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Selection of the Sustainable Area for Rubber Plantation of Thailand by Eco-efficiency

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Abstract

The objective of this study was to analyse the suitable area for rubber plantation enlargement in Thailand by eco-efficiency assessment. This research evaluated the eco-efficiency value for rubber plantation in each part areas of Thailand including the north, the center, the northeast, the east and the south in 2010. Five phases of aged rubber trees used in this research were 7-9, 10-12, 13-15, 16-18 and more than 18 years. Material and energy consumptions were used as the key of environmental indicators for assessing the eco-efficiency. The result was found that the northern part showed the best eco-efficiency value for current rubber plantation because the labour cost, main cost of material consumption indicator, in the northern part was cheapest. Nevertheless, the highest eco-efficiency value of rubber plantation based on aged rubber trees in the northern part was 16 – 18 years of aged rubber trees. Regarding snapshot graph analysis of the northern part of Thailand concerning the eco-efficiency of rubber plantation based on aged rubber trees in the northern part located in half eco-efficiency. Therefore, the finding of this research suggested that the suitable part area of Thailand for enlargement of rubber plantation in new area was the northern part, which was contrast with National Strategy for Rubber Plantation of Thailand. Hence, this point should be impact into strategic development for rubber plantation in Thailand.

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1. Introduction

Eco-efficiency is a concept that originated as a part of the efforts to measure sustainability, as sustainable development has become a worldwide issue [1]. According to the World Business Council for Sustainable Development (WBCSD) [2], eco-efficiency is "being achieved by the delivery of competitively priced goods and services that satisfy human needs and bring quality of life, while progressively reducing ecological impacts and resources intensity throughout the life cycle, to a level at least in line with the Earth's estimated carrying capacity". The simplicity of the concept and its practical importance led to its widespread acceptance by enterprises [13]. Although the eco-efficiency concept initially focused on organization, it was later adapted for the examination of policy strategies and their possible macroeconomic outcomes [3]. Many researches [4, 5, 6] demonstrated that the eco-efficiency can be applied to assess the agriculture activity.

Natural Rubber enterprises have been underpinning the socio-economic security for Thailand for a century [7]. Rubber latex is used as a raw material to produce several products such as rubber tires, medical gloves, condoms, rubber bands, flexible tubing, etc [8]. Thailand is the top rubber producers in the world, with production at approximately 2.5 million tons per year. At the present, there are more than 5 million acres of rubber plantations [7]. Currently, the rubber product cost continually enhances because the demand trend of rubber product continually increases. Thus, Thai farmers and government were encouraged to enlarge the rubber plantation area. But as though Thai strategy approaches for rubber plantation enlargement focused only on the productivity increase not the suitability under the sustainable concept [15]. Then, there has been challenging for Thai farmers and government to seek for appropriate environmental measures together with the increasing productivity based on the sustainability of rubber plantation.

Therefore, the objective of this study is to analyse the sustainable area for rubber plantation of Thailand by eco-efficiency assessment. First, the situation part area of Thailand for rubber plantation based on aged rubber trees was selected by eco-efficiency. Then, the situation of aged rubber trees for rubber plantation of Thailand based on the situation part area of Thailand was selected by eco-efficiency. The finding of this research should be the suggestion to the development of rubber strategy in the context of sustainability for increasing the production rate of fresh latex.

2. Methodology

The data used in this research was obtained from the Land Development Department, Ministry of Agriculture and Cooperatives, Thailand [9]. This data was collected in 2010. Economic and environmental performances for rubber plantation of Thailand were used as the indicators in this study as shown in Table 1. The eco-efficient situations between area and aged rubber trees were analyzed by using eco-efficiency approach. Five phases of aged rubber trees used in this research according the criteria of this report were 7-9 years, 10-12 years, 13-15 years, 16-18 years and more than 18 years.

The eco-efficiency assessment used in this research was adapted from the WBSCD and previous literatures [10,11]. The formula of eco-efficiency as a ratio of economic and environmental performance is combined as following:

$$EEn = \frac{EIn}{\sum ENnm} \quad (1)$$

Table 1 The eco-efficiency indicators

eco-efficiency indicators	
Economic indicators	**Unit**
Revenue from the sale of rubber sheets	Baht/rai
Environmental indicators	
Energy consumption indicators	Baht/rai
- Fuels and lubricants	
- Oil products,	
- Electricity	
- Transportation costs	
Material consumption indicators	Baht/rai
- Chemical fertilizers	
- Pesticides fertilizers	
- Sulfuric acid	
- Labor for machinery	
- Supplies.	

Note: 30.841 Baht = 1 US. dollar (October 17, 2011)
2.5 rai = 1 acres

Where, EI_n and EN_{nm} are the economic and environmental performance indicators, respectively in unit of Baht. The environmental indicator regards as environmental burdens from plantation activities.

$\sum EN_{nm}$ refers that 'm' type of environmental aspects in of the rubber plantation is the function (f) of total energy and material consumptions. In equation below "t" denotes total sum of each environmental influence and "r" denote different source.

$$\sum Enm = f[\sum_{t=1}^{r} Et, \sum_{t=1}^{r} Mt] > 0 \quad (2)$$

Where E_t = Total energy consumption from "r" difference sources
M_t = Total material consumption from "r" difference sources

The eco-efficiency trend was analyzed by snapshot graph, which was adopted and presented by the Anite System in Netherland [12,14]. The percent variations of the economic and environmental indicators based on aged rubber trees phase were calculated following formula:

$$\%VE = \left[\frac{\sum Ei - \sum Eb}{\sum Eb}\right] \times 100 \quad (3)$$

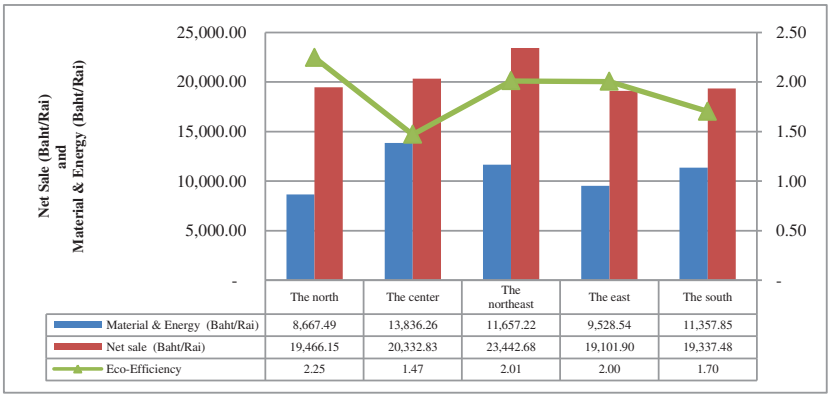
Where % VE = Percent variation of economic or environmental indicators
$\sum$ Ei = Summation of economic or environmental indicators in each aged rubber tree phase
$\sum$ Eb = Summation of economic or environmental indicators in 7-9 years of rubber trees base year

The calculated percent variation of economic and environmental indicators based on aged rubber tree phases were subsequently plotted in one graph, where the Y-axis represents the variation of the percent variation of the economic indicator in each aged rubber tree phases and the X-axis represents the variation of the percent variation of the environmental indicator in each aged rubber tree phases. The interpretation of the eco-efficiency level is made by the X–Y plan [11].

3. Results and discussions

3.1 The area selection of rubber plantation in Thailand by eco-efficiency

Figure 1 illustrates the eco-efficiency values for rubber plantation of each part areas of Thailand including the north, the center, the northeast, the east and the south. These values came from the ratio of average net sale from selling the rubber sheet (Baht/rai) and the values resulting from material and energy consumptions (Baht/rai). It was found that the north of Thailand was highest value (2.25) of eco-efficiency for rubber plantation. In the parts of the northeast, the east and the south of Thailand were 2.01, 2.00, 1.74 and 1.47 of eco-efficiency value for rubber plantation, respectively. This finding originated from the lowest material and energy consumptions for rubber plantation in the north of Thailand with the similar net sale value of all area because the factor of production costs for rubber plantation including pesticide, fertilizer, acid uses and energy consumption were the lowest in comparing with other areas [9]. Thus, the north of Thailand was selected as suitable area for rubber plantation of Thailand based on eco-efficiency value.



	The north	The center	The northeast	The east	The south
Material & Energy (Baht/Rai)	8,667.49	13,836.26	11,657.22	9,528.54	11,357.85
Net sale (Baht/Rai)	19,466.15	20,332.83	23,442.68	19,101.90	19,337.48
Eco-Efficiency	2.25	1.47	2.01	2.00	1.70

Fig. 1. Eco-efficiency values of rubber plantation various area parts of Thailand

3.2 The aged rubber tree selection of rubber plantation in Thailand by eco-efficiency

Figure 2 showed the eco-efficiency values of aged rubber tree for rubber plantation in the suitable area as the north of Thailand. Five phases of aged rubber trees used in this research according the criteria of Thailand [9] were 7-9 years, 10-12 years, 13-15 years, 16-18 years and more than 18 years. The ratio of average net sale from selling the rubber sheet (Baht/rai) and the value resulting from material and energy consumptions (Baht/rai) was assessed the eco-efficiency. It was found that 16-18 years and 7-9 years of aged rubber tree were highest and lowest values of eco-efficiency, respectively. The value of selling the rubber sheet during 7-9 years, 10-12 years, 13-15 years, 16-18 years increased accordingly but more than 18 years of aged rubber tree for rubber plantation showed the decreasing value of selling the rubber sheet.

In additional, the trend of eco-efficiency of aged rubber tree for rubber plantation in north of Thailand was analyzed by snapshot graph. The results showed that eco-efficiency of all aged rubber

tree for rubber plantation in north of Thailand located in half eco-efficiency. These results recommended that Thai government should be developed the approach to increase the eco-efficiency value from half eco-efficiency to fully eco-efficiency for strengthening the sustainability of rubber plantation in Thailand.

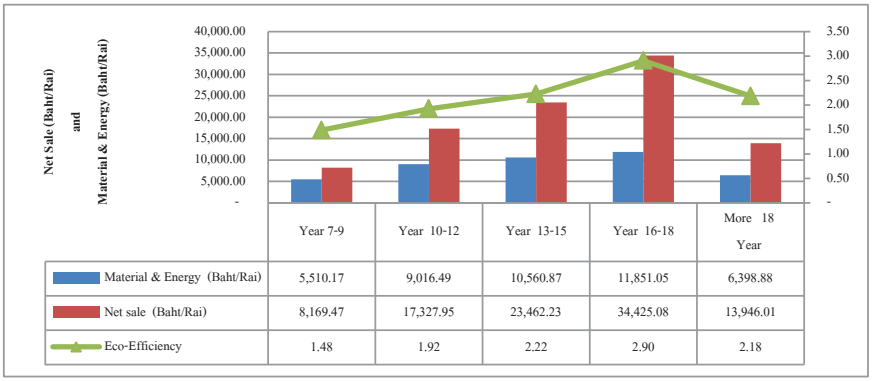


Fig. 2. Eco-efficiency values of rubber plantation various age rubber tree of the north Thailand

3.3 Feedback to National Rubber Strategy for Rubber Plantation of Thailand

Thailand has many policies to develop the whole system of rubber business. The objectives of the policies were supported Thailand to be as the center of the world's rubber. Present, the operation of rubber business is acted followed the National Rubber Strategy for Rubber Plantation of Thailand in the year 2009-2013. This strategy consisted of eight parts and has goal to increase the efficiency of rubber production in Thailand for at least 10 percent or 278 kg / rai/year in 2008 to 306 kg/rai /year in 2013. But the report of Land Development Department, Ministry of Agriculture and Cooperatives, Thailand mentioned that Thai farmers can produce the rubber as 324 kg/rai /year since 2000, which was already higher than the goal of strategy. However, the development of the increasing rubber product by responsible agency was not dropped. The suitable period of rubber tapping and organic fertilizer use were promoted for increasing the value of fresh latex and reducing the cost of fertilizer. Due to the objective of eco-efficiency concept mention to reduce the resource consumption and environmental impact. Thus, the reduction of chemical fertilizer can be enhanced the eco-efficiency values of rubber plantation. Besides, the labour cost was combined to material and energy consumptions for eco-efficiency assessment. This cost was likely to improve. The center and the north of Thailand were highest and lowest cost of labour for rubber plantation, receptively because the minimum wage for center of Thailand regulated by Thai government was highest than other areas.

Furthermore, Thai government has policy to support the increasing area of rubber plantation in 800,000 rai of new planting area including 500,000 rai in the northeast, 150,000 rai in the north and 150,000 rai in the center, the east and the south of Thailand. The new area of rubber plantation was enhanced for supporting 1.24 million ton of the natural latex demand in 2010.

According to the survey of Land Development Department, Ministry of Agriculture and Cooperatives, Thailand, its result reported the 14,873,752 rai suitable areas for rubber plantation of Thailand. They were 10,767,682 rai in the south part (the most of rubber plant area exists originally in this region), 2,113,514 rai of the east part, 1,691,004 rai of the northeast part and 1396,74 rai of the north part. Considering National Rubber Strategy for Rubber Plantation of Thailand found that the northeast of Thailand was prior supported for rubber plantation because of this region is largest area. However, the northeast rubber farmers were a lack of rubber plantation knowledge because the

prototype of agriculture in this area is paddy land. Most of rice production comes from the paddy lands in this region therefore the rubber plantation in this area must to be considered circumspect and has not impact on the agricultural land use for other important economical crops such as rice. Anyway the lack of knowledge problem for rubber plantation is being in all new plantation areas. For this situation, the responsible agency must to press the rubber plantation knowledge promotion to new rubber farmers. This approached was already announced in the National Rubber Strategy for Rubber Plantation of Thailand during 2009-2013, it still needs only the continuous and intention operation. Furthermore, in the real situation, the rubber plantation in the northeast area requires higher materials and confronts higher rubber diseases than that of the north part [9].

Therefore although the northeast part is recognized as the most suitable area for rubber area enlargement with the appropriate geography and climate in accordance with the report of Land Development Department, Ministry of Agriculture and Cooperatives, Thailand [9] but it is not optimized for the circumspect assessment of net sale and cost balance. The novel results of this study recommend that the north of Thailand is the highest eco-efficiency area for new rubber plantation. This area has the high potential of rubber plantation because of low labor cost, low material requirement, low energy consumption and low rubber diseases [9]. Hence, this result was challenging both Thai farmers and Thai governments to cooperate the improve strategy for rubber plantation thought the sustainability.

4. Conclusion

The sustainable area for rubber plantation of Thailand was evaluated by eco-efficiency assessment. The results showed that the northern part area was suitable for rubber plantation in Thailand due to the highest eco-efficiency level. Nevertheless, 16 – 18 years of aged rubber trees was the highest eco-efficiency values in the northern part. Regarding snapshot graph analysis of the northern part of Thailand concerning the eco-efficiency of rubber plantation based on aged rubber trees in the northern part located in half eco-efficiency. Therefore, the finding of this research suggested that the suitable part area of Thailand for rubber plantation was the northern part. Hence, this point was impact into strategic development for rubber plantation in Thailand such as technology or approach development of increasing the fresh latex productivity based on more value with less environmental impact.

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