RF-078 Study on Sustainable Supply and Demand Systems for Bio-fuel in Asia (Abstract of the Final Report)

Contact person Atsushi MARUYAMA
Associate Professor, the Graduate School of Horticulture
Chiba University
648 Matsudo, Matsudo City, Chiba 271-8510 JAPAN
Tel:+81-47-308-8928 Fax:+81-47-308-8928
E-mail: a.maruyama@faculty.chiba-u.jp

Total Budget for FY2007-FY2008 17,555,000Yen (**FY2008**; 8,455,000Yen)

Key Words biofuel, fuel demand projection, fuel plant, energy crops, Philippines

[Abstract]

Rapid and large-scale expansion of biofuel consumption may have a considerable impact on the environment as well as social communities in rural areas of producing countries. There are, however, an insufficient number of studies that have analyzed the countries other than the two leading countries, such as Brazil and the United States. This study examines critical factors necessary to establish a sustainable biofuel supply and demand system in the Asian region, with special reference to the relationship between Japan and the ASEAN countries.

The findings are summarized as follows: first, we developed an automobile energy demand model for seven Asian countries until 2050. As a result, energy demands in these countries are found to be significantly higher; the demand in 2050 compared with that in 2000 is 7.4 times in China, 5.1 times in India, and 3.5 times in ASEAN countries. Secondly, a chemical analysis of biofuels in the Philippines market indicates that the quality of current biofuels satisfies the Philippines National Standard and Asian Automobile Fuel charter. Thirdly, in some ASEAN countries, the production of bioethanol feedstock will be insufficient to achieve even their national goal of promoting bioethanol. Moreover, the sugar millers in the Philippines have negative attitudes toward bioethanol production because of low economic incentive. Fourth, sugarcane production should be efficient and expanded to meet the possible increase of biofuel demand in the Philippines. Farmers' activities, however, should be carefully monitored since sugarcane fields can be easily expanded even in a hilly area regarded as the bad for the production. Lastly, there will be large potential benefit of biofuel trade between Japan and ASEAN countries since bilateral distance is a significant factor that affects producers' and consumers' surplus.

1. Introduction

The demand for biofuel is increasing in the world. The Japanese government is aiming at a full-scale expansion of biofuel into the transportation sector as a way of fulfilling one of the responsibilities of the Kyoto Protocol. Moreover, a growing interest in biofuel has renewed the

national energy policies of developing countries. It should be highly rated that the countries set national goals for domestic use of biofuel under the ratification of the Kyoto Protocol.

We should, however, notice that those actions are taken not only due to the concern for the global environmental but also for the national economy. For example, their rapid economic growth, or quick motorization, of Asian developing countries, will significantly affect the balance of world's fuel market, in which energy security will become doubtful. Moreover, some developing countries that have a comparative advantage in the production of energy crops face an opportunity of developing rural economy by biofuel trade and international investment on the biofuel production.

There are a lot of studies on biofuel regarding the energy efficiency of fuel production and the land competition between food and energy. It still, however, remains controversial whether biofuel is truly environment-friendly or not. Moreover, most of the studies are conducted as to the two major countries, such as the U.S. and Brazil. These studies are insufficient because the factor of regionality becomes important to our interests, which are mainly on socioeconomic impacts as well as the local environment.

This study examines the critical factors necessary to establish a sustainable biofuel supply and demand system in the Asian region, with particular reference to the relationship between Japan and the ASEAN counties. The ASEANs are expected to have a significant relationship with Japan in terms of economic cooperation. One of the features of the study is the approach based on both of macro and micro level analyses. Macro analysis includes demand projection and numerical simulation, while micro analysis covers crop production and individual attitudes toward biofuel. The Philippines was chosen as a study area of the micro-level analyses since the nation has a great potential of biofuel production and its government has been active in biofuel promotion.

2. Research Objectives and Method

There are four objectives in this research. First of all, the research focuses on analyzing the automobile fuel demand trends and sustainable automobile fuel demand systems with a special focus on Asian countries. Here, we developed an automobile energy demand model to estimate the biofuel demands and examine its sustainability by the year 2050. Based on this analysis, the research aims to clarify the optimal biofuel usage under the assumed future energy price and to comprehend the automobile energy balance in Asia.

The second objective is to analyze the influences of biofuels on automobiles and the environment in the Philippines. Here, we reviewed the influence of biofuels on automobiles and their emissions, summarized possible problems, and analyzed the influence on emissions quantitatively based on the B1 diesel and E10 gasoline sampled at gas stations in the Philippines.

The third objective is to study the requirements for the sustainability of large-scale biofuel production in Asia. First, covering India, Indonesia, Malaysia, Thailand and the Philippines, which in recent years have been pushing for the introduction of biofuels in Asia under their national policies, we elucidated the production possibility of biofuels in these countries while checking it against the production level of raw materials for biofuels. As a result, it was estimated

that the current acreage under cultivation would not allow these countries to attain their bioethanol introduction targets, except for the case of sugarcanes in India. Regarding biodiesel, meanwhile, we estimated that if 2-3% of the current acreage can be used, all countries except Thailand should be able to achieve their biodiesel introduction targets.

Next, we examined the current state of raw sugar production in the Philippines by times series and by region, using statistical data and readily available materials and also on the basis of the current situation of the Philippine sugar manufacturing industry in order to shed light on problems that need to be addressed before large-scale production of bioethanol can get under way in the Philippines. We focused on Negros, which accounts for over 50% of sugarcane production in the Philippines, and made an analysis based on the results of interviews with both sugar manufacturing plants and plants designed solely for the production of bioethanol. The supply and demand of sugar in the Philippines are largely in balance. In the past few years, sugar consumption hovered at around 2.1 million to 2.2 million tons, while sugar production stood at 2.1 million to 2.4 million tons. However, as an inflow of cheap sugar into the Philippine market is expected due to tariff cuts in the ASEAN Free Trade Area (AFTA), the domestic environment for sugar sales will not necessarily remain favorable. Nonetheless, sugar manufacturing plants are reluctant to enter bioethanol production, given the lack of request for cooperation or support from the Philippine government, priorities they have to give to contracts with sugarcane farmers and lower prices of bioethanol imported from Brazil.

On the other hand, bioethanol production plants that use sugar cane juice as the raw material are under construction in Negros. They can turn out bioethanol five to six times more efficiently than molasses, and are therefore beginning to invigorate efforts toward a new type of biofuel.

Furthermore, given that the large-scale production of bioethanol is a long-term proposition, we considered both the environmental contribution and environmental load of bioethanol production and made a comparison with bioethanol production plants in Japan. As a result, we found that if bioethanol is produced across the Philippines using molasses as the raw material, it could reduce carbon dioxide emissions by up to 302,000 tons, while BOD in factory effluents would be over 10 times higher than Japan's environmental quality standards, and the hydrogen-ion concentration, at pH 4.5-5.0, would be far lower than Japan's standard of pH 5.8-8.6. These stem from the fact that in the Philippines, the lagoon treatment is dominant due to the vast land and lax effluent standards.

Fourthly, we analyzed the structure of sugarcane production, an energy crop of bioethanol, using farm-level data in order to examine possible ways of increasing the production. In addition to the conventional production analysis, we considered the farmers' perception and attitudes toward sugarcane production and biofuel. The analysis of their perception will contribute to improving the reliability of policy implication in the study. Moreover, using satellite data, the land use of a specific location is visualized and analyzed in order to study the regionally environmental impact of sugarcane field expansion.

Fifthly, the biofuel market and trade are examined using statistical and numerical models.

These analyses will find the factors which significantly affect economic surplus. Moreover, we integrated the results or findings of the study and discuss the requirement for sustainable production and use of biofuel in the Asian region.

3. Results and Discussions

By examining the research results, some important discussions arose. First, we developed an automobile energy demand model for six Asian countries until 2050, and explored the requirements for the assessment models of sustainability on the demand side. As a result, in considering the adequacy of the logical structure, we inferred that the model for Asian countries should refer to prior information of car ownership growth in developed countries where long term automobile statistics are compiled. From the subsequent study, the model and database will be improved considerably to obtain more rational estimates of future automobile energy demands.

Next, chemical analyses of biofuels in the Philippines market suggest the need for quality monitoring. Previous studies indicate that the ethanol mixed gasoline may be corrosive for aluminum, and suggested that more than 5% volume mixture requires modification or replacement of vehicle materials. It is also reported that the ethanol mixed gasoline would increase the emission of NOx from tailpipe, and biodiesels should be checked for its oxidation stability, which would cause damage to vehicle components. These chemical analyses of biofuels in the Philippines market indicate that the quality of current biofuels satisfies the Philippines National Standard and Asian Automobile Fuel charter. However, one sample of high octane gasoline without display of ethanol gasoline is found to contain high volumes of ethanol and Manganese as octane boosters. Currently, ethanol fuel receives tax benefit, which may encourage the use of ethanol. The Manganese is possibly added to differentiate it from E10 gasoline. In the near future, mid-size and small companies will also start to sell biofuels. In this case, unexpected quality degradation could arise, and then monitoring for their quality controls will be increasingly important to secure fuel quality and emission control.

Thirdly, as it is deemed difficult for Asian countries to achieve introduction targets of biofuels, particularly bioethanol, it would seem necessary to consider a scenario after considering the selection of crops used as raw materials and their uses for other purposes. For example, in the case of bioethanol production in the Philippines, it would seem appropriate to use sugarcanes as the raw material. In considering competition with food, it is preferable to use molasses, a by-product from the production of raw sugar, as the raw material, but even when the entire quantity of molasses is used for bioethanol production, that would only be able to cover some 3% of gasoline consumption in the Philippines. Meanwhile, the tariff rate on sugarcanes is set to be lowered to 5% under AFTA in 2010, and this is likely to push down sugar prices in the Philippines. Thus, it seems that the Philippines would need to adopt a policy linking sugar and bioethanol. In that event, it would be necessary to improve prospective returns on investment, which explain the sugar manufacturing plants' current reluctance to go into bioethanol production, along with efforts to enhance the efficiency of raw sugar production by upgrading sugar manufacturing plants and improve drainage facilities.

Fourthly, the descriptive results show that sugarcane and coconuts have higher potential as feedstock of biofuel among other energy crops, such as corn, cassava and jatropha, in the Philippines. However, while the coconuts production might have a certain amount of reserves for biodiesel use, the sugarcane production should be increased or operated efficiently to meet the possible increase of bioethanol demand. The data collected by the farmers' survey in Negros Occidental show that large-scale farmers depend on nitrogen input to produce sugarcane. On the other hand, small-scale farmers use labor input more effectively than large-scale farmers. Moreover, our estimation of frontier production function shows that there is no significant inefficiency in sugarcane production among farmers. Attitudes about future production are different on average between large and small scale farmers. That is, large-scale farmers are more active in increasing their sugarcane production for biofuel. In addition to the production and perception analyses, land use of a part of Negros Oriental was visualized and statistically analyzed in order to identify a pattern of expansion of sugarcane production. The results show that sugarcane fields are easily expanded even in hilly areas that are regarded as being bad for the production.

Fifthly, we found that global ethanol production and trade have become active since 2005, that GDP and bilateral distance (the distance between importer and exporter) have significant effects on ethanol trade, the effect of the distance has been negative and stable for the period analyzed, and the surplus of a biofuel consumer, such as Japan, declined rapidly as the bilateral distance is increased. These results would supply a reasonable ground for the demand and supply system of biofuel among Japan and ASEAN countries.

Major Publications

1) Satoshi Kai, Albert P. Aquino, and Atsushi Maruyama (2007), "Supply Potential of Biofuels and Raw Material Crops in Asia," Society of Automotive Engineers of Japan 2007 Autumn Annual Congress, No. 146-07, 1-4, Kyoto International Conference Center. (In Japanese)
2) Masanobu Kii. (2007) "Study on automobile biofuel demand estimation in Asian countries," Society of Automotive Engineers of Japan 2007 Autumn Annual Congress, No. 146-07, 5-8, Kyoto International Conference Center. (In Japanese)
3) Masanobu Kii, Atsushi Maruyama, and Satoshi Kai (2008) "Study on the sustainability of demand-supply system of bio-fuels in Asian region," The 38th Conference of Infrastructure Planning and Management, CD-ROM, Wakayama University. (In Japanese)
4) Atsushi Maruyama, Albert P. Aquino, Xandra B. Dimaranan and Satoshi Kai. (2009) "Potential of Biofuel Crop Production in the Philippines: A Preliminary Analysis" HortResearch 63, 67-76.
5) Satoshi Kai, Atsushi Maruyama, Masanobu Kii, and Albert P. Aquino. (2008) "Sugarcane Production of Small-scale Farmers and Their Perception Related to Biofuel: A Case of Negros, the Philippines," The 6thConference of the Asian Society of Agricultural Economists, Manila, Philippines.