Effect of Gasohol Production on the Sugarcane Industry in Thailand

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Abstract: The purpose of this research is to investigate the effect of gasohol production on sugarcane planting in Thailand. Pure ethanol of 99.5 percent concentration is used to replace MTBE (Methyl Tertiary Butyl Ether), which is normally used to increase octane number of gasoline, to blend with gasoline at the rate of 10 percent to produce Octane 95 gasohol. There are several types of raw materials used in ethanol production such as sugarcane, molasses, cassava, sweet potato, rice, corn, wheat, sweet sorghum, etc. The popular raw materials used in ethanol production in Thailand are molasses and cassava. Molasses are a by-product of sugar production process. They are the sugarcane residues that can no longer be extracted for more sugar. In many countries including Thailand, molasses are used as raw material to produce ethanol (1 ton of molasses can produce 260 liters of ethanol) used in gasohol production. In this research, the researcher found that the problem of excess supply and low price of sugarcane can be solved if gasohol E20 or higher was used to replace the Octane 91 gasoline and Octane 95 gasoline.

Keywords: Gasohol, Gasoline, Alcohol, Ethanol, Sugarcane

1. Introduction

Gasohol is a synthetic fuel which made up of the 10 percent or more of alcohol mixed with gasoline. The oil crisis of the 1970’s led to an intensified search for alternative...
sources of energy, including biomass energy in the form of alcohol fuels (B. Johnston 1991). Ethanol and methanol are the main alcohol fuels.

Ethanol is the most commercially important alcohol. It is also called ethyl alcohol, and its chemical formula is \( \text{C}_2\text{H}_5\text{OH} \) (The Encyclopedia 1980). It is present in all alcoholic beverages and is used as an industrial solvent as well as a source material for many other organic substances. Most industrial ethanol is denatured that is substances are added to it that render it unfit for drinking and these substances cannot be readily removed. Denatured alcohol is not subject to taxation and sells for less than 15% of the price of beverage alcohol. Undenatured ethanol is used in beverages, flavorings, pharmaceuticals, and medical products. In some countries where the cost of petroleum is very high, ethanol is added to motor gasoline as an extender. Pure ethanol is a clear, colorless liquid with a characteristic odor. It boils at 78.4 °C (173 °F) and freezes at -114.5 °C (-174 °F) (The Encyclopedia 1980). Its specific gravity is 0.789 (The Encyclopedia 1980). It is infinitely soluble in water, ether, and acetone. Ethanol was formerly made by fermenting blackstrap molasses, grain, or grain products, and then distilling the resulting products. Most industrial ethanol is processed from ethylene, a petroleum by-product.

Ethanol can be made by fermenting almost any starchy material. Grains such as corn and sorghum are good sources, but sugarcane, potatoes, Jerusalem artichokes, and other farm plants and waters are also suitable. Methanol or methyl alcohol is made from coal, methane, wood, or any material containing cellulose. The manufacture of sugar from sugarcane is usually done in two series of operations (McGraw-Hill Encyclopedia of Science & Technology 1987). First, raw sugar of about 98% purity (McGraw-Hill Encyclopedia of Science & Technology 1987) is produced at a location adjacent to the cane fields. The raw sugar is then shipped to refineries, where a purity that is close to 100% (McGraw-Hill Encyclopedia of Science & Technology 1987) is achieved. At the mill the cane stalks are crushed and macerated between heavy grooved iron rollers while being sprayed counter currently with water to dilute the residual juice. The expressed juice contains 95% or more of the
sucrose present. The cane juice is treated with lime to bring its pH to about 8.2 (McGraw-Hill Encyclopedia of Science & Technology 1987). The juice is then heated to facilitate the precipitation of impurities, which are removed by continuous filtration. The purified juice is concentrated by multiple stage vacuum evaporation and, when sufficiently concentrated, is boiled to grain or seeded with sucrose crystals in a single-stage vacuum pan. Usually three successive crops of crystals are grown, cooled, and centrifuged. The final mother liquor, which is resistant to further crystallization, is called blackstrap molasses. It is used principally as a feed for cattle. Relatively small amounts are still fermented to produce industrial alcohol and rum.

As a component of gasohol, ethanol can be viewed not only as an extender of crude oil but also as a means of increasing the octane levels of unleaded fuels. Octane numbers measure the antiknock compounds in gasoline. These compounds are added to prevent or lessen detonation in spark ignition engines. The higher the octane numbers the better the quality of the gasoline. Some countries such as the United States, Brazil, Mexico, Australia and Thailand have gasohol programs under way and others are expected to follow. However, some problems remain. Questions of cost, the environmental effects of distilling alcohol on a vast scale, and of a proper regard for grain as Thailand’s economic agricultural produce, will all need careful consideration.

2. Policy on alternative energy by ethanol using

Ministry of Energy had determined the energy strategies for a country competitiveness, which had been approved by the cabinet on 2 September 2003 (Department of Foreign Trade 2007, Department of Mineral Fuels 2007, Department of Agriculture 2007, Ministry of Foreign Affairs 2007, Bangchak Petroleum Public Co., Ltd. 2007, PTT Public Co., Ltd. 2007, Thai Cabinet’s resolutions 2007, The Institute of Industrial Energy 2007, The Office of the cane and sugar board 2007 and The Office of Industrial
Economics 2007). One among these strategies is the sustainable alternative energy development that had set the target on increasing the proportion of commercial renewable energy or renewable power generation /industry from 0.5 percent in 2002 up to 8 percent by 2011. Bio-fuel development, for ethanol and bio-diesel, is a goal under the Plan of increasing proportion of renewable energy use. Ministry of Energy, by DEDE, had established a Gasohol Strategy to propose in the Joint Meeting between Ministers of Energy, of Agricultural and Cooperatives and of Industry and then proposed to the cabinet on 9 December 2003, which the summary is as shown below.

2.1 Objectives of Ethanol Strategy

1. To create the sustainable energy security of a country and communities
2. To enhance the potentials of communities to be energy production sources
3. To support a domestic bio-chemical industry development

2.2 Target of Ethanol Strategy

Ministry of Energy had set the target on using an ethanol for MTBE substitution in gasoline 95 by 1 ml/d by 2006 and on using an ethanol for MTBE substitution in gasoline 95 and for oil substitution in gasoline 91 for 3 million liters per day by 2011.

3. Government Promotion of Ethanol Use

Ministry of Energy (MoEN) has supported and promoted the gasohol use through these implementations (Department of Foreign Trade 2007, Department of Mineral Fuels 2007, Department of Agriculture 2007, Ministry of Foreign Affairs 2007, Bangchak Petroleum Public Co., Ltd.)
1. MoEN had issued the documents to every ministry for their support the gasohol use in the government and state enterprise vehicles. This aims on the market promotion and assuring the investors and the people in using gasohol. This implement was conducted on 9 June 2004 with a requirement that every organization shall monthly report its results of gasohol use.

2. MoEN has issued the document to the National Supply Board at the Office of Prime Minister and Bureau of the Budget dated 9 June 2004 to determine the car spec. to be procured in fiscal year 2005 with a capability of fuelling by gasohol.

3. The Department of Energy Business (DEB) announced the requirements on gasohol spec. (No.3) 2004 with an effective date on 15 November 2004 for the spec. of both Gasohol 95 and gasohol 91.

4. MoEN had reduced the remittance to the Oil Fund and the ECP Fund, including the excise tax exemption, thus causing the lower price of gasohol than gasoline 95 by 0.75 baht with an effective date on 1 November 2004.

5. The press release to convince on gasohol use by an Energy Minister together with the 13 Automobile Companies and the Gasohol Distributors dated 1 November 2004 at the PTT Head Office.

6. The cabinet resolution to accept the MoEN proposal dated 2 November 2004 RE: The Promotion of Gasohol through the Gas Stations within Bangkok to distribute gasohol 95 in replacing of gasoline 95.

7. The DEB had invited the gasohol producers and distributors into the meeting for getting informed the gasohol promotion schemes of the MoEN and for hearing any problems that might occur in that implementation. The EPPO had invited the ethanol producers and the Refinery Group to discuss on ethanol purchasing price for a long run
of 3-6 months and the arrangement in the long term ethanol purchasing contract.

8. MoEN and Ministry of Industry had a joint meeting on 24 December 2004 and agreed on an improvement in ethanol organization to regulate, supervise and determine the policy by abrogating the National Ethanol Board and establishing the National Bio-fuel Promotion Board for replacing in implementation. This aims to make the fuel operations as a national agenda with an effective implementation for both ethanol and bio-diesel and an integrated operation, starting from raw material, factory establishment, production, blending and distribution of gasohol, including the selling price determination.

9. PTT and Bangchak have campaigned on a gasohol selling by reducing a retail price at 1.50 baht lower than of gasoline since 15 February 2005 for a month and then extending to 15 April 2005.

10. DEDE had created the confidence on gasohol use by setting the Project on Solving the Gasohol Problems in Old Model Cars and Motorcycles and the Project on Pollution Measurement in Gasohol Use. Presently, the ECP Fund had approved the budget to support the Projects since 9 March 2005.

11. The Deputy Permanent Secretary of MoEN had invited the concerned organizations, i.e. DEDE, EPPO, DEB, PTT and Bangchak to discuss on speeding up a gasohol use promotion and on determining the ethanol pricing structure on 25 February and 8 March 2005. The work group of such these organizations was assigned to establish the detailed Roadmap, for a short term of 2005 up to the end of 2006, to push up the Gasohol 95 distribution in all gas stations within Bangkok Metropolitan by 2005 and throughout the country by 2006.

12. A Press Release at Muang Thong Thanee on the 30th March 2005 by Energy Ministry in co-operation with Executives from the World Leader Automobile Companies, for ex: Thailand Toyota Motor, Honda Car Automobile (Thailand), Mitsubishi Motor (Thailand), Volvo Car (Thailand), Thailand Mazda Sale, General Motor (Thailand), the President of Demler Chrysler (Thailand), (Benz) Ford Sale
and Services (Thailand), BMW (Thailand) to create more confidence on gasohol use for vehicles.


14. MoEN had proposed the cabinet to agree on reducing the Oil Fund burden on 19 April 2005 by proposing the gasohol use promotion schemes, i.e. using 4 ml/d of gasohol, speeding up an increasing of gas stations from 800 to 4000 stations by the end of 2005. With a strict order on using gasohol in all vehicles of government and of state enterprises, to comply with the cabinet resolution dated 9 December 2003. A requirement on the 413 gas stations located within the government and state enterprise campuses to change for selling only the gasohol.

15. MoEN had determined the measures to support and promote using of bio-fuel, esp. gasohol by increasing the pricing difference between gasoline and gasohol by 1.50 baht/l and increasing the remittance to the Oil Fund by 0.05 baht/l.

4. Production and use of ethanol situation in Thailand

According to Thai government has a policy to contribute using gasohol in Thailand (Department of Foreign Trade 2007, Department of Mineral Fuels 2007, Department of Agriculture 2007, Ministry of Foreign Affairs 2007, Bangchak Petroleum Public Co., Ltd. 2007, PTT Public Co., Ltd. 2007, Thai Cabinet’s resolutions 2007, The Institute of Industrial Energy 2007, The Office of the cane and sugar board 2007 and The Office of Industrial Economics 2007), this effected gasohol supply was increased in a little bit. The volume was about 4,000,000 liters per day or use ethanol 400,000 liters per day only. (Thailand industry.com as at 9 May 2007) But it still could not absorb all volume of ethanol production. (about 400,000 liters per day) This situation effected surplus of ethanol 400,000 liters per day. This is a
problem of ethanol producer in Thailand now because of no enough market to absorb the surplus production.

On above situation effected to stop production of ethanol industries because there are not tanks enough for stock ethanol 99.5% for mixing to be gasohol. And new companies which had just doing this business in a few months, at present their tanks for stock ethanol also almost full. This caused there are not enough tanks for stock the continuous production of ethanol. Hence it is necessary to stop production temporally and could not define timing for re-production. To contribute the ethanol industries to be survival, Thai government had to export some of ethanol. This way was opposite to Thai government policy that to reduce import gasoline and try to use energy which was able produced within in Thailand.

To help the ethanol entrepreneur to be able to survive, it was necessary to export some of ethanol but this is a opposite way against the policy of Thai government that need to reduce import of gasoline and use energy that could be produced within own country (Department of Foreign Trade 2007, Department of Mineral Fuels 2007, Department of Agriculture 2007, Ministry of Foreign Affairs 2007, Bangchak Petroleum Public Co., Ltd. 2007, PTT Public Co., Ltd. 2007, Thai Cabinet’s resolutions 2007, The Institute of Industrial Energy 2007, The Office of the cane and sugar board 2007 and The Office of Industrial Economics 2007). Around early May 2008, an ethanol firm had exported ethanol 99.5% to Philippine 350,000 liters and may export to other countries continuously such as Korea and China. Export price of ethanol was nearly local price, the past 3 months price was Baht 18.62 per liters excluded transportation cost. The ethanol firms planned for running production and they would consider from potential sale to foreign countries including consideration of capability of negotiation with petroleum company to buy this additional volume of ethanol.

At present Thai government’s problem solution only rush a campaign using gasohol of Thai people. The using target of gasohol would be 8,000,000 liters per day by the end of this year or use ethanol 800,000 liters per day (Department of Foreign Trade 2007, Department of Mineral Fuels 2007, Department of Agriculture 2007, Ministry of
Foreign Affairs 2007, Bangchak Petroleum Public Co., Ltd. 2007, PTT Public Co., Ltd. 2007, Thai Cabinet’s resolutions 2007, The Institute of Industrial Energy 2007, The Office of the cane and sugar board 2007 and The Office of Industrial Economics 2007). In addition to next 2-3 months there will be 2-3 ethanol factories are entry to this market. This reason will effect to excess supply of ethanol more and more. Thai government solution now would have to stop using gasoline 95 immediately in order that there would be a market absorbed ethanol as most as possible.

However the situation of excess supply of ethanol now caused all of ethanol entrepreneurs turned to help each other by reducing own supply volume to equalize for all members of Thai Ethanol Producers Association, this assistance from all ethanol entrepreneurs caused the sale volume was high enough and they could survive on this situation. Sale volume of gasohol in April 2008 was increased 4 million liters per day (data from Energy Policy and Planning Office [EPPO] 2008, Ministry of Energy, Thailand) or increased from the same period of last year 8.5%, increased from March 2008 3.6 million liters per day (Department of Foreign Trade 2007, Department of Mineral Fuels 2007, Department of Agriculture 2007, Ministry of Foreign Affairs 2007, Bangchak Petroleum Public Co., Ltd. 2007, PTT Public Co., Ltd. 2007, Thai Cabinet’s resolutions 2007, The Institute of Industrial Energy 2007, The Office of the cane and sugar board 2007 and The Office of Industrial Economics 2007). All of these occurred because ethanol price was adjusted lower at Baht 18.62 per liters from previous price Baht 19.33 per liters in April 2008. If there would be an adjustment of gasoline price in the next future, the EPPO would allow the price raise only 40 Stangs per liter. (100 Stangs equal Baht 1) This effected to occur a different price between gasoline and gasohol 95 equal Baht 2.90 per liter (May 2008), and between “unleaded gasoline research octane number 91” and “gasohol 91” equal Baht 2.40 per liter. (May 2008) The price would not be unchanged for 3 months. It was expected that gasohol use would be more increasing.

5. Basic theory
5.1 Strategic Management

An assessment of the opportunities and threats in the organization’s external environment is essential in formulating strategy. In this case, we turn from the external environment to take an inward look at the firm. This step in the strategy process establishing the organization’s mission and goals—requires management to determine the direction in which the organization is to move within its external environment.

Organizational direction is difficult to determine unless management and the board of directors, with input from diverse stakeholders, have clearly delineated the firm’s purpose. The purpose of a firm is delineated in order to strategically create wealth for the shareholders through the satisfaction of the needs and expectations of various stakeholders. A firm’s purpose may be conceptualized in the context of S.W.O.T. analysis (the strengths and weaknesses of the firm relative to its competitors as well as the opportunities and threats in the external environment). Hence, a discussion of S.W.O.T. analysis and more specifically the firm’s resources, which comprise its strengths and weaknesses, before we examine the organization’s mission, its reason for existing. Goals and objectives, as well as other related topics, are subsequently examined.

Underlying the organization’s mission is an analysis of its internal strengths and weaknesses and the opportunities and threats that are posed in the external environment. The framework presented in Table 1 identifies many of the variables that management should analyze. The point of the analysis is to enable the firm to position itself to take advantage of particular opportunities in the environment and to avoid or minimize environmental threats. In doing so, the organization attempts to emphasize its strengths and moderate the impact of its weaknesses. The analysis is also useful for uncovering strengths that have not yet been fully utilized and in identifying weaknesses that can be corrected. Matching information about the environment with knowledge of the organization’s capabilities enables management to formulate realistic strategies for attaining its goals.
Table 1 Framework for S.W.O.T. Analysis

<table>
<thead>
<tr>
<th>Sources of Possible External Environmental Opportunities and Threats</th>
<th>Economic forces</th>
<th>Political-legal forces</th>
<th>Social forces</th>
<th>Technological forces</th>
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<tr>
<td>Industry forces</td>
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<tr>
<th>Possible Organizational Strengths and Weaknesses</th>
<th>Access to raw materials</th>
<th>Distribution</th>
<th>Management</th>
<th>Purchasing</th>
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<tbody>
<tr>
<td>Advertising</td>
<td>Economic forces</td>
<td>Manufacturing and operations</td>
<td>Quality control</td>
<td></td>
</tr>
<tr>
<td>Board of directors</td>
<td>Environmental scanning</td>
<td>Market share</td>
<td>Research and development</td>
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</tr>
<tr>
<td>Brand names</td>
<td>Financial resources</td>
<td>Organizational structure</td>
<td>Selling</td>
<td></td>
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<tr>
<td>Channel management</td>
<td>Forecasting</td>
<td>Physical facilities/equipment</td>
<td>Strategic control</td>
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<tr>
<td>Company reputation</td>
<td>Government lobbying</td>
<td>Product/service differentiation</td>
<td>Strategy formulation</td>
<td></td>
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<tr>
<td>Computer information system</td>
<td>Human resources</td>
<td>Product/service quality</td>
<td>Strategy implementation</td>
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</tr>
<tr>
<td>Control systems</td>
<td>Labor relations</td>
<td>Promotion</td>
<td>Technology</td>
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</tr>
<tr>
<td>Costs</td>
<td>Leadership</td>
<td></td>
<td></td>
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<tr>
<td>Customer loyalty</td>
<td>Location</td>
<td>Public relations</td>
<td>Inventory management</td>
<td></td>
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<tr>
<td>Decision making</td>
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</tbody>
</table>

A firm’s resources constitute its strengths and weaknesses. They include human resources (the experience,
Capabilities, knowledge, skills, and judgment of all the firm's employees), organizational resources (the firm's systems and processes, including its strategies, structure, culture, purchasing/materials management, production/operations, financial base, research and development, marketing, information systems, and control systems), and physical resources (plant and equipment, geographic locations, access to raw materials, distribution network, and technology). Sustained competitive advantage refers to valuable strategies that cannot be fully duplicated by the firm's competitors and that result in high financial returns over a lengthy period of time.

5.2 Determination of Price and Quantity

The demand curve shows what consumers wish to purchase at various prices, and the supply curve shows what producers wish to sell. When the two are put together, we see that there is only one price at which the quantity consumers wish to purchase exactly equals the quantity firms wish to sell. In Figure 1, that price is 20 baht/kg, where consumers wish to purchase sugar 62,500 tons and firms wish to sell the same quantity. It is identified by the point of intersection between the supply and demand curves.

The intersection identifies the equilibrium price and quantity in the market. The concept of equilibrium means there is no tendency for the price or quantity to change as long as the supply or the demand curve does not shift.

The point of intersection of the supply and the demand curves identifies the equilibrium price and quantity. Here, at the price of 20 baht/kg, the quantity demand by consumers exactly equals the quantity supplied by firms. Market forces tend to produce this conclusion of microeconomic theory is that the independent actions of buyers and sellers will tend to establish the equilibrium price and quantity.
That a market composed of thousands or millions of persons, each acting independently, could by itself attain equilibrium is really quite remarkable. Market equilibrium signifies a great degree of coordination among the activities of many separate persons and firms. Each individual consumer decides how much to purchase without regard to what other consumers are doing, and yet all consumers are able to acquire the quantities they wish. Each individual firm decides how much to produce and sell without regard to what other firms is doing, and yet all firms are able to sell what they have produced. The mutual compatibility in the plans of independent economic agents is characteristic of market equilibrium and explains why equilibrium will persist unless something happens to change the position of the supply or the demand curve.

We have just asserted that a market left to itself will establish the equilibrium price and quantity shown graphically by the intersection of supply and demand curves. This conclusion can best be understood by imagining that the price is not at its equilibrium level and recognizing that market participants-firms and consumers-have incentives to
behave in ways that produce a movement toward the equilibrium. Suppose, for example, that the price is 14 baht/kg in Figure 1. At 14 baht the demand curve indicates that consumers want sugar 80,000 tons, but the supply curve shows that firms will only produce 28,000 tons. This situation is disequilibrium; the quantity demanded exceeds the quantity supplied, so the plans of buyers and sellers are inconsistent. The excess of the amount consumers want (80,000) over what firms will sell (28,000), or 52,000 tons, is called the excess demand (XD), or shortage, at the price of 14 baht.

Think about how the people involved—consumers and business managers will react in this situation. Consumers are frustrated at not getting as much as they wish, and they are willing to pay a higher price to obtain more shoes. Business managers will see that consumers want more sugars and are willing to pay a higher price for them. There will therefore be a strong tendency for the actual price to rise. Whenever there is a shortage at some price, market forces—the behavior of buyers and sellers in the marketplace—tend to produce a higher price. As the price rises, quantity demanded falls below 80,000 tons (a movement along the demand curve), and quantity supplied increases beyond 28,000 tons (a movement along the supply curve). The process continues until quantity demanded equals quantity supplied at a price of 20 baht.

Alternatively, if for some reason the price is above 20 baht, the quantity firms wish to sell will be greater than the quantity consumers are willing to purchase. An excess supply (XS), or surplus, will exist at a higher-than-equilibrium price. Unsold goods pile up. In this case market forces exert a downward pressure on price, because firms cut prices rather than accumulate unwanted inventories. Once again there is a tendency toward the equilibrium price and quantity.

Therefore, at any price other than the equilibrium price, market forces will tend to cause price and quantity to change in the direction of their equilibrium values. That observation is the basis for asserting that the supply-demand intersection will tend to be established. We say "tend to be" because there is no presumption that a market
is always in equilibrium. The equilibrium position itself will change whenever demand or supply curves shift, so actual markets may, in effect, be pursuing a moving objective as they continually adjust toward equilibrium.

6. Methodology

The research “Effect of Gasohol Production on Sugarcane Planting in Thailand” was a qualitative research which expressed methodology details as following:

6.1 Data source

The researcher had defined data source for this study into 2 types as follows.

6.1.1 Document data sources: those are textbooks, weekly newspapers, daily newspapers, magazines and all papers which were concerned to sugarcane production: products of sugarcane, ethanol, gasohol and all concerned research papers. And bring those data to be a study frame, analysis and result discussion.

6.1.2 Personal data sources: those are the persons who are concerned with sugarcane production, products of sugarcane, ethanol, gasohol, etc. by depth interview with these persons:

   6.1.2.1 Entrepreneur of sugarcane factory.
   6.1.2.2 Entrepreneur of ethanol factory.
   6.1.2.3 Entrepreneur of gasohol factory.
   6.1.2.4 Entrepreneur of gasoline station.

6.2 Data collection timing period

The data collection of this qualitative research, the researcher spent time for collecting all data for 6 months during June – November 2007 by interview all directly concerned persons.
6.3 Data analysis and presentation
The researcher analyzed all data from individual interview by researcher own. And use a tape recorder while interviewing all persons to collect the most perfect data. And the researcher had presented this study result by show some tables and graphs and also explained in descriptive result. The researcher selected only the concerned data to present on this study.

6.4 Statistic
The researcher used two types of statistics: descriptive statistics and estimate statistics to seek the factors which effected to cassava consumption in Thailand.

6.5 Data description
After analyzed all data, the researcher had described all data by show some tables and graphs. Meaning in tables and graphs was analyzed exhaustively together with deep interview the concerned persons. All data were presented by sequence as defined point.

7. Results and discussion
Thailand was necessary to import fuel energy for using in almost whole of transportation section. Trend of import volume was increasing respectively. As shown in Figure 2 clearly explained that import volume of crude oil during year 2001-2006 increment trend continuously (Jai-In S. 2005). This effected Thailand had lost a lot of money to import the fuel oil from foreign country in each year. Amount of import fuel oil was much more than total revenue of export rice, cassava, rubber latex, palm oil and cane sugar. Moreover cost of fuel oil trends increasingly, in addition to the petroleum which had existed in limit volume may be nothing remains soon. This effected many countries had to seek the fuel and energy source from natural resources within their own countries to substitute import fuel oil, for example: using coal, nuclear energy, natural gas etc. But those energy sources in Thailand had existed in limit volume.
Figure 2 Import volumes of crude oil, petroleum’s products and natural gas
Effect of Gasohol Production on the Sugarcane Industry in Thailand

**Figure 3** Consumption of gasoline 95 and gasohol 95 (E10)

However Thailand still has some energy sources which can be produced within own country such as substitute energy source from agricultural. At present Thailand agricultural produce’s price was also drop, especially agricultural produce that was depended on foreign market such as rice, cassava and sugarcane. In spite of these 3 kinds of agricultural produce of Thailand were exported in very high volume to foreign market. Ethanol fuel using which was produced from agricultural produce, for example: cassava, sugarcane, molasses, rice, corn etc., by bringing these produces to be transfigured by digest, fermentation and refinement for getting ethanol from these agricultural produces and then mixing with petroleum fuel, is a solution and can solve above problem very well.

Gasohol obtained from ethanol was mixed up with gasoline. If ethanol was mixed up with diesel called diesohol. In some countries used ethanol to be directly fuel 100% in their countries, for example: in Brazil, United States of America and European countries (Rodrigues D. and Ortiz L. 2005, Browning E. K. and Browning J. M. 1992, Bilister G. 2006, Shapouri H., Salassi M. and Fairbanks J. N. 2006, James J. 2007, Vasconcelos J. N., Lopes C. E. and Franca F. P. 2004, Gonsalves J. B. 2006/7 and Saka S. 2005). Ethanol fuel using will reduce a problem of environment pollution, especially carbon monoxide and hydrocarbon which blew off exhaust pipe of a car. This will also reduce amount of carbon dioxide in atmosphere which effected directly to glasshouse condition.

Ethanol was a kind of alcohol which was obtained from plant and vegetable fermentation, those kinds of agricultural produce were a sugar type raw material such as sugarcane, sugar, molasses, trash, beetroot which was changed from sugar to be alcohol and a starch type raw material such as cassava, sweet potato, grains (corn, rice, wheat, barley, millet, etc.) which was changed from starch to be sugar and then changed sugar to be alcohol finally.
Ethanol production from sugar-based plant fermentation process is as follows:

Sugar-based plant (sugarcane, trash, beetroot, etc.) ↦ alcohol

Ethanol production from starch-based plant fermentation process is as follows:

Starch-based plant (cassava, corn, rice, wheat, barley, etc.) ↦ sugar ↦ alcohol

The alcohol which was purified 95% called ethanol. Ethanol product which was made from raw material, for example: a different kind of plant or vegetable weight 1 ton when enter to production process would obtain a different ethanol product. If the grain is used as a raw material such as rice and corn, the ethanol would be obtained about 375 liters by volume. If the molasses is used as a raw material, the ethanol would be obtained about 260 liters by volume. While cassava is used as a raw material, the ethanol would be obtained only 180 liters by volume. (data from Department of Agriculture, 2007; The Institute of Industrial Energy, 2007; The Office of the cane and sugarcane board, 2007; The Office of Industrial Economics, 2007; Bangchak Petroleum Public Company Limited, 2007; PTT Public Company Limited, 2007)

Thai council of the ministers had a resolution for approval a project of alcohol production from agricultural produce to use in fuel energy. The ministry of industry had appointed The National Ethanol Committee and assigned the under-secretary of the ministry to be the chairman, the director of The Office of Industrial Economy to be a member of the committee and also be a secretary at the meeting of council of the ministers held on 26 December 2000. The meeting resolution had approved on support and encouraging policy of ethanol fuel using and production as the ministry of industry had proposed. Thai government had encouraged investment of private sector on establishment an ethanol factory. Thai government had assigned the ministry
Effect of Gasohol Production on the Sugarcane Industry in Thailand

of agriculture and cooperatives to define the sugarcane and cassava cultivation plan to support and to be in line with the investment of ethanol production. This effected to using volume of gasoline 95 becoming reduced, at the same time using volume of gasohol 95 (E10) was respectively increased. Figure 3 clearly explained a change of using volume of gasoline 95 and gasohol 95 (E10) during January 2005 to December 2006.

According to research result of Office of the National Research Council of Thailand and the sugarcane production development plan in 2002 – 2006 of Ministry of Agriculture and Cooperatives, and also the National Energy Policy Committee Board, these organizations had a conclusion of using raw material for ethanol production, that was cassava which was the most suitable crop to be a raw material for ethanol production because this kind of crop was exceeded in the market about 4 million tons per year and could produce ethanol about 2 million liters per day. Sugarcane was not suitable to be a raw material to produce ethanol because there were not sugarcane in enough quantity for demand of the sugarcane industry and although the molasses from sugarcane could be used to be a raw material to produce ethanol but only got from some surplus after consumption within country.

Figure 4 shows the molasses volume which could be produced from sugarcane during year 2003 to 2010 (sugarcane 1 ton would give molasses volume average 46.72 kilograms or 4.672% by weight). Figure 5 shown about volume of molasses production, consumption, and use for produce ethanol and for export in Thailand. This indicated that Thailand had enough raw material to produce ethanol that not necessary to expand any planting area of sugarcane. Because there was exceeding raw material for ethanol production in the first phase which was expected that not exceeds 1 million liters per day. This volume of ethanol would be brought to mix up gasoline for obtaining gasohol E10. (use ethanol 10% mixing with gasoline 90%)
Figure 4 Comparison of sugarcane production quantity and produce molasses from sugarcane

Figure 5 Quantity of molasses production, consumption, use for produce ethanol and export
The National Ethanol Committee (NEC) had announced an invitation to investors to submit the project of ethanol factory establishment and also discussed about permission for ethanol factory establishment, setting rules and conditions of factory establishment permission. The NEC had examined 8 investors who had already submitted complete documents. The National Energy Policy Committee and council of the ministers had a conclusion to permit the ethanol factory establishment of those 8 investors. Beside these 8 investors who already got a permission to establish factories which the whole production capacity of these 8 factories were equal 1,502,000 liters per day, (May 2007) there also be the other 11 entrepreneurs were interested to invest in this project which the whole production capacity of these 11 factories will be 4,530,000 liters per day. (May 2007)

Thai government had thoroughly encouraged using gasohol in Thailand. This affected to gasohol consumption was increased just a little bit. But it could not absorb the whole production volume of ethanol, and then there was a surplus of ethanol 400,000 liters per day and now no any market can absorb this surplus volume. At present the problem solving of Thai government only pushed all Thai people who used another kind of fuel to change to use gasohol much more than the former, as the setting goal, the gasohol consumption will be 8,000,000 liters per day by the end of year 2007 or use the ethanol 800,000 liters per day. Because of there was new entry of ethanol factory into this business continuously, this effected to surplus of ethanol more and more.
At present using ethanol in Thailand was a critical situation because the production volume was over demand in the market and the whole volume of ethanol could not be used in the gasohol production process. All of these effected by using volume of gasohol that it was still a small use volume because some of Thai people who had a car still used gasoline. Beside that ethanol admixture volume into gasoline was still very low proportion. At present use ethanol only 10% mixing with gasoline 90% to be gasohol called gasohol E10. Figure 6 shows the excess supply of ethanol in the market and there still would be exceeding volume if gasohol E10 was used continuously.

Since January 2008, Department of Alternative Energy Development and Efficiency (DEDE), Ministry of Energy had cooperated with department of mechanical engineering, King Mongkut Institute of Technology Ladkrabang, Thailand to study and research the feasibility of use gasoline mixing with ethanol to be fuel for automobile in proportion of ethanol 20% up (E20). This study is for being a beginning data to prepare the completion for development and design of both
automobile and motorcycle for automobile industry in Thailand that would be able use fuel called E20 up in the future. And also to establish stability for energy which used raw material within Thailand. If all users of gasohol E10 could change to use gasohol E20 since year 2008, this effected to reduce the excess supply of ethanol, however there was still some exceeding ethanol in the market as shown in Figure 7.

**Figure 7** Comparison of ethanol consumption of gasohol and ethanol production volume from molasses in case of beginning use gasohol E20 in 2008

![Ethanol production volume from molasses](source: Ethanol production volume from molasses, Nattaromthong N., Ethanol and Biofuels Asia 2006)
Figure 8 Comparison of ethanol consumption of gasohol and ethanol production volume from molasses in case of beginning use gasohol E30 in 2008

Figure 9 Comparison of ethanol consumption of gasohol and ethanol production volume from molasses in case of beginning use gasohol E40 in 2008
If the government wished to reduce this excess supply of ethanol in the market, should have to use gasohol which had a mixing proportion of ethanol in a higher rate such as gasohol E30 as shown in Figure 8, and if need to clean out on problem solving of excess supply of ethanol would have to use gasohol E40 as shown in Figure 9. This caused having to produce more ethanol from molasses, it had to increase production of molasses 19,230 tons per year or had to plant more sugarcane 411,600 tons per year or estimated of increasing planting area 47,300 rais. (2 ½ rai = 1 acre) The sugarcane was grown average 8.7 tons per planting area 1 rai.

And if gasohol E50 was begun use in 2008, this clearly indicated that government would have to accelerate on sugarcane planting of the agricultural sector or increased the planting area of sugarcane. Because of ethanol production would be less than ethanol consumption in a very high volume as shown in Figure 10. This caused having to produce ethanol from molasses additionally. It was necessary to produce additional molasses 511,500 tons per
year or had to grow additional sugarcane 10,949,000 tons per year or estimated additional planting area 1,258,500 rais from the original planting area 6,675,000 rais. This was an average calculation during 2003-2006. (data from Department of Agriculture, 2007; The Institute of Industrial Energy, 2007; The Office of the cane and sugarcane board, 2007; The Office of Industrial Economics, 2007)

An another solution which government could solve this problem and be able to push this policy, that was rushing all automobile users turned to use gasohol E20 within year 2008 and stop using gasoline 95 within year 2009. This solution would cause using of ethanol was higher than ethanol production volume as shown in Figure 11. This effected having to produce the additional ethanol from molasses, had to produce additional molasses 165,400 tons per year or had to grow additional sugarcane 3,539,900 tons per year or estimated the additional planting area 406,900 rais from the original planting area 6,675,000 rais by average calculation during 2003-2006.
The problem of pushing the use of gasohol (increase the use of ethanol in a type of use gasohol), problem of requirement for planting area additionally if the government had set a policy to use gasohol E10, E20, E30, E40, E50 within 2008, and the another problem that required more planting area if begin using gasohol E20 within 2008 and stop using gasoline 95 within 2009. Both cases might use a strategic plan by analyzing general environment, for example: economic environment analysis, this factor would define the economics survival which effected to the firm’s potential. If the economy declined would also affect consumer expenditure was decreased. Technological environment analysis, the technology affected to the product which could be renewable, for example: Honda Automobile (Thailand) Co., Ltd. is an automobile manufacturer and exporter, they produced a new class of automobile by adapting the engine of automobile which will be sold in 2008, and this class of automobile was able to use gasohol E20. This was an automobile which can use an alternative energy. Social environment analysis, this factor could be both opportunity and threat, for example: if most of drivers trend had changed to use gasohol more and more, it was held that being an opportunity of ethanol production. But if the drivers were not confident whether the existing engine could use gasohol and if most Thai people were not attentive for helping each other to economize use gasoline, this would be a threat. And also use the theory of micro economics about price and quantity equilibrium to manage this business. In general principle, price movement was depend on market but at present situation which there was an excess supply of ethanol, supply volume was higher than demand volume. Thus the government should fine a way to release the excess supply of ethanol as the most rapidly such as mixing ethanol in gasoline in a higher percentage than previously, for example: mixing proportion to be gasohol E30, E40, or E50 etc. An another solution was to attempt reduction of use gasoline 95 as possible by set the gasoline 95’ price more expensive and encourage using gasohol in a higher volume by reducing the gasohol’s price to be lower
than at present, this would be a balance condition in the market or called market equilibrium.

8. Conclusions

Because of Thai government’s encouragement in using gasohol was not successful as much as a supplement policy of additional production plan of ethanol, this effected to ethanol supply exceeded a lot in the market. With an awareness of the current ethanol crisis, due to mixing volume of ethanol into gasohol which current use still being a low proportion, that is using ethanol 10% mixing with gasoline 90% obtained gasohol called gasohol E10. To reduce the surplus of ethanol in the market, need to mix with ethanol in a higher rate such as gasohol E20, E30, E40, or E50 etc.

If the government wished to exhaustively solve the problem of excess supply of ethanol, would have to begin using gasohol E40 within year 2008. This plan caused having to produce ethanol from molasses additionally and effected having to grow more sugarcane 411,600 tons per year. This caused having to increase more planting area of sugarcane 47,300 rais. (2 ½ rai = 1 acre) If begin using gasohol E50 within year 2008, the ethanol production volume would be less than the ethanol using volume in the market. This caused having to produce more ethanol from molasses and had to grow more sugarcane 10,949,000 tons per year. This effected having to increase planting area of sugarcane 1,258,500 rais. (2 ½ rai = 1 acre) But both cases there are not any engineering research certified that whether be able to use gasohol E40 and E50 for automobile which was sold in Thailand.

In additionally there was another solution, which was use gasohol E20 within year 2008 and stop use gasoline or benzene 95 within year 2009. This solution would cause the use volume of ethanol was higher than the production volume and effected having to produce more ethanol from molasses and also having to grow more sugarcane 3,539,900
tons per year. And this plan would have to increase the planting area of sugarcane 406,900 rais. (2 ½ rai = 1 acre) As mentioned above case may use a method of strategic plan for general environment analysis by analyzing these factors: technological environment analysis, social environment analysis and also use the theory of microeconomics concerned the price and quantity equilibrium for all management.

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