# Economic Crop Plantation Advisory System in Rubber-Based Intercropping

Urairat Makchan
Department of Digital Technology
Faculty of Science and Technology
Phuket Rajabhat University
Phuket,Thailand
+66 76211959
urairat.m@pkru.ac.th

Putsadee Pornphol
Department of Digital Technology
Faculty of Science and Technology
Phuket Rajabhat University
Phuket,Thailand
+66 76211959
putsadee.p@pkru.ac.th

Suphamit Chittayasothorn
Department of Computer Engineering
Faculty of Engineering,
King Mongkut's Institute of Technology
Ladkrabang Bangkok, Thailand
+66 2 329 8341
suphamit.ch@kmitl.ac.th

## ABSTRACT

Plummeting demand and increasing production have triggered a fall in rubber prices. This may be due to the impact of technological progress that can evolve synthetic raw materials to replace the use of rubber in certain industries. There are a number of reasons that cause the rubber price crisis. Consequences are not only affecting rubber planters, but also causing a direct impact to the overall economy of the country. Various agencies have seriously sought ways to solve the problem to help rubber farmers. One simple and practical method that has been proposed is to grow some other crops in free spaces of rubber plantations. It is an excellent idea to transform a single rubber plantation into an integrated farmland, in which rubber planters will not have to rely only on one source of income. Pursuing the sufficiency economy philosophy, the main objective is to help rubber farmers earn greater incomes in a sustainable manner, particularly by improving the quality and quantity of their crops, while remaining firm in preserving natural resources, such as soil, water, and air. To make such solution achievable, the public and private sectors have conducted various researches on how to produce a greater yield on a given plot of land in a rubber plantation. Certain types of crops have been determined to be grown in rubber plantations. They are compatible crops, multiple crops, and economic crops, which can ensure increasing agricultural productivity throughout the rubber plantation period.

This paper aims to present the analysis of data related to the cultivation of other crops in unoccupied areas of rubber plantations, where rubber farmers and relevant parties will be offered productive suggestions on rubber farming. For data that have been input to process in the advisory system such as soil, water, air, and alternative crop prices can be obtained from data online and data offline. The results from the system will be knowledge for rubber famers directly or agricultural specialists to provide rubber farmers with extensive knowledge on the benefits of transforming a single rubber plantation into an integrated farmland, as part of the goal to create greater income-earning opportunities by growing compatible crops, multiple crops, and economic crops.

## CCS Concepts

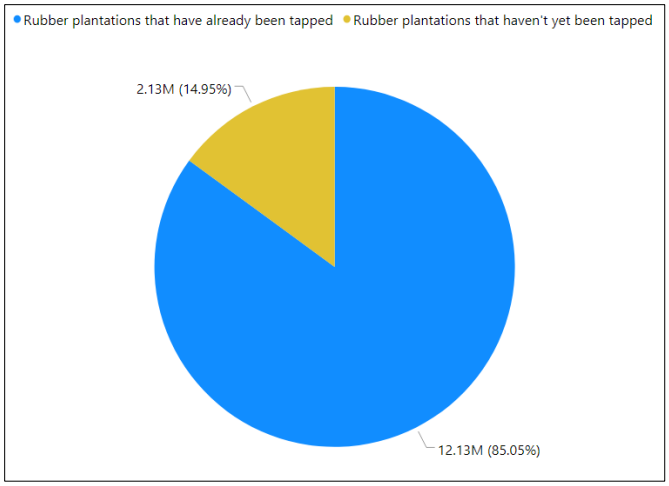
• **Information systems~Online analytical processing**

## Keywords

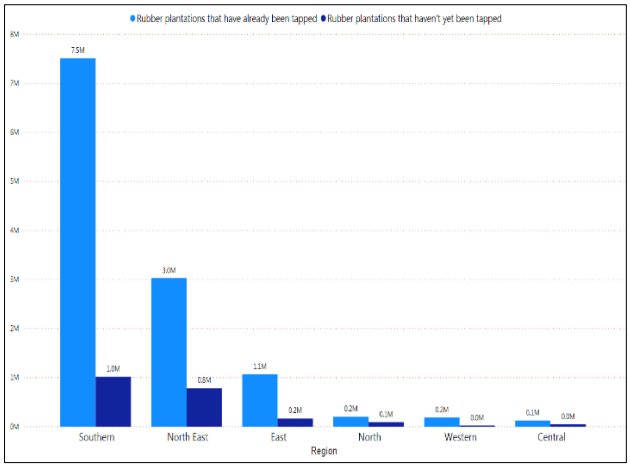
Information Systems Advisory System, Data Analytics, Web Query, Rubber, Para Rubber

## 1. INTRODUCTION

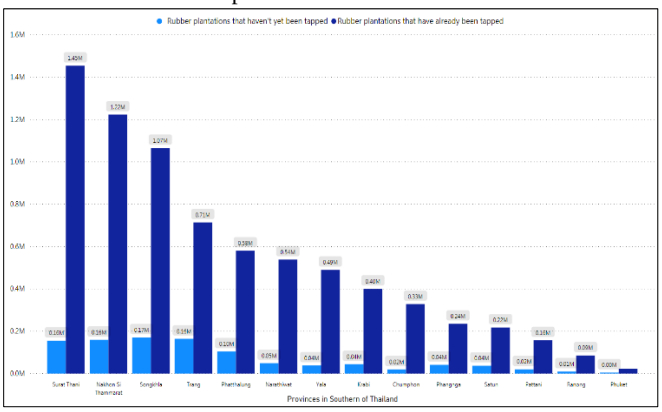
Rubber is an important economic crop in Thailand. This perennial plant helps generate substantial incomes for the country since the past and continues into the present. Rubber has become the country's top agricultural product as it is ranked No. 1 among other exported products, with the highest export volume of around 170 billion baht in 2015. At the same time, Thai rubber possesses the highest market share, particularly in terms of production and export, in the global market. The rubber production capacity has reached 4.4 million tons per year, considered 36 percent of the global production capacity of 12.3 million tons per year. Rubber is a significant raw material for the production of various products, for instance, car tire, rubber gloves, elastic rubber tube, condom, and several other products. Hence, the decrease in rubber prices will cause a domino effect on other industries involved in the use of rubber as raw materials. During 2005-2011, the price of natural rubber had increased dramatically from 20 baht to 200 baht per kilogram. As a result, several countries across the world, including Thailand, had determined to expand their rubber cultivation areas. For Thailand, rubber was basically planted in the southern and eastern regions of the country due to topographical conditions and climatic characteristics that are highly appropriate for rubber planting. However, following the sudden price increase, rubber farming had been expanded to other parts of Thailand. In consequence, the output of rubber had exceeded the demand for use, causing the rubber price to fall constantly from 2014 to the present. This has caused a severe impact on the overall economy, particularly in the southern region of the country, where local agriculturists' major source of income comes from rubber farming [1] [2] . Figure 1 shows rubber plantation areas in Thailand, together with details on rubber plantation obtained from each region, rubber farming in each southern province, and the quantity of rubber planting in Phang-Nga province used as a case study for this research [3].



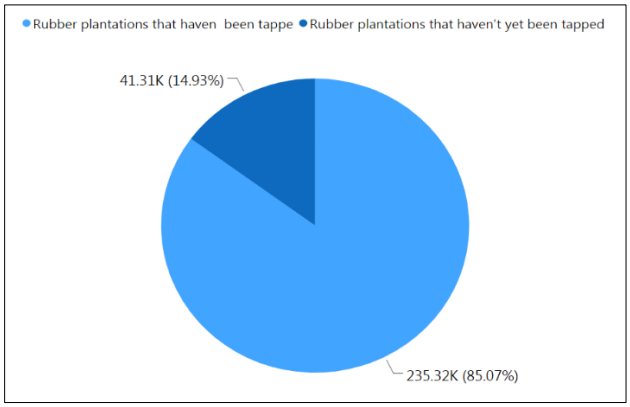

Rubber plantation areas in Thailand.




Rubber plantations in each region of Thailand.




Rubber farming in each southern province.




Quantity of rubber planting in Phang-Nga province.

**Figure 1 shows rubber plantation areas in Thailand**

Referring to the problem of oversupply of rubber products, the price of rubber has fallen drastically, causing a direct impact on rubber farmers. Meanwhile, the impact has spillover effects on other businesses and society in a broad area. The government has attempted very hard to seek effective solutions to the problems of oversupply and falling prices of natural rubber. As there are some free spaces remained in rubber plantations, planting other crops in those spaces can be the best and most efficient solution.

Figure 2 shows that the cultivation of alternative crops and plants can help rubber farmers to earn greater incomes. Nevertheless, to get the idea implemented, rubber farmers are suggested to take these requirements into consideration, where 1) Crops or plants expected to be cultivated must comply with soil conditions and the age of a rubber tree, 2) Rubber farmers must acquire sufficient knowledge on cultivated crops or plants, 3) It is necessary for rubber farmers to initially conduct a planting experiment in a small plot of land, and 4) If the planting experiment of suitable crops or plants has become successful, it can be expanded to a large-sized plot of land [4] . According to the above-mentioned suggestions, the researcher has agreed that the development Information system should be applied to ensure the effectiveness of data collection of alternative crops or plants grown in rubber plantations. Also, the advisory system has been expected to facilitate the data analysis of crops and plants to be suggested to rubber planters, as part of the intention to provide them with accurate decision-making and minimized risks of implementation.

**Figure 2 Free space in rubber plantations**

## 2. PARA Rubber AND THE OTHER PLANTS IN RUBBER PLABTATION

### 2.1 Para Rubber

Para rubber is a perennial plant native to rainforests in the Amazon region of South America. Originated from Brazil's Para state, Para has become the name of the rubber since then. Figure 3 shows the scientific classification of Para rubber, which is officially known as 'Hevea brasiliensis'. The latex obtained from the Para rubber tree will be brought to the processing method, which can be divided into two major categories: 1) Dried rubber, consisting of smoked sheet rubber, block rubber, crepe

rubber, air-dried sheet rubber, and skim rubber and 2) Liquid rubber, which is basically concentrated latex to be processed into finished products, for instance, vehicle-related rubber, elastic rubber, rubber band, medical exam gloves, shoes, and sports equipment [5].


**Figure 3 Scientific Classification of Hevea brasiliensis** [5]

Para rubber was firstly cultivated in Thailand during 1899-1901. It was said that Trang governor had introduced rubber seeds to local people to be planted in several areas of Trang province. Later, the cultivation of Para rubber had been expanded into other provinces in the southern and western regions of Thailand as the geography and climate are quite similar to its origin in South America. When selling prices of Para rubber increased, the cultivation had been expanded into almost all regions of the country [6] [7]. There are plenty of Para rubber species and each of them is often analyzed by conditions of soil, water, and air, which will determine the productivity of latex extracted from the Para rubber tree. Para rubber species that are famously grown in Thailand are BMP254, RRIM600, RRIT225, RRIT250, and RRIT251 [8]. According to the data analysis, RRIM600 is the most famous type planted in the country and southern provinces as shown in Figure 4 and Figure5.

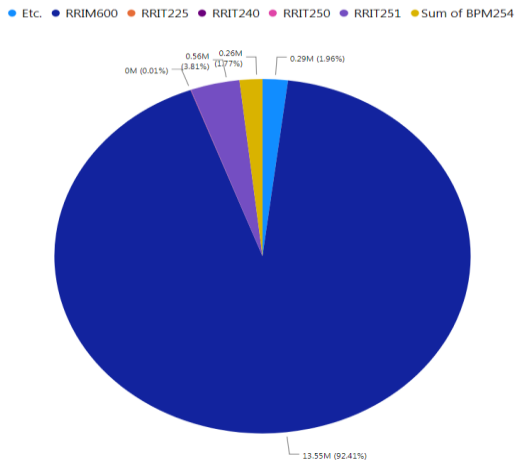



**Figure 4The number of rubber plantations in each species in Thailand**

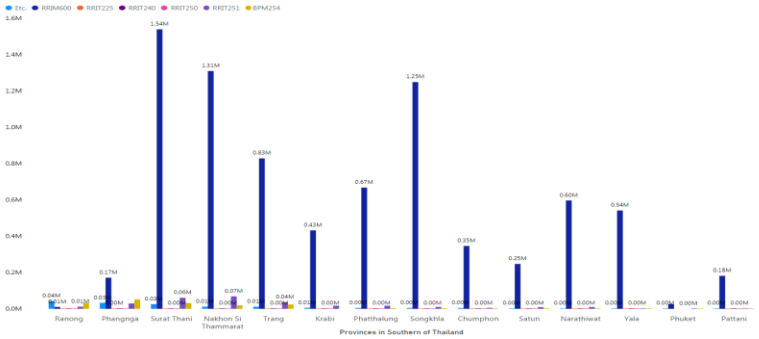



**Figure 5 Planting rubber of each species in Southern of Thailand**

## 2.2 Major types of croups grown in vacant spaces in rubber plantations

There are three major types of crops grown in vacant spaces in rubber plantations. They are 1) Compatible crops – are basically grown when the Para rubber tree has reached one to three years of age, 2) Multiple crops – are crops planted when the Para rubber tree is four years old or above, and 3) Economic crops – can be grown since the beginning period of the Para rubber tree or after the first to fourth years of the cultivation of the Para rubber tree. Nonetheless, it is never recommended to plant those crops after the Para rubber tree has reached five years of age or above as the tree's heavy shadow usually harms the growth of the crops [9] [10] .

**Table 1. Three type of crops grown in vacant spaces in rubber plantations (Partial)**

| Planting time | Common Name | Yield period (Months) | Average income/ Rai / Baht | Average income when deducting cost/Rai |
|---|---|---|---|---|
| 4 Years or more | Anthurium flower | 5-7 | 74,375 | 26,325 |
| | Torch ginger | 48 | 60,000 | 56,500 |
| | Ginger | 4-12 | 30,000 | 18,000 |
| | Galanga | 6-12 | 50,000 | 30,000 |
| | Baegu | 24 -> | 39,500 | 30,500 |
| 1-3 Years | pineapple | 13-16 | 71,400 | 55,200 |
| | Corn | 3 | 11,250 | 6,050 |
| | Gruondnut , Peanut , Monkeynu | 3 | 11,250 | 6,050 |
| | Bambara groundnut | 4-6 | 10,000 | 7,000 |
| | Gros Michel | 11 | 28,000 | 15,500 |
| | Papaya | 4-10 | 70,000 | 52,500 |
| | Taro | 5-6 | 65,000 | 30,000 |
| | Sweet potato | 3 | 15,000 | 10,000 |
| 1-4 Years | Brown salwood,Mangium | 10-15 | 16,000 | 12,500 |
| | Eucalyptus. | 10-15 | 16,000 | 12,500 |
| | Black wattle, Wattle. | 10-15 | 16,000 | 12,500 |
| | Dominican mahogany | 10-15 | 16,000 | 12,500 |
| | Teak | 30 | 1,200,000 | 1,194,060 |
| | Yang | 30 | 1,200,000 | 1,194,060 |

Table 1 provides some useful details related to the mentioned crops, which are obtained from data collection to be used for preliminary analysis regarding the conditions of soil, water, and air. The information has been analyzed from the area selected for this research, which is Phang-Nga province. The province, situated in the southwest of Thailand, has different soil conditions as surveyed by the land development department [11]. The soil conditions can be divided into categories, consisting of 1) Beach Ridges and Sand Dune – Plenty of sandy soil can be found, which is used mostly for coconut farming, 2) Active Tidal Flat – Many types of soil, such as slush, slush-filled sand, clay, salty soil, and saline sulfate soil, are found in various mangrove forest areas, and 3) Alluvial Plain – This type of soil consists of (3-1) Levee – It is fine soil with good drainage, suitable for fruit cultivation, (3-2) Low Terrace – This type of soil varies in clay and sand-filled clay, possessing poor drainage appropriate for rice and oil palm farming, (3-3) Old Alluvial Terrace – The soil is rough, sandy,

and sometimes contaminated with gravel, suitable for planting Para rubber, coconut, oil palm, and other fruits, (3-4) Erosional Surface – The soil can be found in different conditions depending on the layer of sedimentary rock, which is beneficial for Para rubber and oil palm cultivation, (3-5) Foothill Slope and Hilly – The soil is filled with fragments of rock found mostly in natural forests and Para rubber plantations, and (3-6) Hills and Mountains – Many types of rock are contained in the soil, which can be found in areas of stream, swamp, and rainforest. Phang-Nga province is influenced by tropical monsoon climates, where only hot and rainy seasons can be experienced [12] [13].

## 3. An Economic Crop Plantations (ECP) Advisory System

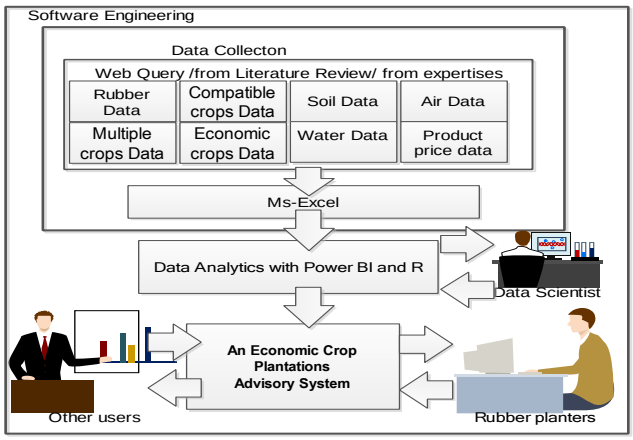



**Figure 6 ECP Advisory System Architecture**

Figure 6 presents the advisory system architecture of the economic crop plantation, in which the Advisory System [14] [15] is developed based on the Software Engineering theories [16] [17] [18]. Data collection for analysis in the system includes: 1) The Web Query [18] [19] must be used to obtain the online data related to Para rubber, compatible crops, multiple crops, and economic crops as well as the required geographic aspects, such as soil, water, and air, of certain areas, 2) The researcher obtains such data from various educational researches and documents, and 3) The researcher must seek further data from renowned specialists as it helps ensure the accuracy and reliability of data to be used for the analysis. The obtained data will be saved in the Excel file ready for analysis to be conducted by the .system Users must specify keywords before obtaining suggestions. The key words must consist of the total area of the rubber plantation, current conditions of the rubber plantation (the rubber tree has just been planted, is cultivated for a certain period of time not exceeding three years, or is ready for rubber tapping), and location to obtain the information on soil, water, and air. The system will provide an accurate and reliable answer on what type of crop rubber farmers should grow to increase their incomes while being able to calculate costs of implementation as well as their incomes derived from rubber farming alone. An example of an analysis is shown in Figure 7-10.

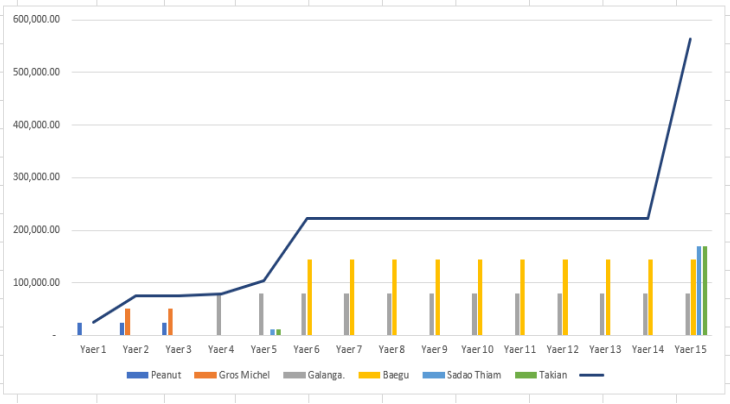



**Figure 7 Average annual income derived from the implementation of an integrated rubber plantation (1-rai)**

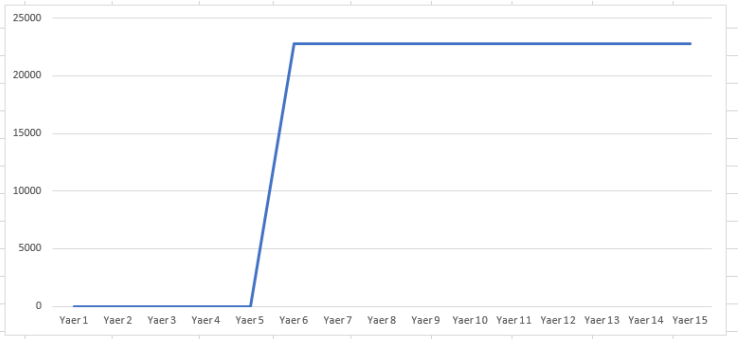



**Figure 8 The average annual income earned from rubber plantations only (1-rai)**

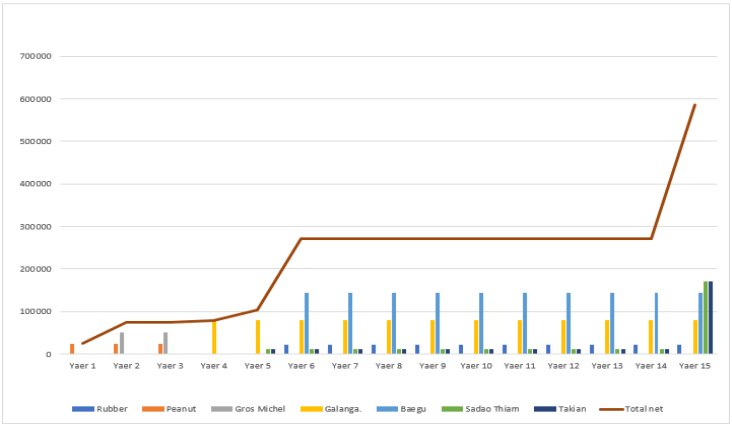



**Figure 9 The average annual income generated from an integrated rubber plantation (rubber, compatible crops, multiple crops, and economic crops) (1-rai)**

Figure 7 shows the average annual income derived from the implementation of an integrated rubber plantation, with the cultivation of peanut and Gros Michel as compatible crops, Galangal and Baegu as multiple crops, and Sadao Thiam and Takian as economic crops, as the rubber trees are grown until they reach 15 years of age in the one-rai plot of land. Figure 8 explains the average annual income earned from the rubber plantation alone in a similar size of land. During the first to fifth year, there will be no chance to generate income from rubber farming alone. Rubber planters have to wait until the fifth year for their rubber

trees to be ready for rubber tapping. Contrastively, Figure 9 shows the average annual income generated from an integrated rubber plantation and compatible crops, multiple crops, and economic crops.

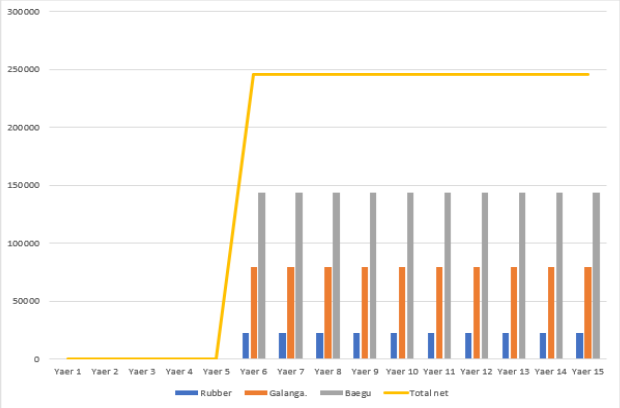



**Figure 10 the average annual income received from the rubber plantation when the rubber trees are able to provide productivity (1-rai)**

Figure 10 shows the average annual income received from the rubber plantation when the rubber trees are able to provide productivity. In this case, rubber farmers will only be allowed to grow multiple crops like galangal and baegu as they will not affect the growth of the rubber trees and other planted crops.

## 4. CONCLUSION

Obtaining such accurate and reliable information is similar to possessing powerful weapons ready for combating a war. It is crucial to solving problems of oversupply and falling prices of rubber, which have a direct and severe impact on the economy as a whole. The problems also cause difficulties, directly or indirectly, to other related businesses. Therefore, planting other crops in vacant spaces of rubber plantations can be the best and most effective way to solve such problems, particularly since the integrated rubber farming can lead to sustainable agriculture. Rubber farmers will be provided with greater income-earning opportunities in the long run by growing alternative crops in their rubber plantations. However, accurate and reliable information must be delivered to farmer planters to reduce risks associated with rubber farming, while being able to maximize agricultural productivity and prosperity sustainably. It is essential to proceed with the analysis of information related to existing geographic conditions, in which agriculturists must take into account the importance of investing in alternative crop cultivation, particularly since it serves as a new source of income to be received throughout the year in addition to rubber farming alone.

## 5. REFERENCES


[1] ForbesThailand. (2017, 20/03/2019). *Pará or Hevea Brasiliensis-Economic backlash*. Available: https://forbesthailand.com/commentaries/insights/%E0%B8%A2%E0%B8%B2%E0%B8%87%E0%B8%9E%E0%B8%B2%E0%B8%A3%E0%B8%B2-%E0%B8%9F%E0%B8%B1%E0%B8%99%E0%B9%80%E0%B8%9F%E0%B8%B7%E0%B8%AD%E0%B8%87%E0%B8%82%E0%B8%B1%E0%B8%9A%E0%B9%80%E0%B8%84.html

[2] C. Sowcharoensuk, "Natural Rubber Process," *Thailand Industry Outlook*, vol. 21, 2019.

[3] RubberAuthorityofThailand. (2019, 18/03/2019). *Rubber Database*. Available: http://emarket.raot.co.th/rdu/#il_14_126_0

[4] S. Moungna. (2015). *Farmers' solutions during the price of rubber fluctuations.* Available: https://www.bot.or.th/Thai/ResearchAndPublications/articles/Pages/Article_09Jul2019.aspx#

[5] WIKIPEDIA, "Hevea brasiliensis," in *The Free Encyclopedia*, ed. https://en.wikipedia.org/wiki/Hevea_brasiliensis, 2019.

[6] WIKIPEDIA, "Rubber in Thailand," in *The Free Encyclopedia*, ed. https://th.wikipedia.org/wiki/%E0%B8%A2%E0%B8%B2%E0%B8%87%E0%B8%9E%E0%B8%B2%E0%B8%A3%E0%B8%B2%E0%B9%83%E0%B8%99%E0%B8%9B%E0%B8%A3%E0%B8%B0%E0%B9%80%E0%B8%97%E0%B8%A8%E0%B9%84%E0%B8%97%E0%B8%A2, 2016.

[7] WIKIPEDIA, "Phraya Ratsadanupradit Mahitsaraphakdi," in *The Free Encyclopedia*, ed. https://en.wikipedia.org/wiki/Phraya_Ratsadanupradit_Mahitsaraphakdi, 2019.

[8] ARDA. (2019). *Rara Rubber*. Available: http://www.arda.or.th/kasetinfo/south/para/controller/01-02.php

[9] S. Charernjiratragul, A. Romyen, and P. Satsue, "Development of rubber-based intercropping system in Southern Thailand: Problems and obstacles " *Kasetsart Journal of Social Science*, vol. 38, p. 11, 2017.

[10] A. Romyen, P. Sausue, and S. Charenjiratragul, "Investigation of rubber-based intercropping system in Southern Thailand," *Kasetsart Journal of Social Science*, vol. 39, p. 7, 2018.

[11] Land-Development-Department. (2016). *Soil data*. Available: http://www.ldd.go.th/www/lek_web/web.jsp?id=18906

[12] kaset-phangnga, "Phang-Nga Data," 2015.

[13] PhangNgaProvincialGovernmentCenter, "Master Plan Project for Establishment of Phang Nga Provincial Government Center Project," ed. library.dmr.go.th › Document › DMR_Technical_Reports, 2015.

[14] P. Pornphol and G. McGrath, "Implementation of the Tourism Area Life Cycle Model as an Advisory Decision Support System," presented at the 14thPacific Asia Conference on Information Systems, Taipei, Taiwan, 2011.

[15] P. Pornphol and S. Chittayasothorn, "Using SQL in CBR for Similarity Retrieval: The case of the TQF Advisory System," in *The Asian Conference on Society,Education & Technology*, Kobe, Japan, 2016.

[16] P. Pornphol and S. Chittayasothorn, *Sufficiency Economy Web Search for Non-IT Literates*, 2017.

[17] S. L. Pfleeger and J. M. Atlee, *Software Engineering Theory and Practice*. USA: Peason Prentic Hall, 2006.

[18] U. Makchan and P. Pornphol, "Phuket Mangrove Gastronomy Information System Development," presented at the The 5th International Conference on Engineering, Applied Sciences and Technology (ICEAST 2019) Luang Prabang, Lao, 2019.

[19] P. Pornphol and S. Chittayasothorn, "Sufficiency Economy Web Search for Non-IT Literates," in *The 4th International Conference on Information and Intelligent Computing (ICIIC2015)*, Tokyo,Japan, 2015.