itthipong Mahathanaseth (2014) who studied Thai rice market power. This study assumes that the main point of the pledging policy is the government assumption about the market power of Thai rice. In the policy, the government asked farmers to pledge rice to reduce the quantity of Thai rice in the market so that the rice price would increase .However, Mahathanaseth (2014) applied an econometric modelling technic, the instrumental variable (IV), to prove that "Thai rice has no market power to do it" .This study confirmed that in rice demand studies after 1981, "quantity is not the only main factor controlling price[22]". In other words, the government cannot raise the rice price by controlling the quantity of rice.

[22] There are some studies after 1981 that found a relationship between rice price and rice quantity. For example, Erwadee Premasatian (2014) construct an agriculture model including a rice model, and found a relationship between rice price and rice quantity. However, Premasatian, (2014) focused on other agricultural products such as corn rather than rice, and did not try to prove the market power, in contrast to Mahathanaseth (2014)

Computable General Equilibrium (CGE)

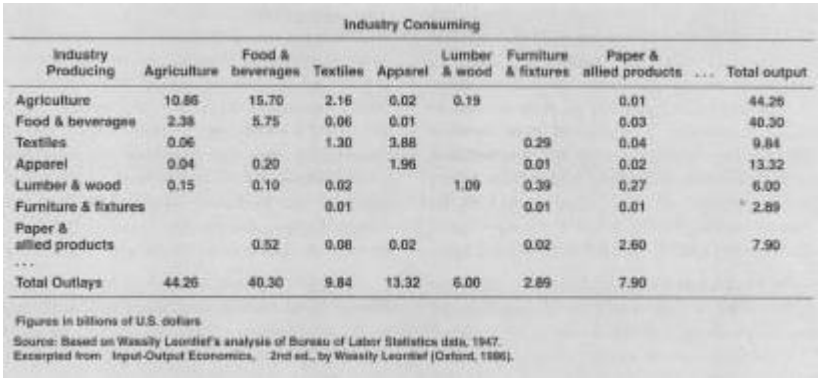
Developed after the succession of Linear Programming, Computable General Equilibrium (CGE) is the method accepted widely around the world. There are a lot of convenient CGE analysis computer programs. For example, the General Trade Analysis Program (GTAP) has been used by international economists around the world especially in the FTA boom period. The CGE, which uses an Input-output matrix as core data, has been applied in much research including research on rice . This section will present the basic idea of CGE, how it can be applied in rice industry analysis, and the pros and cons.

The Basic Idea

Before CGE, the Input-Output table (I-O table) and Social Accounting Matrix (SAM) were employed .SAM was developed from the I-O table n and CGE is also developed from SAM to answer more complicated questions .Therefore, to understand CGE, the I-O table and SAM also have to be explained.

The I-O table was introduced by Wassily Leontieff (1941) by applying the "tableau d'economique" of Francoise Quesnay .The table below shows the relationship between each industry and the industry as a whole .Therefore, it can explain the impact of one industry on other industries and the whole economy as a chain effect, which other models normally cannot do.

Figure 3-1 :I-O Table of Leontieff



Industry Producing	Industry Consuming: Agriculture	Food & beverages	Textiles	Apparel	Lumber & wood	Furniture & fixtures	Paper & allied products	...	Total output
Agriculture	10.86	15.70	2.16	0.02	0.19		0.01		44.26
Food & beverages	2.38	5.75	0.06	0.01			0.03		40.30
Textiles	0.06		1.30	3.88		0.29	0.04		9.84
Apparel	0.04	0.20		1.96		0.01	0.02		13.32
Lumber & wood	0.15	0.10	0.02		1.09	0.39	0.27		6.00
Furniture & fixtures			0.01			0.01	0.01		2.89
Paper & allied products		0.52	0.08	0.02		0.02	2.60		7.90
...									
Total Outlays	44.26	40.30	9.84	13.32	6.00	2.89	7.90		

Figures in billions of U.S. dollars.

Source: Based on Wassily Leontief's analysis of Bureau of Labor Statistics data, 1947. Excerpted from Input-Output Economics, 2nd ed., by Wassily Leontief (Oxford, 1986).

Source :Based on Wassily Leontief's analysis of Bureau of Labor Statistics data, 1947 .Excerpted from Input-Output Economics, 2nd ed., by Wassily Leontief (Oxford, 1986).

However, the I-O table cannot answer the non-industry question. For example, the unemployment rate, tax revenue, government budget, consumption and investment. SAM was developed to answer those questions by extending the I-O table to cover those details. As a result, SAM can answer more questions than the I-O table.

However, with the more complicated relationships between the extended details, the matrix is huge and cannot be solved manually. In addition, some relationships are not (cannot be) put into the matrix, so it cannot be solved by SAM. As an advanced computable program, CGE was developed to answer those questions.

There are a lot of CGE models applied in analysing economics problems, both in packaged programs such as GTAP, the most popular one used in the analysis of the impact of FTA, and customized programs which CGE developers have to develop by themselves .Since the CGE is based on I-O table data and consisted of all economic sectors, there are more than a hundred equations that are linked together in the program. Because of the large number of equations, CGE cannot compute solely from normal calculations .A computer program, for example, GAM or Gem-Pack is used to perform the calculations.

To apply CGE in analysis, there are 3-4 steps .First, economists need to construct the model by coding the equations and data into the GAM, Gem-Pack, or other coding program. This step is laborious work, especially when the developer has to modify the I-O table to SAM. Moreover, there are some problems, such as an un-updated data because the I-O tables in Thailand for example, are made 1 time in 5 years and less frequently than that in many less developed countries such as in Africa.

The second step is to set up the scenario, for example put the uninterested sectors or countries together as 'others' .The third steps is to shock (change the variable) the exogenous variable. For example, if the CGE user wants to analyse the impact of the full FTA between countries A and B, he will shock (changes) the value of tariffs on imported products from A to B and B to A to zero. The final step is to analyse the result.

How Rice Analysis is Applied

There are some studies such as Caecar Cororaton (2004)'s research on International Food Policy Research Institute (IFPRI) and Center for Agro-Socioeconomic Research (CASER) (1997)'s research on the impact of rice policy in Indonesia, and Rizwana Siddiqui (2007)'s research on the impact of rice policy in Pakistan.

To construct the model, each of these three researchers used different methods. Cororaton (2004) used GAM based CGE to be modified for rice analysis, IFPRI and CASER (1997) also used GAM to construct the Agricultural CGE (AG-CGE) for Indonesia for analysis while Siddiqui (2007) chose GTAP.

Findings

Since the policies in each country were different, these three researches shocked the model differently. In the Philippines, the government had to reduce the

tariff on rice due to the free trade agreement; so Cororaton (2004) shocked the model through import tariff value.

In Indonesia, the rice market is controlled by BULOG; therefore IFPRI and CASER (1997) shocked under the scenarios that BULOG was the price setter who set a different price while production was also different in many scenarios. The price scenario can be higher, lower, or unchanged, while production can be high or low. In Pakistan, Siddiqui (2007) focused on the impact of the liberalization of trade in the global rice market; therefore, the scenario was the changes in the tariff rate in each country/region for the Pakistan rice industry.

It seems that not many economists have applied CGE for rice problems perhaps because of the complexity of CGE. To apply CGE, the economist has to deal with many economic activities many of which are not mainly related to the rice industry, and the data are strictly with the national I-O table .Therefore, especially for a complicated policy like the pledging policy, it is difficult for them to modify the model.

In addition, the CGE result is in equilibrium condition, while many policy questions are in non-equilibrium periods. With this equilibrium condition, CGE cannot find the scarce resource and the shadow price of that resource, which is one of the main questions for the Thai rice industry.

Linear Programming

Similar to CGE, Linear Programming (LP) can answer many questions in one model. However, the CGE model is normally larger than the LP, so the objectives of applying these two methods are different. While CGE is normally used for studies of the impact of both macro and micro economic results, the LP is normally used for optimal decision making. Therefore, the LP can study both the impact under the assumption that all parties optimized their objective and can also compare an optimized period and a non-optimized period. In addition, LP can answer other questions such as the real value of each resource (the shadow price), and also can be applied for a social objective with the “goal programming” method.

The Basic Idea

LP was introduced and developed by George Dantzig and his team from the US Air Force and the RAND Corporation. In 1941, when the USA entered World War II, Dantzig decided to join the US Air Force Office of Statistical Control while he was studying in a doctoral program in Berkeley. At that time, computable programs such as LP had not yet been introduced to the US Air Force, so all the strategists had to compute it manually. In 1946, after receiving his Phd.,Dantzig decided to join the US Air Force instead of being a lecturer at Berkeley. At that time, Dantzig and his team developed and introduced LP to the US Air Force. Therefore, LP was used firstly in war rather than for business or economics purposes. Nowadays, LP is not only used in war, but has been used for many purposes, such as logistics and production management and economics policies.

The basic idea of LP is to optimize the objective with many constraints under the assumption that both the objective and constraints functions are "linear"[23]. However, LP can answer many questions in the fields of economics, business, logistics and many other fields. First of all, LP can determine the optimal level in decision making; for example, the optimal amount of production to maximize profit, the optimal trade route to minimize cost within a time constraint, and the optimal food to minimize calories under health conditions. Secondly, compared with non-linear optimization, LP is more comfortable with problems with many conditions. Finally, LP can answer many types of question, including the real value of each resource and the shadow price.

[23] In the non-linear case, LP can be applied in "non-linear" techniques to solve the problem. Thanks to advances in computer program development, even a simple optimization program can solve non-linear problems with simulation techniques. However, this study assumes the rice objective function to be a linear Leontieff production function, not a Cobb-Douglas function, so this study has no need to deal with non-linear subjects.

According to Hamdy Taha (2011)[24], there are four steps of LP; the definition of the problem, the construction of the model, the solution of the model, the validation of the model, and implementation. First, the definition of the problem is the most important step before constructing the model. Then the model construction should be developed based on the problem definition. The model can then be solved and discussed for validation. If the solution is not valid, the model can be modified (based on rational definition) before it will be implemented in the final stage.

For this study, the definition of the problem is presented in chapter 2 and chapter 3; the model construction is in chapter 4, and the solution and validation is in chapter 5, chapter 6 and chapter 7. It should be noted that this study has no implementation stage but makes recommendations for implementation in the future in chapter 8.

Compared with other non-linear optimization methods, although LP needs a linear function, it can handle many more constraints than other methods. These reasons make LP suitable for industrial analysis both in both the agricultural and industrial sectors in situation where there are many conditions .The rice industry study also involves many conditions .For example, a farmer has many resource constraints, as shown in chapter 2. As a result, LP is suitable for this study.

Other techniques of LP can addressother important issues .Other issues for rice farmersare not only an optimal policy, but also optimal decisions, scarce (important) resources and the value of the scarce resources .The duality technique can address scarce resources and their value (the shadow price). Table 3-3 shows the difference between primal and dual problems and how to perform the duality technique based on the example.

[24]Hamdy Taha (2011) “Operations Research :An Introduction, 9th Edition”, Pearson

Table 3-3 :Primal and Dual Problem

	Primal	**Dual**
Objective;	Minimize; $\geq$	Maximize; $\leq$
Constraint type	Maximize; $\leq$	Minimize; $\geq$
Example	Max: $Z = 5X_1 + 12X_2 + 4X_3$	Max: $w = 10Y_1 + 8Y_2$
	Subject to $X_1 + 2X_2 + X_3 \leq 10$ $2X_1 - X_2 + 3X_3 \leq 8$	Subject to $Y_1 + 2Y_2 \geq 5$ $2Y_1 - Y_2 \geq 12$ $Y_1 + 3Y_2 \geq 4$

Source *:* Taha (2011)

The other technique is goal programming. The goal programming target is to solve the society or the total industry at the same time. For example, imagine a society of many parties where each member's objective is to maximize profit or utility. Goal programming aims is to maximize the profit of the whole society not just the individual objective by summing all parties' objectives and conditions together and solving all objectives at the same time. This technique can also weight the focused and unfocused parties by priority with the normal goal programming technique.

Although LP is useful, there are some weaknesses. First, LP is in linear form, so a non-linear objective function is not appropriate. For example, in operational decisions, the LP user should ensure that the production function is in Leontieff form not a Cobb-Douglas form. In other words, one resource could not be substituted by other resource.

Secondly, LP requires a lot of knowledge in the "problem definition" phase. This phase requires the researcher to know exactly about both the objective and condition definitions and the data for the model. It is time consuming to obtain data. There are many types of data needed for LP, so it requires data from many sources.

These different types also create differences in the data variables that need to be conversed.

Therefore, not many economists apply linear programming on rice analysis. However, most of the research focused only on farmers and had no relation with other players. For example, A.G .Laborte, R .Roetter, and C.T .Hoanh (1999) and Hossein Jafari, Qhorbanali R .Koshteli and Babak Khabiri (2008) used linear programming to analyse the optimal amount of land use in rice farms in the Philippines and Iran. Both researches allowed farmers to choose their land to grow rice and other crops such as sugar cane, and measured the number of resources used, such as urea and potash to address many objectives such as cost reduction, increasing revenue and increasing output.

A study that links farmers, millers and exporters is Frank Rose (1977) who studied the impact of rice policies in Sierra Leone on farmers and the processing sector. Rose (1977) ran the model for 10 different scenarios and, Rose (1977) found that technological improvement policy is more effective than subsidy because even without subsidy, technological improvement helps farmers in the long run. However, the policies applied in Serra Leone are less complicated than Thailand. Most of the policies are direct subsidies or fixed price.

In conclusion, it can be seen that LP can answer all of this study's objectives without data problems, and can answer other questions related to the objectives, such as scarce resources, resource allocation impact, and shadow price. However, the problem of LP is the linear form, so this study has to ensure that the farming, milling, and rice trading functions are linear.

Comparison of Methodologies

There are three methodologies presented in this chapter 3. Econometrics methodology is the most popular, but it cannot explain complicated policies like pledging and guarantee policy. Moreover, econometrics cannot provide some details that are appropriate for policy problem, such as the shadow price.

The other two methods, CGE and LP, are more suitable. Table 3-4 compares both methodologies. Both methods can address complicated policy problems. However, LP is more appropriate than CGE for this study.

Although CGE is more popular and includes many economics equations, many are unrelated to rice equations. This problems require more time for CGE and make the study inflexible. Moreover, because of the large number of equations, the study results may not provide an exact value for impact. Finally, LP is more favourable since it can address three issues; scare resources and shadow price, the situation in a non-equilibrium period, and goal programming.

The problem of LP is that the objective function needs to be linear. From Chapter 2, it can be seen that the objective functions of farmers, millers, and traders are linear. In other words, all parties' production functions are Leontieff, not Cobb-Douglas.

For example, the production function of the farmer is linear since it cannot substitute one resource, for example seed, with another resource, such as fertilizer, to maintain the same amount of paddy yield .Therefore, the production rate of paddy is constant. Consequently, the function is linear. Since there is no non-linear problem, LP is selected.

Table 3-4 :Comparing CGE and LP

CGE	LP
Pros: consists of whole economy and very popular *Cons*: - contains many features unrelated to rice equations - all situations are assumed to be in equilibrium, no resource remains as abundant and no scarce resources are shown	*Pros*: - Can answer pledging and guarantee policy problems - Shows abundant resources and scarce resources and also can find the shadow price of the scarce one - Does not contain unrelated equations *Cons:* - Linearity for both objective and constraints functions are required

Source :From the study

3.3 .Summary

The main rice policies applied in Thailand are different from many other countries. In Thailand, the processes of the policy are more complicated.

In the past, there were around three main techniques applied in rice policy study; econometrics, CGE and LP. The most popular is econometrics, which was initially focused on rice demand .However, after 1981, most studies accepted that price is not the main factor in rice demand, so pricing policy has no importance. Moreover, policy was changed from consumer protection policies to new complicated policies, such as pledging policy and the studies about rice demand decreased. At present, most econometrics study focuses on specific issues of rice policy, such as market power. Therefore, econometrics is not appropriate for this study.

For CGE and LP, there are not many studies that have applied these methods even though CGE and LP can answer a variety of questions. One of the reasons is that the two methodologies require many types of data. However, when comparing

CGE and LP, LP is more appropriate in the sense that (1) LP is more convenient to apply, (2) LP is more focused on the rice industry, (3) CGE results are in “equilibrium” periods, so it cannot explain non-equilibrium periods, and (4) LP can determine what the scarce resource is and its value.

Hence, LP is chosen to be applied in chapter 4.

Chapter 4 :Model and Data

4.1 .Introduction

In Chapter 2, the characteristics of the Thai rice industry along the value chain arepresented .In addition, chapter 3 concluded that linear programming (LP) was selected for the study. This chapter (chapter 4) will introduce the core LP model and the data applied in this study. The model presented in this chapter will be applied in two main cases, under a normal situation (chapter 5) and under a corrupt situation (chapter 6) For both cases, the two schemes, pledging and price guarantee, will be applied and analysed. Finally, in chapter 7 goal programming will be applied as an alternative situation.

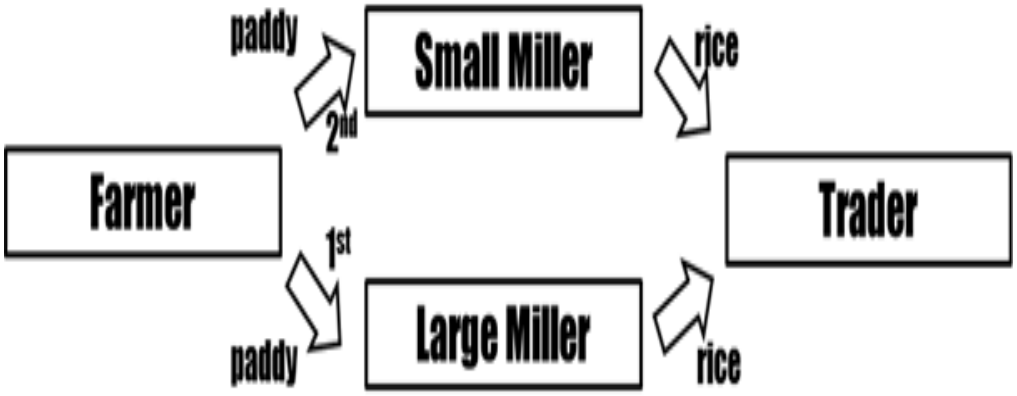
4.2 .Model

As introduced above, this model is developed according to the value chain study in chapter 2. However, there are some details that have to be added, which will be shown later. This part is separated into five sections: the introduction to the model, the farmer's model, the miller's model, the trader's model, and a model summary.

4.2.1 .Model Introduction

Figure 4-1 shows the brief value chain of the Thai rice industry. In this model, there is only one type of farmer who grows paddy and sells it to two types of miller, large millers and small millers. The large miller is the first buyer who buys paddy from farmers and mills it into rice. The small miller also buys paddy from farmers, transform the paddy into rice, and sells it to trader. The trader buys rice from both types of miller and sells it in two markets, the domestic and export markets.

Figure 4-1 :Brief Value Chain of the Thai Rice Industry



All of these players have their own objectives and conditions. This model will construct sub-models for all of these players in which the conditions of some players depend on other players' decisions. For example, one of the millers' conditions is the paddy the farmer produces. Therefore, the steps of the models include the farmer's model, the large miller's model, the small miller's model, and the trader's model. The objectives and the conditions of all of these players are as follows.

4.2.2 .Farmer's Model

The farmer's model consists of two parts, the objective and the conditions. The farmer's objective is to maximize profit when selling his paddy. Farmers can choose to grow two types of paddy, season and off-season paddy. These two types of paddy have different costs and prices. Therefore, the farmer's objective function can be written as:

Max: $\pi^f = \sum_{p=1}^{2} (P_p^f - C_p^f) Q_p^f$

By choosing Q_p^f

Where P_p^f =price of paddy "p"

Q_p^f =amount of paddy "p"

C_p^f =cost of paddy "p"

p = 1; seasonal paddy2; off-season paddy

Moreover, the cost of paddy derives from many resources (k) for example land rental, seed, fertilizer, and pesticide. To produce one ton of paddy requires different amounts of resources (γ_{pk}^f) and each resource has a different unit price (c_k^f) Therefore,

$$C_p^f = \sum_{k=1}^{8} \gamma_{pk}^f c_k^f \qquad \forall_p$$

Where c_k^f =cost of one unit of resource "k"

k = 1; land

2; seed

3; fertilizer

4; fuel

5; pesticide

6; labor for seedling

7; labor for harvesting

8; irrigated land

For the condition, the farmer can grow as much as the resources permit .In other words, the farmer cannot use more resources than he has available .All of the resources are limited at some amount which will be shown later in part 4.2 .In addition, to grow different types of rice requires different amounts of each resource . So, the farmer's condition is subject to

$$\sum_{p=1}^{2} \gamma_{pk}^{f} Q_{pi}^{f} \leq Z_{k} \qquad \forall_{k}$$

Therefore, the farmer's model can be written as

Max: $\pi^{f} = \sum_{p=1}^{2} (P_{p}^{f} - C_{p}^{f}) Q_{p}^{f}$

By choosing Q_{p}^{f}

subject to

$$\sum_{p=1}^{2} \gamma_{pk}^{f} Q_{pi}^{f} \leq Z_{k} \qquad \forall_{k}$$

4.2.3 .Miller's Model

For the miller, according to the Department of Industrial Work (DIW) (2006), Kittipong Chaiwongsa (2014), Onruedee Sritarapipat (2013) and the interview with Hengpoontana Rice mill, (presented in chapter 2) the miller's objective is to maximize profits which are the summation of all profits from each type of rice produced .Rice is produced by milling the paddy .So, his two main costs are the paddy price (P_{p}^{f}) and the milling cost (c_{r}^{m}). In addition, some parts of the paddy are rice (R) and the others, for example bran and germ, can be sold as by-products (b_{r}^{m}) for extra revenue .

In addition, there are three main types of rice which are fragrant rice, which is made from seasonal paddy, white rice, which is made from off-season

paddy, and par-boiled rice which is also made from off-season paddy but requires other processing and special machines to produce. Given "δ" as the chance of unbroken rice, then the objective function can be written as:

Objective :

Max: $\pi_s^m = \sum_{r=1}^{3}(P_{rs}^m - C_{rs}^m)Q_{rs}^m \qquad \forall_s$

By Choosing Q_{rs}^m

Where π_s^m =Profit of miller "s"

P_{rs}^m =Price of Rice "r" miller "s" received

C_{rs}^m =Cost of miller "s" producing rice "r"

Q_{rs}^m =amount of rice "r" produced by miller "s"

r =1; Fragrant rice

= 2; White rice

=3; Par-Boiled rice

s =1; large miller

=2; small miller

The cost of producing rice consists of input (paddy) cost and operation cost, and there is also extra revenue from by-products .As mentioned above, not all paddy becomes rice, and there is a chance of broken rice .So the paddy amount for making one ton of rice "r" is

$$Q_{rs}^m = \delta_R Q_p^f \quad \text{or} \quad Q_p^f = \frac{1}{\delta_R} Q_{rs}^m$$

To make rice, millers have both cost and revenue from selling by-products which are bran, germ and husk. In addition, the operation cost for each type of rice (b_{rs}^m) is different. For example, the process of making par-

boiled rice is more complicated than white rice, so the operation cost for par-boiled rice is higher. Given " c_{rs}^{m} " as the operation cost of miller "s" for making rice "r", the miller's cost function is

$$C_{rs}^{m} = \frac{1}{\delta R} P_{p}^{f} + c_{rs}^{m} - b_{rs}^{m} \qquad \forall_{r}$$

Where C_{rs}^{m} =milling cost of rice "r" of miller "s"

b_{rs}^{m} =by-product price of miller "s" from making one ton of rice "r"

c_{rs}^{m} =operation cost of miller "s" from making one ton of rice "r"

In rice processing, there are some conditions. Firstly seasonal paddy can yield only fragrant rice, so the miller cannot produce more fragrant rice than the seasonal paddy grown, and the large miller can buy rice before the small miller. So, the large miller's condition can be written as

$$Q_{11}^{m} \leq \frac{1}{\delta R} Q_{p}^{f}$$

The small miller can buy only what the large miller has left for them. So,

$$Q_{12}^{m} \leq \frac{1}{\delta R} Q_{p}^{f} - Q_{11}^{m}$$

As the off-season paddy can be made into both par-boiled and white rice, the second condition can be written as

$$Q_{21}^{m} + Q_{31}^{m} \leq \frac{1}{\delta R} Q_{2}^{f}$$

and

$$Q_{22}^{m} \leq \frac{1}{\delta R} Q_{2}^{f} - (Q_{21}^{m} + Q_{31}^{m})$$

Next, the miller cannot produce more of all types of rice than the total capacity (K_s), which can be written as

$$\sum_{r=1}^{3} Q_{rs}^{m} \leq K_s \qquad \forall_s$$

Finally, only some millers can produce par-boiled rice .Given "K_B" as the Capacity for Par-Boiled Rice, then the fourth condition is

$$Q_{31}^{m} \leq K_B$$

Therefore, the miller's model is

Objective :Max: $\pi_s^m = \sum_{r=1}^{3} (P_{rs}^m - C_{rs}^m) Q_{rs}^m \qquad \forall_s$

By Choosing Q_{rs}^{m}

Subject to

$$Q_{11}^{m} \leq \frac{1}{\delta R} Q_p^f$$

$$Q_{12}^{m} \leq \frac{1}{\delta R} Q_p^f - Q_{11}^{m}$$

$$Q_{21}^{m} + Q_{31}^{m} \leq \frac{1}{\delta R} Q_2^f$$

$$Q_{22}^{m} \leq \frac{1}{\delta R} Q_2^f - (Q_{21}^{m} + Q_{31}^{m})$$

$$\sum_{r=1}^{3} Q_{rs}^{m} \leq K_s \qquad \forall_s$$

$$Q_{31}^{m} \leq K_B$$

4.2.4 .Trader's Model

Traders also aim to maximize profit from selling the rice he bought from millers. Traders buy rice from both small and large millers at the same market price,

but he sells it at different prices to domestic and export markets[25]. The trader's profit equation can be written as

$$\pi^t = \sum_{j=1}^{2}(\sum_{r=1}^{3}(P_{rjs}^t - C_{jrs}^t)Q_{rjs}^t)$$

By Choosing Q_{rjs}^t

Where π^t =Profit of trader

P_{rjs}^t = Price of Rice "r" buying from miller "s" in market "j"

C_{jrs}^t = Cost of Rice "r" selling in market "j" by miller "s"

Q_{rjs}^t =Amount of rice "r" buying from miller "s" selling in market "j"

j =1; Export market

= 2; Domestic market

Since, the cost of rice "r" selling in market "j" consist of the price of rice bought from millers and the operation cost, the cost of rice "r" in market "j" is

$$C_{jr}^t = (1 + c_{jr}^t) + P_r^m \qquad \forall_r$$

However, traders cannot sell more rice than the millers produce .So,

$$\sum_{i=1}^{2} Q_{jr}^t \leq \sum_{s=1}^{3} Q_{rs}^m$$

Then, the trader's model can be written as

[25] Although Erwadee Premasatian (2014) estimated that rice export and paddy prices affect the rice export quantity, the study did not focus only on the rice market, but also on other crops especially sugar cane and cassava, and constructed a combined agricultural model.However, Mahathanaseth (2014) tested the model with the necessary econometric tests, so the model of Mahthanaseth (2014) is more appropriate for this study. Therefore, this study assumes price is static.

$$\underline{\text{Max}}: \pi^t = \sum_{j=1}^{2}(\sum_{r=1}^{3}(P_{rjs}^t - C_{jrs}^t)Q_{rjs}^t)$$

By Choosing Q_{rjs}^t

Subject to

$$C_{jr}^t = (1 + c_{jr}^t) + P_r^m \qquad \forall_r$$

$$\sum_{i=1}^{2} Q_{jr}^t \leq \sum_{s=1}^{3} Q_{rs}^m$$

4.2.5 .Summarized Model

In summary, the normal rice model consists of four sub-models; the farmer, large miller, small miller, and trader's models. The farmer's model aims to optimize the amount of paddy production that brings the maximum benefit for farmers. Large millers also optimize the amount of rice production based on the amount of paddy the farmers harvested. Small millers optimize rice production from the amount of paddy the large miller leaves. Lastly, traders also optimize profit from the amount of rice that large and small millers produce.

Each sub-model has a different profit/production function and conditions. Farmer conditions derive mostly from the amount of resources provided. The two miller's conditions derive from their capacity and the amount of paddy the farmers produce. Lastly, trader conditions derive from the amount of rice the millers produce and the market size.

Therefore, there are four kinds of data needed for each party; the price, the cost, the required resources, and availability. Each party has different types of data. For example, there are 8 types of resources for farmers, two types of paddy and three types of rice.

In next section (section 4.3), the data for the model will be explained. Then the study will input the data to the model and study the results, which will be presented in chapter 5. The studies on data are as follows

4.3 .Data

In section 4.2, the model was introduced. This section will present the data used in the model. This section will begin with the source of data which will show how and where the variables come from and the value of them. Then, in the second part, the problems of each type of data will be discussed.

4.3.1 .Source of Data

This source of data section will explain the source of data and the value of each variable used in the model. The explanation will begin with the data for farmers, millers and traders.

Farmer

For the farmer, the data are the price of paddy and the cost, requirements, and availability of each resource. The model includes two types of paddy, seasonal and off-season paddy. Resources include land, fertilizer, pesticide, seed, fuel, labor for seedling, labor for harvesting and irrigated land.

For the cost, this model used data from four sources. BAAC (2013) is used for the cost of land, irrigated land, fertilizer and fuel .The cost of seed is from the rice department (2014). Prang Pakpanich (2012) provides the data for pesticide cost. Lastly, the cost of labor is measured by labor wages from the Labor Force Survey (2014).

In addition, for the land area, the Ministry of Interior made an announcement in June 2015 about land rental price law, which according to their survey, was 1,000-2,000 Thai Baht for the central plain area, 1,000-1,200 Thai Baht for the north-eastern area, 1,000-1,800 Thai Baht for the Northern Area, and 1,000 Thai Baht for the Southern Area[26]. When the two sources, the Ministry of Interior (2015) and BAAC

[26]Isranews Agency, 30th June 2015

(2013), are combined, the average rental fee is 1,000 Thai Baht per rai. The cost of each variable is shown in Table 4-1.

Table 4-1 : Cost of Resources for Growing Paddy

Variables	Cost (Baht)	Unit	Sources
Land	1,000	Rental fee per year per Rai	Ministry of Interior and BAAC
Seed	29	Per Kilogram	Rice Department
Fertilizer	800	Per 50 Kilogram Bag	BAAC
Pesticide	1,120	Per Rai	Pakpanich
Labor for Seedling	300	Per day which is equal to 15 Rai	BAAC and LFS
Harvested fee	300	Per Rai	BAAC

Source :collected/computed by Author

For the paddy price, the data were collected from the Thai Rice Miller Association (2014). At that time, the price of seasonal paddy or Hommali paddy was 1,500 Baht per ton. The price of off-season paddy is 8,000 Baht per ton.

For the required resources used to grow one ton of each paddy, there are four main sources of data. OAE (2014) is used for non-irrigated and irrigated land area data[27]. Data from BAAC (2013) are used for fertilizer[28], fuel, and labor needs for

[27] OAE defined seasonal rice (paddy) differently from this research. The OAE defined seasonal rice as any paddy grown between May and October, while off-season is any paddy grown from November to April. Therefore, the real off-season amount is twice that of the OAE report, and the seasonal amount has to be subtracted from that amount.

[28] BAAC (2013) was an in-depth interview study with more than 50 farmers in 9 regions, Upper-North, Lower-North, Central, Eastern, West, Upper-North East, Lower-North East, Upper South, and Lower South. The question on fertilizer usage relates to the amount of fertilizer used per rai, which can be converted to yield per rai and is shown in the table.

growing one ton of paddy. Seed amount comes from the Rice department (2014). Lastly, pesticide use data are from Pakpanich (2012).

Table 4-2shows the amount of each resource required to produce one ton of paddy.

Table 4-2 *:* Resources Used to Grow One Ton of Paddy

Variables	Resources Used	Types of Paddy	Sources
Land	2.38 Rai	Seasonal	OAE
Land	0.74 Rai	Off-Season	OAE
Irrigated Land	0.74 Rai	Off-Season	OAE
Seed	25.17 Kilograms	Seasonal	Department of Rice
Seed	28.86 Kilograms	Off-Season	Department of Rice
Fertilizer	1.51 of 50 Kilogram Bag	Seasonal	BAAC
Fertilizer	1.3 of 50 Kilogram Bag	Off-Season	BAAC
Fuel	2.52 Litters	Seasonal	BAAC
Fuel	1.442 Litters	Off-Season	BAAC
Pesticide	2.53 Litters	Seasonal	BAAC
Pesticide	1.52 Litters	Off-Season	Pakpanich
Labor for Seed	0.17 Man Days	Seasonal	BAAC
Labor for Seed	0.05 Man Days	Off-Season	BAAC
Labor for Harvesting	0.05 Man Days	Seasonal	BAAC
Labor for Harvesting	0.01 Man Days	Off-Season	BAAC

Source :collected/computed by Author

The next type of data is resource availability. The OAE (2014) provides the amount of both rice land area and irrigated land area, which has to be recalculated by multiplying the ratio of the rice area and other agriculture areas to the amount of

irrigated land in Thailand. For the rice seed, the Director of the Department of Rice gave an interview and stated that "farmers demand 1.4 million tons (both grown themselves and bought from the market), demand from the market is 0.6 million but there is only 0.4 to 0.5 million. In other words, the seed amount is short of demand by about 1.4 million ton for around 0.1 to 0.2 million kilograms. Therefore, the seed amount should be around 1.29 million kilograms. For fertilizer, the OIE provides data for the domestic production of fertilizer and UNCTAD provides the fertilizer trade data. When these two sources are combined, it is evident that the fertilizer is around 130 million 50 kilogram bags of fertilizers. For fuel, the data are collected from the Energy department which provides the amount of diesel fuel sold. Pesticide data are from UNCTAD. Lastly, the Labor Force Survey of the National Statistical Office (NSO) provides the agriculture labor data. All data are summarized in Table 4-3.

Table 4-3 :Amount of Farmer's Resources

Resources	Availability	Units	Sources
Land	70,000,000	rai	OAE
Seed	1,290,000,000	Kg	Rice Department
Fertilizer	130,000,000	Bag	OIEandUNCTAD
Fuel	1,422,000,000	litre	EnergyDepartment
Pesticide	36,756,643,000	litre	UNCTAD
Labor for Seed	30,040,144	Manday	LFS
Labor for Harvesting	1,728,100	Manday	LFS
Irrigated Land	15,000,000	rai	OAE
Non-Irrigated Land	55,000,000	rai	70,000,000 minus 15,000,000 rai

Source :collected/computed by Author

Finally, the paddy prices which can separated for two cases; the normal situation and under the pledging scheme, are from the Thai Rice Miller association

and the government pledging committee announcement. Under the normal situation, the paddy price, P_p^f, is from Thai Rice Miller association who set standard prices for buying paddy. However, under the pledging situation, the pledging committee announced the pledging price, so the announced price is the paddy price under the scheme.

Under the pledging situation, the pledging price is set at 15,000 Baht per ton for off-season paddy and 20,000 Baht per ton for seasonal paddy. Under the normal situation, after the pledging period, the data from Thai rice miller association shows that the paddy price was quite stable at around 8,000 Thai Baht per ton for off-season paddy and 15,000 Thai Baht per ton for seasonal paddy.

Millers

Similar to farmers, millers have three types of data; cost, usage, and amount/capacity. For the cost of the milling process, there are three types of cost, which are paddy price, operational cost, and by-product (which actually is revenue, not cost). For the paddy price, the price in the farmer's model, "P_p^f", can be applied. The operation cost consists of electricity, labor, and maintenance cost. The Department of Industrial Work (DIW) (2006)[29] computed the different operation costs for small and large millers and for each type of rice, as shown in table 4-4. For the price of by-products, which are bran, germ, husk, and broken rice, the prices were collected from the Thai Rice Miller association, which provide the price per ton.

[29] DIW (2006) "Industrial Sector Code of Practice for Cleaner Technology"

Table 4-4 :Price of Rice and By-Product by Type

Unit :Baht

	Fragrant Rice	White Rice	Par-Boiled Rice
Unbroken Rice	29,540.00	12,790.00	12,740.00
By-product	6,618.50	6,052.13	6,197.52

Source :Thai Rice Miller Association

However, one ton of paddy provides different amounts of by-product for small and large millers, especially for broken rice .Kittipong Chaiwongsa (2013) provided data for the small miller by-product ratio, and the Thai Rice Miller association provided data for the large miller by-product ratio. These by-product ratios and the price of by-products per ton can be used to compute the by-product revenue per ton of rice, as shown in Table 4-5.

Table 4-5 :Cost of Rice Production

Cost Types	Miller Types	Rice Types	Cost per Ton of Rice (THB)	Source
Operation cost	*Large*	Fragrant Rice	255.00	DIW
		White Rice	226.00	DIW
		Par-boiled Rice	235.00	DIW
	Small	Fragrant Rice	565.39	DIW
		White Rice	565.39	DIW
		Par-boiled Rice	565.39	DIW
By-product	*Large*	Fragrant Rice	6,618.50	Thai Rice Miller Association

Cost Types	Miller Types	Rice Types	Cost per Ton of Rice (THB)	Source
		White Rice	6,052.13	Thai Rice Miller Association
		Par-boiled Rice	6,197.52	Thai Rice Miller Association
	Small	Fragrant Rice	2,745	Thai Rice Miller Association and Chaiwongsa
		White Rice	2,745	Thai Rice Miller Association and Chaiwongsa
		Par-boiled Rice	2,745	Thai Rice Miller Association and Chaiwongsa

Source :collected/computed by Author

For usage, there are two conditions for millers; paddy as input and the production capacity. For paddy usage per ton for rice, the paddy conversion to rice ratio from the Thai Rice Miller association has been applied for large millers and Chaiwongsa (2013) is used for small millers. For the Thai Rice Miller association, the rate of 0.46 tons of rice per ton of paddy is applied, so it can be computed as 2.17

tons of paddy to produce one ton of unbroken rice. However, Chaiwongsa (2013) claimed a different rate at 1.67 tons of paddy for one ton of unbroken rice for small millers. This may be because of the smaller amount of rice production, where the smaller miller has more opportunity to reduce the rate of broken rice. For production capacity, since the limited amount is computed in tons of paddy per day, the usage data can use “one by one” as a ratio.

Finally, there are two types of quantity provided. First is the amount of paddy. In accordance with the model section (section 4.2), the amount of paddy is computed from the farmer’s model, so no data are needed. Lastly, the miller’s capacity is estimated from many sources and can be separated into par-boiled rice capacity, large miller capacity, and small miller capacity.

For the par-boiled rice capacity, the President of the Thai Rice Exporter Association, Mr Vichai Sriprasert, stated that there is 7 million tons of par-boiled production capacity per year. In addition, the Thai Rice Miller association also claimed that there are 200 millers with a capacity of 100 ton per day that can produce par-boiled rice. With this amount, it is also possible to compute the total par-boiled capacity at 7.3 million tons per year. Therefore, the par-boiled rice production capacity should not exceed 7 million tons per year. However, although the capacity is at 7 million tons per year, the real production should be much lower than that since the demand for par-boiled rice, which mostly is from Africa, is at only around 3 million tons per day, Sriprasert (2015).

For large miller capacity, since our model assumesthat millers can join the program, the amount of pledged paddy is used as the capacity. In the 2013/2014 period, there was around 23 million tons ofpaddy in the program, so the large miller capacity is assumed to be 23 million tons.

For the total capacity, the Department of Business Development (DBD) claimed that in 2014 there were 847 small millers, 187medium-sized millers and 74 large millers in the industry. Assuming 1 to 10 tons of rice per day for small millers, 50 to 100 tons of rice per day for medium-sized millers, and 100 to 500 tons of rice

per day for large millers, the total capacity is 6.4 to 26.5 million tons of rice per year, which is equal to 13.9 to 57.5 million tons of rice per year. However, 13.9 million tons of rice per year is too low since only the large millers in 2013/2014 can produce rice for the pledging program at 23 million tons of paddy in one year. The median value is 35.7 million of paddy which is used as the total capacity per year.

Finally, the small miller's capacity can be computed by deducting the large miller's capacity from the total capacity. Since the total capacity is the large miller's capacity and the small miller's capacity, with a total capacity of 35.7 million tons, and 23 million tons of paddyis the large miller's capacity, 12.7 tons of paddy is the small miller's capacity.

In addition, to produce rice, the millers need stocks, such as silos, warehouses and storage. Thamasart University (2009) provided data on the total stock in Thailand at 8.2 million tons of rice. This amount indicates that all rice cannot be stocked at the same time. Old rice has to be distributed before the new rice is stocked .In 2014, Thai rice production was the highest in the last five years at 20.4 million tons; therefore, the ratio of rice per stock is around 2.5 times in that year, while the lowest year (2016) was15.8 with a ratio of only 1.9. Generally, there is no fixed ratio for stocked rice.

Traders

For traders, there are also three types of data to explain; price, the quantity ceiling in each market, and the cost of each product. There are two types of data that come from the miller's model. The amount of each type of rice and the miller's rice price can be found in the results of the miller's model.

However, the total cost for traders is not only the price of rice, but also the management cost. This management cost is estimated to be less than 3 percent. The reason is that the traders, both domestic and exporter, get rice from agents (Yong) who charge a service fee at one percent of the trade value[30] from both the trader

[30] Interview with Hengpoonthana Rice mill

and the miller, and the trader also charges a margin of one percent[31], also. Therefore, the cost cannot be over two percent of the rice value.

Rice market prices are collected from two sources. For the domestic market, the data are collected from the Department of Interior Trade at the Ministry of Commerce. For the export market, the data from Thai rice exporter association are employed. It can be seen that fragrant rice is more expensive in the export market, but white rice is cheaper.

Table 4-6 :Rice Trading Prices

Types of Rice and Market	Prices (Baht)	Source
Export Fragrant	33,958.00	Thai Rice Exporter Association
Export White	14,129.00	Thai Rice Exporter Association
Export Par-Boiled	14,138.00	Thai Rice Exporter Association
Domestic Fragrant	32,000.00	DIT
Domestic White	14,700.00	DIT

Source :collected/computed by Author

The last type of data is the ceiling amount of each type of rice in each market. The selling amount dating back five years for both domestic and export markets from UNCTAD and USDA are used .For both export and domestic rice markets, the total amount of rice has never been more than 11 million tons per year per market. For par-boiled rice, the export amount never exceeds 3.5 million tons. For fragrant rice, the export market has never exceeded 2 million tons.

[31]VichaiSriprasert, president of Thai rice exporter association.

4.3.2 .Data Discussion and Problems

With the data shown above, there are three important issues that need to be discussed and understood. The first issue is time consistency .The second issue is the difference in the definition of each organization. Lastly is the difference in value for each source of data.

For the time difference issue, most of the data in this study were collected between 2012 and 2013, subject to data availability. The problem of time consistency is that many types of data, for example the required resources, are not collected monthly or yearly. Many types of primary data are collected occasionally. Therefore, a question of time lag occurs.

However, this kind of variable does not change much over five to ten years. For example, the resources required to grow rice changes only when the farmer has new, better technology or knowledge, but (1) there is no new innovation for paddy farming and (2) the farmers already have accessed the current technology or advanced machinery by buying, renting or hiring persons who have the knowledge to work on their farms. Therefore, this type of variable can be assumed to be unchanged.

Another problem is the definition of each source of data. This study tries to convert all different definitions into the same format. For example, the definitions of seasonal and off-season paddy from OAE are different from this study. OAE defines seasonal paddy as all paddy harvested from May to October, no matter whether it is photosensitive paddy or not. This study has to convert this amount to only photosensitive paddy.

Finally, there are some data that provide different values from different sources. This study tries to select data from only one source, which is significantly more reliable. However, in the case that both sources are reliable, the study will apply the middle value .

4.4 .Summary

The first half of the chapter (section 4.1) gathers all knowledge from chapter 2 and chapter 3 to construct the “base model” for the study .Then in the second half (section 4.2), the data for the model are explained and discussed .

The model consists of four sub-models, which are farmers, large millers, small millers, and traders. All of these parties are linked together by some conditions. For example, large millers are linked with the farmer by the amount of paddy the miller bought from the farmer.

For the data, many sources of data are collected. Although there are some differences in terms of time, definition and value, they can be converted and applied.

In the next chapter, the model and data will be applied and computed. Then it also will be modified and studied for policy change situations.

Chapter 5 :The Thai Rice Industry under the “Normal Situation”

5.1 .Introduction

In chapter 4, the model with its sub-models and the data were introduced . This chapter will apply the model and data provided in chapter 4 in three cases. There are cases of “no government intervention” as a very normal case to compare with main policy situations, which are under the pledging scheme case and under the price guarantee policy case. The assumptions and the results for these three cases in detail are as follows.

5.2 .No Government Intervention

5.2.1 The Assumption of No Government Intervention

The first case is the industry in a no government intervention situation. The no government intervention situation means the market runs freely on its own. In chapter 4, section 4.2, the model of Thai rice market under no government intervention is explained. In addition, section 4.3 shows the data for the Thai rice market model in a no-government intervention situation. When section 4.2 and 4.3 are combined, the Thai rice model under no-government intervention can be computed and yields the results as shown in section 5.2.2.

5.2.2 Results

The focus of this study is on all main parties in the Thai rice industry. Therefore, this part attempts to explain the study results for all main parties in the industry and comparisons and discussion will be at the end of this sub-chapter.

Farmers

The model found that farmers decide to produce 22 million tons of season paddy and 19.5 million tons of off-season paddy to maximize profit. With this amount of production, the farmer gains a total profit of 217 billion Thai Baht. This total profit can be separated into157 billion Thai Baht from selling seasonal paddy and 60 billion Thai baht from off-season paddy.

Table 5-1 :Farmer's Optimal Decision under No Government Intervention

	Price *(Baht)*	**Production Amount** *(Tons)*	**Cost** *(Baht per ton of paddy)*	**Profit** *(Million Baht)*
Seasonal Paddy	15,000	23,109,243.70	8,214.33	156,811.70
Off-Season Paddy	8,000	20,270,270.27	5,026.14	60,280.95
Total Profit		217,092.65 Million Baht		

Source :Model Calculation

When focusing on the resource used, it has been found that the resources which have been used until run off are normal land areas and irrigated land area. The normal land area is 70 million rai of 70 million rai whereas the irrigated land area is 15 million out of 15 million rai. In addition, there is another resource which uses almost all of available stock. This resource is seed, for which 1.17 million kilograms out of 1.29 million kilograms is used. Moreover, the duality technique has been applied in this study to find the real value of each rai of land (the shadow price of land area).

The scarce resources in this model are normal and irrigated land areas. With the duality technique, the shadow price is calculated at 6,268 Baht[32] per rai of the normal land area and 10,379 Baht per rai of the irrigated land area. These shadow prices can be interpreted and applied in many ways as follows.

For the normal land area, it means that the real value of the normal land area is 6,268 Baht. This can be interpreted in two ways. Firstly, the shadow price is much higher than the real rental price at around only 1,000 to 2,000 Baht per rai, so the landlord could actually increase the rental fee. Secondly, it can be implied that the government or the related organization should not spend more than 6,268 Baht per year to increase the normal land area by one rai[33]. However, in reality, it is difficult for Thailand to increase the normal agricultural land area. The types of land such as forest land area and urban land area are very difficult to change to agricultural and rice land areas. Thai law and government policy aim to preserve the forest land area rather than allow use as agricultural land areas. For urban land areas, the land price is much higher than agricultural land, so it is uneconomic to change to rice land area. Therefore, it is difficult to increase the normal agricultural land area for paddy growing. The possibility could be to change from other crops such as sugar cane that yield on average 3,200 Baht per rai to the normal rice land area. However, in this case of transformation from sugar cane field to paddy, the other conditions on other resources such as labor and machinery must be taken into account.

For the irrigated land area, although the shadow price is computed at 10,379 Baht per rai, it does not directly imply that the government or related organizations

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[32]The market land rental price before June 2015 (before the maximum land rental price law had been issued) was 1,000-2,000 Bath for the central plain area, 1,000-1,200 Baht for the North-eastern area, 1,000-1,800 Baht for the Northern Area, and 1,000 Baht for the Southern Area; source: Isranews Agency (The Ministry of Interior 30th June 2015)

[33]Since it is computed from the revenue per year, the land cost for eternal used is 6,268/interest rate (0.015) which is equal to 417,867 Baht per rai.

should spend up to 10,379 Baht to increase the irrigated land area by one rai. The reason is that the irrigated land area is created from the normal land area. Therefore, the real shadow price for the irrigated land area is 10,379 Baht minus the shadow price of normal land area (6,268 Baht) or 4,111 Baht. That is, the real value of switching from a normal land area to an irrigated land area is 4,111 Baht per rai. In other words, the government or related organization should not spend more than 4,111 Baht to transform one rai of the normal land area into an irrigated land area.

Table 5-2 :Shadow Prices for Farmers under No Government Intervention

Resources	Shadow Prices
Normal Land Area	6,268 Baht per rai
Irrigated land area	10,379 Baht per rai

Source :Model Calculation

Millers

Since there are two types of miller in the model, this part will show the results of the large miller followed by the small miller. The results are as follows.

According to the model assumption, large millers can buy the paddy before small millers. Therefore, large millers can decide the amount of fragrant rice, white rice, and par-boiled rice to maximize profit. The optimal amount of fragrant rice is 10.2 million tons. The miller decides not to produce white rice and produces 375,634 tons of par-boiled rice. The total profit for the large miller is 22.8 billion US dollars.

Table 5-3 :Large Miller Optimal Decisions under No Government Intervention

	Price (Baht)	Production Amount (Tons)	Cost (Baht per Ton)	Profit (Million Baht)
Fragrant Rice	29,540.00	10,223,444.22	27,358.56	22,301.86
WhiteRice	12,790.00	-	11,535.18	-
Par-BoiledRice	12,740.00	375,634.12	11,398.79	503.80
Total Profit		**22,805.66 Million Baht**		

Source :Model Calculation

For the resources used, the scarce resources are clearly the amount of seasonal paddy and the production capacity. 22.2 million tons out of 22.2 million tons of the seasonal paddy that the farmer produced is used and the total production is 23 million tons out of 23 million tons of production capacity. However, the large miller uses only 0.8 million tons of off-season paddy out of the total 19.5 million tons. So, there is around 18.7 million tons of off-season paddy left for small millers.

With the duality technique, the shadow price of seasonal paddy for large millers is equal to 7,936Thai Baht per tons and the shadow price of production capacity is 8,726Thai Baht per ton. So, the recommendation for each resource is (1) the cost for bringing new seasonal paddy should not be higher than 7,936Thai Baht per ton and (2) one million Thai Baht for new technology or new machinery investment with a ten year operational life should provide more than "1,000,000 ÷ (10 x 8,726) = 11.5 Tons". It can be seen that the shadow price for seasonal paddy is lower than the market price. So, in this case, large millers might not be willing to buy more seasonal paddy at the market price.

Table 5-4 :Shadow Prices for Large Millers under No Government Intervention

Resources	Shadow Prices
Season Paddy	7,936 Baht per ton
Production Capacity	8,726 Baht per ton

Source :Model Calculation

Small millers will decide the optimal amount of rice products to maximize profit. From the results, it can be seen that large millers left no seasonal paddy for small millers, and only the off-season paddy is left. The small miller's decision is based on the amount of off-season paddy the large miller left. The model found that the optimal amounts of rice production are 11.2 million tons of white rice and no production of par-boiled rice. The reason for no par-boiled rice production is that in this case, the small miller is assumed not to be able to produce par-boiled rice since there are specific techniques for producing par-boiled rice. The production yields 18.8 billion Thai Baht for small millers.

Table 5-5 :Optimal Decisions for Small Millers under No Government Intervention

	Price (Baht)	Production Amount (Tons)	Cost (Baht per Ton)	Profit (Million Baht)
Fragrant Rice	29,540.00	0.00	23,772.38	0.00
WhiteRice	12,790.00	11,164,271.50	11,181.40	17,958.89
TotalProfit	18,739.89 Million Baht			

Source :Model Calculation

The scarce resources of the small miller in this case are the two types of paddy, seasonal paddy and off-season paddy. By employing the duality technique, the shadow prices are computed. The shadow price of the seasonal paddy is much higher than the shadow price of off-season paddy at 19,332to 9,302Thai Baht per ton. This indicates that the small miller is willing to buy extra season paddy at the price up to 19,332 Baht per ton and 9,302Thai Baht per ton. The shadow price for the small miller for seasonal paddy is much higher than for the large miller. The reason could be because the small miller has a better broken to unbroken rice ratio compared to the large miller. Therefore, the small miller values the paddy at a higher price than the large miller.

Table 5-6 :Shadow Prices of Small Miller under No Government Intervention

Resources	Shadow Prices
Season Paddy	19,332 Baht per ton
Off-season Paddy	9,302 Baht per ton

Source :Model Calculation

Traders

From the model, the trader will maximize the profit by selling 2 million tons of fragrant rice, 8.9 million tons of white rice and 0.13 million tons of par-boiled rice to the export market and selling 8.2 million tons of fragrant rice 2.8 million tons of white rice domestically. With that traded amount, the trader will obtain a profit (which mostly comes from domestic fragrant rice) of 32 million Baht.

Table 5-7 :Trader's Optimal Decisions under No Government Intervention

	Price (Baht)	Production Amount (Tons)	Cost (Baht per Ton)	Profit (Million Baht)
Fragrant Rice	33,958.00	2,000,000.00	2,033,958.00	4,067,916.00

	Price (Baht)	Production Amount (Tons)	Cost (Baht per Ton)	Profit (Million Baht)
Export				
White Rice Export	14,129.00	8,873,231.17	8,887,360.17	78,859,601.36
Par-Boiled Rice Export	14,138.00	126,768.83	140,906.83	17,862.59
Fragrant Rice Domestic	32,000.00	8,223,444.22	8,255,444.22	67,888,185.00
White Rice Domestic	14,700.00	2,776,555.78	2,791,255.78	7,750,077.39
Total				**32,032.21 Million Baht**

Source: Model Calculation

The shadow price for each type of rice is 14,138 Thai Baht for par-boiled rice, 31,419 for fragrant rice, and 14,129 Thai Baht for white rice. These all are higher than the market prices, so the trader is willing to buy more rice if possible. For example, it is worth importing rice from neighbouring countries and exporting it to a third country if the price is lower than the shadow prices.

The global shadow price for fragrant rice is 2,529 Thai Baht. Therefore, marketing budgets such as for advertisements and promotion for the international market should not be higher than 2,529 Baht per ton of forecast demand for fragrant rice. For example, if the new advertisement budget is 100,000 Thai baht, it would need to improve sales by at least 40 tons of rice.

This is similar to the shadow price for domestic rice demand. This shadow price also shows that the budget for the promotion for each ton of rice to increase domestic rice sales should not be higher than 571 Thai baht .For example, if the new advertisement is forecast to increase the amount of Thai domestic rice sales by 100 tons, the budget should not be over 57,100 Thai Baht.

Table 5-8 :Shadow Prices for Traders under No Government Intervention

Resources	Shadow Price
Fragrant Rice	31,419
White Rice	14,129
Par-boiled Rice	14,138
Domestic Market Size	571
Market Size for Exported Fragrant Rice	2,529

Source :Model Calculation

5.2.3 Discussion

The results indicate that there are some issues that need to be discussed especially when making comparisons with the real situation.

First is the farmer's revenue. OAE (2014) shows the amount of seasonal and off-season paddy grown and harvested by the farmer. With the same price and cost for both types of paddy in the model, the real profit is computed at 162 billion Baht, which is lower than 217 billion Baht in the model. The lower amount in reality comes from the "non-optimized decisions" of farmers .Therefore, it is worth the government pursuing policies to encourage optimization for farmers.

However, the assumption that all parties optimize their profit makes the model different from the real situation. There are differences not only for the farmer, but also for the miller. To optimize profit under the conditions assumed in the model, large millers decide not to produce white rice and bought the entire seasonal paddy to produce fragrant rice, so small millers can produce only white rice. This result is different from the real situation in which small millers can also produce fragrant rice and large millers produce both white and fragrant rice.

The difference results from two reasons. The first reason is that neither type of miller optimizes their decisions in reality. So, they decide to buy and produce any type of paddy and rice as long as they still gain a profit. The second reason could be

that there are other important conditions excluded from the model, for example, some informal rules or traditions of the miller association and informal contact between small and large millers.

The other issue is the shadow price. This shadow price shows the real value of each resource. Compared with other resources, irrigated land area is very benefit for investment. The rental fee per rai per year is normally only 1,000 Baht, but the real value or the shadow price is computed at 4,111 Baht per rai per year. Therefore, one of the most interesting policies for lifting poor farmers out of poverty should be the expansion of the irrigated land area.

The other shadow prices that should be focused on are the shadow prices of seasonal and off-season paddy. The shadow prices are different for the two different types of miller. The large miller values the paddy lower than the small miller. The reason is that the small miller has a better paddy to unbroken rice ratio. However, the small miller is the second priority for farmers to sell paddy to. Therefore, the policy for the small millers should be the chance for them to get extra paddy.

Finally, the model shows that the capacity of small millers is not the scarce resource. So, the policy to increase the number of small millers, which was popular for a short period of time, is not appropriate. This is supported by the fact that almost half of the small millers are out of the industry in only a few years[34].

5.2.4 Summary

With the model and data provided in chapter 5, the results for an optimal rice industry are computed. The total profit of the industry is computed at 293 billion Baht. The amount consists of the net profit of four players; farmers, large millers, small millers, and traders. Large amounts of profit come from the farmer at 217 billion Baht. However, there are more than 4.8 million paddy farmers in the

[34] Already shown in Section 4.3

country, while only a few traders. Therefore, traders gain much more individual profit than farmers.

Table 5-9 :No Government Intervention Case Summary

Players	Profits
Farmers	217,092.65
Large Millers	22,805.66
Small Millers	18,739.89
Traders	32,032.21
Total	**290,670.41**

Source :Model Calculation

In addition, some results are clearly different from the real situation. There are two reasons for that. First of all, there is no party that optimizes their profit and decision. Secondly, some assumptions or conditions under the model might be omitted in reality .However, the farmer's case shows the significance of optimizing the farm.

5.3 .Pledging Scheme

5.3.1 .Assumptions for the Pledging Scheme

In the pledging scheme, the government intervened in the market by buying all paddy from farmers, hiring the large millers[35] to produce rice, and selling the rice to traders. Therefore, this situation is different from the normal situation in three ways: the paddy prices, large miller rice prices, and the government budget. In other words, only the farmers, large millers, and government are changed in this situation.

For farmers, the rice price is changed to the pledging price (P_p^{fp}). However, only the amount of paddy sold via large millers (Q_{p1}^{f}) *is* paid at the pledging price;

[35]Since there are many conditions for the scheme, most of small miller cannot join the program.

the small miller still pays for the amount of paddy bought (Q^{f}_{p2}) at the normal price. In addition, the large miller who joined the program can choose to buy either at the market price or the pledging price. However; the decision to join the program is the farmer's. Selling at the pledging price provides better benefits but there is a need to wait for the money for one to two months .The farmer who cannot wait would decide not to join the program. The DIT provided the amount of paddy in the program for the 2014 period*:* 4.8 million tons of seasonal paddy and 17.6 million tons of off-season paddy .In other words, only 4.8 million tons of seasonal paddy and 17.6 million tons of off-season paddy can wait for better profit .The rest is the amount of paddy that cannot wait for the money to be transferred from the program.

Therefore, the farmer's decision model can be modified as

$$\pi^{f} = \sum_{p=1}^{4} (P^{f}_{p} - C^{f}_{p}) Q^{f}_{p}$$

Where

p = 1; seasonal paddy for non-scheme
2; off-season paddy for non-scheme
3; seasonal paddy for scheme
4; off-season paddy for scheme

For large millers, his decision model is changed to

$$\pi^{m} = \sum_{r=1}^{6} (P^{m}_{r1} - C^{m}_{r1}) Q^{m}_{r1}$$

Where

r = 1*; fragrant* rice for non-scheme
2; white rice for non-scheme
3; par-boiled rice for non-scheme
4; fragrant rice for scheme

5; white rice for scheme

6; par-boiled rice for scheme

$C_{r1}^{m} = \frac{1}{\delta R} P_{p}^{f} + c_{rs}^{m} - b_{rs}^{m}$ For r =1 to 3

P_{r1}^{m} =ex-miller market rice price For r =1 to 3

$C_{r1}^{m} = \frac{1}{\delta R} P_{p}^{fp} + c_{r1}^{m} - b_{r1}^{m}$ For r =4 to 6

$P_{r1}^{m} = \frac{1}{\delta R} P_{p}^{fp} + c_{r1}^{m} + g_{r} - b_{r1}^{m}$ For r =4 to 6

g_r = milling fee the government paid per ton of rice, which is equal to 500 Baht

In addition, the scheme of Phue Thai involved pledging all paddy .Therefore, the new condition for large millers (who are assumed to be in the program) is the amount of both seasonal and off-season paddy in the program that must be used . Then the new conditions are

$$Q_{11}^{m} \leq \frac{1}{\delta R} Q_{3}^{f} \text{ and } Q_{11}^{m} \geq \frac{1}{\delta R} Q_{3}^{f}$$

or

$$Q_{11}^{m} = \frac{1}{\delta R} Q_{3}^{f}$$

and

$$Q_{21}^{m} + Q_{31}^{m} = \frac{1}{\delta R} Q_{3}^{f}$$

Small millers cannot join the program due to many conditions, especially having sufficient standard silo spaces to meet the program's conditions. The small miller's objective function and the conditions remain unchanged under the "no government intervention case". This is similar to traders who buy from both the government and millers and sell to the unchanged markets (export and domestic) at the same market price as in the "no government intervention case". Therefore, the

small miller and the trader model are the same model as the no government intervention case.

Lastly, the government budget is computed from the difference between the pledging rice price and the market price and the amount of rice under the scheme. In this case, the government buys rice from millers at the pledging price, but sells to traders at the market price[36]. In addition, the scheme does not cover by-products . The government let the millers sell or manage it to their benefit. In other words, the pledging price only refers to the unbroken rice price. Thus the model is

$$\pi^{G} = \sum_{r=1}^{3} (P_{r1}^{m} - P_{r1}^{pm}) Q_{r1}^{m}$$

5.3.2 .Results

Farmers

With the model modified above, the farmer's decision results are shown as follows .Farmers decide to grow and harvest a total of 43.4 million tons of paddy. This amount can be separated into four types; seasonal paddy in the program, off-season paddy in the program, non-program seasonal, and non-program off-season paddy .The amount of seasonal paddy in the program is 4.8 million tons and the amount of off-season paddy in the program is 17.6 million tons .For the non-program paddy, there were 18.3 million tons of seasonal paddy and 2.6 million tons of off-season paddy which were not in the program and were sold at the market price . With this decision, the total profit of the farmer is calculated at 364.7 Billion Baht, with 232 Billion Baht from the scheme and 132 Billion from non-scheme production.

[36] Although there are some rice schemes that used the government to government (G to G) trading process, G to G price is computed based on the market price minus or plus other expected fringe benefits; (from interviews with Mr. Wanchai, Department of Interior Trade and Mr. Siridev, Department of Foreign Trade officer). Therefore, the G to G price is assumed to be the market price.

Table 5-10 :Farmer's Optimal Decision under the Pledging Scheme

	Price per Ton	Amount Grown	Cost per Ton	Profit
Scheme				
Seasonal Paddy	20,000	4,827,909	8,214.33	56,900.14
Off Season Paddy	15,000	17,648,687	5,026.14	176,025.53
Non-Scheme				
Seasonal Paddy	15,000	18,281,334.70	8,214.33	124,051.10
Off Season Paddy	8,000	2,621,583	5,026.14	7,796.22
Total		**43,379,513.70**		**364,773.00**

Source :Model Calculation

For the shadow prices, there are four scarce resources which are normal land area, irrigated land area, and the amount of seasonal and off-season paddy, for which the farmer is prepared to wait for the money from the program .The shadow prices for normal and irrigated land area are 6,268 and 10,809 Thai Baht per rai, respectively .These are close to the results in the "no government intervention case" .

The different resources from the 'no government intervention' case are the amount of seasonal paddy and off-season paddy in the program .The shadow prices for these two conditions are 5,081 Thai Baht per ton of seasonal paddy and 7,001 Thai Baht per ton of off-season paddy .It can be said that the price received when waiting (for farmers to join the program) is 5,081 Thai Baht per one ton of seasonal paddy and 7,001 Thai Baht per one ton of off-season paddy .For example, a farmer with two tons of off-season paddy in the program should not borrow money with total interest over 14,000 Thai Baht.

Table 5-11 :Shadow Prices for Farmers under the Pledging Scheme

Resources/Conditions	Shadow Price
Normal Land	6,268.28
Irrigated Land	10,809.46
Seasonal Paddy for Program	5,081.49
Off-Season Paddy for Program	7,001.00

Source :Model Calculation

Millers

With the objective and the conditions provided in section 5.3.1, the large and small millers'profit can be optimized .The results for both types of miller can be explained as follows.

The profit optimized for large millers is computed at a total of 6 billion Thai Baht. 5.2 billion Thai Baht is from the scheme and 0.8 billion Thai Baht is from non-scheme paddy .In this case, the miller decide to produce 2.2 million tons of fragrant rice, 3.5 million tons of par-boiled rice, and 4.3 million tons of white rice in the scheme and allows 0.24 million tons for non-scheme fragrant rice.

Table 5-12 :Large Miller's Optimal Decision under the Pledging Scheme

	Price per Ton	Amount Produce	Cost per Ton	Profit
Non Scheme				
Fragrant Rice	29,540.00	241,200.00	26,009.67	808.86
White Rice	12,790.00	0	11,531.70	0
Par-boiled Rice	12,740.00	0	11,395.31	0
Scheme				
Fragrant Rice	37,536.50	2,224,842.86	37,036.50	1,112.42
White Rice	27,223.87	4,633,035.48	26,723.87	2,316.52
Par-boiled Rice	27,087.48	3,500,000.00	26,587.48	1,750.00
Total	**5,987.81 million Baht**			

Source :Model Calculation

There are three scarce resources in this situation; seasonal paddy under the scheme, off-season paddy under the scheme, and the capacity of large millers .For the capacity, the shadow price is computed at 16,662.90 Thai Baht per ton .This means the large miller will have better revenue of 16,663 Thai Baht for every ton of increased capacity .For seasonal paddy under the scheme, the shadow price is at 1,923 Thai Baht, so the millers can pay 1,923 Thai Baht more per ton for seasonal paddy in the program .It should be noted that there is no actual cost for the program paddy because the government paid for the program paddy and left only 500 Thai Baht per ton for millers as the milling fee .Therefore, the millers subsidize the farmers who grew seasonal paddy in the program by up to 1,923 Thai Baht

The last scarce resource is the program off-season paddy .The shadow price of this paddy is -5,271 Thai Baht per ton .The minus sign shows that the millers in the program do not actually favour the extra off-season paddy in the program,

since the miller can use the other scarce resource, the capacity, to make non-scheme rice.

Table 5-13 :Shadow Prices for Large Millers under the Pledging Scheme

Resources/Conditions	Shadow Price
Seasonal Paddy (scheme)	1,923.12
Off-season Paddy (scheme)	-5,270.76
Capacity	16,662.90

Source :Model Calculation

The small miller is not in the scheme .This miller uses the paddy that the large miller left in the pledging program to optimize their profit .The optimized profit of the small miller is 63,857 million Thai baht .The small miller decided to produce 10 million tons of fragrant rice and 1.5 million tons of white rice in this case.

Table 5-14 :Small Miller's Optimal Decision under the Pledging Scheme

	Price per Ton	Amount Produce	Cost per Ton	Profit
Fragrant Rice	29,540.00	10,633,491.44	27,393.30	58,514.78
White Rice	12,790.00	1,569,810.34	11,180.39	1,655.66
Par-boiled Rice	12,740.00	0	11,180.39	0
Total		**63,857.20**		

Source :Model Calculation

The scarce resources of the farmer are seasonal paddy and off-season paddy .The shadow price for seasonal paddy is 19,332 Thai Baht and the off-season paddy is 9,302 Thai Baht .For the seasonal paddy, the shadow price for small millers is higher than the large miller by about 10 times .These shadow prices are also higher than the market price, but lower than the pledging price .

Table 5-15 :Shadow Prices for Small Millers under the Pledging Scheme

Resources(Constraints)	Shadow Prices
Season Paddy	19,332.34
Off-season Paddy	9,302.40

Source :Model Calculation

Traders

The last party is the trader .In the pledging case, the program changes not only farmers' profit, but the amount of rice that is milled .This can also change the traders' profit .Under the scheme, the traders' profit is in total 31,866 million Thai Baht .The profits are from selling 2 million tons of fragrant rice, 6 million tons of white rice and 2.9 million tons of par-boiled rice abroad, 11 million tons of fragrant rice domestically, and 0.14 million tons of white rice domestically .

Table 5-16 :Trader's Optimal Decision under the Pledging Scheme

	Price per Ton	Amount Trade	Cost per Ton	Profit
Fragrant Rice Export	33,958	2,000,000.00	30,558.74	6,798.52
White Rice Export	14,129	6,061,180.12	13,163.87	5,849.83
Par-boiled Rice Export	14,138	2,938,819.88	13,214.14	2,715.06
Fragrant Rice Domestic	32,000	10,858,334.29	30,500.00	16,287.50
White Rice Domestic	14,700	141,665.71	13,181.00	215.19
Total				**31,866.10**

Source :Model Calculation

There are three scarce resources for traders; white rice, par-boiled rice, and the market size of the export and domestic markets .The shadow prices of each ton of market size increase are 14,129 Thai Baht for all rice exports, 13,829 Thai Baht for fragrant rice abroad, and 32,000 Thai Baht for all rice domestically .It can be seen that the scarce resource in this case is different from in the 'no government intervention' situation .In the 'no government intervention' period, the scarce resource is the amount of rice, but in this scheme, only the market size increase is valued .

Table 5-17 :Shadow Prices for Traders under the Pledging Scheme

Resources	Shadow Price
Market Size of Thai Rice Export	14,129.00
Domestic Market Size	32,000.00
Market Size of Exported Fragrant Rice	19,829.00

Source :Model Calculation

Government

Because of the decisions of farmers and large millers mentioned above, the government budget is computed to be "122.2 billion Thai Baht" in deficit .These large amounts of deficit are from white rice at 67.1 billion, par-boiled rice at 50 billion and from fragrant at 17.8 billion Thai Baht .

Table 5-18 :Government Budget under the Pledging Scheme

	Market Price	Amount in Program	Pledging Price	Profit
Fragrant Rice	29,540	2,224,842.86	37,536.50	-17,790.96
White Rice	12,790	4,633,035.48	27,223.87	-67,104.28
Par-boiled Rice	12,740	3,500,000.00	27,087.48	-50,041.18
Total				**-134,936.42**

Source :Model Calculation

5.3.3. Discussion

Firstly, it has been found that the pledging policy showed a slightly better profit compared to normal circumstances .Therefore, this result supports the pledging program and economists like Pichit (2011), especially for the greater benefits for farmers .

However, the economists who do not support the scheme like Siamwala and Poapongsakorn (2011) and Puapongsakorn, et.al (2014) are not completely rejected . There are some losers in the program, especially millers .The model shows that the program takes from the small miller's hand .However, the program left the seasonal paddy instead of off-season paddy in the normal case .Therefore, the small miller gains benefits, but the large miller does not .This might be different in reality as many small millershave left the market since they had no paddy to process. This difference affects traders' decisions .There is also no white rice in the domestic market .This is also different from the real situation .However, this case assumes that all parties have to maximize benefit without any other conditions, which is not represented in the model.

For the traders, the model found differences from Chulaphan, Jatuporn, Chen, and Jiewiriyapant (2012) who stated that traders will suffer from a production subsidy, such asthe pledging program, in the sense that traders gain a small benefit in this case .In addition, the results of this model are slightly different from Mahathanaseth (2014). Although the model is based on the result of Mahathanaseth (2014) who found that the rice price is unchanged in the pledging case, the program shows a slight benefit, especially for farmers.

However, the scarce resource in the trader's case is represented by the problems of market size or how to deliver the product to the market .The delivery problem is the main problem according to Siamwala and Poapongsakorn (2011)

Moreover, in practice, it has been found that this pledging policy has been condemned by the non-rice industry parties, who are taxpayers who have no

direct benefit from the program but finance huge government spending. In addition, this program has also been criticised by traders who have not received rice from government stocks. In contrast, the program is supported by the farmers who gained benefit from the program. This is in keeping with this study whichreveals positive impacts for farmers and millers and negative impacts for taxpayers and traders in the rice stocking case. However, although the rice millers gain the most from the program, there is no response from them.

For the government budget, the model found a lower budget compared to the real situation .The model calculated the government budget at 122 billion Baht, or 37 per cent lower than the real budget spending of 580 billion Baht for the three year program which ison average 193.33 billion Baht a year, according to the Ministry of Finance (2014). These differences may result from many reasons, for example, management cost, and corruption, which are not included in this study .

Finally, the government budget in the program is mostly spent on off-season paddy, which is grown in irrigated land areas .In other words, the programs support the wealthier farmer, not the poorer one .This result is also similar to Puapongsakorn, et.al (2014)

5.3.4. Summary

Table 5-19 shows the profit of each party in two cases; under the pledging scheme and with no scheme .In summary, the pledging case brings a profit to farmersof138 billion Baht, but the government lost 122 billion Baht.

For farmers, there are no changes in decision .The reason is that the main scarce resources remain irrigated land and non-irrigated land .The capacity to wait for the money is the second scarce resource which is actually decided after they have already harvested .The increase in their income is only from the government subsidy.

The main changes in this situation are for the two types of miller .The large miller changes their decision due to the conditions of the program .These changes

leave more seasonal paddy to the small miller .The small miller profits more from the increase in the amount of seasonal paddy .Finally, the small miller, who normally has lower capacity, a better unbroken rice rate creates more fragrant rice, so the trader can trade more fragrant rice and also benefit more .Therefore, the whole society benefits from the increase .

Although it seems that the policy is worthy, some parties also lost from the program .In addition, the program supports wealthier farmers more than the poorer ones .Lastly, rice delivery is also the big issue for this scheme.

Therefore, a pledging scheme could be applied with care in practice .It needs to beware of some issues, for example, how to compensate the losers who should gain more benefit; how to deliver the rice, and the corruption problem, which will be presented in the next chapter.

Table 5-19 :Pledging Case Summary

Players	No Scheme	Pledging
Farmers	217,092.65	364,773.00
Large Millers	22,805.66	5,987.81
SmallMillers	17,958.89	63,857.20
Traders	31,793.54	31,866.10
Government		-134,936.42
Total	**289,650.74**	**331,547.69**

Source :Model Calculation

5.4. Price Guarantee Scheme

5.4.1. Assumptions for a GuaranteeScheme

A price guarantee scheme is the idea by economists who believe that the Thai rice market is under almost perfect condition .They say that the only problem for the Thai rice market is the market price of paddy or the revenue of the farmer, which should not be received by other parties. Therefore, the price guarantee

scheme was created to be a policy that directly pays subsidies to the farmer when the market paddy price is lower than the policy target price.

Since it is a direct subsidy to farmers, the scheme has no effect on other parties .So, only the farmer's model needs to be modified .In practice, government subsidises based on land area instead of by quantity to eliminate fraud by the farmer in the program, especially as there are uncertain quantities of rice production.

In this case, the government will firstly set the guarantee paddy price per ton (P_p^{fg}), the market paddy price (P_p^f) and the yield per rai .Then, the government will pay a subsidy by the number of rai (land area) the farmer has. This subsidy payment can be computed as

$$(P_p^{fg} - P_p^f) \times \frac{Q}{L} \times L = (P_p^{fg} - P_p^f)Q$$

Q =amount (yield) of paddy

L =number of rice (land area)

Therefore, the farmer's objective function in this case can be written as

Max: $$\pi^f = \sum_{p=1}^{2}(P_p^f - C_p^f)Q_p^f + \sum_{p=1}^{2}(P_p^{fg} - P_p^f)Q_p^f$$

By choosing Q_p^f

Where P_p^{fg} =guarantee price of paddy "p"

Q_p^f =amount of paddy "p"

C_p^f =cost of paddy "p"

p = 1; seasonal paddy

2; off-season paddy

The other parties; large millers, small millers, and traders, have the same model as in section 4.2 .Only the government budget calculation model is added in this case .With the subsidy process that is explained above, the subsidy amount is

$$\sum_{p=1}^{2}(P_p^{fg} - P_p^{f})Q_p^{f}$$

Finally, according to the objectives of this study (Chapter 1), the pledging and guarantee scheme need to be compared by employing the same pledging/guarantee price .Therefore, a price guarantee of 15,000 Thai Baht per ton for off-season paddy, and 20,000 Thai Baht per ton for seasonal paddy are applied in the model.

5.4.2. Results

Under the assumption in 5.4.1, the model can be calculated and the results for all parties are shown in this part .In addition, in this scheme (1) the system of industry is unchanged, (2) the amount of production and the conditions for each party are the same as in the 'no government intervention' case, so the shadow price is the same as in section 5.3.2 .Therefore, this section will not re-explain the shadow price .The results, which include profit and production quantity, of the farmer, large miller, small miller, and trader are shown as follows

Farmers

Table 5-20 shows the amount of paddy the farmer decided to grow/harvest, the profit from each type of paddy, and the total profit .Under the model, the farmer decides to grow 23 million tons of seasonal paddy and 20 million tons of off-season paddy .This decision gives the farmer a profit from seasonal paddy of 156.8 Billion Thai Baht and 60.3 Billion Thai Baht from off-season rice .Under this decision, the government has to pay a subsidy of 257.4 billion Thai Baht to the farmer, which makes the total benefit at 474.5 Billion Thai Baht .

Table 5-20 :Farmer's Optimal Decision under the Price Guarantee Scheme

	Price per Ton	Amount Grown	Cost per Ton	Profit
Seasonal Paddy	15,000.00	23,109,243.70	8,214.33	**156,811.70**
Off-Season Paddy	8,000.00	20,270,270.27	5,026.14	**60,280.95**
Subsidy		**257,438.11**		
Total	156,811.70 + 60,280.95 + **257,438.11** = **474,530.76**			

Source :Model Calculation

Millers

The results for millers are separated into two types of miller .This section will begin with the large miller and then the small miller will be discussed .

For the large miller, with the model, data, and the results from the farmer's model, it was found that the large miller will decide to produce 10.2 million tons of fragrant rice and 0.37 million tons of par-boiled rice to optimize his profit .So, the profit of the large miller will be 29.6 Billion Thai Baht in the price guarantee program .

Table 5-21 :Large Miller's Optimal Decision under the Price Guarantee Scheme

	Price per Ton (Baht)	Amount Produce (Tons)	Cost per Ton (Baht)	Profit (Million Baht)
Fragrant Rice	29,540.00	10,223,444.22	27,358.56	22,301.86
White Rice	12,790.00	-	11,535.18	-
Par-boiled Rice	12,740.00	375,634.12	11,398.79	503.80
Total		**29,540.00 Million Baht**		

Source :Model Calculation

For the small miller, with the model, data, the results from the farmer's model, and the results from the large miller's model, the profit optimization for the small miller requires him to produce 11.2 million tons of white rice and produce no fragrantor par-boiled rice .This decision yields a profit of 18.7 Billion Thai Baht for the small miller.

Table 5-22 :Small Miller's Optimal Decision under the Price Guarantee Scheme

	Price per Ton (Baht)	Amount Produce (Tons)	Cost per Ton (Baht)	Profit (Million Baht)
Fragrant Rice	29,540.00	0.00	23,772.38	0.00
White Rice	12,790.00	11,164,271.50	11,181.40	17,958.89
Total		**18,739.89 Million Baht**		

Source :Model Calculation

Traders

In this case, the trader's decision is computed to trade 10.2 million tons of fragrant rice and 0.126 million tons of par-boiled rice abroad, and trade 11.1 million tons of white rice domestically to maximize profit .These amounts of trading will maximize the profit of the trader at a total of 32 Billion Thai Baht.

Table 5-23 :Trader's Optimal Decision under the Price Guarantee Scheme

	Price per Ton (Baht)	Amount Produce (Tons)	Cost per Ton (Baht)	Profit (Million Baht)
Fragrant Rice Export	33,958.00	2,000,000.00	2,033,958.00	4,067,916.00
White Rice Export	14,129.00	8,873,231.17	8,887,360.17	78,859,601.36
Par-Boiled Rice Export	14,138.00	126,768.83	140,906.83	17,862.59
Fragrant Rice Domestic	32,000.00	8,223,444.22	8,255,444.22	67,888,185.00
White Rice Domestic	14,700.00	2,776,555.78	2,791,255.78	7,750,077.39
Total		**32,032.21 Million Baht**		

Source :Model Calculation

Government

The government subsidy budget is computed at 257,438.11million Thai Baht in this case .This amount is more than half of the farmer's total profit computed in the farmer's model .

5.4.3. Discussion and Summary

This case is different from the real situation during the government under Abhisit as PM .The difference is on the guarantee price which this case assumes to be equal to the pledging price .Therefore, it is hard to compare it with the real situation .

In addition, this case has no impact on other parties or the market .There are only two parties that have an impact which are farmers and the government .This is in keeping with reality .In that period of time, no parties came out to criticise the

policy, except for the farmers, who got less from the program since the guarantee price was much lower than the pledging price.

For the farmer, this case provides the best benefit compared to the normal situation and the pledging scheme .However, in this case, the government budget is also the highest .The reason is that the government pays all farmers directly, while in the pledging program, the government only pays the farmers who can wait for the money from the program.

However, in reality, the guarantee case creates more paddy land claims for the government .The reason is that the farmers need more subsidy money, so they expand their land, or make false claims that non-paddy land is paddy land .This type of problem will be studied in Chapter 6, corruption in the price guarantee scheme .

5.5. Comparison of the three cases and Conclusion

In this chapter, the model was calculated in chapter 4 and also modified for the situations under the two main policy periods .For pledging, run by former Prime Minister Yingluck's government, the pledging price is applied instead of the market price .However, to compare with the pledging case, the guarantee price of PM Abhisit is set to be equal to the price set during PM Yingluck's government .The results show that the pledging case brings more benefit to society from the changes in milling patterns, while the guarantee case made no difference .

The results for farmers show no different decisions in the no-pledging case, since the scarce resources remain irrigated and normal land .However, the large miller who joined the program changed behavior .This behavioral change increases the small miller and trader profits, which increased the whole industry profits.

For the price guarantee, the situation is similar as the government subsidizes farmers directly and there are no changes for other parties .Since there are no behavioral changes of the market, the industry's profit remains constant.

Although the total profits of the industry are better in the pledging case, the farmers enjoy most of the benefits in the guarantee case .The reason is that the

pledging case pays only the ones who can wait for the money, who are mostly the wealthier farmers, but the guarantee pays every farmer .This study also found that pledging pays for the off-season rice which is grown in irrigated land areas more than the normal land areas .Therefore, the guarantee case spends much more money in this study .

The reason for the higher spending is that that in practice the guarantee applied a much lower price and in this study there is no corruption in the two cases . Thus, in the next chapter, corruption will be studied .

Table 5-24 :Summary of Results (*P*rofits) for the Three Cases

Unit :Millions Baht

Players	No Scheme	Pledging	Guarantee
Farmers	217,092.65	364,773.00	474,530.76
Large Millers	22,805.66	5,987.81	22,805.66
Small Millers	17,958.89	63,857.20	17,958.89
Traders	31,793.54	31,866.10	31,793.54
Government		-134,936.42	-257,438.11
Total	**289,650.74**	**331,547.69**	**289,650.74**

Source :Model Calculation

Chapter 6: The Thai Rice Industry under "Corruption"

6.1. Introduction

Chapter 5 discussed some of the weaknesses of the model, one of which is that corruption is not included .This chapter studies corruption in the two main rice programs by reviewing the methods of corruption and modifying the model to include them .Unfortunately, there is no clear evidence about the real degree of corruption. In addition, these two programs are corrupt in different ways, so they cannot be compared innterms of the degree of corruption. In comparison, the government budget spending in these two cases are set to be equal.

One of the findings from the study found that the corruption in guarantee cases does not increase the government budget, but the corruption in the pledging case does increase the government budget. Therefore, to compare these two cases, the chapter will begin with the corruption in the pledging case, followed by the guarantee case. For the corruption in the pledging case, the model will be studied by changing the degree of corruption until the results yield an equal budget as in the guarantee case shown in chapter (at 257,438 million Baht). Finally, these two cases can be compared, discussed and concluded.

6.2 Corruption and the Pledging Scheme

The main investigation of the pledging scheme is not only on the scheme process, which harms many players, especially from the short run impact on traders and the high government budget, but also on the corruption that is involved. There were nine cases reported to the National Anti-Corruption Council between 2004 and 2015. These cases can be separated into four types .However, in this study only rice smuggling cases are included.

The model is modified to include rice smuggling .The assumptions and the model modification for rice smuggling is shown in section 6.2.1 .Under these

assumptions, a new situation has been optimized, and the results under the rice smuggling situation for each party are shown in section 6.2.2 .

From 2004 to 2015, there were nine cases of corruption in the pledging scheme reported to the NACC. Those cases can be separated into four types. One type is for farmers, two types arefor millers and one type for traders.

Figure 6-1 :Fraud in the Pledging Policy

Source :NACC

For farmers, although there is only one type, which is rice smuggling, it occured in many places where the scheme was operated .The process of corruption begins with the farmer .Since the paddy price in the pledging scheme is higher than the market price, especially for paddy from neighbouring countries, the farmer can gain an extra profit by smuggling the paddy across the border .In this case, the corrupt farmer buys paddy from a neighbouring country which is sold at the global market price, which is much lower than the pledging price, and then sells it to the government as authorized pledging paddy. In this case, the farmer will gain benefit

from the margin between the world market price and the pledging price, but the government will losemoneyin that corrupt process.

Although the main corruption in this case comes fromthe farmer, many other players are involved. Actually the paddy that can be in the program needs to be authorized by many government officers and also the miller. In addition, to import the paddy into Thailand, it has to go through customs processes. In general, rice smuggling is officially prohibited and difficult to do .To smuggle paddy, the paddy needs to be imported without obtaining customs clearance by persuading the government officer in charge of authorizing importation, and then other officers in the processing of the paddy in the program. Therefore, it is not only the farmer that is involved in the case.

The next two cases are about millers. In the first case, the miller takes the opportunity of the government paying a different price for different types of rice, off-season and seasonal rice. The millers who are in the scheme pledge off-season paddy but corruptly claim it is seasonal paddy to receive money from the scheme. The corrupt miller will get extra benefit from the margin between these two prices.

In the second case, the miller gains from the over payment of operation fees. In the pledging process, the government will pay the operation or milling fee to the miller. This fee is computed from the rate of unbroken rice the miller's milled. In the 2012 to 2014 scheme, the government paid 500 Thai Baht per ton of paddy, so if the miller claimed 0.46 for unbroken rice per paddy, the government paid 500 divided by 0.46 or 1,087 Thai Baht per ton of rice for the milling fee .But, if the miller claimed a lower amount, for example only 0.3 for unbroken rice per paddy, the government needed to pay 1,667 Thai Baht per ton of rice .Therefore, the corrupt millers would try to claim that they have a lower amount than the actual amount, for example claim for only 0.3 instead of the real amount at 0.46 and would gain extra corrupt profit of 580 Thai Baht per ton of rice.

The millers can be corrupt when the government officers do not notice it for many reasons. First of all, the miller needs to use some tricks to confuse the

government officers .Secondly, to make the trick successful, the miller has to ensure that the government officers are unaware or have little knowledge about paddy and rice, unless the government officer is also involved in the corrupt process .It is a fact that the government officers gain or lose nothing from the successful implementation of the program. So, they have little incentive to implement the program successfully .Therefore, some corruption can occur in the program.

The last case is the trader .This case involves no government officers. Only traders can commit this corruption although it might be rather difficult. In the pledging process, the government will sell most of the pledged rice through bidders. The bidder who offers the highest price will get the rice, and the government has no need to care what the bidder will do with the rice .However, corruption can occur in the bidding by cooperating groups .To be corrupt, all, or almost all, bidders can have secret meetings before the bidding process .In the meeting, they will make an agreement about the win price and lose price; who will win, and the post bid agreement, for example the winner will sell to losers after bidding or sometimes the winner pays commission to the loser.

This phenomenon has happened in many government project bids especially in construction and many other government procurement projects .In response, the government has to set up an appropriate rule or sometime has to cancel the bidding when there is some information about this type of corruption .For the pledging scheme case, although the corrupter need no government officer in the process, in reality some government officers are involved in corruption cases at the NAAC .

6.2.1. Assumptions about Corruption under the Pledging Scheme

In this study, only “paddy smuggling cases” are focused .The reason is that these cases can impact the whole value chain of the rice industry by increasing the amount of rice in the market .The other three cases impact only the profit/budget of the two parties involved in the program, which are the corrupt farmer and the government .Therefore, the only interesting case is “paddy smuggling”.This case

begins with the farmer and impacts both millers and traders .Therefore, this part will show the assumptions and model modification from farmer to trader.

Farmers

Farmers, who are the main corrupters in this process, smuggleineligible paddy from neighbouring countries and gain benefit by pledging this paddy to the government .Given p= 5 for ineligible seasonal paddy, and p=6 for ineligible off-season paddy, the objective function of the farmer from section 5.3 (Chapter 5) can be modified as follows:

Maximize

$$\pi^{f} = \sum_{p=1}^{6} (P_{p}^{fp} - C_{p}^{f}) Q_{p}^{f}$$

The cost for ineligible seasonal (C_3^f) and ineligible off-season paddy (C_4^f) are the world market prices for those two types of paddy .

In addition, the amount of corruption depends on the degree of corruption or the ability of farmer to be corrupt .Given Z_9 and Z_{10} for the corruption amount, then the additional conditions are:

$Q_5^{fp} \le Z_9$ and $Q_5^{fp} = Q_3^{fp}\lambda$ where λ = corruption degree

$Q_6^{fp} \le Z_{10}$ and $Q_6^{fp} = Q_4^{fp}\lambda$

Therefore, the farmer's model in the pledging scheme with the paddy smuggling situation is

Maximize

$$\pi^f = \sum_{p=1}^{6} (P_p^{fp} - C_p^f) Q_p^f$$

By choosing Q_p^f

Subject to

$$\sum_{p=1}^{2} \gamma_{pk}^f Q_{pi}^f \leq Z_k \qquad \forall_k$$

$$Q_5^{fp} \leq Z_9$$

$$Q_6^{fp} \leq Z_{10}$$

Millers

After the farmer is successful in smuggling paddy into the market, the quantity of paddy is increased in the system .For the miller, the eligible and ineligible types of paddy are not different .Only seasonal and off-season paddy are different . So, the rice miller can still produce three types; fragrant, white, and par-boiled rice . Therefore, the objective function is the same as in the pledging case

However, in this case, the amount of paddy provided for them is increased . For seasonal paddy, it is not only Q_1^f and for off-season not only Q_2^f, but also Q_3^f and Q_4^f .Then the conditions about the paddyquantities in section 5.3 are changed to

$$Q_{11}^m \leq \frac{1}{\delta R}(Q_1^f + Q_3^f)$$

$$Q_{21}^m + Q_{31}^m \leq \frac{1}{\delta R}(Q_2^f + Q_4^f)$$

Therefore, the miller's model is

Objective :Max: $\pi_s^m = \sum_{r=1}^{3} (P_{rs}^m - C_{rs}^m) Q_{rs}^m \qquad \forall_s$

By Choosing Q_{rs}^m

Subject to

$$Q_{11}^{m} \le \frac{1}{\delta R}(Q_{1}^{f} + Q_{3}^{f})$$

$$Q_{12}^{m} \le Q_{p}^{f} - Q_{11}^{m}$$

$$Q_{21}^{m} + Q_{31}^{m} \le \frac{1}{\delta R} Q_{2}^{f}$$

$$Q_{21}^{m} + Q_{31}^{m} \le \frac{1}{\delta R}(Q_{2}^{f} + Q_{4}^{f})$$

$$\sum_{r=1}^{3} Q_{rs}^{m} \le K_{s} \qquad \forall_{s}$$

$$Q_{31}^{m} \le K_{B}$$

Traders and the Government

The trader's model is unchanged since the two types of millers do not change their operational pattern as a result of corruption .Although the amount of rice provided for the trader will increase, the changes are from the new calculation, not the model .Therefore, it has no change in the trader's model .Consequently, the model is still

$$\pi^{t} = \sum_{j=1}^{2}(\sum_{r=1}^{3}(P_{rjs}^{t} - C_{jrs}^{t})Q_{rjs}^{t})$$

By Choosing Q_{rjs}^{t}

Where π^{t} =Profit of trader

P_{rjs}^{t} = Price of Rice "r" buying from miller "s" in market "j"

C_{jrs}^{t} = Cost of Rice "r" selling in market "j" by miller "s"

Q_{rjs}^{t} =Amount of rice "r" buying from miller "s" selling in market "j"

j =1; Export market

= 2; Domestic market

This is the same as the government profit .The equation for the government profit calculation is based on miller behaviour, so there is no change in the government profit equation .The equation is still

$$\pi^{G} = \sum_{r=1}^{3} (P_{r1}^{m} - P_{r1}^{pm}) Q_{r1}^{m}$$

6.2.2. Results

Section 6.1 aims to compare the result with the guarantee case .For that purpose, the degree of corruption (λ) is simulated until the budget is equal to the budget spent in the guarantee case, which is equal to -257,438.11 million Baht. With the simulation process, the corruption degree is computed at 89.9 per cent to make the budget in the pledging case equal to -257,438.11 million Baht.

With the corruption degree at 89.9 per cent and the model modification in section 6.2.1., the results for all parties are presented as follows.

Farmers

With the corruption degree at 89.9 per cent, the farmers are able to illegally pledge 89.9 per cent more paddy to the program. The extra 20 million tons of paddy are pledged to the program, with 4.3 million tons for seasonal and 15.9 million tons for off-season paddy. With this ineligible paddy, the farmers earn 132.7 million Baht more than the no corruption case. The farmers earn 497.5 million Baht in this case.

Table 6-1 :Results for the Corruption of Farmers under the Pledging Scheme

Types of Paddy	No Corruption		Corruption	
	Amount	Profit	Amount	Profit
Program Seasonal	4,827,909	56,900.14	4,827,909	56,900.14
Program Off-Season	17,648,687	176,025.53	17,648,687	176,025.53
Non-Program Seasonal	18,281,334.70	124,051.10	18,281,334.70	124,051.10
Non-Program Off-Season	2,621,583	7,796.22	2,621,583	7,796.22
Ineligible Seasonal			4,340,290.19	21,701.45
Ineligible Off-Season			15,866,169.61	111,063.19
Total	**43,379,513.70**	**364,773.00**	**63,585,973.77**	**497,537.64**

Source :Model Calculation

Millers

With corruption from the farmer, the amount of paddy in the program is increased more than in the no corruption case. This extra amount of paddy reduces the non-scheme paddy production for the large miller. Table 6-3 shows that the large miller decides to increase the production of scheme rice, but reduces the production of non-scheme rice. The reason is that the large millers have contracts with the government to buy all of the paddy in the program, so they decide to increase the production of the paddy in the program until they meet their total production capacity. However, because the corruption creates a large amount of smuggled paddy, they have no production capacity left for non-scheme paddy.

The large millers in this corruption case decide to produce 4.2 million tons of scheme fragrant rice, 3.2 million tons of scheme white rice, 3.2 million tons

of scheme par-boiled rice, and no production for non-scheme rice. The total profit of the large millers is 5.3 billion Baht.

In addition, the study also found the crucial finding that there are 19.7 million tons of off-season paddy left unused as over stocked paddy from the program. With this degree of corruption, there is a huge amount of illegal trafficked paddy in the program. The amount is higher than the total production capacity of the large millers in the program. This amount of paddy is the over-stocked paddy that cannot be milled or sold. Therefore, this 19.7 million tons of off-season paddy which has a value of 116,012 million Baht is lost.

Table 6-2 :Results for the Corruption of Large Millers under the Pledging Scheme

Types of Rice	No Corruption		Corruption	
	Amount	Profit	Amount	Profit
Non-Scheme Fragrant Rice	241,200.00	808.86	0.00	0.00
Non-Scheme White Rice	0.00	0.00	0.00	0.00
Non-Scheme Par-Boiled Rice	0.00	0.00	0.00	0.00
Scheme Fragrant Rice	2,224,842.86	1,112.42	4,224,976.59	2,112.49
Scheme White Rice	4,633,035.48	2,316.52	3,187,050.88	1,593.53
Scheme Par-Boiled Rice	3,500,000.00	1,750.00	3,187,050.88	1,593.53
Total	**10,599,078.34**	**5,987.81**	**10,599,078.34**	**5,299.54**

Source :Model Calculation

For the small millers, it seems that they gain from the corruption in the program because there is more paddy in the market which they can use to produce more rice products. In this case, the small millers produce more fragrant rice than in the no corruption case. The small millers decide to produce 10.9 million tons of fragrant rice, and 1.6 million tons of white rice which yields 65.7 million Baht in profit.

Table 6-3 :Results for the Corruption of Small Millers under the Pledging Scheme

Types of Rice	No Corruption		Corruption	
	Amount	Profit	Amount	Profit
Fragrant Rice	10,633,491.44	58,514.78	10,946,907.00	63,139.73
White Rice	1,569,810.34	1,655.66	1,569,810.34	2,525.19
Par-Boiled Rice	0	0	0	0
Total	**12,203,301.78**	**63,857.20**	**12,516,717.34**	**65,664.93**

Source :Model Calculation

Traders

Traders also lose from corruption .Their profit is decreased from 31.86 billion Baht in the no corruption case to 31.85 billion Baht in the corruption case .The corruption case changes the amount of rice production by mills, so traders are also impacted by this production. The reason is that the trader cannot trade rice in larger amounts than the market size; so even though the amount of rice produced by mills has increased, the trader cannot trade more .In addition, the reason for corruption being bad for traders in this case is that it changes the structure of rice production .

Table 6-4 :Results for the Corruption of Traders under the Pledging

Types of Rice	No Corruption		Corruption	
	Amount	Profit	Amount	Profit
Fragrant Rice Export	2,000,000.00	6,798.52	2,000,000.00	6,798.52
White Rice Export	6,061,180.12	5,849.83	5,887,835.11	5,682.53
Par-Boiled Rice Export	2,938,819.88	2,715.06	3,112,164.89	2,875.20
Fragrant Rice Domestic	10,858,334.29	16,287.50	11,000,000.00	16,500.00
White Rice Domestic	141,665.71	215.19	-	-
Total		**31,866.10**		**31,856.25**

Source :Model Calculation

6.3.3. Discussion

There are three main findings from this case to be discussed in this section. First is the impact on farmers and the government. Second is the topic of over stocked paddy. Finally, the impact on the overall industry is discussed.

The corruption in this case begins with the corrupt farmers. The corrupt farmers gain illegal profits from smuggling paddy from neighboring countries to sell in the program. However, the government, who acquires its income from tax, needs to spend the budget to fund this illegal profit. Therefore, a higher degree of corruption creates higher illegal profits for the farmers, and higher budget spending for the government.

Secondly, rice smuggling in this case, which is set at an 89.9 per cent degree of corruption, creates a huge amount of programmed paddy. This amount exceeds the production capacity of the large millers, so there are 19.7 million tons of paddy left unused. The value of this amount of paddy is calculated at 116 billion Baht, which is almost equal to the budget in the no corruption case (135 billion Baht). So, this case makes the government lose a lot of money. Interestingly, this finding is confirmed by the actual situation in Thailand during the pledging period. In the pledging policy which was run from 2011 to 2014, the government has faced an over-stocking problem until now (2017).

Finally, although paddy smuggling brings more paddy and rice into the market, the overall profits of the industry decreased significantly. The reason is that the government lost a lot of money as a result of the over-stocking problem. The money lost is much greater than the benefit from the increased quantity of paddy in the market. Therefore, the overall industry profits decreased.

6.3.4. Summary

In this case, there is only one type of corruption. In addition, the real amount of corruption has never been announced or evaluated. Therefore, in this case, the sub-cases are separated by the degree of corruption .The degree of

corruption depends on the amount of ineligible paddy the farmer could claim under the program.

The results show that corrupt farmers gained most from illegal paddy smuggling. However, the government lost much money as a result of corruption. Although paddy smuggling adds more paddy and rice to the market, the loss from corruption is much higher. The loss from corruption comes in two ways; firstly, directly from the budget spending to buy more paddy under the program and secondly from the over-stocking of paddy that cannot be milled or sold. The loss from over-stocking is very high and the government and the whole industry lost much money.

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Table 6-5 :Summary of the Results of Corruption under the Pledging Scheme

	No Corruption	Corruption
Farmers	364,773.00	497,537.64
Large Millers	5,987.81	5,299.54
Small Millers	63,857.20	65,664.93
Traders	31,866.10	31,856.25
Budget	-134,936.42	-257,438.11
Lost from Excess Stock	**-**	**-116,012.11**
Total	**331,547.69**	**226,908.25**

Source :Model Calculation

6.3. Corruption and the Price Guarantee Scheme

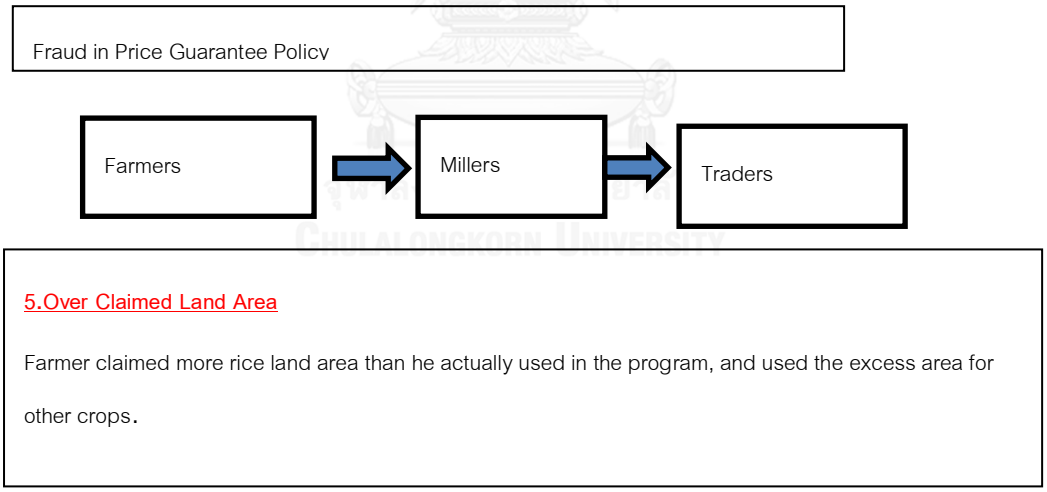
6.3.1 .Assumptions for Corruption under the Price Guarantee Scheme

In contrast to the pledging scheme, there is only one current NACC case for the price guarantee scheme .In that case, NACC does not explain much about the details of the allegation .The allegation accuses former PM Abhisit of “some faulty authorizations about the paddy price guarantee scheme so that there is a severe impact on government budget” Actually, there were more cases of corruption in the

price guarantee scheme at the NACC; however, the NACC announced that "all of the documents were lost in the great flood phenomena in 2013[37]" .Therefore, many cases of corruption in this scheme have disappeared from the NACC.

However, the Pheu Thai party claimed that there was corruption in the scheme .This corruption can be done by farmers with the cooperation of some government officers .To do that, the farmers claimed an exaggerated land area to the government, but grew rice in a smaller area .For example, a farmer who has 50 rai claimed a paddy area for all 50 rai but may actually grow paddy on only 20 rai and grow other crops, such as sugar cane, on the other 30 rai .So, the government has to pay for the 30 extra rai for that farmer .Unfortunately, in practice, the government charged officers to check this behaviour .Therefore, to do this crime, the farmer has to cooperate with the government officer or the government officer cooperates with the farmer.

Figure 6-2 :Fraud in the Price Guarantee Scheme



Source :Pue Thai Party

[37]Thairath, 25 February 2014

With this behaviour, the price guarantee model in section 5.4 can be modified to include the results .Since this kind of corruption occurs in the farmer's process, the model modification only affects the farmer's model.

In this case, the farmer is corrupt by claiming the total land for subsidies from the government, but in reality the farmer used some of the land for other crops, such as sugar cane, instead of paddy .Therefore, the model can be modified by introducing a new crop (Q_3^f) since sugar cane is the second crop and generally used as a substitute for paddy .

In chapter 5, the study found that only normal land and irrigated land are scarce resources for farmers; the others, except for seed, which is needed for sugar cane, are abundant .So, in this model, to grow sugar cane requires only land, which is equal to the misclaimed land area (Z_9.)

Wimolratana Ngokpilai and Supaporn Puangchompoo (2015)[38] provided various important data for sugar cane growing in this case .To produce one ton of sugar cane ($\gamma_{3,9}$) requires 0.06 rai .The cost for sugar cane per rai ($c_{3,9}^f$) is equal to 14,966 Baht .Finally, the price of sugar cane per ton (P_3^f) is 1,089.98 Baht .

Given Z_9 is equal to the corruption degree (λ) times the total land, the normal land area plus the irrigated land area, the normal land area (Z_1) is equal to the real normal land area minus the normal land area times the corruption degree, and the irrigated land area (Z_8) is equal to the real irrigated land area minus the real irrigated land area times the corruption degree, it can be written as

$$Z_1^{\lambda} = Z_1 - Z_1\lambda = Z_1(1-\lambda)$$
$$Z_8^{\lambda} = Z_8 - Z_8\lambda = Z_8(1-\lambda)$$
$$Z_9 = Z_1\lambda + Z_8\lambda = \lambda(Z_1+Z_8)$$

[38]WimolratanaNgokpilai and SupapornPuangchompoo)2015 ("Study on Costs and Returns of Smallholder Farmers Using Agricultural Mechanization for Sugarcane Production for Smallholder Farmers at Nongrua District Khonkaen Province Case Study :Sugarcane Harvester Machinery"; NICBMI 2015

Where Z_1^{λ} and Z_8^{λ} =normal and irrigated land area for paddy crop in corruption cases

In chapter 4, it has been shown that Z_1 is equal to 55 million rai and Z_8 is equal to 15 million rai .Therefore,

Z_1^{λ} =55,000,000 - 55,000,000 λ

Z_8^{λ} =15,000,000 – 15,000,000 λ

Z_9 =70,000,000 λ

For example, if λ =1 %or 0.01 then,

Z_1^{λ} =54,450,000

Z_8^{λ} =14,850,000

Z_9 =700,000

Finally, the model can be written as

<u>Max:</u> $\pi^f = \sum_{p=1}^{3}(P_p^f - C_p^f)Q_p^f + \sum_{p=1}^{3}(P_p^{fg} - P_p^f)Q_p^f$

By choosing Q_p^f

Subject to

$\sum_{p=1}^{3}\gamma_{pk}^f Q_{pi}^f \le Z_k \qquad \forall_k$

Where

$Z_1^{\lambda} = Z_1(1-\lambda)$

$Z_8^{\lambda} = Z_8(1-\lambda)$

$Z_9 = \lambda (Z_1 + Z_8)$

6.3.2. Results

Farmers

Different from the pledging corruption case, this case is separated by the degree of corruption in three cases; ten per cent, twenty per cent, and thirty per cent .The reasons are that the budget in this case is unchanged with the degree of corruption in these two cases is uncomparable, so this study attempts to investigate the impact of corruption on different levels.

The results show that corruption benefited the farmers. Compared with the no corruption case, a 30 per cent degree of corruption increases the profits of farmers from 474.5 billion Baht to 476.7 billion Baht .

The reason is that the profit per rai from growing sugar cane is higher than growing paddy .When the farmers are corrupt by not growing paddy but claiming the subsidy, they decide to grow sugar cane instead . Therefore, the excess area provides more benefit for farmers from sugar cane .

However, the increased sugar cane production also lowers the amount of paddy. Instead of growing 23 million tons of seasonal paddy and 20 million tons of off-season paddy, farmers produced only 16 millions of seasonal paddy and 14 million tons of off-season paddy .This higher profit of the farmer creates pain for other parties, which is shown below.

Table 6-6 :Results for the Corruption of Farmers under the Price Guarantee Scheme by Corruption Degree

Cases		Seasonal Paddy	Off-Season Paddy	Sugar Cane	Profit with Subsidy
No Corruption	*Amount*	23,109,243.70	20,270,270.27		474,530.76
	Profit	272,357.92	202,172.84		
10%	*Amount*	20,798,319.33	18,243,243.24	7,000,000.00	475,223.83
	Profit	141,130.53	54,252.85	22,402.33	
20%	*Amount*	18,487,394.96	16,216,216.22	14,000,000.00	475,916.90
	Profit	125,449.36	48,224.76	44,804.67	
30%	*Amount*	16,176,470.59	14,189,189.19	21,000,000.00	476,609.96
	Profit	109,768.19	42,196.66	67,207.00	

Source :Model Calculation

Millers

Although corruption makes profits for farmer, it hurts millers .Since the paddy production is reduced, millers can produce less rice and make lower profits . This situation occurred for both large and small millers.

For large millers, the profit is lowered from 22.8 billion in the no corruption case to 20.2 billion Baht in the 30 per cent corruption case .The lost 260 million Baht comes from the reduction in fragrant rice production .Fragrant rice production dropped from 10.2 million tons to 7.1 million tons in the 30 per cent corruption case .Although par-boiled rice production increased from 0.4 million tons to 3.4 million tons, total profit was still reduced.

Table 6-7 :Results for the Corruption of Large Millers under the Price Guarantee Scheme by Corruption Degree

Cases		Fragrant Rice	White Rice	Par-Boil Rice	Total
No Corruption	*Produce*	10,223,444.22	0.00	375,634.12	22,808.29
	Profit	22,304.49	0.00	503.80	
10%	*Produce*	9,201,099.79	0.00	1,397,978.55	21,949.00
	Profit	20,074.04	0.00	1,874.96	
20%	*Produce*	8,178,755.37	0.00	2,420,322.97	21,089.72
	Profit	17,843.59	0.00	3,246.13	
30%	*Produce*	7,156,410.95	0.00	3,442,667.39	20,230.43
	Profit	15,613.14	0.00	4,617.29	

Source :Model Calculation

Similar to the large millers, the small millers' reduction in benefits results from the lower production of white rice .The profit is reduced from 17.9 billion Baht to only 5.9 billion Baht in the 30 per cent corruption case .This is a results of white rice production that is reduced from 11 million tons to 5.9 million tons .Therefore, it can be seen that corruption hurts both types of miller.

Table 6-8 :Results for the Corruption of Small Millers under the Price Guarantee Scheme by Corruption Degree

Cases		Fragrant Rice	White Rice	Par-Boil Rice	Total Profit
No Corruption	*Produce*	0.00	11,164,271.50	0.00	17,958.81
	Profit	0.00	17,958.81	0.00	
10%	*Produce*	0.00	8,670,598.84	0.00	13,947.49
	Profit	0.00	13,947.49	0.00	
20%	*Produce*	0.00	6,176,926.18	0.00	9,936.18
	Profit	0.00	9,936.18	0.00	
30%	*Produce*	0.00	3,683,253.52	0.00	5,924.87
	Profit	0.00	5,924.87	0.00	

Source :Model Calculation

Traders

With the lower amounts of rice produced by the millers, the trader loses profits .The profits of traders are lowered from 31.7 billion in the no corruption case to only 23.3 billion in the 30 per cent corruption case .This profit reduction results from the reduction in fragrant and white rice production although the production of par-boiled rice production increased .

Table 6-9 :Results for the Corruption of Traders under the Price Guarantee Scheme by Corruption Degree

Unit: million Baht

Cases		Export			Domestic	
		Fragrant Rice	White Rice	Par-Boiled Rice	Fragrant Rice	White Rice
No Corruption	*Amount*	2,000,000.00	8,387,715.72	375,634.12	8,223,444.22	2,776,555.78
	Profit	6,798.52	8,095.24	347.03	12,335.17	4,217.59
10%	*Amount*	2,000,000.00	4,871,698.64	1,397,978.55	7,201,099.79	3,798,900.21
	Profit	6,798.52	4,701.82	1,291.54	10,801.65	5,770.53
20%	*Amount*	2,000,000.00	1,355,681.56	2,420,322.97	6,178,755.37	4,821,244.63
	Profit	6,798.52	1,308.41	2,236.04	9,268.13	7,323.47
30%	*Amount*	2,000,000.00	-	3,442,667.39	5,156,410.95	3,683,253.52
	Profit	6,798.52	-	3,180.54	7,734.62	5,594.86

Source :Model Calculation

6.3.3. Discussion

The study found a loss for the industry resulting from the reduction in the amount of paddy and by growing sugar cane resulting from corruption in the program .The reason is that the model assumes farmers use their land to harvest sugar cane instead of paddy .Thus the amount of paddy is reduced for the industry . This reduction harms the industry, including large millers, small millers, and traders.

However, the government still pays the same amount as in the no corruption case .The reason is that under this policy, the government pays subsidies from the land area not the amount of paddy production, so the budget is fixed to the land area, not the amount of paddy. Therefore, the government and the citizens who pay tax are not harmed by the corruption in this case.

Compared with the pledging case, it is harder to see the damage to society . Therefore, in reality, corruption in the guarantee case is not a serious issue in Thailand.

6.3.4. Summary

In brief, the corruption in the price guarantee case harmed the overall industry and some parties .Only farmers gained benefits from the corruption, while the government felt no impact .However, the only party for whom the impact can be seen in reality is the government .Therefore, no corruption issues have arisen for this case .

When comparing the impacts on each party, it can be seen that only farmers gained benefit from corruption in this case .The other parties lost from the corruption, except the government who felt no effects from corruption .The party that suffers the most from corruption is the small miller who lost around 5 per cent at the three per cent corruption degree .The second largest losses are for traders, who lost around 2 per cent, and large millers who lost around 1 per cent at the three per cent corruption degree.

Table 6-10 :Summary of Results for Corruption under the Price Guarantee Scheme by Corruption Degree

	No Corruption	10% Corruption Degree	20% Corruption Degree	30% Corruption Degree
Farmers	474,530.76	475,223.83	475,916.90	476,609.96
Large Millers	22,808.29	21,949.00	21,089.72	20,230.43
Small Millers	17,958.81	13,947.49	9,936.18	5,924.87
Traders	31,793.54	29,364.06	26,934.57	23,308.54
Budget	**-257,438.11**	**-257,438.11**	**-257,438.11**	**-257,438.11**
Total	**289,653.29**	**283,046.27**	**276,439.26**	**268,635.69**

Source :Model Calculation

6.4. Comparison of the Two Cases

With the same budget spending at 257.4 billion Baht, the overall profit of the price guarantee case is higher than the pledging case. Although the farmers prefered rice pledging due to the higher profit, the other parties gained from there being more paddy and rice in the industry, while the government lost from the corruption in the program. The loss comes from two sources; firstly, the direct budget for pledging the paddy, and secondly, the loss from over-stocked paddy. The value of the over stocked paddy is computed at 116 billion Baht. This loss makes the total industry profit at only 227 billion Baht compared to 269 billion Baht at the 30 per cent corruption degree in theprice guarantee case, and 332 billion Baht in pledging in the no corruption case.

Table 6-11 :Comparison of the Results for Corruption under the Pledging and Price Guarantee Schemes by Corruption Degree

Parties	Pledging		Guarantee			
	No Corruption	Corruption	No Corruption	10% Corruption Degree	20% Corruption Degree	30% Corruption Degree
Farmers	364,773.00	497,537.64	474,530.76	475,223.83	475,916.90	476,609.96
Large Millers	5,987.81	5,299.54	22,808.29	21,949.00	21,089.72	20,230.43
Small Millers	63,857.20	65,664.93	17,958.81	13,947.49	9,936.18	5,924.87
Traders	31,866.10	31,856.25	31,793.54	29,364.06	26,934.57	23,308.54
Budget	-134,936.42	-257,438.11 and -116,012 For over stocked	- 257,438.11	- 257,438.11	- 257,438.11	-257,438.11
Total	331,547.69	226,908.25	289,653.29	283,046.27	276,439.26	268,635.69

Source :Model Calculation

6.5 Conclusion

Chapter 5 addresses the question of corruption in the two main policies; the pledging and price guarantee policies .This chapter reviews the corruption cases under both policies, and then modified the model based on these cases .The corruption by “smuggling paddy” is chosen for study in the pledging case and “over claimed land” is the case study for the price guarantee case.

The study found that corruption in the two cases reduced the overall profits of the industry. The corruption in the price guarantee case damaged the industry by reducing the amount of paddy and rice. The corruption in the pledging case, although adding more paddy and rice to the industry, greatly increased government spending. The government faced two problems from the corruption in this case; the extra budget from smuggling rice and over-stocked paddy.

To compare the two cases, the degree of corruption in the pledging case is set at 89.9 per cent to make the budget equal to the guarantee case. In comparison, the corruption in the price guarantee case is less, due to the large amount of over-stocked paddy in the pledging case. This over-stocking problem is parrarel with the real situation that occurred in Thailand.

The policy recommendations are as follows: firstly, corruption should be studied to understand the impact and to create policy responses to address the weaknesses. Secondly, for the pledging policy, the government should issue rules for controlling the budget .For example, the pledging should control the amount based on the land area. Finally, for the guarantee policy, the government should control the amount of paddy by not less than the expected amount, computed by land area. In other words, both cases of corruption can be seen by the amount of paddy in the industry .Corruption can be signalled by observing the differences between the expected paddy and the real paddy production.

Chapter7 :The Application of Goal Programming in the Thai Rice Industry

7.1. Introduction

In the previous chapter, the cases of main rice policies implemented in Thailand were studied with the normal Linear Programming method .In this chapter, the new alternative policies will be examined with the Goal Programming method. This goal programming method is different from the normal LP .While the LP target is to solve each objective one by one, the goal programming aim is to solve the multiple objectives simultaneously by weight differently for the different prioritize objective .

As explained above, the main old rice policies implemented in Thailand were studied in the previous chapter .Those policies are blamed for the corruption, the over budget spending, and the market distortion that were proved in chapter 5 and chapter 6 .Those policies are created by targeting on only one party, which mostly is farmer, not the whole industry, so the weaknesses are created .For example, in pledging policy, the policy is for farmer only, therefore it ended up with a very high budget spending, the market distortion, and the pain for some parties .In addition, those policy makers cannot answer the question on “what the whole society got from those policies?” Therefore, a study on the policy for the whole society is needed to study.

The main difference between the Linear Programming and the Goal Programming are their objectives .In Linear Programming, the main objective is to maximize individual objective .In Goal programming, the objective is not for individually purpose but the whole society (or industry).

The policy based on the whole industry objective have never been implemented in Thai rice industry before .There is low cooperation between all main parties’ association such as farmer, miller, and exporter’s association .This is different from sugar industry .In sugar industry, the sugar board which consisted of

representatives from sugar cane plant farmers, sugar factories, sugar traders and government are appointed for making the decision for “sugar quota” .This sugar board has an authority to determine the amount of sugar sold domestically and abroad .This quota decision stabilizes and satisfies the industry and individually objective .Unfortunately, the rice board act differently from sugar board.

In this chapter, the study will be separated into two cases; the case of equal priority and that of different priority .The assumptions, models, results, discussions and conclusions of the two cases are shown as followed.

7.2. Assumptions for Goal Programming

As stated above, this chapter will study in two cases; the equal priority and the different priority .Equal priority means all parties are equally prioritized .It means that farmer, large miller, small miller, domestic trader, and exporter are treated equally .All of them are important and no one is more important than others .This is different from the different priority case .In different priority case, some parties are treated better than others .In other word, some parties are more important than others in different priority case.

For the equal priority case, the social objective is assumed to be the sum of all objectives (profits) of all parties in the industry. The decisions are the decisions of all parties together in the same time. The constraints are also same constraints in chapter 4 .The main different between this case and the case in chapter 5 is that in chapter 5 the decision is solved based on individually maximization which started from farmer to large miller, small miller, and trader. In this case, all parties are solved together .In practice, this case is the experiment of the cooperative board members between all important association in the industry, such as farmer association, miller association, and exporter association when all of them have equal power in the board.

For the different priority, the conditions and the way the decision made are same as equal priority case. The different is on the objective only. Although both

case are aimed for industry objective, not individually objective, the different priority case prioritized some parties more than others .Therefore, the objective of this case is the sum of all parties' profits with weighted differently .For example, if the farmer is the most important party in the industry with the important degree of 2:1:1:1:1 comparing with the millers and traders, the objective is the sum of all other parties' profit plus the double of farmer's profit .This case is applied for examining the results of some special prioritized targets .It can be used to compare between different target policy, for example comparing between no priority, farmer, miller and trader .

There are some scenarios in different priority case as shown in Table 7-1 . Table 7-1 picked up eight scenarios, which five scenarios are focused on only one party .The other three scenarios are the mixed priority .The two combinations between small miller and large millers and between exporter and domestic trader is to investigate when priority on only total mid-stream and down-stream industry (the up-stream case is shown in only farmer scenario). There is the scenario that priority both small miller and farmer .The farmer and the small miller are the first two parties gained highest prioritized for most of the policy makers .The reasons are that these farmers and small millers are the largest number of population in the rice industry and most of them are poorer than the other parties .In addition, most of the small millers are also the farmers .Therefore, there are eight scenarios as shown in Table 7-1 .

Table 7-1 :Study Scenarios in Chapter 7 (Goal Programming)

	Scenarios	Weighted (importance) for each Party in each Cases				
		Farmer	Large Miller	Small Miller	Domestic Trader	Exporter
1	Equal Priority	1	1	1	1	1
2	Only Farmer	1	0	0	0	0

3	Only Large Miller	0	1	0	0	0
4	Only Small Miller	0	0	1	0	0
5	Only Domestic Trader	0	0	0	1	0
6	Only Exporter	0	0	0	0	1
7	Farmer and Small Miller	1	0	1	0	0
8	Large and Small Miller	0	1	1	0	0
9	Domestic Trader and Exporter	0	0	0	1	1

7.3. Model Set Up

Instead of solving individually, Goal programming target is to solve the social objective together. In this study, the social objective is separated into two main cases; equal priority and different priority. The case of equal priority will be observed, before the other.

7.3.1 .Equal Priority

Assumed all parties are prioritized equally, the social profit (the objective of all parties in the rice industry) can be written as

$$\pi^{s} = \pi^{f} + \pi_{1}^{m} + \pi_{2}^{m} + \pi^{t}$$

Where π^{s} is the social profit

Recalling the equations in chapter 4 (section 4.2); the social objective is as follows:

$$\text{Max: } \pi^{s} = \sum_{p=1}^{2}(P_{p}^{f} - C_{p}^{f})Q_{p}^{f} + \sum_{r=1}^{3}(P_{r1}^{m} - C_{r1}^{m})Q_{r1}^{m} + \sum_{r=1}^{3}(P_{r2}^{m} - C_{r2}^{m})Q_{r2}^{m} + \sum_{j=1}^{2}(\sum_{r=1}^{3}(P_{rjs}^{t} - C_{jrs}^{t})Q_{rjs}^{t})$$

By choosing

$Q_{p}^{f}, Q_{r1}^{m}, Q_{r2}^{m}$, and Q_{rjs}^{t}

All parties still face the same conditions as in LP case. The difference is only that in GP case all conditions are solved simultaneously. Therefore, the conditions are

$$\sum_{p=1}^{2}\gamma_{pk}^{f}Q_{pi}^{f} \le Z_{k} \qquad \forall_{k}$$

$$Q_{11}^{m} \le \frac{1}{\delta R}Q_{p}^{f}$$

$$Q_{12}^{m} \le \frac{1}{\delta R}Q_{p}^{f} - Q_{11}^{m}$$

$$Q_{21}^{m} + Q_{31}^{m} \le \frac{1}{\delta R}Q_{2}^{f}$$

$$Q_{22}^{m} \le \frac{1}{\delta_R} Q_2^f - (Q_{21}^{m} + Q_{31}^{m})$$

$$\sum_{r=1}^{3} Q_{rs}^{m} \le K_s \qquad \forall_s$$

$$Q_{31}^{m} \le K_B$$

$$\sum_{i=1}^{2} Q_{jr}^{t} \le \sum_{s=1}^{3} Q_{rs}^{m}$$

7.3.2 .Different Priority

Now the priority is changed from prioritize equally to prioritize differently .For example, society may prioritize farmers over millers and traders. This means the profit of each party can be weighted differently by their prioritization .Therefore, the social profit can be rewritten as

$$\pi^s = W_1\pi_1^f + W_2\pi_1^m + W_3\pi_2^m + W_4\pi^t$$

Where

W_i =weighted for; i =1 farmer

i =2 large miller

i =3 small miller

i =4 trader

Therefore the objective function is

Max:

$$\pi^s = W_1 \sum_{p=1}^{2}(P_p^f - C_p^f)Q_p^f + W_2 \sum_{r=1}^{3}(P_{r1}^m - C_{r1}^m)Q_{r1}^m + W_3 \sum_{r=1}^{3}(P_{r2}^m - C_{r2}^m)Q_{r2}^m + W_4 \sum_{j=1}^{2}(\sum_{r=1}^{3}(P_{rjs}^t - C_{jrs}^t)Q_{rjs}^t)$$

By choosing

$Q_p^f, Q_{r1}^m, Q_{r2}^m,$ and Q_{rjs}^t

This weighted can be chaged by the preferences or importance of each party .For example, if the policy maker preference for farmer, large miller, small miller and trader as 5:1:3:1, then $W_1 = 0.5$, $W_2 = 0.1$, $W_3 = 0.3$, $W_3 = 0.1$.

For the conditions, since they are unchanged, they can be written as

Subject to

$$\sum_{p=1}^{2} \gamma_{pk}^f Q_{pi}^f \le Z_k \qquad \forall_k$$

$$Q_{11}^m \le \frac{1}{\delta R} Q_p^f$$

$$Q_{12}^m \le \frac{1}{\delta R} Q_p^f - Q_{11}^m$$

$$Q_{21}^m + Q_{31}^m \le \frac{1}{\delta R} Q_2^f$$

$$Q_{22}^m \le \frac{1}{\delta R} Q_2^f - (Q_{21}^m + Q_{31}^m)$$

$$\sum_{r=1}^{3} Q_{rs}^m \le K_s \qquad \forall_s$$

$$Q_{31}^m \le K_B$$

$$\sum_{i=1}^{2} Q_{jr}^t \le \sum_{s=1}^{3} Q_{rs}^m$$

Data

There is no new data need in the model .All data gathered in section 4.3 can be reapplied in this chapter.

7.4. Results

The results are separated into two cases; equally weighted and unequally weighted. The results are shown from equally weighted, followed by the unequally weighted cases.

7.4.1 .Equal Weighted

Comparing the result in Goal Programming (GP) with equally weighted with the Linear Programming (LP) from chapter 5 .The results can be shown for each party as follow.

For the farmers, the GP and LP cases show no difference between the two cases .In both cases, off-season paddy is produced at 23 million tons and season paddy is produced at 20 million tons .These amounts of productions provide the profit for farmers in two cases at 217 billion Thai Baht .

The reason for indifference result is the scarce resources in two cases, which are unchanged .The farmer still faces the same conditions about scarce land for both normal and irrigated land area .In addition, the other variables such as price are also unchanged .With these same circumstances, the farmer decisions and profit are unchanged.

Table 7-2 :Results for the Farmer in LP and GP-Equally Weighted Cases

Unit :Tons of Paddies

	GP	LP
Off-Season Paddy	23,109,243.70	23,109,243.70
Season Paddy	20,270,270.27	20,270,270.27
Profit (million Baht)	217,092.65	217,092.65

Source :Model Calculation

Different from farmer, millers in GP and LP cases decide differently. Since large miller has a power to buy a large amount of paddy in one place most of the farmer goes to sell at large miller before the small one. In LP case, this normal situation is assumed to persist. Therefore, the results are on large miller preference. The large miller decides to produce 10.6 million tons of fragrance, which equal to his capacity, and left the other paddies to the small miller. So the small decides to produce 12 million tons of white rice and 65 thousand tons of fragrance rice. These decisions provide them a profit of 35 billion Thai Baht for large miller and 20 million Thai Baht for small miller.

In GP case, the large and small miller has a right to decide together. To maximize the profit of all millers (large and small), the best decision is to left the more efficiency decide first. Since there is smaller scale which provide them more time for elaboration especially in reduction of broken rice ratio[39], the small miller[40] are more efficiency. So, the small miller can decide first in GP. However, there are many small millers in the country, which was explained in the previous chapter that the small miller is over supply, there is no paddy left for large miller. Therefore the

[39] Mr. Adulya Clonebhandhu claimed in "TRF Forum Series 1 : Agricultural Cooperation is one of the Solution for Farmer" 21 December 2016 that his small miller gain a better rate than the large miler. To do that he has to mill the husk out and rest the milled but unpolished paddy for more than a day before polishes the bran out again. This resting process is to reduce the heat from the milled paddy, before polished. This process can reduce the broken rate. However, the large miller that operates for twenty-four hour has no time for this resting process. Therefore, the small miller yields a better rate than the large miller.

[40] In this study the small miller means small and medium sized millers, who have more time to focus on rice production, especially for the reduction of broken rice ratio. These small millers are different from the very small miller with the capacity at around only one to five tons per day. The study does concerns that those very small millers are very inefficient, due to a very high broken rice ratio.

decision is the small miller produces 13.8 million tons of fragrance rice and 12 million tons of white rice, while the large miller produces nothing, and the small miller received the profit of 111 billion Thai Baht.

Table 7-3 :Productions and Profits for Large and Small Millers in GP-Equally Weighted and LP Cases

Unit :Tons of Rice

	GP	LP
Large Fragrance	0	10,599,078.34
Large White	0	0
Large Par-Boiled	0	0
Small Fragrance	13,837,870.48	65,415.39
Small White	8,637,886.39	12,137,886.39
Small Par-Boiled	3,500,000.00	0
Profit Large Miller (Million Baht)	0	35,544.01
Profit Small Miller (Million Baht)	111,655.59	19,973.62
Profit of All Millers (Million Baht)	**111,655.59**	**55,517.63**

Source :Model Calculation

With the decisions of millers, the decisions in LP and GP cases for traders are different. In LP, the exporter will decide to export 2 million tons of fragrance rice and 9 million tons of white rice and the domestic trader will decide to trade 8.7 million tons of fragrance rice and 2.3 million tons of white rice domestically. These decisions provide the profit of 15.6 billion Thai Baht to exporter and 17.2 billion Thai Baht to domestic trader.

In GP case, the exporter will decide to export 2 million tons of fragrance rice, 5.5 million tons of white rice, and 3.5 million tons of par-boiled rice. The domestic trader will trade only 11 million tons of fragrance rice domestically and trade no

white rice in Thailand. This will make the profit of 15.8 billion Thai Baht for exporter and 17.3 billion Thai Baht for domestic trader, which is better than in LP case.

Table 7-4 :Results for Exporter and Domestic Traders in LP and GP-Equally Weighted Cases

Unit :Tons of Rice

	LP	GP
Fragrance Rice Export	2,000,000	2,000,000
White Rice Export	9,000,000	5,500,000
Par-Boiled Rice Export	0	3,500,000
Fragrance Rice Domestic	8,664,494	11,000,000
White Rice Domestic	2,335,506	0
Profit of Exporter (Million Baht)	15,661.30	15,873.05
Profit of Domestic Trader (Million Baht)	17,200.86	17,311.80

Source :Model Calculation

In conclusion, the profit of all parties are shown that **the GP case is more preferable in the sense that it yields a higher profit at 356.5 billion Thai Baht compared to 305.5 billion Thai Baht in LP case (**Table 7-5). For the farmers, it can be seen that the profit of farmer are no different between two cases and for domestic trader and exporter are different only little (one to two hundred million Thai Baht). The big differences are on millers' profit. In LP case, both millers earn profit which the large miller gains most. However, in GP case, large miller earn no profit (since there is no production), while the small miller earn much larger profit than in LP case. Therefore, the total profits for all parties, which can also be called the social or industrial profit, are different. The reason is that the GP case changes

the trade pattern from going first to large miller, who can buy a large amount of paddies in one time, to the small miller, who is more efficiency.

Table 7-5 :Profits of All Parties in GP-Equally Weighted and LP Cases

Unit :Million Baht

	LP	GP
Total Profit	**305,472.44**	**361,933.09**
Farmer Profit	217,092.65	217,092.65
Large Miller Profit	35,544.01	0
Small Miller Profit	19,973.62	111,655.59
Exporter Profit	15,661.30	15,873.05
Domestic Trader Profit	17,200.86	17,311.80

Source :Model Calculation

7.4.2 .Unequal Weighted

With the model and data shown in section 7.3.2, the cases shown in table 7-1 can be solved. The results for each case in table 7-1 are shown in Table 7-10

The results for these scenarios can be separated by the overall profits into 4 groups; Group 1: the highest profit, Group 2: the second highest profit, Group 3: the third highest profit and Group 4: the least profit. The results for each group are as follows.

Group 1: The highest total profit

There are two scenarios in this group**;** the equal priority case and the priority only farmer case (case 1 and case 2). The total profit of the two scenarios is the highest amongst all groups at 361.9 billion Baht. The party that gains the highest profit is the farmer, who gains 217 billion Baht. The second is the small miller who gains 111.6 billion Baht. The third is the domestic trader who gains 17.3 billion Baht. The fourth is the exporter who gains 15.8 billion Baht. The small miller gains nothing.

Table 7-6 :Profits of Group 1 Scenarios by Parties

Unit: million Baht

Priority Scenarios	Equal Priority and Only Farmer				
Total	Farmer	Large Miller	Small Miller	Domestic Trader	Exporter
361,933.09	217,092.65	0.00	111,655.59	17,311.80	15,873.05

Source: From the Study

Group 2: The second highest total profit

There are four scenarios in this group. The scenarios are priority on (1) farmers and small millers, (2) only small millers, (3) small and large millers and (4) only domestic traders. This group yields slightly less benefits than group 1. The total benefit yield of group 2 is 361.896 billion Baht. The farmer gains 217.093 billion Baht, i.e. most of the total benefit, the small miller gains 111.83 billion Baht, the domestic trader gains 17.3 billion Baht and the exporter gains 15.6 billion Baht

In this case, the small miller gains more than in group 1 by around 175 million Baht, while the exporter gains 212 million Baht less than in group 1. Therefore, the higher profit of the small miller is traded off by the losses of the exporter.

Table 7-7 :Profits of Group 2 scenarios by Parties

Unit: million Baht

Priority Scenarios	farmer and small miller, only small miller, large and small miller, and only domestic trader				
Total	**Farmer**	**Large Miller**	**Small Miller**	**Domestic Trader**	**Exporter**
361,896.34	217,092.65	0.00	111,830.59	17,311.80	15,661.30

Source: From the Study

Group 3: **The third highest total profit (exporter first)**

There are two cases in this group. The the domestic trader and the exporter, and only the exporter, are prioritized in this case. The total profit of this group is 351.4 billion Baht. The highest profit party is still the farmer. The farmer gains 211.4 billion. The small miller gains second highest profit at 103.9 billion Baht. The third is the domestic trader who gains 17.3 billion Baht. The exporter gains 15.8 billion Baht. Finally, the large miller gains 2.9 billion Baht in this case.

The farmer gains 5,709 million Baht less than in group 1. The small miller also gains 7,872 million Baht less than in group 1, while the domestic trader and the exporter are unchanged from group 1. The biggest gainer is the large miller. The large miller gains 2,902 million Baht more than in group 1. Therefore, the exporter first program makes the exporter wealthier, but it is traded off by the loss of the farmer and the small miller.

Table 7-8 :Profits of Group 3 Scenarios by Parties

Unit: million Baht

Priority Scenarios	Only exporter and Domestic Trader and Exporter				
Total	**Farmer**	**Large Miller**	**Small Miller**	**Domestic Trader**	**Exporter**
351,429.65	211,383.29	2,902.53	103,958.98	17,311.80	15,873.05

Source: From the Study

Group 4: **The lowest total profit or the exporter first**

Only the large miller is prioritized is this group. The total profit in this group is 300 billion Baht. The farmer is the highest profit party and gains 216.7 billion Baht. The large miller is second and gains 35.5 billion Baht. The third largest profit is the small miller who gains 19.4 billion Baht. The domestic trader gains 17.2 billion Baht. Lastly, the exporter gains 11.8 billion Baht.

The parties who lose from this group are the farmers, the small millers, the domestic traders and the exporters. The farmers lose 61,214 million Baht, the small millers lose 92,293 million Baht, the domestic trader loses 39 million Baht, and the exporter loses 4,072 million Baht. The large miller is the only gainer in this group. The large miller gains 35,544 million Baht. Therefore, the gain of the large miller comes at the expense of the farmers, small millers, domestic traders, and exporters.

Table 7-9 :Profits of Group 4 Scenarios by Parties

Unit: million Baht

Priority Scenarios	only large miller				
Total	**Farmer**	**Large Miller**	**Small Miller**	**Domestic Trader**	**Exporter**
300,719.55	216,739.22	35,544.01	19,362.32	17,272.82	11,801.17

Source: From the Study

Table 7-10 :Results of the Total Profits and the profits for Each Party in Each Case

Unit: million Baht

Groups	Priority Scenarios	Results of the Profits for Total and Each Party					
		Total	Farmer	Large Miller	Small Miller	Domestic Trader	Exporter
1	Equal Priority	*361,933.09*	217,092.65	0.00	111,655.59	17,311.80	15,873.05
	Only Farmer	*361,933.09*	217,092.65	0.00	111,655.59	17,311.80	15,873.05
2	Farmer and Small Miller	*361,896.34*	217,092.65	0.00	111,830.59	17,311.80	15,661.30
	Only Small Miller	*361,896.34*	217,092.65	0.00	111,830.59	17,311.80	15,661.30
	Large and Small Miller	*361,896.34*	217,092.65	0.00	111,830.59	17,311.80	15,661.30
	Only Domestic Trader	*361,896.34*	217,092.65	0.00	111,830.59	17,311.80	15,661.30
3	Only Exporter	*351,429.65*	211,383.29	2,902.53	103,958.98	17,311.80	15,873.05
	Domestic Trader and Exporter	*351,429.65*	211,383.29	2,902.53	103,958.98	17,311.80	15,873.05
4	Only Large Miller	*300,719.55*	216,739.22	35,544.01	19,362.32	17,272.82	11,801.17

Source: From the Study

7.5Discussion

7.5.1 .Equal Weighted

There are many points can be discussed in this case .Firstly, the overall results that shown that the GP or “the social maximization” method are more preferable than the LP or “individual maximization” case, because the total profit in GP case is higher than in LP case for 17 per cent (356 billion to 305 billion Thai Baht).

The reason based on the data that small miller who is more efficiency in reducing the broken rice ratio have more bargaining power in GP case, but no power in LP case .Therefore, the whole industrial enjoy the more efficiency in the system and it reflect to the total industrial profit.

In addition, it can be seen that there are more varieties of rice for export market, but less variety of rice for domestic market in GP case .In GP case, the small miller who earns benefit from par-boiled rice more than white rice has an opportunity to produce rice instead of large miller in LP case .So, the small miller decides to produce par-boiled rice, before the white rice .This decision makes more par-boiled, but less white rice in the market .With this small amount of white rice, there is no white rice left for the domestic market .Therefore, there is par-boiled rice in export market, but no white rice for domestic market in GP case, where there is no par-boiled rice in export market, but white rice in domestic market in LP case. In other word, for variety of rice products in the market, GP case is good for export market (fragrance, white, and par-boiled rice are available), but not for domestic market (since no white rice) and LP case is good for domestic market (both fragrance and white rice are available), but not good for export market (no par-boiled rice).

It can be seen that the GP case harms the large miller .Although, the whole society gets benefit from the decision, the large miller lost all profits in the case .This issue can be discussed in many ways .First of all, it is impossible that the large miller will agree on the decision .Secondly, this decision does not take the transaction cost into account .Although, the small miller is more efficient, the large miller can reduce

the transaction cost for farmer to sell for only one miller instead of many small millers .Therefore, in reality the decision has to leave some benefit for large miller.

Finally, both cases provide better results than reality. OAE (2014) shows the amount of seasonal and off-season paddy grown and harvested by the farmer .With the same price and cost for both types of paddy in the model, the real profit is computed at 162 billion Baht, which is lower than 217 billion Baht in the model .The lower amount in reality comes from the “non-optimized decisions” of farmers . Therefore, it is worth the government pursuing policies to encourage optimization for farmers.

7.5.2 .Unequal Weighted

The goal programming studied in this rice industry is the situation that all players in the industry do not decide individually, but together as a group. Unequal weighted mean that there are some players prioritized higher than the other in the group. So, the study on unequally weighted section can be used in two ways. Firstly, it can be used to study on the situation that different groups of people have different powers in the “rice board”. For example, if the farmers are the sole powerful member, the case that priority on only farmer can be applied. So, this study can observe the results of those scenarios.

Comparing each group and scenario, it can be seen that the parties that should be prioritized for the benefit of industry (social) are ranked by farmer as a first priority, small miller as a second priority, domestic trader as a third priority, exporter as a fourth priority, and large miller as a last priority. In other word, the farmer and the small miller are first two that should be empowering.

In addition, the results from unequally weighted case reconfirm some findings from equally weighted case .The benefit of prioritized on small miller more than large miller are also found in this case .Prioritize on only small miller scenario and both small miller and farmer scenario have a higher total profit than in only large miller scenario .So, this result is support for the policy that enhancing the small millers.

The different is the prioritized on domestic trader than the exporter .The reason is that the small trader has a larger margin comparing to the exporter. However, this higher margin does not indicate that each domestic trader is wealthier than the exporter, since the exporter sales in averagely larger amounts. There are many domestic traders in the market, while not many exporter in the country .The biggest five exporter earn around fifty per cent of Thai rice export value .So, the domestic trader is not wealthier than the exporter.

7.6 .Summary

In conclusion, the GP case provide a better social benefit than the LP case. In other word, the social's maximization is more preferable than the individual's maximization for Thai rice market. Therefore, the main recommendation for a new policy is to encourage farmers, millers, and traders to cooperate.

However, the GP case in not perfectly superior to LP case. The large miller lost in social's maximization case. To make the large miller cooperate in the decision some compensation should be made.

The GP case is better than LP case, because GP case does not let the large miller who comparatively inefficient to produce. However, in reality the large miller can accept a larger amount of paddy to produce, so it can reduce the transaction cost from transferring paddy to many small and middle millers.

In addition, there are many small millers who have capacity to mill around one ton of paddy per day yield a very low rate of unbroken rice. In other word, this type of miller is not efficiency. However, with some mistakes, there are many small milling machines sold around the countries. Many farmers who not specialized in milling and selling rice were encouraged to be the small miller. With lacked of business skilled, knowledge, and efficiency machine, most of small millers were out

of the market. The data from Department of Business Development (2016) shows that there were 843 small millers in 2013, but it reduces to only 666 small millers in 2015.

Therefore, the first recommendation is to encourage or establish the “rice board” that consist of all parties in the industry and provide them the equal power. One of the objectives of this rice board is to determine the paddy and rice amount production in each stage for the benefit of society. This is also to guarantee the paddy amount for middle size miller.

Secondly, the large miller should provide or sell the business shares to small middle size miller. This business sharing will keep many small millers in one place that can reduce the transaction cost which is the weakness of middle size miller and can increase the efficiency of large millers which is also the weakness of them. Alternatively, the large miller can allow the small and middle size miller to rent the sub-factory (land, worker and machine), instead.

Finally, the farmer should have business share in the small or middle size miller who have share or rent from large miller. In this policy, the farmers who have no benefit or differences from two cases can received the extra benefit from this sharing.For the small and middle size miller, the problem of no paddy to mill, since farmer go to large miller before, can be solved. This policy will encourage the farmers who have share in the small or middle size miller to sell paddy to the miller they earned a share. This policy is more appropriated than encourage farmer to be the miller or business man that they are not “born to be”.

Chapter 8: Conclusion and Suggestions

This chapter will be separated into two sections; the conclusions and suggestions. The conclusion will conclude the study from chapters 1 to 7 .The suggestions part will analyse the findings from all chapters and present policy recommendations

8.1. Conclusions

The aim of this study is to recommend appropriate policies for the Thai rice industry. To recommend appropriate policies, the study analyses the impact, advantages and disadvantages of the main policies for the Thai rice industry by constructing a model based on the nature of the industry and the policies that have been implemented over the past three decades.

From many policies launched in Thailand and other countries, only a few policies were selected for study. Export and import duty policies were not selected because they are against the principles of the WTO and have not been applied in Thailand for more than twenty years. Many other types of policy are not applied by rice exporting countries. So, the main policies applied in Thailand selected for this study are the pledging and price guarantee policies, which are studied in both normal and corruption cases. In addition, policies such as technological and production improvement are indirectly studied via the shadow prices.

For the nature of the rice industry, this study applied the value chain as the framework for the study. The value chain focuses on the five main parties in the industry, which are farmers, millers (small millers and large millers), exporters and domestic traders. The value chain begins with farmers who grow, harvest and sell paddies to both small and large millers. Both types of miller mill the paddy into rice and sell it to both exporters and domestic traders. Generally, farmers sell paddy to

large millers before small millers because they can reduce transaction costs by selling large amounts of paddy at one place.

For the price relationship, the price of paddy, the wholesale rice (rice from miller) exported rice, and domestically retailed rice are determined by the world market price which cannot be controlled by any country. The rice price along the value chain is transmitted from the world market price to export, domestic, wholesale, and paddy prices. Normally, traders have more negotiation power than millers so they gain a higher margin. Compared to farmers and traders, millers gain the least margin. In addition, the world rice market price cannot be controlled since no country has rice market power. Surprisingly, the literature review revealed that the rice price is not determined by the supply of world rice, but depends on world income per capita, the population, and GDP. This is different from normal goods.

With this information on rice industry, the price transmission relationship, and the focused policies, the study constructed an LP model on the rice industry under various situations which revealed some interesting and both surprising and unsurprising findings as follows.

In the normal situation with no government intervention, the study found some crucial results. First of all, the study found that the main scarce resources for the industry are both types of land area. The scarce resource for season paddy which also impacts the amount of fragrant rice for both millers and traders is the normal land area, while the scarce resource for off-season paddy which impacts the amount of white and par-boiled rice is the irrigated land area. The benefits of increasing one rai of normal land area (the shadow price) is 6,268 Thai Baht and the benefit of increasing one rai of irrigated land area on the normal land area is 4,111 Thai Baht[41]. However, it is difficult to expand the normal land area in Thailand, so the only possible policies are to develop more irrigated land area in normal land areas or

[41] The irrigated land area is made from the normal land area, so the real benefit of increasing one rai is 10,379 minus 6,268 (shadow price of normal land area) or 4,111 Baht.

replace other cash crop such as sugar cane with paddy fields. However, for such replacement, farmers have toevaluate other resources such as labour and machinery. Secondly, the miller gains the least margin in the industry. The millers have a very low margin from selling broken and unbroken rice, so the by-products such as bran, husk and germ are very important for them[42]. Thirdly, small millers have the lowest broken rice rate. To have a low broken rice rate, after milling the husk out of the paddy, the miller needs to wait for at least 24 hours before polishing the bran and germ out, otherwise the paddy will be hot and easily broken. The small millers have more time than large millers to wait, so they gain a better rate. Fourthly, one of the scarce resources for the trader is the market size. However, the study found that with a budget of 1 million Thai Baht, marketing programs should increase the trade amount by at least 1,752 tons of rice. Lastly, the decision for farmer in the study is a better decision than in reality, due to higher profits. This suggests that the farmers have not optimized their farm.

For the pledging and price guarantee situation, the study found some interesting issues. Firstly, the price guarantee scheme is better for farmers but requires higher budget spending compared to the pledging case. The reason is that all farmers can benefit from the program, which is different from the pledging policy in which only farmers that can wait for the money can benefit from the program. Secondly, the total industry profit (the sum of all parties' profit) for the pledging policy is higher than no policy implementation and the price guarantee policy .The pledging case changes the market structure from "large miller first" to "small miller first", so the small miller who has a better unbroken rice rate has more rice to produce. Therefore, the total industry profit is higher in the pledging case.

However, there are many more important findings in the corruption cases. Firstly, a higher corruption level creates bigger budgets for the pledging case, but the same budget for the price guarantee case. The reasons are that in the pledging case,

[42] Some millers share the profit with farmers by the miller gaining revenue from by-products while the farmers gain revenue from the unbroken rice.

the farmer is corrupt by smuggling more paddy from neighbouring countries into the program, so the government needs to spend more money, but in the price guarantee case, the corrupt farmers do not use land for growing rice, but for other crops, so the government who pays by land area, pays the same amount as in the no corruption case. Secondly, with more rice from corruption in the pledging case and less rice in the price guarantee case, the corruption in the pledging case creates more paddy and rice for the industry, but the corruption in the price guarantee case harms the industry. The corruption in the pledging case involves smuggling more rice into the industry, but the price guarantee case is corrupt by growing other crops instead of rice, so the corruption in the pledging case creates extra rice in the industry, but the corruption in price guarantee case reduces the amount of rice in the industry.

To compare both cases, the study observes the degree of corruption where the two cases spend the same amount of money. Interestingly, the study found that with that degree of corruption, the amount of smuggling paddy is too large to mill based on the production capacity of the large millers, so a large amount of paddy is wasted as over-stocked paddy. This over stocked paddy is calculated at 19.7 million tons and the value is 116,012 million Baht. Therefore, instead of creating a net benefit to society by increasing the amount of paddy and rice, the social benefit is reduced from 331.5 billion Baht in the no corruption case to only 226.9 million Baht in the corruption case, due to the large amount of unused over-stocked paddy.

For recommendations on corruption, the government can detect corruption from the amount of rice in the program. In the pledging case, the sign for corruption is when there is too much rice in the program, but in the price guarantee case, the government can detect corruption from the low amount of rice in the industry.

Finally, goal programming as an alternative case reveals some important findings. First of all, goal programming shows the benefit of cooperation between all parties in the industry. The social optimization case yields a better industrial profit compared to individual optimization. Secondly, goal programing also shows the benefit of empowering the farmers and the small millers.

In conclusion, there are many crucial findings that can be developed in appropriate policies. Firstly, the scarce resources are the normal land area and the irrigated land area. Secondly, the farmers have not optimized their farms. Thirdly, price guarantee policies are advantageous for farmers, but disadvantageous for the budget and the total industrial profit. Fourthly, the government can detect corruption from the amount of paddy in the program. Fifthly, socially optimized decision making is better than individually optimized decision making. Finally, the main parties who are encouraged to be prioritized are farmers and small millers.

8.2. Suggestions

8.2.1. Policy Suggestions

From the findings presented in the conclusion, the policy suggestions are as follows.

Firstly, the amount of irrigated land area should be increased. The reason follows the finding that the scarce resources are the normal land area and the irrigated land area. However, it is difficult to increase the normal land area in the country because the arable land in Thailand is almost fully utilized for agriculture. So, it is recommended to only increase the amount of irrigated land area. The irrigated land area can be increased by developing the irrigation system by better water management in the country.

Secondly, policies for increasing the yield per area, including the “Thai rice technological road map” are needed. The reason is that to increase the normal rice land area in Thailand is difficult due to the reason stated above. Indirect methods to increase the yield per area are recommended instead. To achieve this, the government can apply other measures such as research, development and training . Thailand can study the Vietnamese experience which increased the yield per hectare from 4 tons per hectare in 2001 to 5.6 tons per hectare in 2013. In addition, a “Thai rice technological road map” may encourage efficient technological improvement.

Thirdly, government agents or other organizations should advise farmers how to optimize their farms. This recommendation follows the finding that farmers have not yet optimized their farms, so they earn a low income. However, to support this policy, the paddy and rice prices have to be secured.

Fourthly**,** pledging policy is recommend in low government budget cases and a price guarantee policy is recommended for high budget cases to secure the paddy price in the short run. The reasons are that to optimize the farm, the price has to be secured and these two policies have some advantages and disadvantages that can be applied in combination with other controlling policies .The price guarantee policies have advantages in terms of the profit for the farmer, but disadvantages from the higher budget spending, so it is recommended that government has a large budget to spend on the program.

Fifthly, checks and balances should be employed to control the pledging and price guarantee programs .The reasons are that such measures can control the budget[43] and the checking can detect corruption, which was proved to be negative for society in chapter 6. In practice, for transparency, the government should also increase the role and authority of the National Anti-Corruption Council (NACC) in the program.

Sixthly, it is suggested to enhance the power of small millers by supporting the farmers' joint stock in small millers. The reason is that this study found the benefit of empowering the small miller in society; however, one of the obstacles for small millers is "no paddy to mill". Sharing the profit of small millers can encourage the farmers to sell paddy to the small millers. In addition, with this profit sharing, millers can also transfer the excess social profit to the farmers.

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[43] The government can control the budget by setting an appropriate programme price or quantity following the formula : $(P^p - P^m)Q^p \leq B$. Where $P^p - P^m$ are the price differences between the programme price (pledging or guarantee price), Q^p is amount of paddy in the program, and B is the total budget .

Eighthly, the capability of the small millers also needs to be improved. The only advantage of small millers over large millers is time. The other aspects such as capacity per day, standard and quality are the disadvantages of the small millers. To empower the small millers, their capabilities need to be developed.

The final recommendation is **to support rice organizations, such as the rice board**. The reason is that in chapter 7, the comparison between GP and LP cases showed that the benefit from cooperation is higher than individual decision making . The rice board should consist of real representatives from all important parties in the rice industry. The task of the board is mainly to decide the optimal rice and paddy production amount for all parties along the rice value chain.

8.2.2 .Suggestions for Further Studies

From the recommendations, several studies could be conducted. Firstly, a study on science, technology and innovation for improving the yield per land area is needed. The study could be, for example, on growing techniques, seed, fertilizer, and chemical improvement, and new machine development.

Secondly, a study on farm optimization in many levels from regional studies to individual farms should be conducted. This type of study can support policy at the regional, provincial, city and village level. Individual farm studies can also be conducted as pilot projects.

Thirdly, the study of rice mill enhancement, for example, the study of technology to reduce the broken rice rate, cost reduction, and marketing, is recommended.

Fourthly, the study of other cash crops should be included in the model. Such study could help government to make better decsions and provide better solutions for farmers, instead of allowing them to produce only a few crops.

Finally, the study of other alternative policies, such as the possibility for founding or restructuring the “Thai rice board” and a “Thai rice futures market” should be conducted. These types of study should combine legal, financial, and economic aspects.

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APPENDIX

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