Current Status of New and Renewable Energies in China♦
- Introduction of Fuel Ethanol -

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Introduction

After the recent rise in oil prices, the use of bio-ethanol (hereinafter "ethanol"), part of the bio-fuel family, has become the focus of global attention. China is accelerating its efforts to make bio-ethanol gasoline, a mixture of ten percent ethanol and ninety percent gasoline (hereinafter "E10") accepted throughout the country. On February 10, 2004, the Chinese government enforced the *"Law Concerning Testing for the Extensive Use of Bio-Ethanol Gasoline for Automobiles and the Regulations Concerning the Conduct of Testing for the Extensive Use of Bio-Ethanol Gasoline for Automobiles*,[1]*"* and has thereafter been introducing the use of E10 on a gradual basis up to the end of 2005 in five provinces (Heilongjiang, Jilin, Liaoning, Henan, Anhui) as well as 27 cities (nine in Hubei Province, six in Hebei Province, seven in Shandong Province, five in Jiangsu Province). These regions were chosen because the grain from which ethanol is made was produced there, and these regions were major consumers of transportation fuels. In addition, the impact on the automobile industry — which corresponds to the changes in the composition of transportation fuels in China as a result of the foregoing systems — are by no means considered to be nominal, given the fact that gasoline consumption in the five provinces and 27 cities accounts for approximately 25 percent of the total consumption in China.

In this report, the author provides an overview of the policy for the introduction of E10 that the Beijing government currently employs, explains the background of the implementation policy including challenges for the government, and examines the effects of the introduction of E10 on the Chinese society as well as future tasks. In Sections 1 through 4, we will take a quick look at the background of the expanded use of E10 as well as China's status quo and plans. In Section 5 and 6, we will be summarizing the policy's impact and challenges.

♦ This report is a revision of an independent research paper that was published on the website of the Institute of Energy Economics, Japan on January 30, 2006.

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[1] See Reference 2.

1. Global Trends in the Use of Bio-fuels

The world's forerunner in the use of ethanol is Brazil. After the first oil crisis, the Brazilian government launched the *"Proálcool program"*[2], a national alcohol plan, in 1975. Brazil succeeded in steadily spreading the use of ethanol after many twists and turns, to become a major ethanol production / consumption center, thereby accumulating a great amount of expertise. Meanwhile, the United States, the EU, Japan and other developed countries as well as developing countries including China, India, Thailand and Philippines also set up their own introduction plan one after another during these years.

The U.S. *"Energy Policy Act of 2005"* sets forth an initiative to increase the use of ethanol, which is made from maize, by 20 percent by 2012.[3] It also estimates that, as a result of this initiative, over 200,000 additional jobs will be created while the U.S. gross domestic product (GDP) will grow by 200 billion dollars.[4] In the State of the Union Address in January, President Bush declared a departure from a dependency on oil, which later resulted in the 2.1 billion dollar annual budget request to Congress for the development of ethanol and other alternative fuels. In response to these moves, General Motors (GM) announced a plan which states that the shipment of its nine models that can be fed with the E85 fuel, which contains 85 percent ethanol as of 2006, would be increased by 50 percent (i.e. 400,000 vehicles) as compared with the previous year. Meanwhile, Ford Motor plans to produce 250,000 vehicles of similar type.[5]

In December 2005, the EU announced its *"Biomass Action Plan"*, in which the use of bio-fuels in the transportation sector was set as a priority. At the same time, the EU aims at increasing the share of bio-fuels in the total transportation fuel consumption up to 5.75 percent by 2010. Meanwhile, the Japanese Ministry of Economy, Trade and Industry is implementing a review of a policy for selling E3, in which 3 percent ethanol is contained, for automobiles in its domestic market in 2008 in an effort to cut down on the emission of greenhouse gases.[6] A backdrop for this initiative is that the Japanese government proclaimed in the Kyoto Protocol target achievement plan that it would begin to use 500,000 kiloliters (crude oil equivalent) of bio-fuels by 2010.

What underlies the ethanol policies established by different governments are high oil prices and global warming. As crude oil prices soar, action for stable energy supply as well as environmental measures for the reduction of greenhouse gas emission should

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[2] After the first oil crisis of 1973, the Brazilian government launched a national alcohol plan called "Proálcool" in November 1975. The Brazilian economy at that time was suffering from trade deficits due to oil imports, and the agricultural economy in underdeveloped districts in the country was on the decline. This national initiative was expected to produce a synergy effect that would increase the country's energy self-sufficiency, reduce deficits, and revive the devastated agricultural sector.

[3] "Latest Trends on US Energy Legislation," NEDO Kaigai (Overseas) Report No. 956, June 1, 2005.

[4] "U.S. GDP to grow by 24 trillion yen," Nihon Keizai Shimbun, February 25, 2006.

[5] "GM and Ford to beef up environmental strategies—Doubling ethanol cars," Nihon Keizai Shimbun, February 9, 2006.

[6] From the Asahi Shimbun website's business news section (www.asahi.com/business/update/0719/044.html).

continue to be regarded as important as ever. It is expected that the use of ethanol will be accelerated on a global basis as a currently available countermeasure.

2. Background on the Use of Bio-Ethanol in China

In ethanol production, the yield of the crops from which alcohol is made plays an extremely important role. For China, it is also important to estimate the yield of raw materials, especially redundant volumes, before supplying such raw materials. In fact, the recent introduction of E10 was originally planned with a view to consuming the country's stale emergency food stocks.

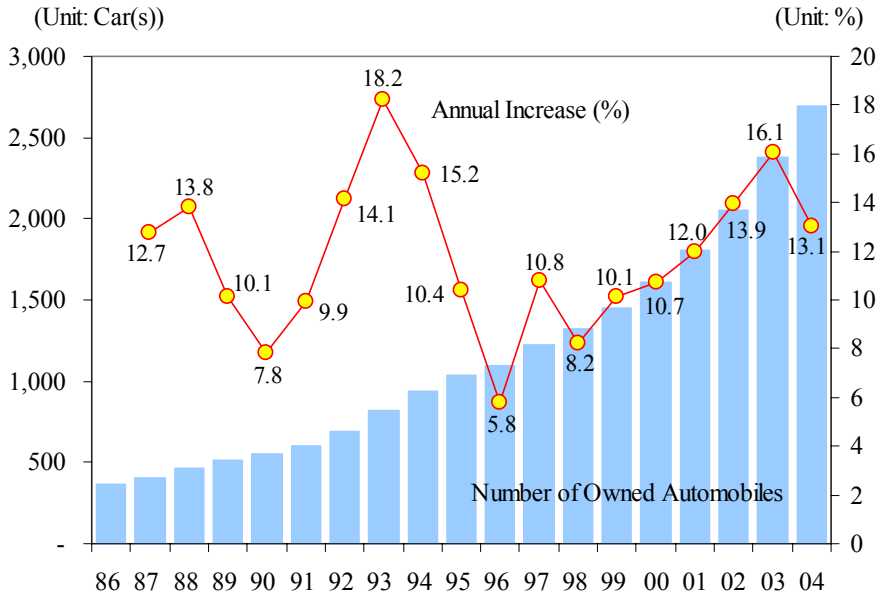
Now, taking these conditions into account, it should be noted that not only the above mentioned energy security and environmental issues but also the Chinese food situation have to be considered to be major factors for the widespread ethanol use in China. In this report, we will look at the accelerated use of ethanol in the nation from three perspectives: stable energy supply by replacing gasoline, effective use of food stocks, and environmental measures.

2.1 Stable energy supply

Increased demand for liquid fuels as a result of rapid motorization

Thanks to the reforms and *"open-door policies"* of 1978, China made a transition from a state-planned economy to a market economy - from 1978 to 2004, the Chinese economy grew at an annual average economic growth rate of 9.4 percent. This development caused national income to increase, which in turn improved the domestic standard of living, while motorization advanced quickly. According to data from the National Bureau of Statistics of China, the number of automobiles owned nationwide reached 26.94 million in 2004 (passenger cars: 17.36 million, trucks: 8.93 million, others: 0.65 million), and the annual average increase rate during the period from 1986 to 2004 was 11.8 percent. Specifically, remarkable increases in the number of owned vehicles are observed in Beijing (13.6 percent during the same period), Hebei Province (13.0 percent during the same period), Shanghai (12.0 percent during the same period), Zhejiang Province (17.5 percent during the same period), Jiangsu Province (13.3 percent during the same period) and Guangdong Province (14.5 percent during the same period), among others.

Figure 2.1: Number of automobiles owned in China and changes in annual increase (1986 - 2004)

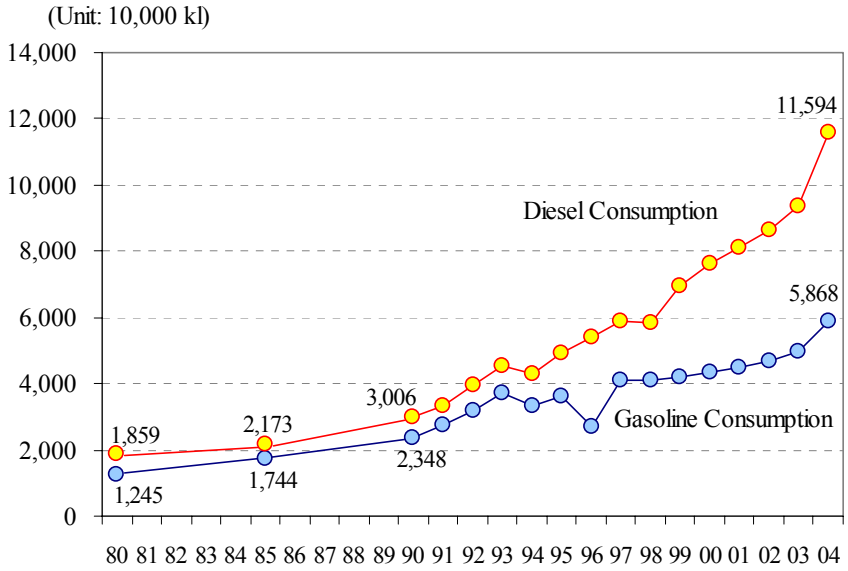


Source: *"China Statistical Yearbook 2005 (First Edition)"*, China Statistics Press, September 2005.

These increases in the number of privately owned automobiles are accompanied by the rapid expansion of the consumption of gasoline and diesel as transportation fuels. According to 2004 statistics, the consumption of diesel and gasoline reached 115.94 million kiloliters and 58.68 million kiloliters, respectively.[7] The amount of gasoline and diesel consumed grew slowly during the 1980's. From the start of the 1990's, however, the growth rate skyrocketed - the annual average growth rate for gasoline and diesel during the period from 1990 to 2004 reached 6.8 percent and 10.1 percent, respectively. It can be assumed that one of the reasons for this significant increase in the consumption of diesel is that both the number of trucks owned and the demand for transportation increased as a result of the construction of national roads and highways that interconnect cities throughout the nation. In addition, the widespread use of mechanized farming resulted in a significantly growing number of farming trucks, which also contributed greatly to the increased consumption of diesel.

[7] The data on gasoline and diesel consumption released by the National Bureau of Statistics of China are indicated in its original unit tons - the heat values of gasoline and diesel are 10,300 kcal/kg and 10,200 kcal/kg, respectively. These values were converted into kcal/L by using the specific gravity of gasoline (i.e. 0.75) and diesel (i.e. 0.84), along with the values of 8,266 kcal/L (for gasoline) and 9,126 kcal/L (for diesel oil) given in *EDMC "Handbook of Energy & Economic Statistics in Japan, 2005"*.

Figure 2-2: Changes in the consumption of gasoline and light oil in China (1980 - 2004)



Source: *China Statistical Yearbook* (different editions); prepared from *China Energy Statistical Yearbook 2004*.

Gasoline consumption was primarily influenced by the popularity of passenger vehicles. This increase was due to the "Buy your own car" boom and the boosted consumption attributed to active commercial activities. While the demand increased, gasoline smuggling was rampant in the early 1990's at major coastal cities, particularly Guangdong Province. This problem compelled the Chinese government to declare a ban on gasoline importation in 1999.

Meanwhile, companies in China tended to place importance on exportation because, in the context of higher oil prices abroad, the Government was encouraging export activities by maintaining domestic oil prices at levels that were lower than international standards, and by refunding export duties. The data for 2003 indicate that the annual gasoline production for the year was 59.70 million kiloliters (consumption was 49.97 million kiloliters), of which 9.39 million kiloliters were exported. In 2004, gasoline consumption reached 58.68 million kiloliters with an annual increase of 17.4 percent, while exports recorded 6.73 million kiloliters, 28.3 percent lower than the previous year. This trend is expected to be increasingly reinforced against the background of the active domestic gasoline demand. It can be safely said that pressures against the gasoline import ban will continue to strengthen.

When the concerns for domestic gas undersupply were generated at the beginning of 2005, the Ministry of Finance and the State Administration of Taxation announced that a

refund of appreciation duties[8], or a value-added tax, concerning the export of gasoline for vehicles, jet fuels and naphtha would be suspended on a temporary basis starting from September 1, 2005 through December 31, 2005 to demonstrate the nation's policy to give priority to responding to internal demand.

2.2 Effective use of food stocks

Adjustment of domestic food reserves

China has basically been self-supporting in terms of food[9], yet, if we look at the data for the 1960's and later, domestic food production has not always been stable. It boasts extremely high food self-sufficiency rates: 98.3 percent in the period from 1960's to 1970's, and over 95.0 percent in the 1980's.

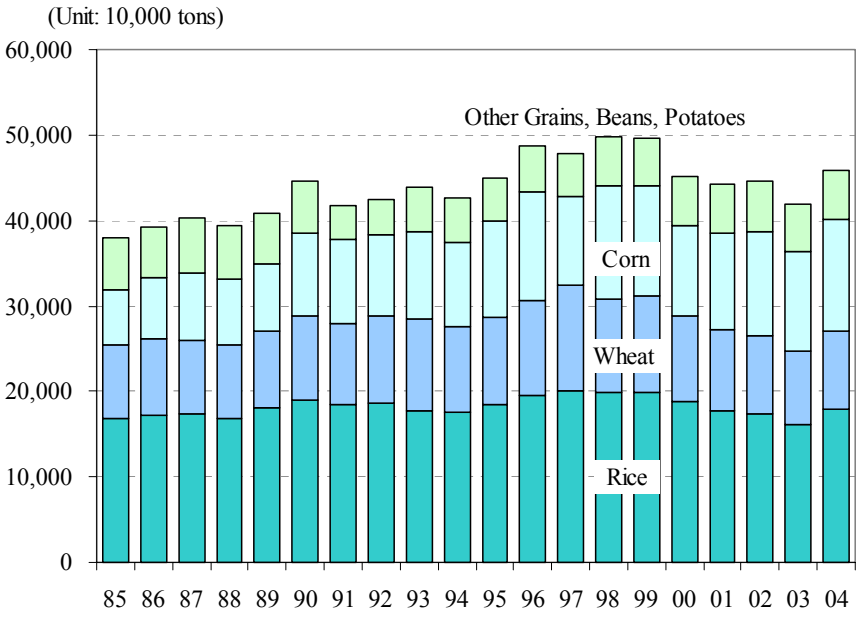
According to the guidelines established by the United Nation Food and Agriculture Organization (FAO), the food reserve safety line can be achieved if the crops in stock accounts for 17 to 18 percent of the total consumption. As such, based on the annual food consumption of approximately 490.0 million tons in China in 2003, it is suggested that around 125.0 million tons of food reserves should secure the safety line. The Chinese government's food stocks amounted to 180.0 million tons at the end of 2003 while private farmers stored 388.9 million tons of food.[10] These two figures total 568.9 million tons, which exceeds the annual food consumption of the year by around 80.0 million tons. During the 1980's, the country, at times, experienced some difficult food supply conditions that led to a maximum of approximately 20.0 million tons of annual imports. Around 1990, however, food began to be overproduced due to bumper crops, and by 1999, the food stockpile had grown. Yet, the national food reserve has been maintained with the support of subsidies, causing a heavy burden on administrative agencies. In an effort to reduce the financial burden caused by food reserves, the Chinese government is promoting ethanol production by using stale food stocks; i.e., it aims to organize a system in which food stock volumes are adjusted through the use of ethanol. Figure 2-3 shows the changes in food production in China in recent years.

[8] This duty is levied on businesses that carry out sales, importation, processing or repair of goods in China. Enforced in 1994 with a tariff of 17 percent (13 percent for some agricultural products).

[9] *China Statistical Yearbook* group's food into grain (i.e. rice, wheat and Indian corn) and other grains/pulse/potatoes/taros. This report basically follows this definition.

[10] Food stocks of 506 kg per farmer. The food reserved by farmers in the private sector is estimated at 388.86 million tons by multiplying by 768.51 million, which is stated in *China Statistical Yearbook 2004* as the number of China's agricultural population.

Figure 2-3: Changes in food production in China (1985 - 2003)



Source: *China Statistical Yearbook 2004 (First Edition)*, China Statistics Press, September 2004.

2.3 Environmental measures

Environmental regulations (on automobile exhaust gas)

As a result of the rapid economic growth witnessed in China, the country's environment is experiencing a marked change for the worse. What lies behind this phenomenon is the energy supply system that depends on approximately 70 percent of its total energy production on coal. At the same time, NO_2 and airborne particles (dust) that are increasingly emitted from automobiles continue threatening public health in urban areas. The State Environmental Protection Administration enforced EURO3[11] regulations, the European automobile emission standards, in Beijing on July 1, 2005, and plans to launch a nationwide effort in the future.

Meanwhile, the Chinese government announced the passenger car fuel consumption standards and regulations[12] on October 28, 2004, which were enforced on July 1, 2005. These regulations provide double regulation values for the fuel efficiency of passenger

[11] The EURO3 exhaust gas regulations were came into effect in 2000 in Europe. A number of Asian countries follow these regulations.

[12] The passenger car fuel consumption standards and regulations were announced on October 28, 2004. The first phase, which was enforced on July 1, 2005, stipulates that fuel efficiency must be improved by approximately 10 percent as compared with the then average fuel economy standard. The second phase, which will be effective from January 1, 2008, provides that an additional 5 percent improvement must be achieved. The reference value for automobile fuel economy will be reduced by approximately 15 percent by 2010. (Chinese name: 乗用車燃料消耗量限値標準.)

cars and light vehicles, targeting a 15 percent overall improvement in fuel economy by 2010. The Chinese government also plans to establish fuel efficiency standards for light commercial vehicles, trucks and special vehicles.

As mentioned above, the expanded Chinese automobile society has already brought about a number of social / environmental issues. The use of E10 is expected to play a role as one of the most effective measures among many counterparts. The Chinese Academy of Social Sciences published a result of an analysis stating that, by adding 10 percents ethanol to gasoline, air pollution is expected to be improve by around 30 percent.

3. Status Quo of the Use of E10

The Chinese commitment to the introduction of E10 is grouped into three stages: research, development and establishment of relevant technologies and demonstration thereof; legislation; and enforcement. At the first stage of research and development, subsidies were granted to the technology development efforts for three areas - ethanol, bio-diesels and fermented methane gas - and a number of trials were carried out under the *"National High Technology Research and Development Initiative"* (also known as "863 Plan")[13], enforced in March 1986. This stage was followed by the second stage: legislation. On April 2, 2001, China announced *"Denatured fuel ethanol" (GB18350-2001)* and *"Bio-Ethanol gasoline for automobiles" (GB18351-2001)*[14] standards to specify the production of the E10, as the national standards. In the following year, on March 22, 2002, the government enforced the *"Law Concerning Testing for the Use of Bio-Ethanol Gasoline for Automobiles"* and launched a model business for the introduction of E10 in specified areas. Building on the results of this model business, China announced, on February 10, 2004, the *"Law Concerning Testing for the Extensive Use of Ethanol Blended Gasoline for Automobiles and the Regulations Concerning the Conduct of Testing for the Extensive Use of Ethanol Blended Gasoline for Automobiles"*, as a bridgehead toward the third stage: the full-scale spread of ethanol use. In the following section, we will review the story and specifics of introduction at each step.

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[13] The *"National High Technology Research and Development Initiative"* (also known as "863 Plan") was launched on March 3, 1986 by four scientists of the Chinese Academy of Social Sciences—Wang Da Heng, Wang Gan Chang, Yang Jia Chi and Chen Fang Yun - and promoted with the support of the Chinese central government. This program aims at reinforcing the national support for domestic high tech research and development while promoting joint academy, industry, government efforts toward the development of new technologies especially in six sectors: telecommunications, biotechnology, energy, automation, new materials and ocean development.

[14] On April 18, 2001, the *"National Development and Reform Commission"* (formerly the National Development and Planning Commission) and the General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China jointly announced *"Denatured fuel ethanol"* (Chinese name: "变性燃料乙醇") and *"Bio-Ethanol gasoline for automobiles"* (Chinese name: "車用乙醇汽油") standards, Which established the country's Bio-ethanol gasoline standards.

3.1 Introduction policy for ethanol blended gasoline

3.1.1 First stage

Research, development and demonstration

During the period from the early 1980's to the mid-1990's, research and development efforts for the use of alcohol mixed transportation fuels were carried out under the auspices of the State Science and Technology Commission. A number of tests were made at this stage, which contributed to the improvement of the country's technology levels. From 1991 through 1995, agencies of the Chinese government cooperated with Volkswagen, a German manufacturer, to gather actual operation data. On April 8, 2001, the Tian Guan Group, a corporation based in Nanyang, Henan Province, launched a 250,000 kiloliter-class[15] (200,000 ton-class) ethanol production testing business ahead of the rest of the country with the support of the national government. On July 1 of the same year, it started a one-year pilot program in three cities - Zhengzhou, Luoyang and Nanyang in Henan Province—working hand-in-hand with the National Development and Reform Commission (formerly the National Development and Planning Commission) and China Petroleum & Chemical Corporation (SINOPEC). A large amount of data was gathered from this demonstration experiment and it appears that China's own ethanol-related technologies were developed during this period. Backed up by the nation's 863 Plan, this organization currently aims at applying and promoting different technologies concerning maize, cassava, sweet potato, sugar cane, sorghum[16] and other wood materials, as well as starting commercial ethanol production.

3.1.2 Second stage

Legislation

In order to promote the use of ethanol, it was necessary for China to prepare a complete legal system at the second stage. The *"Bio-ethanol utilization plan"*[17] was included in the *"Tenth Five-Year Plan"* that was announced in 2001. On March 22, 2002, based on this *"Bio-ethanol utilization plan"*, notice was given regarding the *"Law Concerning Testing for the Use of Bio-Ethanol Gasoline for Automobiles and the Regulations Concerning the Conduct of Testing for the Extensive Use of Bio-Ethanol Gasoline for Automobiles"*[18] (hereinafter "testing business"). The objectives of this

[15] The original Chinese document refers to this ethanol volume as 200,000 tons, which is converted into kiloliters here by using the specific gravity of ethanol (i.e. 0.7894 g/ml).

[16] An annual grass in the Poaceae family, native to East Africa, that is cultivated as a crop especially in China, South Korea and Japan. It is one of the major food materials in Southwestern Asia, Africa, and Northeastern China. Also known as "kaoliang".

[17] The formal Chinese name of the "Bio-ethanol gasoline utilization plan" is "変性燃料乙醇及車用乙醇汽油"十五"発展専項規画."

[18] See Reference 1.

legislation were to prepare a legal system and to establish a public sector along with raw material procurement / production / transportation / sales systems. The following is a summary of the major regulations:

(a)Ethanol production testing business

Both Henan Tian Guan Group and the Jin Yu Group in Heilongjiang Province have been granted preferential treatment: the 5 percent consumption tax on ethanol production is exempted, value added taxes are refunded, food reserve (stock) prices are compensated, and the prices of E10 products are treated with consideration (any loss is compensated with a grant and such products are sold at prices on a par with traditional commercial gasoline).

(b)Pilot utilization areas and terms

For a period of one year starting from June 30, 2002, the E10 was introduced on a trial basis in five cities: Zhengzhou, Luoyang and Nanyang in Henan Province, and Harbin and Zhaodong in Heilongjiang Province. In Nanyang and Zhaodong, the E10 ethanol was used by all automobiles excluding motorcycles while in Zhengzhou, Luoyang and Harbin, partial introduction escalated into a gradual all-out adoption.

(c) Legislation regarding E10 production, transportation and sales

On April 18, 2001, the *"Denatured fuel ethanol"* and *"Bio-Ethanol gasoline for automobiles"* national production technology standards were established in an effort to standardize ethanol production. For the blending, storage and transportation of E10 products, the internal standards of China Petroleum & Chemical Corporation (SINOPEC) were used. These products are sales by China National Petroleum Corporation (CNPC) and SINOPEC.

Table 3-1: *"Denatured fuel ethanol"* the Chinese fuel ethanol

Item	Unit	Standard
Appearance		Clarification
Ethanol content	Vol%	≦ 92.1
Methanol content	Vol%	≧ 0.5
Actual washed gum	mg/100ml	≧ 5.0
Moisture content	Vol%	≧ 0.8
Chlorine ion	mg/l	≧ 32.0
Acidity	mg/l	≧ 56.0
Copper content	mg/l	≧ 0.08
pH value		6.5 to 9.0

Note: The pH values prior to April 1, 2002 are 5.7 to 9.0.

Source: *"Denatured fuel ethanol"* (GB18350-2001)

Chinese ethanol is produced primarily from maize and wheat. These materials are saccharified and fermented before conversion into ethanol. The Chinese fuel additive ethanol is regulated in accordance with the *"Denatured fuel ethanol"* standards as shown in Table 3-1. These standards are basically the same as the U.S. fuel ethanol standards except that the moisture content (0.8 percent or less) and the copper content (0.08 mg/L or less) are somewhat more stringent than in their American counterparts. (The U.S. fuel ethanol standards require moisture content of 1.0 percent or less and copper content of 0.1 mg/L or less.) This testing business treats 90#, 93# and 95#[19] gasoline products as E10, controlled in accordance with the standards shown in Table 3-2. Although the standard values for these three different Bio-ethanol gasoline products are similar to each other, the octane numbers are different.

Table 3-2: *"Bio-ethanol gasoline for automobiles"*, the Chinese ethanol mixed gasoline standards

Item	Unit		Index		
			90#	93#	95#
Octane number		≦	90	93	95
Lead	g/l	≦	0.005		
Distillation characteristics (Decrease loss volume added)					
10% distillate temp.	℃	≦	70		
50% distillate temp.	℃	≦	120		
90% distillate temp.	℃	≦	190		
Residual oil volume	Vol%	≦	2		
Vapor pressure					
Sep. 16 to Mar. 15	kPa	≦	88		
Mar. 16 to Sep. 15	kPa	≦	74		
Actual gum	mg/100ml	≦	5		
Sulfur content	%	≦	0.1		
Sulfuric acid	%	≦	0.001		
Copper corrosion	50℃,3h	≦	1		
Moisture content	%	≦	0.15		
Ethanol	Vol%		9.0 to 10.5		
Benzene	Vol%	≦	2.5		
Aromatic hydrocarbon	Vol%	≦	40		

Source: *"Bio-ethanol gasoline for automobiles"* (GB18351-2001).

[19] China has three major standards for automobile gasoline products: 90#, 93# and 97#. (Some companies market the 98# gasoline.) Each of them has to be lead-free with sulfur content of 800 ppm or less. The difference is in the octane number, which is referred to by the product number. For example, a 90# gasoline product has the octane value of 90.

3.1.3 Third stage (Enforcement)

Having reviewed the results of the *"Tenth Five-Year Plan"*, the General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China, on February 10, 2004, gave notice of the *"Law Concerning Testing for the Extensive Use of Bio-Ethanol Gasoline for Automobiles and the Regulations Concerning the Conduct of Testing for the Extensive Use of Bio-ethanol Gasoline for Automobiles"* (hereinafter *"Extensive Use Law"*).[20] This incremental step forward was made possible because all relevant conditions for the extension to other areas were satisfied by establishing a series of systems comprising production, logistics and sales by making use of the results of the pilot utilization in the five cities that were involved in the second stage testing business. The *Extensive Use Law* stipulates the following:

(a) Establishment of an administration system

In order to facilitate the use of E10 for automobiles, the Chinese government established a promotion group within its organization. Led by the National Development and Reform Commission, this group has CNPC, SINOPEC and eight other relevant government agencies as its members that are working in collaboration.

Table 3-3: The national ethanol promotion

Group leader	National Development and Reform Commission
Subgroup leaders	China National Petroleum Corporation (CNPC)
	China Petroleum & Chemical Corporation (SINOPEC)
Members	Ministry of Public Security of the People's Republic of China
	Ministry of Finance People's Republic of China
	Ministry of Commerce of the People's Republic of China
	State Administration of Taxation
	State Environmental Protection Administration of China
	State Administration For Industry & Commerce
	General Administration of Quality Supervision, Inspection and Quarantine
	State Grain Administration

Source: Law Concerning Testing for the Extensive Use of Ethanol

(b) Establishment of an ethanol production system

- The ethanol production capacities of the four designated companies (See Table 4-1) total 1,292,000 kiloliters. The following financial support is granted to these four businesses:

[20] This notice was jointly given on February 10, 2004 by eight government offices: the National Development and Reform Commission, the Ministry of Public Security, the Ministry of Finance, the Ministry of Commerce, the State Administration of Taxation, the State Environmental Protection Administration, the State Administration for Industry & Commerce and the General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China.

  - Refund of value added taxes (appreciation duties).
  - 5 percent consumption tax on ethanol is exempted.
  - Around 100 yuan of profit is guaranteed for each ton of ethanol.
- Food reserve subsidies can be granted by supplying food stocks on a preferential basis. Such subsidies are divided into halves, each of which is paid by the central and local governments. Stock food prices are determined by referencing market prices in each relevant area.

(c) Supplementary policies regarding adjustment, transportation and sales

- The selling price for E10 is calculated by multiplying the shipping price of the 90# gasoline published by the National Development and Reform Commission by a factor of 0.9111. The fluctuation range of the selling price is similar to that of the traditional gasoline.
- Any loss incurred as a result of adjustment, transportation or sales of E10 is covered by the government. A specific fixed amount of compensation is provided by the Ministry of Finance.
- Other specifics regarding transportation and sales activities are provided in accordance with SINOPEC's standards.[21]

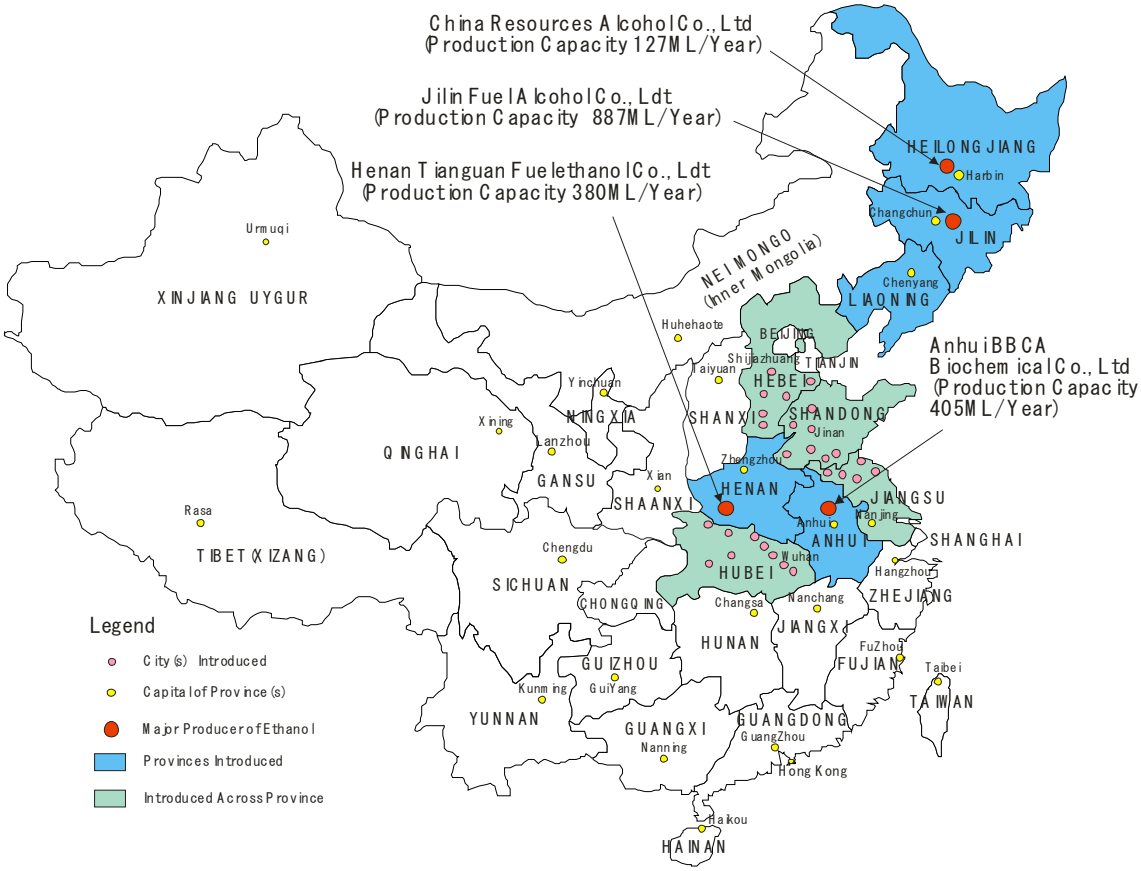
(d) Areas and terms

- In Heilongjiang, Jilin, Liaoning, Henan and Anhui Provinces, the E10 products had been made available throughout the regions by the end of 2005.[22] A phased introduction approach will be taken in six cities in Hebei Province, seven cities in Shandong Province, five cities in Jiangsu Province and nine cities in Hubei Province. No demand in the military sector or the national special stockpiles is covered by these regulations.

[21] *"Automobile bio-ethanol gasoline preparation oil"* (Q/SHR010-2001), *"(Oil depot design standards) Regulations concerning expansion of automobile bio-ethanol gasoline preparation facilities"* (SHQ003-2001), *"(Automobile oil/gas supply station design standards) Regulations concerning filling up of automobile ethanol blended gasoline*" (SHQ002-2001).

[22] Heilongjiang, Jilin, Liaoning, Henan and Anhui Provinces completed the total introduction on April 1, 2005.

Figure 3-1: Areas where E10 is used and its manufacturers (as planned for the end of 2005)



Note: Jilin Fuel Ethanol Company Ltd. has started its second phase construction. This company expects to ensure a production capacity of 887,000 kiloliters in the future.

Source: Different materials.

4. Ethanol Production Capacity Expansion Plan

The *Extensive Use Law* plans to ensure an annual ethanol production of 1,293,000 kiloliters. Specifically, 380,000 kiloliters per year for the first phase for Jilin Fuel Ethanol Company Ltd., 380,000 kiloliters per year for Henan Tian Guan Group, 405,000 kiloliters per year for Anhui Fengyuan Biochemical Company Ltd., and 127,000 kiloliters per year for Heilongjiang Huarun Alcohol Co., Ltd. Table 4-1 shows the specifics of production at each plant, along with its shipment destinations. At Jilin Fuel Ethanol Company Ltd., the second phase construction started on June 20, 2005 to expand its production capacity to around 887,000 kiloliters a year - the production of the ethanol that is used to produce the E10 will reach 1,799,000 kiloliters. This production scale is almost equivalent to the total consumption in the five provinces where total ethanol introduction is in place, which means only a nominal surplus can be

directed to the four provinces where E10 utilization is partially enforced.

Yet, expansion of production capacity is currently limited because maize and wheat are used to produce the E10 in an effort to consume stale food stocks. In addition, these four companies are receiving preferential treatment through the government's subsidy policy. This makes it difficult for them to expand their scale by using market mechanisms.

Table 4-1: Major Chinese ethanol manufacturers and their shipment destinations

Location	Company Name	Major Raw Material	Ethanol Production Capacity (10,000 k/year)	Supply Location	Supply Volume (10,000 k/year)
Heilongjiang - Zhaodong City	China Resources Alcohol Co., Ltd	Corn	12.7	Heilongjiang	12.7
Jilin - Jilin City	Jilin Fuel Ethanol Co., Ltd.	Corn	38.0	Jilin	12.7
				Liaoning	25.3
Henan - Nanyang City	Henan Tianguan Fuelethanol Co., Ltd.	Wheat	38.0	Henan	16.5
				Hubei (9 cities) ①	21.5
				Hebei (4 cities) ②	
Anhui - Bengbu City	Anhui BBCA Biochemical Co., Ltd.	Corn	40.5	Anhui	12.7
				Shandong (7 cities) ③	27.9
				Jiangsu (5 cities) ④	
				Hebei (2 cities) ⑤	
				Total	129.3

Note 1: Jilin Fuel Ethanol Company Ltd. started second phase construction (507,000 kiloliters) on June 20, 2005. Its production capacity is expected to reach 887,000 kiloliters per year eventually.
Note 2: Total implementation in Heilongjiang, Jilin, Liaoning, Henan, and Anhui Provinces.
Note 3: No demand in the military sector or the national special stockpiles is covered by these regulations.
Note 4: ①The nine cities in Hubei Province refer to Xiangfan, Jingmen, Suizhou, Xiaogan, Shiyan, Wuhan, Yichang, Huangshi and Ezhou.
②The four cities in Hebei Province refer to Shijiazhuang, Baoding, Xingtai and Handan.
③The seven cities in Shandong Province refer to Jinan, Heze, Zaozhuang, Linyi, Liaocheng, Jining and Tai'an.
④The five cities in Jiangsu Province refer to Xuzhou, Lianyugang, Huai'an, Yancheng and Suqian.
⑤The two cities in Hebei Province refer to Cangzhou and Hengshui.
Source: *"Law Concerning Testing for the Extensive Use of Bio-Ethanol Gasoline for Automobiles and Regulations Concerning the Conduct of Testing for the Extensive Use of Bio-Ethanol Gasoline for Automobiles"*.

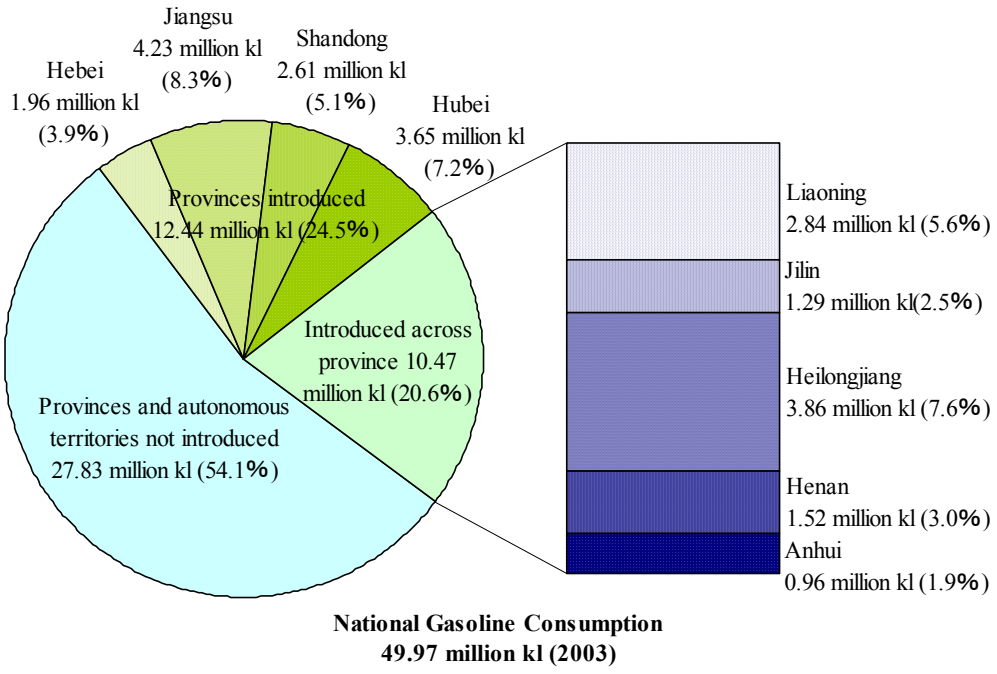
5. Impact of the Popularization of E10 on Chinese Society

The impact of the introduction of E10 includes reduced oil demand due to the replacement of gasoline, development of new industries, environmental improvements and the betterment of farmers' lives as a result of the government's agricultural policies.

Among them, the replacement of gasoline and development of new industries are considered to be particularly important.

As previously mentioned, the bio-fuel that China chose as the gasoline replacement is E10. China's nationwide gasoline consumption in 2003 was 49.97 million kiloliters. If we assume that the E10 gasoline is used to fulfill this entire demand, 4,997,000 kiloliters of ethanol will be required. The 2003 data for each province states that the total gasoline consumption in the five provinces where total introduction of E10 is in place was 10.47 million kiloliters, which accounted for 20.6 percent of the national total. In the four provinces where E10 utilization is partially enforced, the gasoline consumption amounted to 12.44 million kiloliters (24.5 percent). When these two sets of values are combined, nearly half of the total national gasoline consumption is covered, with a share of 45.2 percent (requiring approximately 2.29 million kiloliters of ethanol). In short, the introduction of E10 has the effect of mitigating gasoline consumption growth, while the important issue of ensuring ethanol supply remains unresolved.

Figure 5-1: Gasoline consumption in areas where E10 is used (2003)



Source: "*China Statistical Yearbook 2004 (First Edition)*", China Statistics Press, March 2005.

Another important impact to be mentioned here is the creation of new industries in China. Specifically, the following positive effects can be expected: (a) The development of ethanol-related industries boosts crop production, which promotes the

industrialization of the farming sector, which in turn produces an increase in farmers' revenue. In this way, the economic disparity is reduced between the agricultural districts and urban areas, an issue that has existed for some time. (b) Oil demand in the transportation sector is increased. (c) New employment opportunities are created in new industries. (d) Both state-of-the-art technologies and relevant industries are developed.

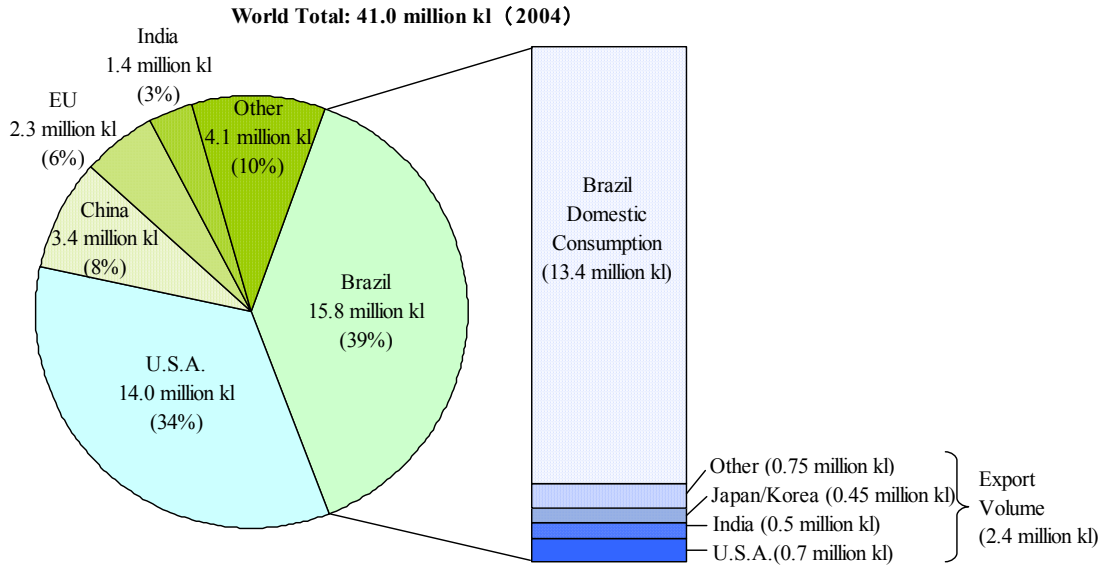
6. Future Developments and Issues

While total introduction of E10 in five provinces (Liaoning, Jilin, Heilongjiang, Henan and Anhui) and partial introduction in four provinces (Hebei, Jiangsu, Shandong and Hubei) are currently planned, each provincial government, under the pressure of skyrocketing oil prices, is studying the introduction of this gasoline product. The Hebei Province government announced on December 28, 2005 that it had finished establishing its bio-ethanol gasoline system covering the entire province. This province embarked on the total introduction of E10 earlier than previously planned. In Jiangsu, Shandong and Hubei Provinces, similar introduction systems are currently being finished on a gradual basis - a total introduction will be decided on once the ethanol supply is ensured. The fact that the administration of Beijing, Shanghai and Guangdong Province, where a large number of automobiles are owned, is considering introducing bio-ethanol gasoline endorses the prospect of more use of the gasoline products. This notwithstanding, a number of issues must be resolved before China can enjoy the widespread use of bio-ethanol gasoline in a satisfactory manner. Now, let us look at some of these issues.

6.1 Availability of imports

The global ethanol trade market in 2004 was still limited in terms of scale - the only country that had surplus ethanol to be exported was Brazil. This country produces 15.80 million kiloliters of ethanol, which accounts for 39 percent of the total global ethanol production of 41.00 million kiloliters in 2004. Brazil exports a total of 2.40 kiloliters of ethanol to the U.S. (700,000 kiloliters), India (500,000 kiloliters), Japan and South Korea (450,000 kiloliters in total) among others. While the Brazilian government regards China as a promising ethanol trading partner, Petróleo Brasileiro SA (Petrobras), a Brazilian public corporation, has already launched discussions with relevant Chinese representatives. Nevertheless, it will leave unresolved issues with regard to maintaining secure supply and national security to rely solely on Brazil when a competitive ethanol importation environment emerges as a result of growing demand in different countries.

Figure 6-1: Major ethanol production countries and Brazil's exports (2004)



Source: *"Brazil Maps Out an Ethanol Strategy"* on the website of the Institute of Energy Economics, Japan, July 2005.

6.2 Domestic food reserve adjustment

Ethanol production was expected to play a role in adjusting food stock volumes and alleviating financial burdens by effectively consuming accumulated food reserves. Recently, it has become increasingly difficult to allocate surplus food to ethanol production because such old food stocks have almost been used up. Therefore, it is now essential to use new foodstuffs to maintain ethanol production. New harvest procured from the market is priced higher than those old food stocks, which inevitably means a higher ethanol production cost. In addition, it is difficult to hold back production costs due to the higher moisture content in new foodstuffs. Taking these conditions into account, it can be safely said that the strategy of using ethanol production as a means to adjust food reserves does not work any longer.

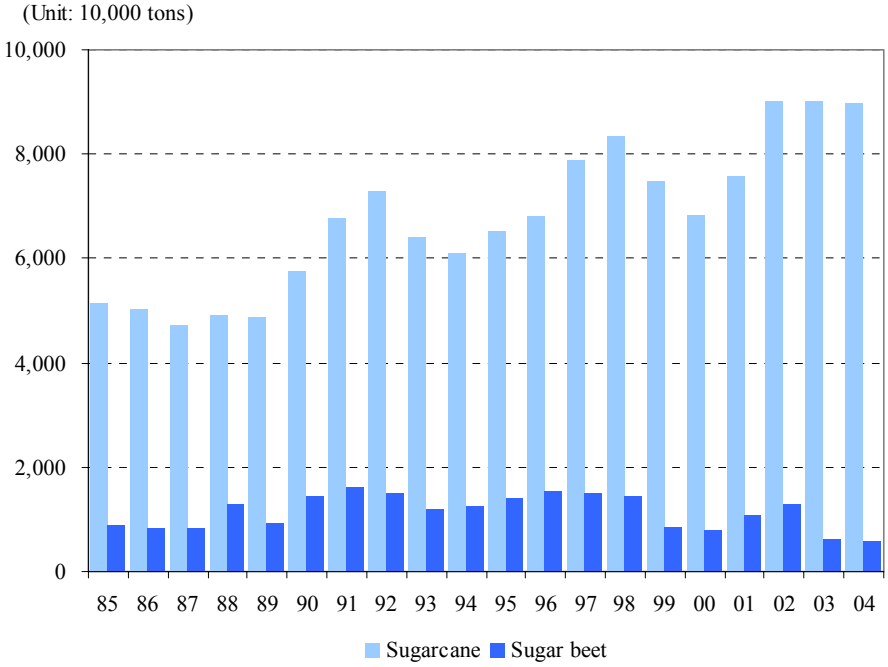
6.3 Challenges of expanding energy crop production

The Chinese government is seeking to procure alternative crops from which ethanol can be produced. An example of these efforts is cassava production consultation with the Laotian government. In January 2006, Henan Tian Guan Group, designated as an ethanol producing company, signed an agreement for the cassava[23] growing project in

[23] Cassava is a plant that belongs to the Euphorbiaceae family, with its origin in Northwestern Brazil and Western

Laos with the country's Committee for Planning and Investment. Henan Tian Guan Group invests 20 million yuan in this project to produce cassava on a 50,000 hectare farm (on a 60-year loan) in Khammouan in central Laos. During the first five years, imported cassavas will be processed into ethanol at the facilities of Henan Tian Guan Group in China. Laotian local production will take over these duties after the completion of local ethanol manufacturing plants in Laos, which is expected to create approximately 4,000 employment opportunities.

Figure 6.2: Changes in sugar cane / sugar beet production in China (1985 - 2004)



Source: "*China Statistical Yearbook 2005 (First Edition)*", China Statistics Press, September 2005.

Meanwhile, in China, Guangxi Academy of Agricultural Sciences, under the direction of the central government, is promoting its ethanol production program by expanding sugar cane rising in the Guangxi Zhuangzu autonomous district and Guangdong Province. Chinese sugar cane, however, grows well only in Guangdong Province and Guangxi Zhuangzu in Southern China. In addition, the sugar manufacturing industry is not positive about constructing ethanol production plants because China has a high domestic demand for sugar and depends on approximately one million tons of imported sugar each year. Furthermore, China has to improve breeds, develop production

Mexico. With a high proportion of starch content, this plant is very useful as food as well as livestock feed. It has been reported that in Asia, cultivation of this plant started in the 19th century. Cassava is one of the most popular foodstuffs in the Southeast Asian region, a good place for the plant to grow.

technologies and expand cultivation areas in a carefully planned manner to be able to convert sugar cane into ethanol. As the leader of an agricultural giant with approximately 800 million farmers, the Chinese government faces some of the most important pending problems: the "three A's"[24] issues and the ever-widening disparity between farming and urban populations as a result of economic growth. Therefore, it is important to promote an ethanol introduction policy that builds on energy crops as an integral part of an agriculture promotion policy package.

6.4 Limitations of the subsidy policy

Subsidies are granted in order to promote ethanol production. This means the more production grows, the stronger the financial pressure on the government. Therefore, amount of subsidies must be cut on a gradual basis. Since Henan Tian Guan Group currently uses not only food stocks but also wheat produced in the same year, ethanol production costs mount up, causing continued deficit. As stated earlier, Henan Tian Guan Group has already started growing cassava in Laos in an endeavor to seek new raw materials. The Chinese government continues to grant subsidies to the four designated ethanol production companies to support their ongoing businesses. At present, the selling prices of ethanol blended gasoline products are basically set on par with traditional gasoline. The profitability of the ethanol blended gasoline business showed some improvement due to the recent hike in gasoline sales prices caused by the appreciation of oil. Yet this business sits in front of formidable obstacles to overcome before it can establish itself as a market segment.

Conclusion

China's bio-ethanol gasoline introduction policy will have an enormous impact on the bio-fuel utilization policies in the East Asian region. Thailand has already started the production and sales of ethanol-based fuels made from sugar cane and cassava. Malaysia and Indonesia have announced their bio-diesel introduction roadmap. Therefore, if the Chinese government promotes further ethanol utilization, this will impact heavily on neighboring countries. Future developments are attracting public attention.

The results of the recent trial introduction led by the Chinese government have demonstrated the following substantial benefits of ethanol: (a) It can be used nationwide as an alternative energy source. (b) It utilized high and firm technologies. (c)

[24] The "three A's" refer to Agriculture, Agricultural villages and Agricultural population. The "three A's issues" refer to lower agricultural productivity, the sluggish economic/social development in agricultural villages, and low-income farmers, which impose restrictions on China's economic growth.

Environmental load is remarkably reduced because pollutant emission is reduced. (d) Higher values are added to agricultural produce through food processing. (e) New industries are expected to form. (f) Sustainable development is achieved with the support of recyclable energy systems. In reality, an enormous obstacle to overcome stands in the way of expanding ethanol production as previously arranged - when taking into account different domestic issues, including food supply security in this age of population explosion, rapidly growing gasoline consumption, ethanol price issues and poverty in the rural districts. In promoting ethanol mixed gasoline on a nationwide basis, one of the potential strategies may be to rely on imported ethanol. Given the fact, however, that international ethanol trading depends solely on Brazil; this supply system may not be stable. In studying future development, it may be important to determine when to expand the coverage areas while ensuring stable ethanol supply.

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<Terminology>

For the convenience of readers who wish to refer to the original proper nouns, some of the source materials are provided in Chinese. The Chinese words that appear in the text and their English equivalents are listed below.

乙醇	ethanol
酒精	alcohol
能源	energy
糧食	foodstuff
質量	quality