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Sustainable Agriculture in Thailand
– An Evaluation on the Sustainability in Ethanol Production –

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1. Introduction

Thailand is now promoting bioethanol at an unprecedented pace. Even though the popularity of biofuels will contribute to an increase in income of farmers that cultivate the biofuels' feedstock, there is possibility of large-scale monoculture expansion that would adversely affect the environment, in turn, the sustainability. Thailand's current feedstock for bioethanol production is sugarcane and cassava, which are mainly cultivated in the Northeastern Thailand. In general, Northeastern soil is infertile. It is sandy, saline and acid with low organic matter and low water retention. Also, widely spreading deforestation due to human activities causes soil erosion, in turn, the more severe salinity problem. Furthermore, in spite of unstable rainfall, undulating landscape in many areas makes it difficult to extend the irrigation system. Most Northeastern farmers must therefore rely only on rainfed agriculture (1,2). Despite the fact that sugarcane and cassava can grow in this severe environment, in order to keep or increase the productivity the proper soil management is indispensable.

In the other hand, Northeastern region is far from the main ports, making it not be able to attract investment in manufacturing industries. As a result, the main economic activity is agriculture and 80% of its population still lives in rural area. With the above mentioned reasons, the agricultural productivity is low. Moreover, the maintenance of economic and social infrastructure also far lags behind. Not only access to the market, access to various opportunities such as education is also restrained. Consequently, the Northeastern region has the lowest income in Thailand (3).

In the implementation of the bioethanol promotion policy, we therefore need to evaluate whether the current sugarcane and cassava cultivation method is sustainable or not in the ecological aspect. At the same time, we also need to evaluate in the social and economic aspects if the policy will really contribute to an increase in income and well-being of the farmers, who plant those crops.

With awareness of these problems, the research team visited and conducted a survey on sustainable agriculture in Northeastern Thailand in December 2007. The survey sites are Puparn Royal Development Study Center in Sakon Nakhon, where we learned its sustainable

agricultural practices and livestock raising, and Khon Kaen, where we visited and interviewed the farmers, who follow the concept of sustainable agriculture. Figure 1 depicts the above mentioned survey sites.

Figure 1 Survey Sites: Sakon Nakhon and Khon Kaen



2. Sustainable agricultural development in Thailand

2.1 Background of Sustainable Agriculture

In Thailand since 1960 the government promoted export-oriented cash crop monoculture practice. To increase the productivity, intensive use of agricultural machines, chemical fertilizer, herbicide and insecticide spread over the country. After two decades the problems from intensive agriculture appeared in 1980s. Those problems are, for example, worse soil condition, lower productivity, farmers' debt due to a purchase of chemical fertilizer and herbicide, as well as, health damage from intensive use of herbicide and insecticide (4).

The first step to attain the sustainable agriculture in general is to move from monoculture to crop rotation or mixed farming. The next step is to choose the plant that generates high income (5). Then, it is essential to keep or improve the soil quality. Next is to reduce chemical fertilizer and herbicide, while using organic matter such as manure and other agricultural residues as organic fertilizer.

Nevertheless, there is no unique method for all regions or all countries. Each country has to find its own way to attain sustainable agriculture itself under its ecological, economic, and social conditions (6).

2.2 Classification of Sustainable Agriculture

Since His Majesty the King Bhumiphol Adulyadej proposed a new agricultural theory in 1993, the government has changed the agricultural development direction to the objective of sustainability. There are 5 types of sustainable agriculture practices in Thailand.

1) Integrated Farming

Integrated farming is a farming system that has at least two different agricultural activities in the same field, for example, paddy and fish raising, or pig farming, fish raising and vegetable plantation. Practicing various agricultural activities at the same time helps reduce costs, that is, the economy of scale is working. For instance, manure and other farm residues can be used as fertilizer when planting crops. This system is suitable for a small-scale farmer, letting him make best use of his limited field area. In practice, the system is widely used in the central area of Thailand, where there are a plenty of water resources.

2) Organic Farming

Organic farming is a farming system that uses only organic fertilizer and herb-based insect-control compound. The reasons of practicing organic farming are a higher demand for organic food and demand for improving soil quality and underground water quality. Until recently, organic rice and vegetables had been sold only in Bangkok and other major cities. Yet, the market of organic food is now increasingly expanding.

3) Natural Farming

Natural farming's concept is no tillage, no application of fertilizer, herbicide and insecticide. For the ecological preservation aspect, we can say that natural farming is ultimate sustainable agriculture practice. At the present, there is nowhere perfectly practicing the natural farming system in Thailand. Yet, a few natural farming cases can be seen in the Northeastern area.

4) Agroforestry

Agroforestry is an idea to put agriculture and afforestation together, that is, to plant cash crops or raise livestock while planting trees in the same area. Its objectives are not only to increase farmers' income, but also to decrease deforestation induced by agricultural area expansion. Besides, it also helps improve the soil quality and biodiversity. Agroforestry is conducted in the Northern and Southern areas.

5) New Theory Farming

New Theory farming is an agricultural system proposed by His Majesty the King Bhumiphol Adulyadej in 1993. Its basic concept is self-sufficiency. Crop selling is a next step after attaining self-sufficiency. The concept is most appropriate to the farmers that have limited small field and lack water resources. The next chapter explores the practice of the New Theory farming system in the Northeastern Thailand.



Picture 1 Agroforestry in the Southern Thailand

2.3 New-Theory farming system

The New Theory's concept (7,8) is explained as following. Thailand's average size of agricultural field is 2.4 ha (15 rai). According the New Theory, the field will be divided into 4 parts in the approximate ratio of 30:30:30:10. The first 30%(0.48 ha) is to make a pond for fish raising. The second 30% (0.4 ha) is for field crops and vegetables. The third 30% (0.8 ha) is rice paddy for self-consumption. The last 10% (0.32 ha) is living space and livestock raising.

Since 1995 the Office of the Royal Development Projects Board has started to introduce the New Theory farming system to farmers over the countries through a number of royal projects. With the cooperation with royal development study centers located in each region, local agricultural cooperatives and government units such as the Department of Agricultural Extension, the royal projects distribute seedlings or livestock breeds that have been developed and proved suitable for the area.

2.4 Characteristics of Thailand's Sustainable Agriculture

In Thailand export-oriented agriculture is practiced by large-scale farmers. On the other hand, small-scale farmers serve the domestic market and their own self-consumption. The number of small-scale farmers with an average field size of 2.5 – 3 ha accounts for 50% of the total farmers in the country. Yet, sales of their farm production are just less than 25% of the total farm products' sales. The poor farmers are the ones, who rely on unstable rainfall. The number of those farmers is estimated around 8 million households (9). Among these, a number of farmers made a mistake in farm management. They previously practiced monoculture but as the prices of inputs such as chemical fertilizer, herbicide and insecticide increased, they financed money to invest more by making a loan. Due to declining agricultural products' prices, they could not pay back their loans. Besides, there are also a certain number of farmers, who experienced health damage from using herbicide and insecticide, and who once went to work in the city but with any reasons they were forced to go back home in the rural area. The concept of sustainable agriculture in Thailand was first created to help these people.

3. Survey (1) – Visit to Royal Development Study Center

3.1 Royal Development Study Center in Summary

For a small-sized farmer, there are restrictions on information (the existence and benefits of sustainable agriculture), capital (primary investment), and technology (soil management and agricultural techniques). To spread sustainable agriculture practices, those restrictions must be removed. The organization that plays role on conducting researches to help farmers remove those restrictions is His Majesty the King Bhumiphol Adulyadej's Royal Development Study Centers. The budget source of the centers is from Chaipattana Foundation. The centers usually cooperate with the Department of Agriculture Extension, the Department of Royal Forestry, the Department of Royal Irrigation, and the Department of Water Supply. The centers' ultimate goal is that Thai individuals, especially rural farmers, can live their own life with the most appropriate way amidst the current social and economic conditions. In order to focus on the development most suitable for each region, 6 Royal Development Study Centers were established. The concept of each center is summarized

below (10,11).

1) Khao Hin Sorn Royal Development Study Center

It was established in Chachoengsao, located in the Central region, east of Bangkok in 1979. The area has a problem of soil erosion. The center thus conducted a survey on agricultural soil utilization and has developed techniques to improve the soil quality. Also, the center disseminates knowledge of soil improvement to farmers in the area by giving lessons and training courses, for example, compost or organic fertilizer making and proper use.

2. Kung Krabaen Bay Royal Development Study Center

It was established in Chathaburi, located the Central region, east of Bangkok in 1981. This center focuses on the conservation and proper use of mangrove, sustainable aquaculture, and aquaculture-incorporating agriculture system.

3. Pikun Thong Royal Development Study Center

The center was established in Narathiwat in the Southern region in 1981. The area is covered with peat soil. The center thus has conducted researches to clarify its effect on the environment and sustainable agriculture. The center also established a small-scale palm oil processing plant and biodiesel plant while conducting researches to improve the palm oil crushing process and biodiesel conversion process.

4. Huai Hong Khrai Royal Development Study Center

Located in Chiang Mai, the Northern Thailand, the center was established in 1982 to develop agricultural techniques and irrigation system that fits the Northern watershed landscape. The center also researches on the crop cultivars that may increase income of farmers and fit in the agroforestry system.

5. Huai Sai Royal Development Study Center

The center was established in 1983 in Phetchaburi, west of Bangkok. The east of Phetchaburi is Gulf of Thailand. The west of it is the border shared with Myanmar. In the center, at Somdej Phrasrinakarindra Garden there is demonstration of farming system based on the New Theory, mixed farming, organic farming, agroforestry, and practical use of herb.

6. Puparn Royal Development Study Center

Established in Sakon Nakhon, Northeastern Thailand in 1984, the center is the survey target that the research team visited.

3.2 Puparn Royal Development Study Center

Puparn Royal Development Study Center focuses on conducting surveys and researches on agricultural practices most appropriate to Northeast Thailand. And, at the same time the center also disseminates agricultural knowledge and techniques to the farmers in the area. One of the activities the Center substantially focuses on is the New Theory farming system. Every year the Center allocates its budget to build a pond for a farmer, who takes part in the project. Besides, the Center also provides knowledge and techniques to the farmers such as insect prevention, rotation crop selection, time and amount to apply fertilizer, how to make organic fertilizer from their own farms' livestock droppings and farm residuals, and how to make best use of rain water in agriculture. Picture 2 depicts the activity map of the Center.



Picture 2 Puparn Royal Development Study Centers' Activity Map

Apart from the New Theory farming system, it also researches on other sustainable agriculture methods. Picture 3 shows the result of one research on the productivity and the cost of different Roselle cultivars. The results of distinguished researches are displayed like this in the Center so that farmers and people, who come to visit the Center can learn from them.



Picture 3 Research Result Display in Puparn Royal Development Study Center

Another activity of the Center is to develop a better breed of livestock. Tajima-breed cows (Picture 4) are raised in the Center. Japanese government gave the breed to HRH Princess Maha Chakri Sirindhorn and later on a Tajima breeder from Japan came to inspect the raising method but did not transfer information of how to raise Tajima in the same way that it is done in Japan because it is a business secret. Therefore, based on information they could gather, the Center has raised Tajima cows on its own style, for example, making them listen to the music, Northeastern-styled music, drink liquor, “Satho”, Northeastern-styled sake. The Center has targeted to make Thai Tajima beef A5-class beef. Besides, Puparn Black Chic (Picture 5) is another chicken breed developed by the Center. The chicken is all black from its feather to its bone.



Picture 4 Tajima



Picture 5 Puparn Black Chic

4. Survey (2) – Interviews with Northeastern farmers

4.1 The New Theory Farming System Practicing Farmer

We visited and interviewed Mr.K, who lives in Khon Kaen and practices the New Theory farming system. Mr.K possesses the field of the total 2.2 ha. Out of those, 1 ha is a paddy field, 0.9 ha fruits and vegetables, 0.2 ha a pond. The rest is for living space and chicken raising. Mr.K used to work abroad as a labor for 9 years since 1987. He came back in 1996 and started rice growing. He started practicing the New Theory farming system in 1998 when he had taken part in the seminar regarding the New Theory organized by the Department of Agricultural Extension. Actually he himself was interested in self-sufficiency farming from the beginning and when he listened to the concept of the New Theory system, he was interested in the theory immediately and decided to follow the concept.

He plants various kinds of fruits, e.g. tamarind, coconut, guava, banana, mango, and papaya (Picture 6). Others are field crops and vegetables such as sweet potato, tomato, maize, garlic, parley, pumpkin, and morning glory. Basically, it is a concept of mixed farming that various kinds of fruits and crops are planted in the same or nearby plot but only a small number for each (Picture 7A – 7C).

He also has a pond for raising fish (Picture 8) as same as what is recommended in the New Theory. He raises fish once a year as he uses only rain water, which can not be changed

during the year. An average fish number he raises is 3,000 fish each time. Time needed until he can catch the fish for sale or self consumption is 4 – 5 months. Around the pond a lot of coconut and banana are planted. Besides, he also has 9 cows and some chicken.



Picture 6 Various Kinds of Fruits e.g. Banana and Papaya



Picture 7A and 7B The Mixing of Tomato and Maize (left) and Parsley and Garlic (right) in the same plot



Picture 7C The Mixing of Pumpkin and Maize in the same plot



Picture 8 Two Ponds in Mr.K's Field

As for fertilizer, he makes compost himself using various kinds of his own field's residue such as rice husks (Picture 9). Basically he does not use chemical fertilizer but he thinks sometimes it is still needed for the crop's growth. Siamese Neem Tree (or Sadao in Thai language) and chili are used to produce organic insect-control compound. He also produces charcoal himself from unused tree branches.

The pros of this farming system he thinks are; first, having various foods and fruits for consumption all times, second, better risk diversification in which monoculture cannot satisfy this condition, last, flexible income. Even he cannot receive revenue each time as large as that of sugarcane planting farmers selling sugarcane once a year in the harvest period, whenever he needs money, he can sell what he has at that time in the field and convert them into money. What he frequently sells is tamarind, which is used to make juice and candy. Neighbors often come to buy tamarind at his home. When it is a good harvest, he sells tamarind at the market nearby. Tamarind's price is 25 – 30 baht/kg, accounting for revenue of 40,000 – 50,000 baht per year. Nevertheless, the harvest highly relies on rainfall, resulting in unstable income. He records an amount of rainfall and crops' production every year to see their relationship (Picture 10).



Picture 9 Compost



Picture 10 Rainfall Measure

Although Mr.K is self-supporting by following the New Theory's concept, he actually has a factor making him able to be self-supporting. That is, he does not have to take care of children as his children has grown and earned their living. He admits that a family, which still has small children and need money for their education may not be able to earn their living only with the New Theory farming system. He used to sell labor abroad to make money for his children. But he now lives with his wife only; there is not necessity to make lots of money. He thus does not hire any labor to help work in the field. Everything in the farm is managed by only him and his wife.

4.2 Crop Rotation Practicing Farmer

We interviewed the farmers that practice the crop rotation system rotating between sugarcane and cassava. We also talked to staff at the Office of Agricultural Research and Development, affiliated with the Department of Agriculture. According to the talk with the Research Office's staff, monoculture is usually a pattern of agricultural practice in the Northeastern region. Cassava and sugarcane are main crops in monoculture practice.

Farmers who practice the crop rotation system are very few. Farmers themselves know that crop rotation or mixed farming helps improve soil quality. But their small-sized field does not allow them to do so. Besides, most farmers use chemical fertilizer to improve their soil quality, but small-scale farmers tend to buy cheap one, which does not have a proper mixture of N-P-K for their field. The Department of Agriculture has recently promoted Eucalyptus to be planted around the paddy field or the pond to small-sized farmers as it does not need much care and fertilizer. It can be harvested within 3 years. Also, there is an increasing demand for Eucalyptus in the area from pulp processing plants.

(1) Interview with Mr.M

Mr.M has a 12-ha relatively large sized field. 6 ha is used to plant sugarcane or cassava. 5.6 ha is paddy field. The rest area is planted Eucalyptus (Picture 11, 12).



Picture 11 Mr.M's Cassava Field



Picture 12 Eucalyptus around the Pond

Mr.M rotates plantation of sugarcane and cassava in the following pattern, 3 years for sugarcane, 1-2 years for cassava, and then 3 years for sugarcane again. Sugarcane and cassava rotation practice has been started in the past decade because of high demand as cash crops. Twenty years ago a rotation of cassava, cotton and watermelon was practiced. To increase income, a rotation of different crops has been tried. A recent pattern is rotation between cassava and rice maybe because of a recent better price of rice than that of sugarcane. Nonetheless, soil preparation for paddy field is different from that for crop field; extra cost and labor are needed, in turn, obstructing the practice of this rotation pattern.

He experienced before that monoculture made soil quality worse, resulting in a lower production, and made insects or diseases come often when always planting the same crop. Crop rotation can prevent these problems. The residues from the previous cultivation period will be left in the field as fertilizer. This can much help improve the soil quality. As for the income aspect, he said that it was not always good but not bad. What he always does is to plant the crop that other farmers would not plant in the same year. This is because the crop

most farmers choose to plant will yield a low or modest price due to a lot of supply in that year. Yet, it does not always come out as he expects. Nevertheless, the strong points of crop rotation he can feel are risk diversification and long-term stability (not relying on only one crop).

(2) Interview with Mr.C

Mr.C has the field of 4.3 ha, which is an average field size of Thai farmers. Among 4.3 ha, 2.4 ha is used to plant sugarcane and cassava in rotation pattern. 1.6 ha is paddy field in which 200 – 300 Eucalyptus is planted surrounding the paddy. Mr.C also has 2 ponds, 13m x 16m one built with the support of the Department of Agricultural Extension, and the other 10m x 40m one built by his own money with the cost of 25,000 baht.

The crop rotation pattern is 2-3 years for sugarcane, 1 year for cassava, and 2-3 years for sugarcane again. The reasons to conduct crop rotation are as same as those of Mr.M, which are worse soil conditions and easy insect invasion in monoculture practice. He said he expected a long-term benefit of crop rotation. Nevertheless, he feels the weak point of the practice, that is, an income aspect. For example, sometimes he knew that the price of sugarcane would be good, while the price of cassava would not be good, but he had to plant cassava, not sugarcane, as planned in his rotation pattern. This really made him hurt, he said.



Picture 13 Atmosphere of Interview

In the community Mr.C lives, farmers established a small group making organic fertilizer by gathering shares for primary investment and distributing profit later. The organic fertilizer consists of manure, rice husks, phosphate-fertile soil, liquid naturally produced from fresh household waste fermentation, Siamese Neem Tree, and lemon grass. The group has 136 members and collects 150 baht/share/person. Among members, 7-8 people, who would like to use the fertilizer in their own field, pay more, 1,000 baht each, and will have a right to use the fertilizer produced and sell it when it is left. The selling price is 130 – 150 baht per 40-kg bag. If the buyer lives nearby, they send the fertilizer to his home. But if not, the buyer will come to buy it at the production place.

5. Conclusion

Amidst the difficult natural conditions in the Northeastern Thailand, to practice environment-friendly agriculture, and to increase poor farmers' income at the same time, are substantially difficult. During the interviews, we heard a lot that "Agriculture is tough", or "Planting A is tough. Therefore, I am thinking to change to plant B". Rather than thinking about environment-friendly agriculture practice, instead thinking about how to practice agriculture with less labor but with more income earned seems to be more practical in the current situation of Thai agriculture. Nevertheless, raising agricultural income cannot be done without the environmental concern if the ultimate goal is to attain sustainability.

The New Theory farming system is basically based on the concept of self-sufficiency. It might seem difficult to be applied with crops not for self consumption such as sugarcane and cassava. Yet, usefulness of the pond, risk diversification because of more income sources, and the dual practice of both crop plantation and livestock raising are strong points found suitable for the Northeastern agriculture practice. As another source of income, bioethanol production can be considered as a potential one.

In the next research step the team would like to propose a farming system that is ecologically sustainable. This is a vital factor that would ultimately affect the country's agricultural sustainability.

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