Overview of the biofuel sectors in selected Asian and Latin American Countries

Asia Latin-America Agri-Food Research Network (ALARN)

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In continuation to the previous booklet on the agricultural sectors of the Asian and Latin American countries*, this print covers the recent developments of the biofuel sectors in the same countries. Since 2007 there has been a growing concern on the role of biofuels in the energy matrix of countries, in the agricultural sectors and their impacts on the food prices and the environment. Amidst this discussion, these analysis papers were written by the experts in each country.

Although each country have biofuel sector in different stages of maturity, most are at the very initial stages. The governments are discussing the policies that should be adopted in order to motivate its development, often through incentives for the farmers to grow the feedstock and the millers to invest in the ethanol or biodiesel mills, as well as infrastructure investments. Therefore, it is also timely to analyze the experiences of other countries where policies helped or are helping to develop the whole sector and those that are not being effective or harming the environment, either directly or indirectly.

Often, the main drivers for a country to invest in biofuel production are increment the cleaner proportion of transportation fuel used in the country and to diversify and to increase value of farmers production and exports. Nonetheless, the ways to reach these objectives are not always so clear or easy to implement in different contexts. If the cost structure of producing the biofuel does not allow for the sale of biofuel at prices comparable to the gasoline or diesel fuel, in proportion to its energy content, then the sector will have a difficult time developing itself, without some kind of support. Yet if these support policies begin to favor the production of biofuel at the expense of benefiting other mechanisms for cutting GHG emissions or improving the sector of a specific crop, then the stakeholders may need to rethink the whole concept of the national biofuels sector.

This publication is the second result of the Asia Latin America Agri-Food Research Network (ALARN), made up of research institutions in China, India, Indonesia, Malaysia, the Philippines, Thailand, and Argentina, Brazil and Chile. The Institute for International Trade Negotiations (ICONE), funded by the William and Flora and Hewlett Foundation, coordinates its activities of this platform for the interaction of agricultural trade specialists in Latin America and Asia. More information on the network can be found at: www.iconebrasil.org.br/en.

We hope this booklet will shed some light on the stages of development in which the biofuel sector of these countries find themselves in and allow for more insight on the policies and initiatives taken by some countries to develop alternative fuels and help mitigate the harmful emissions.

Enjoy your reading!

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* The complete country papers of the nine countries are available at: www.iconebrasil.org.br/en
Biofuels production in Argentina. Main drivers

The purpose of this paper is to analyze the potential for biofuel production in Argentina, together with the related policies, as well as the challenges faced by the agricultural sector and the implications for the country's rural development.

The government interest on biofuels production in Argentina is relatively recent. For many years Argentina has been a net exporter of gas and oil, at very competitive prices, and therefore the production of biofuels did not receive much political support until very recently.

The drivers of Argentina’s current interest on biofuels production are:

- Economic issues
- Diversification of the energy supply matrix
- Environmental concerns

The economic factors are the main drivers, because they allow to diversify and to increase value of exports, and to increase local demand of agricultural goods for non traditional destinations. Argentina is already a relevant and competitive player in world trade of agricultural commodities and could also take advantage of the opportunity provided by the international scenario to increase the value of production and exports through biofuels processing, based on the country’s current large volumes of production of the main raw materials which could be used for biofuels production (oilseeds, corn, sorghum, sugar cane), and the great potential to increase the production of such crops in the near future, as well as the potential production of alternative sources of renewable energy. Currently most of the grains, oilseeds and oils produced in Argentina are been exported as commodities with little added value; therefore, biofuels are an alternative to diversy exports and to add local value.

In the domestic market biofuels contribute to diversify the destination of production and to reduce price variability of agricultural goods. In addition, in many regions -particularly in those which are distant from the ports and which have high transportation costs-, local processing of grains and oilseeds to produce biofuels for self consumption and to supply local energy demand is an interesting alternative to improve regional income, which could result in local job creation and regional economic development.

Diversification of the energy supply matrix. Argentina’s energy policy is now trying to diversify the energy matrix with alternatives to fossil fuels. Argentina faces a reduction of available reserves and, therefore, biofuels are relevant for energy security reasons. In recent years, the local supply of oil and gas did not grow enough to sustain the sharp increase in energy demand, associated with the high rates of economic growth registered in the country. During the 2000’s investment in the oil sector was very limited, resulting from domestic price controls and export taxes on oil and gas, which reduced incentives for research and development. As a result, in recent years Argentina limited its gas exports to Chile, and currently relies more on gas imports from Bolivia.

But the main deficit is in fuel-oil: Argentina became a net importer since 2006, at prices which are substantially higher than the controlled domestic market prices. Taking into account such difference, it could be expected a strong local demand of biodiesel, which will be over the minimum mandatory blends to be complied since 2010.

Environment concerns. Concerns about the negative impact of gas emissions, lead to establish regulations aimed to reduce such impact. The Biofuels Law 26.093 (2006) mandates minimum blends for gasoline and for fuel-oil since 2010. The environment problems in Argentina are less relevant than in other industrialized and emerging countries with high density of population; however, in recent years the local concern

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on climate change has raised, and this trend is expected to continue. Biofuels are one of the alternatives envisaged to reach a better carbon balance. Government areas responsible for environment and many NGOs are promoting substitution of fossil energy with biofuels, particularly in the cases in which biomass production does not imply deforestation.

**Policies for the development of biofuels market**

Fuels are highly taxed in Argentina, as they are in most of the countries. In 2001, the Presidential Decree 1396/01 decided that production and consumption of biodiesel was of “National Interest”, and established for a 10 year period a tax exemption for biodiesel consumption (the domestic tax on fuel oil) and for the biodiesel component of the blends with fuel-oil. It also established a special depreciation system for new plants built to increase the biodiesel storing capacity; and it exempted the biodiesel producers of the payment of the Advanced Minimum Income Tax, which was imposed to most firms in Argentina independently of their actual income. Such legislation created the first long term promotion environment for investment in biodiesel production in the country.

In 2004 the Secretary of Agriculture created the National Biofuels Program (Resolution 1156/04) destined to promote the production and consumption of biofuels, through studies, extension programs and cooperation with other national and provincial agencies. It does not involve economic incentives, neither special loans.

The Biofuels Law (Law 26.093) was passed in 2006. The Law and its regulatory Decree of 2007 regulate and promote the production and sustainable use of biofuels for a 15 year period. Biofuels included are ethanol, biodiesel and biogas produced with raw materials from agriculture, agro-industries and organic waste. The main provisions are:

- A 5% mandatory blend for gasoline (with bioethanol) and for fuel-oil (with biodiesel) consumed in the country, to be complied since 2010. Following the market developments, the Secretary of Energy can increase the blends; it can also reduce them in the event of proved scarcities of biofuels supplies.
- The amount of promotional benefits for investments in biofuel production is defined annually by the Congress in the Budget Law, and the incentives are provided to projects submitted by the firms to the Authorities. Projects are selected taking into account the following priorities: a) small and medium sized firms promotion; b) farmers promotion; c) regional development promotion.
- Incentives provided are: a) a reduced period to receive the return of the VAT paid for the investments destined to biofuels production, or a shorter period for the calculation of depreciations for Income Tax payment; b) tax exemptions on taxes applied to other fossil fuels destined to domestic consumption; c) investment destined to biofuel production is not included in the calculation of the Advanced Minimum Income Tax paid by the firms.

However, the most important incentive for biofuel production destined for export currently available in Argentina is the differential export tax on vegetable oil and on biodiesel. Taxes on exports of soybean oil are currently 32% of the FOB value, while the biodiesel pays 20% export tax. Such difference implies that biodiesel producers can purchase the raw material in the domestic market 32% cheaper than the FOB price, and they receive for the product (biodiesel) 20% less than the FOB price. Such difference is a strong incentive to build biodiesel plants for export, and is having a relevant impact on current investment in the sector.

It should be noted that price controls currently applied by the government to fossil fuels destined to the domestic market are a strong disincentive for biofuel production destined for domestic consumption (fossil fuels are very low priced in Argentina when compared with most of the countries in the world).

The market regulations are decided by Ministerial short term decisions, the same as taxation on different inputs and products of the biofuels chain. Therefore, the main elements of the economic incentives (context) to decide investments on biofuels production are not regulated by the Law, except the mandatory blends to be complied since 2010.

**Production**

**Main raw material production and potential growth**

Argentina has a huge potential for biofuels production at very competitive international prices, based on its current large soybean, corn, sorghum and sunflower seed production. Most of such production is exported as primary commodities, or as vegetable oil and protein meals; therefore they provide an immediate opportunity to produce biofuels. Table 1 shows current production (2004-2006) and estimates on potential growth of the main cereals and oilseeds. Cereals and oilseeds production can grow near 40 million tons in one decade, based on increases in area planted and in productivity, allowing sharp increases in both food and fuel exports.

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2. The carbon balance in Argentina for the main crops (soybean, corn, sugar) is better than in the USA and other developed countries, because Argentine crops use less fertilizers and most of the area is based on no till plantings.
Such estimates include the area which is currently with natural pasture and forests and could be devoted to crop production compatible with a long term sustainable strategy (maximum in Alternative 2). Currently Argentina exports around 7 million tons of vegetable oils (mainly soybean oil and sunflower oil) which could be easily processed to be exported as biodiesel. The tax incentives have had an important impact on biodiesel production and exports during 2007 and 2008; in 2006 there were no biodiesel exports, and it is estimated that such exports could reach 1 million tons in 2008.

Argentina exports around 15 million tons of corn, which could also be destined for ethanol production and exports. However this has not been the case, because the differential export taxes are only 5% in the case corn and bio-ethanol.

### Table 1. Area Planted, Yields and Production Projections for Main Annual Crops

<table>
<thead>
<tr>
<th>Crops</th>
<th>Area (million ha)</th>
<th>Yields (ton / ha)</th>
<th>Production (million ton)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soybean</td>
<td>14.76</td>
<td>19.1</td>
<td>31.46</td>
</tr>
<tr>
<td>Sunflower</td>
<td>2.03</td>
<td>2.3</td>
<td>2.12</td>
</tr>
<tr>
<td>Wheat</td>
<td>5.84</td>
<td>6.3</td>
<td>6.05</td>
</tr>
<tr>
<td>Corn</td>
<td>3.19</td>
<td>6.1</td>
<td>3.34</td>
</tr>
<tr>
<td>Sorghum</td>
<td>0.58</td>
<td>0.7</td>
<td>0.63</td>
</tr>
<tr>
<td>Others</td>
<td>2.80</td>
<td>2.8</td>
<td>2.8</td>
</tr>
<tr>
<td>TOTAL</td>
<td>29.2</td>
<td>37.3</td>
<td>46.4</td>
</tr>
</tbody>
</table>


Argentina is also a competitive producer and exporter of sugar. Currently most of the sugar cane production is destined for sugar production. Only a minor percentage of the crop is used for ethanol production. Despite the country has also an important potential for the expansion of sugar cane production, most of the areas with high productivity are located distant to the ports, and therefore they have disadvantages for exports vis a vis other raw materials (like corn and sorghum) and other competitive countries, like Brazil. Currently, investment projects for ethanol production in the North-Western provinces are being implemented, where sugar cane is produced with high yields. However it could be anticipated that such production will be mainly destined to the regional biofuel domestic market.

Argentina has also a large area with natural forests and with planted forests. Some of such production is destined for energy production (mainly coal and wood for traditional energy local consumption). Such resources, as well as some byproducts not commercially used by the wood industry, provide interesting opportunities for diversification of future bioenergy and biofuels production, particularly if R&D is successful in the development of more efficient systems to process the biomass. Similar comments could be done for the development of alternatives for the production of bioenergy from grass and other non traditional sources (jatropha, safflower, and castor) which are now being tested for areas with low productivity for cereals and oilseeds.

Despite the potential mentioned before, biofuels production in Argentina has been very little until 2007 (there was no significant production), because the domestic prices of fossil fuels have been controlled since 2002, and the international growth in fuel prices did not impact substantially in the local market. It should also be noted that the new regulation destined to promote production of biofuels was only available in 2007, and is limited to small or medium sized initiatives. Therefore, until 2008 there have not been economic incentives to produce biofuels destined to local consumption. During the last five years there has been only some minor investment in small plants built by farmers and/or coops for self or for local consumption, which are still not significant in total supply of fuels.

However, in 2007 begun a strong process of investment in biodiesel plants located at the ports in the Rosario area, where is also based most of the oilseed crushing capacity. Such investments involve some of the main large crushing and oil companies operating in Argentina, and they are mainly destined for export.

Most of the potential production of biofuels in Argentina could be destined for exports. The 5% minimum blend mandated for domestic consumption in 2010 in the case of biodiesel will require around 3.5 million tons of soybeans, which is only 7-8% of current soybean production (in recent years more than 90% of soybean production was destined to export grains and byproducts). In the case of ethanol, the 5% minimum mandated blend for domestic consumption implies only 2.5% of current corn production.

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3. Argentina is the largest exporter of both vegetable oils.
Production structure and costs

The Argentine farms are relatively large when compared with most of the competitors. And the concentration process of farm properties has been significant during the last 20 years. Average size of small farms was around 107 hectares per unit in 2002, they controlled only 20% of total production and they represented 66% of the number of total farms. There is also a large share of medium sized farms. Most of small and medium sized farms producing cereals and oilseeds use improved technologies, because otherwise they cannot survive to competition (the government does not support agriculture in Argentina; PSE’s are negative).

It should be noted that a high percentage of the land, particularly of the small farms, is rented to other larger farmers and also to “production pools” involving large investors. More than 60% of production of cereals and oilseeds is concentrated in large farms implementing modern management and “state-of-the-art” technology, resulting in very cost effective production systems. Also medium sized and small farms adopt rapidly innovations (improved seeds, fertilizers, no till practices, etc.).

Argentine production has comparative advantages (natural resources, short distances to ports, relatively low salaries), and has developed competitive advantages, not only at the primary level but also in the manufacturing and export. Argentina has the most modern and largest oilseeds crushing plants in the world; most of them located at the ports. Crushing costs are very low in Argentina. As a result of such competitive advantages, the raw materials for biofuels production are cheap when compared to other countries. In addition, taxation on exports of grain, oilseeds and its byproducts leads to lower domestic prices for such raw materials, providing additional cost advantages for biofuel producers, particularly in the case of biodiesel as it has been already mentioned.

Impacts on country’s rural development

The increasing international demand of biofuels is very favorable for Argentine farmers producing cereals and oilseeds, because it has improved world prices and provides a diversified source of demand for the raw materials. Since Argentina has a high potential to increase the production of such goods, the existence of a dynamic market provides a bright scenario, particularly for the main extensive annual crops produced in the Pampean Region, which are also expanding to the Northern Provinces. Sugar producers, which involve a large number of small farms in the North Western provinces, also benefit from the increased demand of biofuels.

The Biofuels Law is still very recent. The regulatory Decree was published in February 2007, and many of the provisions were not defined until the end of such year. The Law is aimed to promote the association of farmers for biofuel production, and this could be particularly relevant for future development of regional initiatives to produce raw materials destined to produce biofuels and other byproducts, and to consume them locally for energy and for feed purposes. The promotional benefits will give priority to projects submitted by farmers, small firms and regional development initiatives; and they could eventually create better conditions for regional production of biofuels.

Regional production of some raw materials (grains, oilseeds) is strongly affected by export taxes, because transportation costs have high impacts on feedstuffs produced in areas distant to the ports. For such reason, regional prices of raw materials are relatively low and provide the opportunity to add local value through biofuel production, also for regional consumption.

The two mentioned advantages, lower regional prices of raw materials and the promotional benefits, could be a good base for local development of biofuels and other livestock complementary productions. However, the final outcome should result from the balance between those advantages and the negative impact on the income of biofuel producers of domestic price controls for gasoline and fuel-oil.

It is hard to anticipate which will be the future policy on fuel domestic prices, which have been almost frozen by the government during the last 5 years. It is particularly special the case of the fuel-oil, because the country consumes a lot of such fuel compared to gasoline (most of the trucks and many cars use fuel-oil), and since 2006 Argentina became a net importer of fuel-oil. Larger imports of such fuel will imply high government subsidies to maintain low domestic prices.

It has been highlighted that the most dynamic biofuel production in Argentina is currently the production of biodiesel destined to export, taking the advantage of the differential export taxes along the value chain. The main investment initiatives involve large processing firms located at the ports, which benefit from economies of scale. In this case, the benefits for the farm sector are the diversified and increased demand in the oilseeds domestic market, assuming that the improved purchasing power of processors and traders result in better prices paid to farmers.

Non traditional sources for biofuels involve intensive crops like jatropha and castor. Such crops could be an alternative for current productions of small farmers located in less developed areas in the North and West of the country. They could eventually help to diversify production and

4. The impact of transportation costs is very high for distant areas because prices have huge discounts at the port level (export taxes are on FOB prices), while other kind of taxation refer to local prices.

5. Government interventions, changing permanently the rules of the game related to export taxes and export quantitative restrictions, result in a poor performance of the markets and increased transaction costs. Therefore the benefits for biodiesel exporters not necessarily will result in improved prices for farmers.
reliance on other intensive crops produced by small farms. However, such alternatives need more R&D and other regional development initiatives required to implement successful integrated models involving production of raw materials, and production and consumption of biofuels.

**Challenges faced by the sector**

Most of Argentina's extensive crop production is based on rainfall. Therefore water irrigation availability is not a restriction for current cereals and oilseeds production systems. Increased production of such goods will result from improved productivity and increase in area planted.

Argentina still has pastureland and some natural forest land which has low productivity and could be devoted to crops. Most of this land is located in the North West and the North East of Argentina; but not in the Pampenan Region, where most of the high quality land is already under crop rotations. Planted area with annual extensive crops is around 30 million hectares. Studies conducted on potential increase in area planted mention that it could raise to around 40 to 45 million hectares. Some of the additional areas are less productive (soil and water restrictions for production based on rainfall), and therefore expected average yields in such areas is lower than in the Pampenan Region.

Increase in productivity is the long term main challenge for agriculture growth. Innovations have been very relevant during the last two decades, based on biotechnology and other seeds improvements, a more intensive and effective use of fertilizers and chemicals, and better machinery, including no tilling practices and precision agriculture. There is a real challenge to continue improving productivity through new varieties, better adapted to biotic and non-biotic stresses, and more intensive and cost effective practices. Argentina needs to invest more in public R&D in agriculture, to develop regional and international networks, and needs to improve the environment to promote private investment in R&D in the sector.

It should be also noted that current agricultural policies limit production growth through export taxes, through government intervention on domestic prices, and through quantitative export restrictions, aimed to reduce inflation and the impact of the increase of world prices on domestic food prices. Most of the increases in world prices registered in 2007-2008 were not received by Argentine farmers, because export taxes were raised and export restrictions were implemented; therefore the farmers do not have strong incentives to increase production according to the international situation. Actually, the current productivity increases in the main extensive crops just continue the trends reached during the 1990s. Despite Argentina is losing the market opportunity provided by the international scenario, the increases in productivity during the last decade have been significant, and will allow the continued expansion of cereals and oilseeds production, as stated in Table 1.

Another major challenge for biofuels production is the stability of the commercial policy framework. The tariff escalation policy for feed stuffs and biofuels is subject to short term decisions: export taxes are established through Ministerial Resolutions, which can change at any moment. Such context is very much uncertain, and limits long term investment decisions. Argentina needs to revise such strategy, which is very effective to raise national government revenues, but it creates a very uncertain context for long term private decisions, and violates the spirit of the Constitution which states that taxation is a matter of the Congress.

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6. Some of such rotations involve pastures for livestock production, but it is hard to anticipate that the area planted annually in the Pampenan Region will increase significantly.

7. In the case of beef and dairy productions, which are not a subject of this study, production declined in the last year.
Strategies for engaging in biofuels production

The main objective of developing the ethanol sector in Brazil has been to supply the domestic market (as a fuel substitute for petroleum). In its early stages, facing the first oil price shock, the federal ethanol program (Pró-álcool) was a key element in the import substitution development strategy. At the same time, it would supply the domestic market, save scarce foreign resources and allow the automobile sector to maintain its growth, pushing up national production. More recently though, Brazil has discovered several oil fields that, together with ethanol production, allowed Brazil to become self-sufficient in fuel resources. Therefore ethanol has served as a source of foreign revenues through exports and allowed for a reduction in Green-House-Gas (GHG) emission, as well as other harmful emissions. Rural development has never been central to the plans of developing the sector, perhaps due to the difficulty in involving small family farms in the sugarcane production chain.

When the Proalcool program was being developed, international oil prices were increasing and government economic planners looked for alternative sources of fuel that would allow Brazil to become less dependent on foreign suppliers. The large availability of sugarcane, together with the effective initial technologies developed for producing ethanol, gave way to the policies aiming at creating an ethanol sector. Additionally, the saturation of the domestic market, and international market, of sugar made the millers seek alternative products to sell.

In the 1990's, ethanol production was seen as a way to generate additional revenues to the mills and electricity through the burning of the bagasse. By the late 1990's, more effort was made to export ethanol as a way to expand the market, when other nations (mainly the US) began to demand ethanol as a fuel additive. Before that, other nations did not see the full benefits of engaging in ethanol production, therefore there were no foreign markets for Brazilian ethanol. Similarly, it was only with the growing international concern of global warming and the transportation sector’s GHG emission that ethanol began to attract attention as an environmentally-friendly fuel.

Over recent years, there has been a greater use of bagasse to generate electricity in furnaces, thereby reducing electricity costs of the mills and allowing them to sell electricity to the national grid. With improving technologies available and growing scarcity of electricity in Brazil, cogeneration has become essential to the development of the sector, though logistical and pricing problems exist. Besides using the bagasse for producing electricity for the mills’ own use, new technologies of enzymatic hydrolysis allow mills to convert the bagasse into ethanol, thereby allowing for greater expansion in ethanol production.

Farmer integration through ethanol production does not really take place, rather more jobs are created, especially better paying jobs. The already well-established sector which underwent consolidation throughout the 1990's makes it difficult to incorporate small farms or mills. The sugar mills need to organize their suppliers of sugarcane in order to have a steady flow of feedstock, with optimum sugar content, in order to have continuous ethanol production. This coordination becomes complex since they need to instruct farmers when to plant and to harvest the cane, which may not coincide with the agenda of the farmers. The legal and administrative costs of having contracts with cane suppliers sometimes makes it better for the mills to rent the land and grow the cane themselves.

On the other hand, bio-diesel production has been planned with the small producers in mind, integrating family farms in poorer regions where the feedstock (Jatropha, rapeseed, soybeans, etc.) are most grown. Economists, however, question the effectiveness of such policies, arguing that if the objective is to achieve large scale, logistic difficulties and high costs will turn biodiesel into an economically unsustainable and unstable fuel.

Policies for the development of biofuels market

Brazilian policies aimed at developing a large scale ethanol sector began in 1975 with the PROÁLCOOL I. The legislation was implemented to encourage sugar mills to produce ethanol, increase investments in new mills, standards for the ethanol to be used as a gasoline additive

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During the second-half of the 1980’s, measures were taken to remove government participation in the planning and coordination of the sugar/ethanol sector. The Instituto do Açúcar e do Álcool (IAA), which offered technical support to the government department responsible for implementing the PROALCOOL program, was closed in 1990, i.e. there was no more government intervention. And so, sugar and ethanol prices are currently determined by market forces. In the late 80s due to a combination of high sugar prices, and political choices, ethanol shortage at the pump brought discredit to the national fuel and E100 car sales fell dramatically, turning the consumption of hydrous ethanol as a residue of total consumption in the 90s. By 1999, the price of ethanol no longer needed support, in order to remain economically viable in the market. Currently the required blending into regular gasoline varies between 20% and 25%, depending on the market price of the ethanol in Brazil.

In the case of biodiesel, a legislation (Lei 11.097/05) was passed in January of 2005 which required the mixture of 2% (3% optional) of biodiesel into regular diesel from 2008 onwards, which will be raised to 3% in July 2008 (5% optional). This legislation also specifies the product standards to be followed by the biodiesel producers, as well as market structure for the biodiesel market. The government buys biodiesel in public auctions, organized by the ANP (Agência Nacional de Petróleo e Biocombustíveis), which are then distributed to the gas stations. The auction system guarantees that the producer will sell the biofuel, however the main barrier remains: being able to purchase the feedstock at reasonable prices in order to produce the biodiesel at economically viable costs.

A special taxation applies for biodiesel, with different levels according to the type of feedstock used, its region and the type of producer. While the general taxation (according to Decreto N° 5.297/05) is R$ 218/m³ of PIS/PASEP and COFINS, the same taxes are R$ 115 for biodiesel made from castor seed in the North-East, and R$ 70 for the biodiesel made from feedstock supplied by family farms (belonging to the PRONAF program). Nonetheless, in practice it meant that only 3.6% of vegetable oil production benefited from these tax reductions in the last auction.

Production

In Brazil, sugarcane is the feedstock used for making ethanol. Even though different options were exhaustively tested in the 1973-79 period, it was found that sugarcane produced the highest yields of ethanol per hectare and was most economically viable, though political pressure also influenced the final decision. The large quantities available of sugarcane, ease of harvesting, together with its high energy content, helped determine it as the feedstock to be used, on a large scale, in the Proalcool program. In Brazil, sugarcane is harvested manually and by machinery on different proportions depending on the mill and its location. In the dynamic regions of sugarcane production, manual harvesting is only partially used since machinery is increasingly being used. For the manual harvesters (boia-fria) to collect the cane, the plantations must often be strategically burned before harvesting in order to remove leaves and poisonous animals that threaten workers’ safety. Nevertheless, burning brings serious environmental impacts both by its air pollution in near villages and GHG emissions.

In the case of biodiesel, several alternatives are available such as Jatropha, cottonseeds, soybeans, rapeseed, and castor seeds. Even though some are more productive than others, the feedstock used for producing biodiesel depends on the geographic location, agro climatic conditions, and, more recently, the tax exemptions offered for biodiesel made from different feedstock.

There are two main regions for sugarcane production: Center-South and the North-east. While the former uses much irrigation, the latter is closer to the consumers market and so has developed itself faster. The current sugarcane production capacity stands at around 424 million tons, most of it being located at the center-south regions, particularly in the state of São Paulo (nearly 270 millions tons). In order to estimate the production capacity in the coming years, one needs to consider the expansion of land dedicated to sugarcane plantation, as well as the investments to be made in the construction of new sugar mills.

The sugarcane production has grown steadily since 2001/02, after experiencing a fall in the previous year, going from 293 million tonnes in 2001/02 to 475.1 million tonnes in 2007/08 harvest, an annual growth rate of 7.7%. The area used for sugarcane grew from 4.80 million hectares in 2000 to 6.92 million hectares in 2007, i.e. an annual growth rate of 4.2%. The national productivity level rose from 67.8 tonnes per hectare to 74.4 tonnes per hectare. The ethanol production grew from 10,593 million liters in 2000 to 20,883 million liters in 2007, i.e. an annual growth rate of 9.5%.

Forecasts point to a growth in area of sugarcane of 7.97 million hectares in 2010 and 9.29 million hectares in 2015 (CONAB), with production of 565 million tonnes and 691 million tonnes, respectively. Ethanol production should rise to 25,347 million liters in 2010 and 35,550 million liters by 2015. Estimates point to annual ethanol exports of 5 billion liters by 2015 (MAPA cadeia produtiva 2007).

In 1987 two varieties of sugarcane represented 60% of sugarcane grown while in 2003/04 there were over 500 varieties, though 20 represented...
80% of sugarcane grown. These new varieties each contain specific characteristics, which allow farmers to optimize the allocation of specific varieties that results in maximum production, and lower costs.

Biodiesel production capacity has been estimated at 2.18 billion liters in 2007, from 736 million liters in 2005/06 (ANP). Although this is an impressive annual growth rate, the market remains small. Authorized production capacity is much higher than effective capacity.

According to the 1995/96 Census, 47.1% of sugarcane was grown by medium size farms, i.e. between 200 and 2000 hectares. The large farms with over 2000 hectares represented 33.1% while small producers represented 19.8%. The sugar mills have tended to rent the lands located near to them in order to grow the sugarcane themselves, eg. 70% of sugarcane production came from land belonging to the mills. This has been especially the case in Sao Paulo, where most land owners rent their land to the mills and use the money to purchase land elsewhere, or invest it in other sectors.

In the case of biodiesel, the producers of the feedstock, with the exception of soybeans, are small farms. Soybean growers are mostly medium sized farms, with 43.7% between 200 and 2000 hectares, while small farms (up to 200 hectares) represent 34.4% and large farms (over 2000 hectares) are 21.9%.

The cost structure of producing ethanol in Brazil varies according to the region, therefore we use data for Sao Paulo, the state with the highest consumption. In one calculation, the sugarcane feedstock cost is around R$ 0.47 per liter of ethanol, the mill processing stage is R$ 0.26 per liter, while distribution and profit margin stands at around R$ 0.24 per liter, while the ICMS tax is R$ 0.14, giving a final price of R$ 1.30 (see annex).

The cost of the vegetable oil is the biggest component of the biodiesel cost structure, representing on average 85% of final cost. And so it is important to choose the feedstock to be used that will guarantee a significant amount of oil at reasonable prices. The oscillation of the international price of vegetable oils impacts directly on the price of the biodiesel, which can make it economically unviable to produce.

Although the production cost of biodiesel varies significantly depending on the vegetable oil used, the average cost has fallen since 2004, mainly due to the fall in vegetable oils prices. Depending on the vegetable oil used, the production costs are under or above the stipulated price at the public auctions. Since the sellers need to meet social criteria in order to participate in the auctions, where their product are exempt from taxes, they have to purchase feedstock from economically under-developed regions, where castor seeds or palm fruit prices tend to be slightly higher. This dilemma has resulted in a situation where there are insufficient suppliers of biodiesel that meet the social criteria and so this requirement has been removed from the latest auction held in March 2008. See Annex below with the average cost of production and margins for producers for three types of feedstock.

**Impacts on country’s rural development**

It is questionable whether the growth of the ethanol sector contributed to the integration of farmers to the industry, especially in the case of small farmers. As stated above, it is difficult for small farmers to participate in the sector due to the developed stage in which the sector finds itself in. Small producers as suppliers are considered costly for the mills due to the bureaucratic and legal costs associated with the contracts needed. Therefore, only medium to large property owners with a relatively significant amount of sugarcane production become direct suppliers to the mills. An important figure is that mechanical harvesting is growing fast. The initial federal initiative (1999) was to banish all field burnings by 2021 in flat terrains and 2031 in the other areas (with uneven topology). Last year these deadlines where reduced in the state of Sao Paulo to 2014 and 2017, respectively. Aiming to improve the sector’s social image, and due to the lower costs (lower labor costs), the millers accelerated the process of mechanization, which accounts for 36% in Brazil and 45% of harvested areas in Sao Paulo in 2007/08. The social impact is that it improves their working conditions and wages. Nevertheless, much unemployment of low skilled human resources will occur and these need to be absorbed by other activities on the fields or in the cities through migration.

On the other hand, the government’s plans for the biodiesel sector include small producers, thereby integrating family farms in poorer regions where the feedstock are most grown. A social seal (Selo Combustivel Social) was created to identify biodiesel producers who purchased their feedstock from small family farms and offered technical training to the farmers. This seal is necessary to get tax exemptions and access to financing at special rates.

In 2007, 37% of Brazilian biodiesel was produced in the north-east, one of the poorest regions of the country, where some of the biodiesel feedstock are grown, such as castor seeds, cottonseed and soybeans.

Some small farmers increasingly want to take part in the processing stage of oilseeds in order to benefit from the margins involved and the opportunities of selling the by-products to other sectors. The falling costs of small-scale distilleries together with the expectations of a growing market for vegetable oils and biodiesel encourages the small farmers to invest in this area.

**Challenges faced by the sector**

Sugarcane is harvested manually for around half of the quantities collected, especially in the South-east. There is some controversy surrounding this. On the one hand, manual harvesting creates temporary jobs for lots of workers (called boia-fria), the labor conditions are very arduous and
several NGO’s criticize their working conditions, on the other hand, there are air pollution problems associated with burning the leaves prior to harvesting. Mechanical harvesting increases efficiency however may increase initial costs due to the expensive machinery needed.

Water resource is not an issue in sugarcane production because almost all fields rely on rainfall. However, recent studies show the significant increase in productivity of using irrigation systems which may lead to an increase in irrigation equipment use in the future, thereby increasing the use of water. Nevertheless irrigation costs are still expensive related to non-irrigated fields. In the case of biodiesel, most vegetable oils also use rainwater and not irrigation systems.

In the biodiesel sector, one challenge faced is the choice of feedstock that is most energy/economically efficient and that achieves the government’s plans to develop the poorer rural sectors of the country. Production of castor seeds (grown by small farmers in the Northeast) is insufficient to meet the needs of the biodiesel plants and involve logistical challenges.

The large availability of land available for agricultural expansion in Brazil, whether in open pastures or degraded lands, means that the growth in sugarcane production does not necessarily compete with food commodities. Unlike in the US and in Europe, ethanol production in Brazil does not compete with food production, as shown by the fact that production has grown annually at 3.8% for sugarcane, corn, soybeans and cotton between 2000 and 2008 in Brazil. However in the US, soybeans and wheat have grown during the same period while corn (for grains) and cotton have fallen. In the EU only rapeseed grew while the production of other grains fell. The sugarcane expansion in Brazil is occurring mainly in the state of Sao Paulo, Goais, Mato Grosso, Mato Grosso do Sul, and so some farmers are growing other crops such as soybeans, cotton, and corn further north in the states of Goias and Mato Grosso. Some blame this trend on the movement of farmers up north to the Amazon biome, which threaten the forest. However, the wood cutters are the first to invade the northern territory, followed by the cattle ranchers who use these cheap lands to fatten their herd. The lack of legislation prohibiting the appropriation of devastated lands makes it very challenging to control this movement in the Amazon region. Nonetheless, sugarcane cannot be directly blamed since even though it can be grown in the regions bordering the south of the Amazon, its sugar content is low which makes it economically unviable to produce.

In terms of creating a global ethanol market, Brazil faces key challenges: lack of guarantee of supply of the biofuel to distant foreign markets, such as Japan; if petroleum prices fall the ethanol becomes less competitive; protective measures by developed countries such as the US and the EU; and the lack of empirical studies that show the positive effect on climate change from using ethanol.

In the case of biodiesel, land availability is even less of a concern because the feedstock used comes mainly from already existing production. In the case of soybean oil, the concern is whether competition with its use as food may drive up prices and negatively impact consumers. With Brazil’s significant production of soybeans the most likely impact is a shift from exports of the oil to domestic biodiesel production. As for the other feedstock, their production can grow with demand, as in the case of castor seed, or they are by-products of another production, as in cottonseed.

Annex

Sugarcane varieties:

In 1987 there were six varieties of sugarcane, two of which represent 58% of all sugarcane grown. By 2007, there were 500 varieties. Each type contains specific characteristics. There are four centers for the development of new varieties of sugarcane in Brazil, two of which (the Centro de Tecnologia Canavieira – CTC and Allelyx) are private entities financed by the private sector. There are over 500 varieties of cane, though 20 of these occupy over 80% of the harvested area. The specific use of varieties according to land characteristics has resulted in higher yields, as can be seen in the national average of 74.4 tons per hectare in 2005/06, compared to 53 tons per hectare in 1977/78. It should be noted that productivity is higher in Sao Paulo: 81.9 tons per hectare in 2005/06, in comparison to 66 tons per hectare in 1977/78.

HBio:

Petrobrás developed the H-Bio, a special diesel with better quality, made through a procedure which incorporates hydrogen with the vegetable oil, thereby reducing the chemical by-products normally released, though its GHG emission remains the same as mineral diesel. Currently the company is improving its production process in order to become economically viable. It can be expected that this will increase the use of vegetable oils in making biodiesel in the future.

Cost structure in ethanol production:

In the State of Sao Paulo we have the following average cost structure for ethanol production:

2. However there in some areas it is a sensitive issue, such as in Lucas do Rio Verde county (Mato Grosso), legislation was passed prohibiting the growth of sugarcane which was substituting the plantations of other foods and causing social impacts in the regions.
Cost structure in biodiesel production:

The tables below show the average costs related to producing biodiesel from three different feedstocks. The production costs of biodiesel were taken from a study done by Unicamp (2006) which uses the data for 2005 from different regions for each feedstock. The proportional costs of each stage are taken to be the national average percentage of each stage of biodiesel production. The prices of the auction are those of the first auction done on November 2005.

<table>
<thead>
<tr>
<th>MINIMUM</th>
<th>R$ per liter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost feedstock</td>
<td>0,469</td>
</tr>
<tr>
<td>Cost processing mill</td>
<td>0,261</td>
</tr>
<tr>
<td>Cost mill gate</td>
<td>0,730</td>
</tr>
<tr>
<td>Distribution cost, margin</td>
<td>0,241</td>
</tr>
<tr>
<td>Revenue of mill</td>
<td>0,971</td>
</tr>
<tr>
<td>Price gross</td>
<td>1,165</td>
</tr>
<tr>
<td>Taxes (ICMS)</td>
<td>0,140</td>
</tr>
<tr>
<td>Price at the pump</td>
<td>1,305</td>
</tr>
</tbody>
</table>

Source: Pedro de Assys (2006)

Small farmers participation in the vegetable oil sector:

Small oilseed producers in Brazil have a small participation in the oil feedstock sector. In the case of soybeans and castor seeds, they sell their produce to middlemen (called atravessadores) who purchase from many farmers and sell them on to the processing plants, who then sell the vegetable oil to other firms or traders for exporting. These middlemen have some control over the small suppliers in that they determine the market price and offer informal financing in advance which is deducted from the price of the harvested seeds. In the case of soybeans, there is a large supply of feedstock grown and the potential for expansion is large. However, due to the scale of production, small farmers are increasingly put under pressure to supply soybeans in larger quantities.

<table>
<thead>
<tr>
<th>MAXIMUM</th>
<th>R$ per liter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost vegetable oil</td>
<td>0.8</td>
</tr>
<tr>
<td>Cost ethanol/methanol</td>
<td>0.098</td>
</tr>
<tr>
<td>Cost processing</td>
<td>0.059</td>
</tr>
<tr>
<td>Max. Cost at mill gate /R$ per liter</td>
<td>0.98</td>
</tr>
<tr>
<td>Distribution cost; margin</td>
<td>0.08</td>
</tr>
<tr>
<td>Price at auction (B100) *</td>
<td>1.90</td>
</tr>
<tr>
<td>Production cost</td>
<td>0.76</td>
</tr>
<tr>
<td>Taxes applied</td>
<td>0.218</td>
</tr>
<tr>
<td>Net Profit/ Loss</td>
<td>0.92</td>
</tr>
</tbody>
</table>

Source: Unicamp, 2006; Rabobank (2006).
Objectives and strategies of current government policy

The government of Chile has moved relatively slowly in developing a concrete biofuel policy. While early in her administration President Bachelet made commitments to diversify the country's energy sources, a coherent regulatory framework has yet to be implemented that would promote renewable fuel sources. The primary strategic objective argued for Chile’s participation in biofuel production has been to diversify the supply of fuels to the domestic market. Currently the country imports almost all petroleum: 98 percent of liquid fuel comes from imported oil. Such fuels make up 50 percent of all fossil fuels, and fossil fuels (oil, coal and natural gas) make up about 75 percent of the country’s energy use. The vast bulk of the remainder of energy sources is hydroelectric, and, importantly, solid biomass (i.e., firewood). Gasoline use is expected to grow at about 2.5 percent annually, and diesel use at 4.7 percent. Currently, Chile has excess refining capacity for gasoline and exports; the country is a net importer of diesel, which has been an argument in favor of exploring domestic biodiesel sources. Although less convincingly argued, secondary political objectives have been two: to promote the demand for traditional crops and thereby to support rural development, and to reduce carbon dioxide emissions from fossil fuels by replacing a portion of their use with biomass.

As an initial show of political support for biofuels, the Treasury Ministry announced its approval of tax exemptions on the proportion of biofuels mixed in diesel and gasoline. Beyond this tax measure, however, most of the government's efforts to promote biofuels have been at the level of study of both technical issues and possible regulatory framework. The state-owned petroleum importer, ENAP, and the private (monopoly) domestic sugar producer, IANSA, have done feasibility studies on technical and profitability questions and have concluded that biofuel production would make economic sense under certain scenarios about the price of oil, and only with appropriate incentives deriving from changes in policies. And policy analysts and experts involved in agricultural research and development have toured various countries with practical experience in biofuel production, notably the United States and Brazil, and other countries in recent months to learn more about biofuels.

The comparative sluggishness with which the Chilean government has moved toward an official biofuel policy is, in our opinion, due to two main factors, one economic and the other institutional. Notwithstanding the enthusiasm of some political and agricultural interests, Chile's climate and natural resource limitations (water and arable land) would suggest strongly that biofuels would contribute to only a small part of the country's fuel demand (a probably-optimistic target often mentioned is 2 to 5 percent), without significant financial commitments from the government. The institutional barriers arise due to the country’s open-market paradigm that inhibits (but does not rule out) targeted subsidies and tax exemptions, and which is reinforced both by the low level of import tariffs and by several free trade agreements. At present there is a 6 percent uniform tariff, no quantitative restrictions, and effective tariffs have been reduced to about 2 percent, adjusting for preferential access. This leaves few protectionist instruments available for the promotion of domestic industries.

Current policies for biofuel market development

In 2006 the Chilean government began a series of investigations into the possible design of a national biofuels policy. The present government has promised to diversify and expand energy sources, committing itself to attaining 15 percent of all energy use from alternative, renewable sources by 2010. Note that these alternatives include wind, solar, and other sources, not only fuels derived from biomass.

With respect to biofuels specifically, the Ministry of Agriculture has been given a prominent role in the development of a framework for a possible biofuel policy and has sponsored seminars and various studies. These activities were coordinated by the Ministry’s Office of Policy Analysis (Odepa). The Public-Private Committee (or Commission) on Bioenergy was formed in the fourth quarter of 2006, delivering its final reports in the first quarter of 2007.
In early 2007, the Chilean government announced its intention to exempt in part biofuel mixes from fuel taxes. This measure would imply a considerable subsidy given the high level of fuel taxes plus VAT, currently borders on 50 percent of fuel prices. This proposed tax exemption would be in proportion to the amount of biofuels mixed with gasoline or diesel. Recently the specific tax on gasoline was reduced 25 percent from 6 to 4.5 UTM per cubic meter. (Diesel has a specific tax about one-quarter that of gasoline.) This translates into a reduction of 50 pesos per liter of gasoline. (A UTM is currently 35.085 pesos and there are presently about 450 pesos to the dollar.) In addition to a specific tax of 150 pesos per liter of gasoline (approximately US$ 0.33, or a quarter of the consumer price), all fuels are subject to the 19 percent value-added tax, which is common for all merchandise and service transactions. Biofuel would not be exempted from the value added tax.

The Chilean Corporation for Economic Development (CORFO), a government agency, offers some competitive grants for start-up projects related to renewable energy production, including biofuels. These grants are meant to foment what are considered unproven but potentially profitable enterprises, and are relatively small and not intended as long-term subsidies. In November 2006 Chile entered into an agreement to develop biofuels with CropEnergies, a subsidiary of Sudzucker, a large, German sugar producer. CropEnergies, which claims to operate Europe’s largest bioethanol plant, is exploring the use of wheat and sugarbeet for biofuel production in Chile. The government has also supported research into potential fuel sources from the commercial production of biomass, such as the case of Jatropha curcas in the arid north. No other subsidies or protectionist measure are currently in place for biofuels and no detailed proposals for such policies have yet been brought forward for final legislative consideration.

**Production**

At a relatively small scale there are several existing and planned bio-energy production projects. Most notably, the forestry industry in Chile is almost self-sufficient in energy use, using residual wood from its mills to produce both thermal and electric energy. In fact, the use of forestry and milling residuals in the generation of electricity has allowed the industry to support at least in a small way the national electric power grid. More directly, the industry makes use of forestry biomass in the generation of steam power in drying wood. And residential consumption of wood is substantial, especially in the south. Of a total harvest in 2004 of 44 million cubic meters of wood, 27.8 percent was destined for home heating and cooking, and some commercial uses (e.g., in bakeries). (Harvested wood includes all products, such as firewood, boards, and pulp from natural stands and plantations of pine and eucalyptus.) About three-quarters of the harvest of wood for direct energy use outside the forestry sector comes from natural stands, the remaining quarter coming from plantations. By contrast, slightly over 98 percent of the wood harvested by the forestry-product sector derives from plantations.

Several recent projects are in place or intended to convert waste from agricultural crop and animal production to biogas to supply energy at the firm level. Agrosuper, a large poultry and pork producer, is the most obvious example of augmenting the profitability of biogas by making use of the Kyoto Protocol’s global-greenhouse-gas credits. Transalta, a Canadian electric utility and Tokyo Electric Power were the initial buyers of credits from Agrosuper. Conergy announced investments for methane production, with plans to generate 15 MW from the waste generated from 2000 hectares of cactus pears.

With respect to ethanol and biodiesel production, there are at present no existing large-scale efforts in place, although several firms, such as Sudzucker mentioned above, have expressed interest and some exploratory work has been done. A builder of biodiesel facilities, BioFuel Canada, has allied with the University of Concepción to construct plants to convert rapeseed and waste cooking oil, with a start-up target of six million liters annually. Forestry firms, such as CMPC Arauco, is in alliance with University of Concepción and investing up to US $14 million in wood-based (methanol) fuels. Etanol del Pacifico Sur, a cooperative effort by farmers formed two years ago, contemplated an ethanol plant with an annual capacity of over 40 million liters, depending on maize grain produced on the 6000 hectares farmed by associates. Within the last two months, however, Energy Quest signed a letter of intent with the Chilean company to construct a waste biomass gasification synthetic diesel plant with a daily capacity of 82,000 liters. The project will be a joint venture, where the US firm would supply patents, proprietary technology, and the equipment and Etanol would supply the waste biomass feedstock from farming operations.

Much attention in the government’s contemplation of biofuels has been placed on the potential use of traditional crops. The maximum number of hectares available to the cultivation of rice, maize and wheat, less the hectares currently under cultivation, has been one means used by Odepa and others of estimating the area available for production of those crops for ethanol and biodiesel. These biofuel hectares can then be translated into an equivalent of biofuels in cubic meters. A fairly optimistic scenario of 5 percent of fuel consumption from ethanol and biodiesel supplied by domestic sources is estimated to require approximately 170 thousand additional hectares. Estimates of additional hectares in specific crops under this scenario, and their equivalent in biofuel production are given in Table 1.

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More realistically, government estimates suggest that given available land, the country could self-supply the ethanol required to meet a gasoline substitution level of 3% in 2010, if the processing infrastructure were in place. Of course, increases in fuel demand for automobiles would reduce this substitution rate. (There could be imports of ethanol.) Available land for crops devoted to biodiesel would allow a substitution rate of 5% based on 2010 diesel demand projections.

There is also the possibility of using residues or byproducts of the domestic meat industry, principally animal fat. Merely using conversion factors of animal fat into biodiesel and estimated animal fat produced in meat production at predicted 2010 levels, the sector could, in principle, produce 52 thousand cubic meters of fuel. Currently, about 20 percent of animal fats are diverted to soap manufacture and other industrial products. The Committee on Bioenergy comments that, in addition to contributing to the diversification of energy, the use of animal fat in the production of biofuels would reduce problems of waste disposal and associated environmental problems. Table 2 shows a summary of realistic estimates of biofuel production and resource use from all sources over the next several years. But again this assumes that sufficient processing infrastructure were in place.

The official Odepa publication on biofuels concluded that, given the availability of cropland and standard per-hectare production yields, it is feasible to attain a gasoline substitution rate of 3 percent using biofuels derived from maize and rapeseed. The production of biodiesel would appear more economical given the possible additional revenues generated by the sale of sub products (meal and glycerin). It is also possible to separate in the marketing chain the later production of diesel from the initial production of oil, the latter stage being considered more accessible to small- and medium-sized farms.

### Table 1. Additional cropland required to substitute 5% of fuel use in 2010 with biofuels.

<table>
<thead>
<tr>
<th>Crops</th>
<th>Additional 1000 hectares required</th>
<th>Biofuel production in 1000s M3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethanol</td>
<td>130</td>
<td>457</td>
</tr>
<tr>
<td>Wheat</td>
<td>20</td>
<td>33</td>
</tr>
<tr>
<td>Oats</td>
<td>10</td>
<td>80</td>
</tr>
<tr>
<td>Corn</td>
<td>30</td>
<td>189</td>
</tr>
<tr>
<td>Potatoes</td>
<td>20</td>
<td>65</td>
</tr>
<tr>
<td>Sugarbeet</td>
<td>10</td>
<td>80</td>
</tr>
<tr>
<td>Total</td>
<td>130</td>
<td>457</td>
</tr>
<tr>
<td>Biodiesel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sunflower</td>
<td>20</td>
<td>16.5</td>
</tr>
<tr>
<td>Rapeseed</td>
<td>20</td>
<td>28</td>
</tr>
<tr>
<td>Total</td>
<td>40</td>
<td>44.5</td>
</tr>
<tr>
<td>Total ethanol and biodiesel</td>
<td>170</td>
<td></td>
</tr>
</tbody>
</table>

Source: Comite Publico-Privado de Bioenergia, informe final, January 2007.

### Table 2. Potential resource use and biofuel production of ethanol and biodiesel

<table>
<thead>
<tr>
<th>Bio fuel</th>
<th>Potential resource use</th>
<th>Biofuel production in m3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ethanol</td>
<td>130,000 ha.</td>
<td>457,000</td>
</tr>
<tr>
<td>Biodiesel from crops</td>
<td>40,000 ha.</td>
<td>44,500</td>
</tr>
<tr>
<td>Biodiesel from animal fat</td>
<td>65,423 metric tons</td>
<td>52,338</td>
</tr>
<tr>
<td>Total</td>
<td>196,423</td>
<td>553,838</td>
</tr>
</tbody>
</table>

Source: Odepa.

**Impacts on rural development**

Little can be said beyond platitudes and generalities regarding the impacts on rural development of any possible future biofuel policy. To the extent that the increased demand for agricultural products could increase the profitability of all farmers, then there will be positive effects on rural development. But most of the proposed biofuel crops are import-competing products, and there would likely be no price effect without some increase in the current level of border protection. Note that commodity markets will spread whatever price effects there might be to all producers of commodities in demand by biofuel processors; therefore, as far as prices go, it is matters little whether or not family farms sell directly to processors. There are two considerations with respect to smaller farms, however: If farm production subsidies are to be an instrument
to foment biofuel crop production, then the distribution of such subsidies across farm types would be of policy interest. And the increased demand of domestically-produced commodities will increase land rental rates, which might have distributional effects according to farm size.

Challenges faced by a domestic biofuels sector

The main challenge to the development of a domestic biofuels sector is found in the economic consequences of the Chile’s climate and resource availability. Given the present tentative and limited proposals for mandating biofuels, with appropriate incentives much marginal land can be brought under producer of biofuel crops. Water is another potential resource constraint, although relevant principally to the semi-arid central zones. Chile is prone to droughts and near-droughts. But most of biofuel crops are cultivated in the south, which enjoys greater levels of rainfall.

While the opportunity costs of biofuel crop production in Chile are likely much higher than in other countries, especially Brazil, the technical aspects of biofuel processing are unlikely to be different in Chile than anywhere else. The cost of grains used in ethanol processing would follow international prices, and so there is no difficulty estimating this feedstock component to costs. The largest cost in ethanol production comes from purchased grain (64 percent). Energy costs for processing is 17 percent, chemicals 11 percent and other operational costs 8 percent. Odepa has estimated ethanol prices that would assure a 12 percent rate of return on a processing plant (capacity of 80 to 100 thousand cubic meters): deriving from rice exclusively US$ 0.903, from maize US$ 0.693, and from wheat US$1.006. Not surprisingly, maize is the most economical of these traditional crops for the production of ethanol. These estimates are based on commodity prices as of the end of 2006, and so should be taken as only points of reference.

The largest component of costs in biodiesel production comes from grain (72 percent). Operational costs represent 20 percent, chemical inputs 6 percent, and energy 2 percent. The estimated biodiesel prices that would assure a 12 percent rate of return on a plant with 40 thousand cubic meters are US$ 0.789 per liter of biodiesel made from sunflower and US$ 0.774 per liter made from rapeseed. A larger scale operation – 60 thousand cubic meter capacity – would reduce these break-even prices by about 10 percent.

The Public-Private Committee on Bioenergy foresees that the ability to attain a sufficiently economical scale and constancy in domestic biofuel production would require setting minimum levels of biofuel mixes. The committee also recommends establishing long-term supply contracts that would guarantee sufficient returns to spur investments. Furthermore, in the authors’ view, without some protection of domestically-sourced biofuel (either via border protection or minimum domestic context, both unlikely), minimum biofuel mix requirements could be economically supplied by Chile’s neighbor.

The question of the specific tax exemptions on gasoline mixtures with biofuels is also important for the longer-term feasibility of biofuels. As noted, currently the President has promised to exempt the specific tax in proportion to the inclusion of biofuels. There has not been, however, a legislative conclusion to this proposal, and there is little reason to think that this proposed exemption will move forward in the near term.

There will also be some questions regarding squaring Chile’s trade agreements with any policies that would favor domestic agriculture and biofuel production. Chile would have to justify restrictions on the importation of ethanol or biodiesel from its Mercosur partners, Brazil and Argentina.

From a larger perspective, there are growing questions regarding the contribution that biofuels would make to net carbon dioxide emissions, considering the total balance between the absorption and release of carbon as a result of the direct and indirect use of energy in biofuel production and the downstream effects of bringing other lands (notably forests) into cultivation or animal grazing. The total net impact on carbon dioxide emission would, however, depend on specific country conditions. This subject should be examined in detail for Chile.

Considering the two aspects of net carbon dioxide emissions and the economics of the expansion of biofuels, the current consensus in Chile is that there are limited possibilities for ethanol. There is a better potential for biodiesel. Although not a liquid fuel source, there is continued interest in expanding energy production from animal waste and there is a strong demand for forestry byproducts as an energy source. These biomass energy sources have been developed in a market context.

As to the most prominent rationale for biofuels – the diversification of liquid fuel sources – the immediate goals as stated appear modest – perhaps 2 to 5 percent of gasoline and diesel at 2010 fuel consumption levels. Nevertheless, what might the government do in the medium term to promote biofuels? As mentioned, the government currently supports R&D and start-up grants for private-sector investment in biofuel projects. In order to improve the environment for investment, the government has also signaled an exemption of fuel taxes for biofuels mixed with both gasoline and diesel. Not yet formalized, the government has also explored the possibility of setting minimum biofuel mix requirements. Beyond these measures, and given the open trade regime, the commitment to near-uniform border protection, value-added tax treatments, (and practically no tax exemptions) across industrial sectors, there is little room for subsidies, implicit or explicit, to a biofuels sector.

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4. These conclusions are also reached by Pablo Recaro and Hero Morales, “Biocombustibles en Chile,” Trabajo de Investigación, Escuela de Ingeniería, Universidad Católica, Santiago, May 2006. Furthermore these authors also conclude that biodiesel would offer only a small contribution to the total energy use in the country.
Introduction

During the past three decades, the rapid economic growth of China’s national economy has led to growing consumption of energy. China’s energy trade turned from net exporter into net importer in the beginning of the 1990s. Since then, energy deficit has increased continuously. In 2006, China had an energy deficit of 0.25 billion tons (coal equivalent), accounting for 10 percent of total energy consumption (see Table A1). The increased energy consumption accompanies growing pressure on the environments. The policymakers recognize that the present pattern of development is not viable in the long run. Under such a situation, efforts to exploit alternative energy sources have been significantly enhanced. This paper presents the basic information on biofuel production and related policies in China and discusses implications to China’s rural development and major challenges ahead.

China’s energy strategies

In recent years, the Chinese leaders gave emphasis to socioeconomic development on a sustainable basis. Under such a context, development of renewable energies has been given high priority. The Energy Conservation Law was introduced in 1997 and then revised in 2007, which stipulated to provide support to R&D on new energies, including biofuels. The Renewable Energy Law was enacted in 2005, which drew particular attention to energy derived from biomass. The Energy Law is now under consideration. It is stated that the guideline for energy development is to ensure basic self-sufficiency in energy while opens market for trade. Or in other words, China will use trade opportunities to optimize structure of energy supply within certain scope of overall energy deficit. Conservation of energy, diversification of energy sources, and enhancement of R&D on related technologies are taken as major policy instruments (News Office of the State Council, 2007).

The rural energy problem has been also addressed in the government energy strategy. At present, many rural households in remote regions depend on crop stalks, firewood, dried cattle and sheep dung as fuels. Energy shortage in rural areas is regarded as major factor leading to overexploitation of forestry resources and damage to ecosystem. Besides, providing rural households with cleaning and quality energies has something to do with elimination of urban-rural development gap. For the purpose, extension of biofuel technologies is taken as an important component in constructing “new socialist countryside” by the government in recent years (MOA, 2006).

In August 2007, the Chinese government issued the National Program for Development of Renewable Energy in Medium and Long-term (NDRC, 2007a). The proposed general objectives include raising the share of renewable energy in total energy consumption, solving the problem of rural energy shortage, promoting utilization of organic wastes for energy, and fostering renewable energy industry. It is planned that China begins commercial production of biofuels during the 11th Five-Year Plan (2006-2010) and then develops large-scaled production during the next five-year plan. The program sets a target that renewable resources will account for 10 percent of the total energy consumption by 2010 and 15 percent by 2020. Increased use of biofuels is listed as a priority (see Table A2 for detail). The government will enhance support to R&D on biofuel technologies and encourage related FDIs.

In brief, China’s strategy for biofuel production is characterized by:

- It intends to increase total energy supply aiming at sustaining China’s socioeconomic development in long run;
- It pays specific attention on rural energy problem in addition to commercial biofuel production;
- It gives emphasis on rural income generation;

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• It is strongly inward oriented towards improving national energy security;
• It takes environmental consideration into account, which is related to both quality of live of the Chinese people and China's reputation in the world; and
• It is based primarily on long-term strategic considerations.

Policy programs for biofuel development

The Energy Conservation Law and the Renewable Energy Law set the framework for policy measures towards biofuel production. The Renewable Energy Law mandates to encourage investment into renewable energy production by all types of economic entities, to foster renewable energy market, to protect the interests of developers of renewable energy technology, and to give preferential loans and tax to approved renewable energy development projects. Different policies are applied towards commercial and non-commercial biofuel production.

Commercial production of biofuels includes bioethanol, biodiesel oil, solid biofuels, and power generated with biomass. China initiated research programs on biofuel technologies as early as in the mid 1980s with government funding. Trial production of corn-based bioethanol began in 1999 in Heilongjiang. Program of trial production and marketing of bioethanol was listed as one of the ten important national projects in the tenth five-year plan (2001-2005). Under the plan, four scaled bioethanol production plants were constructed during 2001-2003 with a total capacity of 1.02 million tons of bioethanol. Construction of these grain-based plants aimed at not only increasing energy supply and reducing emission of greenhouse gases, but also disposing over stored grains in the state reserves so as to raise grain prices and rural incomes. Further expansion of bioethanol production capacity was under consideration at that time. The plants were given preferential treatments of total refund of VAT. The price of bioethanol was linked to ex-factory price of gasoline at a fixed coefficient of 0.911. In order to encourage technological innovation and efficiency improvement in bioethanol production, a subsidy at fixed level was provided to the four bioethanol plants, which was determined based on the average production cost. The average level of subsidy per ton of bioethanol was reported at RBM 1883 in 2004/05, 1628 in 2005/06 and 1370 in 2006/07, equivalent roughly to US$ 230, 200 and 175 per ton, respectively. However, China's grain surplus disappeared soon after the four plants put into production. In responding to the growing concern on food security, the government changed guideline for biofuel production. The government decided in 2006 to ban new grain-based bioethanol projects and to prohibit capacity expansion of the four existing plants.

The pilot program of bioethanol gasoline for automobiles was launched in 2002. Marketing of gasoline blended with 10 percent bioethanol (E10) was initiated in three cities in Henan and two cities in Heilongjiang through channels operated by Sinopec and PetroChina, the two state-owned enterprises. The E10 program was extended to whole province of Heilongjiang, Jilin, Liaoning, Henan and Anhui, and 27 cities in Shandong, Jiangsu, Hebei and Hubei in 2004. With the completion of a cassava-based bioethanol plant in Guangxi in 2007, the province began to implement E10 program in April 2008. The blended gasoline was exempted from the 5% consumption tax on gasoline. It was estimated that, by end of 2007, E10 accounted for about 29.4 percent of the total gasoline usage for automobiles (NCDR, 2008).

Biodiesel production was not given special incentives in the government plan. However, significant progress has been made in technological research on biodiesel production with various biomaterials in recent years by both academic institutions with government funding and commercial firms in their own initiatives. Differing from bioethanol, access to biodiesel production is not strictly regulated. As a result, many commercial firms have entered this industry, including state-owned firms, domestic private firms and joint ventures. It was reported that there were about 20 biodiesel plants in China in 2006 with a total of designed annual production capacity over 3 million tons (Cui, 2008). The feedstock for biodiesel include waste cooking oils and oil-bearing seeds from oleaginous plants. At present, biodiesel production based on waste cooking oils is already well developed. Meanwhile, several provinces (e.g. Hubei, Yunnan and Guizhou) have implemented programs for establishing large-scaled production bases of oleaginous plants in hilly and mountainous areas.

In 2007, the government announced new support policies to biofuel production. Three principles were proposed: 1) Biofuel production should not compete for land with grain production; 2) Government assistance should be used as a leverage to foster biofuel enterprises and the state funding should be allocated based on efficiency criteria; and 3) The government will use state assistance to achieve steady and orderly development of the industry (MOF, NDRC, MOA, SGAT and SAF, 2007). The central government establishes special fund to encourage production of bioethanol from crop stalks, sweet sorghum, tubers and other non-grain materials, and biodiesel from oil-bearing seeds of certain crops and trees. Projects that are up to industrial standards would receive full loan interest subsidies for construction of new facilities and rewards ranging from 20 percent to 40 percent of the total investment. The scheme of fixed subsidies to bioethanol is replaced by a scheme of flexible subsidies in 2007. Under the new policy arrangement, the plants are required to establish reserve funds from profits earned at high prices to offset risks of low price, with the government subsidizing extra loss. Establishment of energy plant production bases on marginal lands will be subsidized as well. Subsidies are also given to power plants that use crop stalks to generate power or electricity to meet part of their production costs.

Seeing a promising prospect of biofuels production, many local governments plan or even have launched their biofuel projects. Such a situation leads to concern for orderly development of biofuel industry. On the other hand, distribution channels of bioethanol are monopolized by the state-owned firms and only those designated plants can sell their products through the channels and receive the preferential policies. The regulation on access to retail market is unfavorable for entrance of other enterprises.
Non-commercial utilization of biofuel focuses on energy supply in rural China. By nature, adoption of new energy technologies is to a large extent substitution for the existing ways of biomass use. Biogas (methane) production is a major technique extended in China’s rural areas. Production of biogas turns a wide range of scattered biomass into biogas as clean fuel for rural households, and nutritious liquid residue as fertilizer or feedstuff for animals. China began to extend small-scaled biogas production technology in the early 1970s. In recent years, biogas production is developed into various localized energy-ecology models and extended intensively with government financial support. During the period of 2003-2005 the national government allocated RMB 1 billion annually to construction of rural biogas facilities. It was reported that there were 27 million rural households already using biogas generated from small-scaled pools by end of 2007 (NCDR 2008). The coverage of rural households is planned to reach 40 million in 2010 and 80 million in 2020 (15 and 30 billion cubic meters of biogas). Construction of large-scaled biogas facilities that serve local communities is especially encouraged on the merits of better management and higher efficiency. Other extended biofuel techniques include firewood saving stoves and production of compressed biomaterials for fuel.

Production of biofuels

With limited cultivated land and water, China faces strict constraint in producing grains and oilseeds as feedstock for liquid biofuels. Although China remains as net exporter of cereals during the past decade, imports of soybean and vegetable oils rise significantly. China is an importer of sugar for long time and the potential to expand areas is limited. Southern China may increase rapeseed production using winter fallow land, depending on economic incentives to farmers. It is expected that, as domestic demand for grains, vegetable oils and sugar grows steadily, China will increase imports of such products in the years to come. Therefore, China has limited potential to expand food-based biofuel production. On the other hand, being a country with vast territory and diversified climate conditions, China is abundant in plant species and produces large amount of biomass annually. As a result, future supply of feedstock for biofuel production relies on primarily biomass produced from uncultivated land areas. It is roughly estimated that the usable biomass for biofuels can generate energy equivalent to 500 million tons of coal (NDRC, 2007).

In 2006, China produced 1.33 million tons of bioethanol. With the ban on any spontaneous expansion of grain-based bioethanol production in 2006, the amounts of grains as feedstock should not increase. In fact, the existing four plants begin their own efforts to shift partially to non-grain feedstock already. In the near future, cassava, tubers and sweet sorghum will be used as major alternative materials.

It was estimated that China had 0.44 million hectares of cassava with an output of 7.3 million tons in fresh weight in 2005 (MOA 2007). At present, cassava is mainly used for feeding animals and processing starch and ethanol. A cassava-based bioethanol plant in Guangxi came into operation in the early 2008, which had a designed annual production capacity of 200,000 tons. Expansion of cassava production using low quality land is included into the development plan with a large term target of output reaching 80 million tons (MOA 2007). In 2006, China imported about 5 million tons of cassava (HS071410) and 0.77 million tons of cassava starch (HS110814) from mainly ASEAN (UN, 2008). Whether China can use imported cassava to support bioethanol production depends on ASEAN energy policies.

China is a large producer of tubers and further expansion of the planting areas is possible in some regions. The varieties considered for this purpose include sweet potatoes in southwest China and sugar beet in northern China. The Ministry of Agriculture estimated that about 20 percent of sweet potatoes were lost during storage and fully recovery of the lost could provide feedstock for producing 2.5 million ton of bioethanol (MOA 2007).

A more promising crop is sweet sorghum, which has high adaptability to different agronomic conditions, particularly uncultivated saline soil. Large-scaled production of sweet sorghum on such soil is listed as a priority in the development plan. The potential area was estimated as 2 million hectares, which could generate feedstock for producing 3.5 million tons of bioethanol (MOA 2007).

The long run prospect of bioethanol production relies on breakthrough in technologies converting cellulosic biomass into liquid biofuels. While some experiments show promising outcomes, when such technologies become economically viable is still uncertain.

The estimated production of biodiesel varied wildly. The recent development focuses on using wasted cooking oils, residues of oil crushing, cottonseeds and from oil-bearing trees. China has large potential to expand areas of bio-energy forest (e.g. Jatropha L) by using underdeveloped mountainous and hilly lands. The State Forestry Administration has recently launched several biofuel forest demonstration projects in collaboration with local governments and state-owned firms. It is planned by the government to cultivate 13 million hectares of high-grade bio-energy forest by 2020. Some foreign ventures began to make large investment on bio-energy forest and processing plants in order to catch the opportunity. Fully use of fallow land for rapeseed production was specifically addressed in the development program with estimated potential output of 8.4 million tons of seeds which could produce 2.5 million tons of biodiesel (MOA 2007).

China’s agricultural production is carried out by mainly smallholders with an average size of 0.6 hectare of cultivated land area. To some extent, such smallholders are still semi-subistence by nature. Although they produce mainly conventional agricultural products in small scale, large amounts of biomass are generated in aggregate. It is expected that, in the near future, commercial production of feedstock by smallholders can take place only in limited scale and in limited areas where uncultivated land areas are large, such as southwest and western China. Such a mode of production will inevitably troubled by the high costs in collecting and transporting scattered biomaterials to processing facilities with an appropriate scale.
Information on the cost structure of biofuel production is scarce as well as unrepresentative. It is revealed from several analytic reports that the processing costs of bioethanol are in a range of RMB 1000-1500 per ton. The estimated costs of feedstock per ton of bioethanol vary, about RMB 2500 for stalk of sweet sorghum, RMB 3000 for dried cassava, RMB 3500 for corn. The cost of feedstock for biodiesel from Jatropha L is over RMB 4000. It seems that the costs of liquid biofuels are not competitive at the present state-regulated gasoline prices. The future market potential of biofuels depends on both technical innovation and government support.

Impacts on rural development

Growth of biofuel production has far-reaching implications for rural development. It is expected that production of energy plants cannot become a major undertaking in the rural sector and, therefore, its role in improving farmers’ integration with agricultural market is insignificant. However, on the other hand, more efficient utilization of biomass from agricultural and forestry production can offer potential benefits to the rural people, including turning those traditionally untraded biomass into products with commercial value, improving availability and quality of energy supplied to rural household, reducing pollution in the rural areas, and improving quality of life for rural people. Given the situation that many less developed regions are relatively abundant in uncultivated lands, entrance into commercial production of energy crops and trees may have positive effect on rural poverty alleviation potentially. In fact, the UNDP and the Chinese government have initiated a poverty alleviation project in southwestern China, which includes plantation of energy tress as a key activity.

On the other hand, the development of biofuel production worldwide may raise prices of grains and oilseeds, which may have negative impacts on China as whole, although it offers benefit to the Chinese farmers as well. Poorer rural populations are expected to benefit more from China’s biofuel development given the fact that they are located mainly in southwest and western China where potential for planting bio-energy crops and trees is large. Livestock farmers will have to adjust their production as feedstock prices rise.

Challenges faced by biofuel sector

The future development of biofuel production in China faces some critical challenges:

1) Although the Chinese government intends to develop biofuel production on the basis of non-food feedstock, competition for land and water resources between food, feed and forestry production and energy crops production is still unavoidable, particularly when such development is driven by strong impulse of commercial sector for short-term profit and policy rents. The government needs to ensure that improvement in energy security should not sacrifice food security and food price stability.

2) The current development of biofuel production is heavily oriented towards increasing supply of commercial fuels, which may put rural households at risk with respect to their fuel availability. Scaled planting of energy crops and trees driven by profit may potentially cause damages to environment, such as reduced biodiversity. Even though farmers can participate in feedstock production, they may be too weak to protect their interests in bargaining with commercial processing firms. The government should pay appropriate attention to such problems.

3) Under the current land tenure system, it is not easy for enterprises to engage in large scaled production of feedstock, and it is even more difficult to enter cooperation with smallholders. While involvement of local governments may facilitate implementation of such development projects, there are no guarantees for a win-win relation among all parties. To cope with the problem, appropriate institutional framework needs to be created, which is dependent on the overall reforms in future.

4) Development of biofuel production in China depends very much on the world market conditions. Recent experiences indicate that expansion of biofuel production is accompanied with rising food prices as well as enlarged market fluctuations. The potential negative impacts on developing countries, especially those net-food importing developing countries, should be carefully assessed. Given the technical advantages of developed countries, development of biofuel production is likely to offer opportunities to developed countries and land-abundant developing countries, while majority of developing countries will face challenges. Therefore, efforts should be made to find mechanisms for promoting international cooperation in dealing with energy and food problems. In this regard, financial assistance and transferring new energy technologies to in developing countries should have priority.

5) To a large extent, development of biofuels is just a short-term remedy to the problems resulted from the current unsustainable life styles, which not only prevails in developed countries, but also spreads rapidly in developing countries. The long-run solutions to energy shortage and associated environmental problems require remodeling of the concept and strategy of development, which means a change in social thinking.

Being the largest producer and consumer of agricultural products in the world, China’s entry into large scaled biofuel production may have notable impact on world agricultural market. It is crucial that the Chinese government should have a comprehensive view with regards to domestic supply of biomass and imports of feedstock, innovation in biofuel technologies, and demand-side management on both commercial and non-commercial energy consumption. Efforts should be devoted to creation of appropriate mechanism for healthy development of the biofuel sector. It is equally important to correct market failures and to avoid government failures associated with inappropriate state support to biofuel producers and regulations on biofuel market.
## Table A1. Changes in China’s energy balance and trade of potential feedstock during 1990-2006

<table>
<thead>
<tr>
<th>Year</th>
<th>Energy balance (billion TCE)</th>
<th>Net imports of potential feedstock (million tons)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>production</td>
<td>consumption</td>
</tr>
<tr>
<td>1990</td>
<td>1.04</td>
<td>0.99</td>
</tr>
<tr>
<td>1995</td>
<td>1.29</td>
<td>1.31</td>
</tr>
<tr>
<td>2000</td>
<td>1.29</td>
<td>1.39</td>
</tr>
<tr>
<td>2001</td>
<td>1.37</td>
<td>1.43</td>
</tr>
<tr>
<td>2002</td>
<td>1.44</td>
<td>1.52</td>
</tr>
<tr>
<td>2003</td>
<td>1.64</td>
<td>1.75</td>
</tr>
<tr>
<td>2004</td>
<td>1.87</td>
<td>2.03</td>
</tr>
<tr>
<td>2005</td>
<td>2.06</td>
<td>2.25</td>
</tr>
<tr>
<td>2006</td>
<td>2.21</td>
<td>2.46</td>
</tr>
</tbody>
</table>


## Table A2. Major targets for bio-energy utilization set in China’s Medium and Long Term Development Plan of Renewable Energy

<table>
<thead>
<tr>
<th>Type</th>
<th>Unit</th>
<th>2005 actual</th>
<th>Planning target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Installed capacity of electricity generation with solid biofuels</td>
<td>Million kw</td>
<td>2</td>
<td>5.5</td>
</tr>
<tr>
<td>Compressed solid biofuels</td>
<td>Million tons</td>
<td>N.A.</td>
<td>1</td>
</tr>
<tr>
<td>Biogas</td>
<td>Billion cubic meters</td>
<td>8</td>
<td>19</td>
</tr>
<tr>
<td>Non-grain based bioethanol</td>
<td>Million tons</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>(Billion litres)³</td>
<td>0</td>
<td>(2.72)</td>
</tr>
<tr>
<td>Biodiesel oil</td>
<td>Million tons</td>
<td>0.05</td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td>(Billion litres)³</td>
<td>(0.057)</td>
<td>(0.23)</td>
</tr>
</tbody>
</table>

Note: a. Calculated at conversion rate of 0.736 kg per litre. b. Calculated at conversion rate of 0.88 kg per litre. Source: NDRC (2007).
Bio-fuels: The Indian Scenario

Bio-fuels have gained significance the world over due to rising energy requirements of individual countries, supply uncertainties and skyrocketing global crude oil prices. Of course, increasing stress on clean environment and climate change concerns has also fuelled the interest in bio-fuels as an alternative energy resource. The world energy requirements are likely to be 50 percent higher in 2030 than today and 45 percent of this is likely to originate from China and India together (Executive Summary, page 3, World Energy Outlook, 2007). Due to diminishing fossil fuel reserves, the focus has now shifted to alternative energy sources which need to be renewable, sustainable, efficient, cost-effective, convenient and safe (Chum and Overend, 2001). Bio-fuels (bio-ethanol and bio-diesel) can generate new markets for agricultural products subject to certain serious trade offs between food, fodder and fuel security. The food-fuel debate is getting intense with the recent spike in food prices—food crops being diverted into production of bio-fuels have been cited as one of the major factor. On the other hand, one cannot ignore the escalating crude oil price trends (nearly $134 per barrel), and hence the need for alternative sources of energy. With surging energy demand and a heavy import dependence on volatile oil market, it is contextual to discuss the scope of bio-fuels in India as an alternative fuel base. It will be worthwhile to look at the accompanying government policy in ensuring energy security without sacrificing the food security concerns.

Why Bio-fuels for India?

Presently, India imports more than 70 percent of crude oil needs from highly unstable and volatile world oil market. The country is projected to become the third largest consumer of transportation fuel in 2020, after the USA and China (Kiuru, 2002). Annual oil import bill has increased by nearly 39 percent (currently about USD 61.2 billion (April-February 2007-08)) over last year owing to a surge in global crude oil prices (The Economic Times. 2008a). Every one dollar rise in crude oil prices inflates the import bill of India by about USD 620 million per annum (Reuters, 2003). The recent hike in retail prices of petrol and diesel imply that the government is not left with many soft options and it might be the right time to come up with a clear bio-fuel policy. Bio-fuels like ethanol and bio-diesel are considered to be clean and efficient fuel forms that can be used for blending with petroleum and as a diesel substitute. The early 2000 witnessed a glut in sugarcane production that resulted in promotion of ethanol production from sugarcane juices as also from molasses in India. A lot of emphasis has been laid on tree borne oilseeds (TBO) for production of bio-diesel, much of which is at the experimentation stage and challenge is to make these alternatives commercially viable.

Bio-fuels are produced in many countries, albeit in varying quantities and at different costs. The rationale for bio-fuels for developing countries goes beyond energy security and addressing some of the global environmental and climate change concerns to provide alternative employment opportunities, additional income, rural electrification, and rehabilitation of wastelands through greening. Liquid bio-fuels have the potential to provide communities with multiple essential energy services such as electricity for lighting, small appliances or battery charging; for income generating and educational activities; and for pumping water, cooking, and transportation. Estimates suggest that by 2020, per capita emissions in India would triple as compared to the amount in 1990 (Energy Information Administration 1999). It can be instrumental in carbon trading if certain criteria of the clean development mechanism (CDM) of the Kyoto Protocol of the UNFCCC are fulfilled. Electricity from renewable energy sources such as small hydro, solar and wind energy systems also have high capital costs. Bio-fuels, when produced in respective villages to run diesel engines provide an option of decentralised, reliable and affordable electricity in the rural areas. Cultivation of certain plant varieties such as Jatropha curcas that can withstand poor soil conditions can help revile wasteland areas and also provide an important source of employment for the people belonging to such regions. Ethanol from sugarcane can prove to be remunerative for the millers during periods of

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2. Director and Senior Fellow at the Energy and Resources Institute (TERI).
3. Oil prices have risen by 25 percent in the last four months (BBC News, 2008).
4. UNFCCC stands for United Nations Framework Convention on Climate Change
glut in sugarcane production provided there is a realistic price policy that serves as an incentive to convert the surplus cane into ethanol for fuel. This in turn is likely to have a positive impact on sugarcane growers in terms of better prices received for cane. However, it is still too early to quantify some of these positive externalities of use of bio-fuels, given the state of infancy of bio-fuels in India.

**Policies for the development of bio-fuels market**

In India, as a policy decision, vegetable oils or any food grain crop shall not be used for bio-fuels purposes to avoid any stress on the food scenario. This has gained more significance in the present scenario of accelerating prices and anticipated food shortages (The Economic Times 2008b). The Government of India had launched the first phase of ethanol-doped-petrol program in 2003. Mandatory 5 percent blending was introduced in certain areas of the nine major sugarcane growing states and the four union territories and gradually extending it all over the country. This initiative suffered a serious set back due to a sharp decline in production of sugarcane and sugar in the marketing year 2003-04 and the ethanol supplies went nearly dry by September 2004. Following which the government removed the mandatory supply clause (MPNG 2004). With the production volume reviving in 2005-06 and glut in the market (2006-07), the government was again upbeat on producing ethanol from sugarcane and molasses and moved towards introducing ethanol blending all over the country from October 2007 (The Economic Times 2008c). At 5 percent blending, it is estimated that there is a need for nearly 600 million liters of ethanol (USDA 2006), which is likely to be scaled up to 10 percent in October 2008.

Apart from the ethanol policy, the government has adopted a bio-diesel policy involving several stakeholders including public and private agencies, academic and research institutions. Taking into account the multiple benefits of large-scale bio-diesel production from *jatropha* plantations in wasteland regions, the government announced the ‘National Mission on Bio-diesel’ in 2003 that was to be implemented on an area of 400,000 hectares over the next five years. About 10 million hectares of land under the cultivation of *jatropha* is likely to generate 7.5 million tons of fuel annually and generate year round employment for 5 million people (Government of India, 2002). Several states falling under high and medium rainfall category and where wastelands are in the range of 0.1–5 million hectares can be chosen for bio-diesel production. Although Andhra Pradesh receives an average rainfall of barely 292 mm, its sizeable wasteland exists in the region receiving rainfall as high as 900–1200 mm. This wasteland can be put to use for bio-diesel production.

Since India presently imports edible oil, conversion of which into bio-diesel is not feasible both from demand deficit and energy balance point of view. Therefore, India has to develop its non-edible oil sector around marginal lands with efficient use of technologies including biotechnology, an area in which India has progressed significantly.

The global market for bio-diesel is poised for explosive growth in the coming years. The Ministry of Petroleum and Natural Gas in India had launched bio-diesel procurement policy with effect from January 2006, pricing it at Rs. 25 per litre, which had been further revised to Rs. 26.50. The public oil marketing companies could procure bio-diesel of a specified quality from suppliers through 20 purchase centres at a uniform price. However, till date there has been no commercial sale of bio-diesel under this policy (MPNG, 2007). Government of India has fixed the target to replace 20 percent high speed diesel (HSD) with bio-diesel by 2011-12 and in effect produce 13.38 million tons of bio-diesel annually through plantation of *Jatropha* on 11.19 million hectares (Government of India, 2003). However, given the rate of progress with field experiments in developing superior varieties and moving towards a policy regime that supports private investment as well as protects the interests of the growers, it may not be so easy to achieve the specified target. The much awaited bio-fuel policy is likely to revise the target dates.

**Production of feedstock for bio-fuels**

Species used for production of ethanol include sugarcane (*Saccharum sp.*), sweet sorghum (*Sorghum bicolor*), corn (*Zea mays*), and cassava (*Manihot esculenta*). However, from India’s point of view, sugarcane and sweet sorghum are the most important crops. Of the various options available for production of bio-diesel, *Jatropha curcas* and to a lesser extent *Pongamia pinnata* are the major species selected for large-scale cultivation.

In India, the bulk of alcohol is produced from sugarcane molasses. During 2006-07, India had produced 2300.4 million litres of alcohol out of which 1477.6 million litres was used for industrial, potable and other uses while 822.8 was the surplus (Ethanol India). India is the second largest producer of sugarcane (356 million tons per advance estimates for 2006-07) after Brazil. Molasses production in India has shown overall increasing trend but has been subject to yearly and sometimes wide fluctuations due to cane availability (cyclic phenomenon) and diversion of cane to manufacture other sweeteners and government regulations that did not allow direct use of cane for molasses (now relaxed). Molasses production over the decade has increased from 7.00 million litres in 1998-99 to 11.36 million litres in 2006-07 (Ethanol India). In such a scenario there is ample scope to increase the level of blending from 5 percent to 10 percent or maybe more and cut down the consumption of gasoline.

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5. The states include Andhra Pradesh, Gujarat, Haryana, Karnataka, Maharashtra, Punjab, Tamil Nadu, Uttar Pradesh and Goa and the Union Territories are Daman and Diu, Dadra and Nagar Haveli, Chandigarh and Pondicherry.

6. MPNG stands for Ministry of Petroleum and Natural Gas.
Much of the *jatropha* cultivation is under experimental stage, trying to develop commercial varieties with high oil content feasible for transesterification. As per the Planning Commission’s report on Bio-fuels (GoI 2003), an estimated demand for 52 million tons of petro-diesel in 2006-07 will require approximately 2.2 to 2.6 million hectares of *jatropha*. However, only 0.4 million hectares have been planted (USDA 2006), which makes it very difficult to procure sufficient quantities of *jatropha* seed for producing bio-diesel. While *jatropha* appears to be a potential source of generating bio-diesel in India, it is only after commercial cultivation and marketing of the oil begins, can one comment on it usefulness as an alternative fuel source. Also, there is a debate on the existence of wastelands in India, which are being promoted for cultivation of *jatropha*, the economics of which needs to be looked at closely.

BP (British Petroleum) and TERI have jointly undertaken a USD 9.4 million project for bio-fuels production which is being implemented by TERI in Andhra Pradesh to demonstrate the feasibility of producing bio-diesel from *jatropha*.7 This 10-year project, involves cultivation of around 8,000 hectares in Andhra Pradesh, currently designated as wasteland, with *jatropha* and installation of all the equipment necessary for seed crushing, oil extraction and processing to produce 9 million litres of bio-diesel a year. The project involves planting, cultivating, and harvesting; de-hulling and crushing the seeds; shipping it to a conversion plant and eventually blending it with diesel. A complete environmental and social impact assessment on the supply chain and a life cycle analysis of greenhouse gas emissions will be completed as part of the project. At present, nearly 3,000 hectares of land has been already cultivated with *jatropha* involving around 2,000 farmers. TERI has signed a MoU with the farmers through self help groups, panchayats and farmers’ organization in Andhra Pradesh with a buy back arrangement.8 It has been also providing certain credit facilities through banks which provide a kind of risk coverage for the growers. The impact of such contract farming arrangements on the economic well being of the farmers and the rural areas is yet to be seen.

There is a flurry of private investors in the bio-fuels sector, particularly in marketing of ethanol and development of high yielding varieties of *J. curcas*. Players such as Mission Bio-fuels, D1 Oils, Praj, Reliance and many more have joined the foray. Tata Chemicals has contracted with Praj to set up their first ethanol plant, the feedstock being sweet sorghum. The plant is likely to come up at Nanded (Maharashtra, India) with a capacity of 30,000 litres per day. The stalks of sweet sorghum otherwise used for fodder will be used for production of ethanol. Tata chemicals plan to bring nearly 10,000 acres under cultivation of sweet sorghum. Reliance Life Sciences, a subsidiary of Reliance Industries Ltd is reported to have earmarked 200 acres of land at Kakinada in Andhra Pradesh to cultivate *jatropha*, which can yield high quality bio-diesel. It will supply the know-how, saplings and fertilizers to farmers. D1 Oils, the UK-based global producer of bio-diesel from renewable energy crops, has signed an agreement with PManek Biofarms Pvt (PManek) in Gujarat for the supply of crude *jatropha* oil (CJO) for bio-diesel feedstock covering an area of 40,000 hectares. Reports reveal the Mission Bio-fuels (India) Private Limited had set a target to achieve its 100,000 acres of planted *Jatropha curcas* in 2007. It has signed an agreement with an Indian district controlled entity granting it exclusive, long-term access to *J. curcas* seeds from already planted lands as well as access to additional land in the district that is to be planted over the next three years. Southern Railway on its own part planted about 2,00,000 hectares of *jatropha* and *pungam (karanj)* plants on their vacant land and also erected and commissioned a small plant for the extraction and transesterification of *jatropha* oil (capacity only 5 liters a day) at loco works, Perambur (GoI, 2006). This of course though miniscule in its capacity is a good beginning and will educate the masses about the development and contribute to the level of awareness. Also, under the Rural Business Hub (RBH) initiative of Confederation of Indian Industries (CII) and Ministry of Panchayati Raj, MoUs have been signed in Haryana and Rajasthan to promote *jatropha* plantations and production of bio-diesel.

**Challenges faced by the bio-fuel sector**

In Indian context, one of the major barriers in introduction of bio-diesel on large-scale is the present availability of feedstock. The bio-diesel program in any country has a time lag between policy planning, experimentation and commercialization. Thereby the introduction is gradual, gaining maturity only after few years. This is especially applicable to India where bio-diesel is proposed to be produced from non-edible oils. However, with the massive plantation plans, it is envisaged that feedstock shall be available in large amount subject to a time lag of four to five years. It is also understood that a large potential of various oil-bearing seeds exists in the country and there are plans to tap this potential. For successful launch of bio-diesel, availability of oil on large-scale has to be ensured at reasonable prices. The blending of bio-diesel can be taken up at the depot level of the diesel distribution and marketing company. However, it is necessary that marketing of bio-diesel-blended diesel is done as an organized trade and this activity should be handled by the diesel distributing companies. The quality testing of bio-diesel should be mandatory to check any adulteration.

There is a need for a clear and transparent pricing policy for both ethanol as well as bio-diesel that is profitable for the suppliers. According to recent reports, low demand for ethanol has forced sugar millers to operate at below capacity and molasses are being exported for want of domestic demand (The Economic Times, 2008d). Perhaps millers do not find it profitable to produce ethanol for fuel use due to the low prices offered by the oil companies. The government is likely to raise the fixed price of ethanol from Rs 21.50 a litre to Rs 24 per litre keeping in view the spiralling prices of crude oil (Commoditiesonline, 2008). Also, the government is contemplating to confer a goods status to ethanol and put into effect a uniform levy of 4 percent, replacing the differential sales tax or value added tax levied by states varying from 4 percent to 20 percent (The Economic Times, 2008c).

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7. The project has been launched in 4 districts of East Godavari, West Godavari, Krishna and Khammam in Andhra Pradesh.

8. MoU indicates Memorandum of Understanding.
The first generation bio-fuels are an important source of livelihood for the farmers as well. Hence any attempt to go for contract farming arrangements will necessitate presence of assured markets and risk mitigation. Currently, there are no institutional arrangements that ensure such coverage and farmers fear alienation from their own land. In the case of jatropha, if the farmers are not able to harvest the right variety (high oil content) despite the technology and input support, the company may not be willing to procure the output, resulting in an income loss for the farmer. Once commercial activities start, it is important to adopt certain legal or quasi legal strategies to avoid breach of contract.

The recent spikes in food prices have been attributed to a large extent to the increasing demand for bio-fuels. For example, bio-fuels crop such as sugarcane may be encouraged in water abundant areas of Bihar and eastern Uttar Pradesh rather than Maharashtra where less than 3 percent of the gross cropped area under sugarcane cultivation consumes more than 60 percent of the water available for irrigation in the state. Experts are of the opinion (observed from ongoing trials) that a high yielding jatropha plant may be quite water intensive and not confirm to the popular belief of it being drought resistant. Also, identification of 55.3 million hectares of wasteland in the country for cultivation of jatropha is debatable particularly in a situation where there is a fierce competition for land. Hence it is important to understand the feasibility of growing jatropha in wastelands particularly when it is being looked upon as an emerging source of feedstock for bio-diesel.

The Way Forward

It is imperative on part of the government to come up with a comprehensive policy on bio-fuels at the earliest. Although the exact factors responsible for delay in the announcement of the policy are not known, but deciding on the Ministry which should be entrusted with the responsibility of running the bio-fuels program has been cited as one of them. Current inflationary trends and rising global prices of food grains have drifted some of the attention away from bio-fuels. It has been reported in various sections of the media that the Group of Ministers are likely to come out with the bio-fuel policy shortly. A national Bio-fuels Board under the Ministry of New and Renewable Resources is likely to coordinate the activities. Many experts believe that the diversion of surplus food crops for bio-fuels purposes by the industrialized countries has decreased their supply in the world market leading to sharp increase in the prices. However, this is only partially true as other factors such as drought, continued neglect of agriculture and rapid economic growth in the world are also responsible for this situation. Since the Government of India is yet to announce its bio-fuels policy, it may as well take advantage of present global food crisis as a learning experience and come up with a more balanced bio-fuels policy that does not conflict with our food needs and ensures both food and energy security. While there isn’t any dearth of technologies available to generate alternative fuels, the question arises as to which among these are scalable and cost effective for India. The government should not provide any type of subsidy in any bio-fuel program, including pricing of power and water used for irrigating sugarcane for ethanol (Gulati, A. 2008). The first generation bio-fuels as it seems require large scale land use, therefore, next generation technologies such as micro algae and bio-hydrogen production in bioreactor need to be experimented.
Introduction: Biofuels Engagement

Biofuels is a promising renewable energy for Indonesia, a country rich in fossil-fuel resources and renewable potentials. Attention on biofuels has grown rapidly during the last two years, especially after the world price of oil increased sharply. In the modern history of Indonesia's development, the share of non-renewable energy sources is extremely high, where oil is very dominant (51.7 percent), followed by natural gas (28.6 percent) and coal (15.3 percent). The share of renewable energy sources is less than 5 percent, where hydropower contributes about 3.1 percent and geothermal about 1.3 percent to the total energy source (Ministry of Energy, 2008). Indonesia has also developed other sources of renewable energy, although in a very slow pace, such as mini/micro-hydro, biomass, solar and wind energy.

As an oil and gas-producing country, Indonesia has been long very dependent on the revenue from fossil-fuel energy to finance the development process. In 2008, the state revenue from oil and gas sector is Rp 246.3 trillion (or about US$ 25.9 billion), which is a major increase from Rp 177 trillion (or about US$ 18.6 billion) revenue in 2007 (Ministry of Energy, 2008). However, the production level of Indonesian oil has declined significantly in the last decade or so, while the consumption level increased steadily as the economy grows. In 2008, the estimated daily lifting of oil is 960 thousand barrels, a very significant decline from 1.41 million barrels in 2000 (see Table 1), while the consumption level is nearly 1.5 million barrels per day. As a result, Indonesia is also an oil importing country as there has not been major increase in investment and production capacity of the sector. Consequently, the high price of oil in the international market has caused Indonesia some difficulties in adjusting the state budget and development policies.

Table 1. Production of Oil and Condensate in Indonesia, 2001-2007

<table>
<thead>
<tr>
<th></th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oil</td>
<td>1,271.7</td>
<td>1,208.7</td>
<td>1,117.6</td>
<td>1,013.0</td>
<td>965.8</td>
<td>934.8</td>
<td>883.0</td>
<td>840.0</td>
</tr>
<tr>
<td>Condensate</td>
<td>142.4</td>
<td>131.9</td>
<td>131.8</td>
<td>133.8</td>
<td>128.6</td>
<td>127.3</td>
<td>122.6</td>
<td>126.7</td>
</tr>
<tr>
<td>Total</td>
<td>1,414.1</td>
<td>1,340.6</td>
<td>1,249.4</td>
<td>1,146.8</td>
<td>1,094.4</td>
<td>1,062.1</td>
<td>1,005.6</td>
<td>966.7</td>
</tr>
</tbody>
</table>

Source: Ministry of Energy (2008)

Indonesia can no longer depend heavily on fossil fuels, which have been used lavishly, but depleting very badly fast. For example, in order to maintain domestic price stability of oil, the government has to allocate oil subsidy about Rp 61 trillion in 2006 (about 10 percent of the total state budget). The share of fuel import is estimated about 43 percent of domestic fossil fuel consumption. This is taking a tremendous share of the state budget. Assuming the consumption of fossil fuel reduction is up to 10 percent, the biofuels development program could contribute to foreign-reserve savings up to US $ 10 billion. Renewable energy and biofuels can help reduce the dependency on imported oil, hence contributing the reduction on budget subsidy.

While the development of renewable energy is in progress, recent attention has been given to the development of biofuels, as Indonesia has the production potentials, primarily from palm oil and jatropha for biodiesel; and sugarcane and cassava for bioethanol. However, when the world oil price reached about US$ 120 per barrel, which leads to a high demand for some crops which are biofuel-potentials, the development of biofuels in Indonesia seems to stop at the crossroads. Staple food prices also increased more than double within two years, which provides serious threats for food security in the country. On one hand, Indonesia has to continue to put high priority for food security as the poverty level remains high (16.7 percent), but on the other hand, Indonesia has also to emphasize on energy security, including biofuels development.

This paper examines issues on biofuel development in Indonesia, focusing on recent policies for the development of biofuels market, and recent trends on biofuels production, especially after a sharp increase in the oil price. Impacts on food security and rural development

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are also addressed as the issues of fuels vs. food enter the public debates. Finally, the paper concludes with challenges faced by biofuels development in Indonesia.

Recent Policies for the Development of Biofuels Market

The current government administration of Indonesia has launched biofuels development policies in response to a growing scarcity of fossil fuels, increasing price and contributing to agricultural development and poverty alleviation. For example, in 2004 the government issued the Minister of Energy Decree Number 02/2004 on renewable energy development. This action was targeted at assisting efforts to help the government understand its biofuels agenda, including emphases on research, development and action taken related to biofuels. In 2006 President Susilo Bambang Yudhoyono (SBY) announced his Presidential Instruction Number 1/2006 on the Provision and Utilization of Biofuel. The instruction was addressed to 14 different ministers plus all of Indonesia’s governors and regents/mayors. In the directive the presidents urged officials in all of these agencies “to take any steps necessary to accelerate provision and utilization of biofuel as alternative fuel.” Importantly, at the time of the issuance of the decree, there was no Indonesian-wide study on the effects of biofuels on the country’s agriculture, poverty reduction efforts and/or the environment.

A follow up policy for biofuels is the Presidential Decree No 5/2006 on Biofuel Development that urges a more consultative effort to develop biofuels as a part of energy diversification strategy. The policy explicitly sets target of 17 percent renewable energy in 2025, together with 30 percent from gas, 33 percent from coal, and 20 percent from fossil-oil. According to the Decree, the renewable energy consists of 5 percent of biofuels, 5 percent of geothermal, 5 percent of biomass, nuclear, solar and wind, and the last 2 percent of liquefied coal (see Figure 1).

The biofuels development has some other strategic objectives in 2010, such as to create about 3.5 million jobs, to increase the income of biofuels workers up to the regional minimum wage. The government is planning to establish 1000 energy self-sufficient villages and 12 special biofuel zones, so that the policy is aimed at reducing fossil fuel for transportation up to 10 percent. The area expansion of biofuel crops is targeted up to 5.25 million hectare: consisting of 1.5 million hectare of palm oil, 1.5 million hectare of jatropha, 1.5 million hectare of cassava, and 750 thousand hectare of sugarcane. If all of these targets are met, Indonesia shall be able to fulfill the domestic biofuel demand, and even be able to export the products of biofuels.

To implement the policy, the government established a National Team for Biofuel Development in 2006, which was supported by the state budget. The National Team has formulated the national energy blueprint, although being criticized for lack of rigorous academic study and economic modeling for the blueprint. The national plan specifically outlined that the production of biodiesel was to supply at least 2 percent of the nation’s total energy needs by 2010. Given Indonesia’s climate and soils, bio-diesel from palm oil is the top priority. The national target has been set to produce about 62,000 kiloliters (see Table 2), which many doubts that the target will be achieved.

More recently, Indonesian lawmakers have issued Law Number 30/2007 on energy which stipulates efficient utilization of energy, improving added value, sustainable energy, human welfare, environmental conservation and national security. The law emphasizes on the roles of energy of improving economic activity and the national security. In the supply side, the law stipulates energy security, emphasizing on production exploration and conservation; while in the demand side, the law aimed at conserving energy use and energy diversification, including biofuels development. The government maintains a direct subsidy program for low-income group and at the same time develops energy pricing policy. In short, the new law on energy accommodates the supply-side issues on production, capacity and distribution; the demand-side issues on energy efficiency and conservation, and on more fair pricing policy principles.

<table>
<thead>
<tr>
<th>Description</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diesel consumption (ton)</td>
<td>12,438</td>
<td>13,184</td>
<td>13,975</td>
<td>14,814</td>
<td>15,713</td>
</tr>
<tr>
<td>Biodiesel supply (thousand ton):</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>National Energy Blue-print</td>
<td>50</td>
<td>100</td>
<td>300</td>
<td>500</td>
<td>702</td>
</tr>
<tr>
<td>Palm-oil</td>
<td>62</td>
<td>125</td>
<td>349</td>
<td>593</td>
<td>471</td>
</tr>
<tr>
<td>Jatropha curcas</td>
<td>0</td>
<td>7</td>
<td>70</td>
<td>148</td>
<td>341</td>
</tr>
<tr>
<td>Dedicated area (thousand ha):</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Palm-oil</td>
<td>18</td>
<td>36</td>
<td>100</td>
<td>169</td>
<td>135</td>
</tr>
<tr>
<td>Jatropha curcas</td>
<td>40</td>
<td>341</td>
<td>345</td>
<td>360</td>
<td>375</td>
</tr>
</tbody>
</table>

Source: National Team of Biofuels Development, 2006

Table 2 also explains that dedicated area of palm oil and jatropha for biofuels development should contribute to the implementation performance of biodiesel supply in the country. Increasing trends of palm oil production in recent years should contribute to the acceleration of biodiesel production in accords with or exceeding the national energy blue-print. Similarly, if farmers or jatropha producers consider economic incentives to develop biodiesel production, such a traditionally marginal jatropha crop could contribute to the improvement of farmers’ income and employment generation in rural area.
Fluctuation in Biofuels Production

Production of biofuels in Indonesia grew rapidly in the first year, but tended to decrease steadily in the second and third year because the price of oil has increased sharply. This up-and-down process occurs simply because the biofuel market has not yet developed properly and the price of biofuels has also increased sharply. Pertamina, a state-owned enterprise that has been assigned to buy biofuels products is no longer able to cover the price differences between the market buying-price of biofuels and the subsidized selling-price of the fuels to the consumers.

During the first year of the policy packages on biofuels development, private sectors expressed the interests to invest in biofuels plants. The refinery plants processed palm oil and jatropha to become biodiesel, and sugarcane and cassava into bioethanol. Banking sectors actively provided financial scheme for the seemingly prospective biofuels sectors. As of January 9, 2007, the total amount of credit committed to biofuels development was Rp 5.1 trillions (about US$ 536.8 million).

In addition, the government has provided some policy instruments supporting the biofuels production, among others: Minister of Finance Decree No. 117/PMK.06/2006 on Credit for Bioenergy Development and Revitalizing Plantation (KPEN-RP); Ministry of Finance Decree No. 79/PMK.05/2007 on Credit for Food and Energy Security (KKPE); and Government Regulation No. 1/2007 on Income Tax Facility for Special Business and Special Regions. As a result, such incentive systems lead to 62 units of small-scale jatropha refinery all over the country.

Official data from the Ministry of Energy (2008) show that the production of biodiesel in Indonesia is 2 million kiloliters per year, and bioethanol is 160 thousand kiloliters per year. Among others, the production of fuel-grade biodiesel from CPO of Wilmar in Dumai is 350 thousand per year, BPPT (Technology Research and Development Agency) in Serpong is 300 thousand per year, and Eterindo in Tangerang and Gresik is 120 thousand per year (Table 3). The production of bioethanol comes from, among others: Molindo Raya in Malang at 10,000 kiloliters per year, Sugar Group in Lampung at 70,000 kiloliters per year, and BPPT Lampung at 2,500 kiloliters per year.

Table 3. Annual Production of Fuel-grade Biodiesel from CPO, 2007

<table>
<thead>
<tr>
<th>No</th>
<th>Producer</th>
<th>Location</th>
<th>Production (ton)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Wilmar</td>
<td>Dumai</td>
<td>350,000</td>
</tr>
<tr>
<td>2</td>
<td>BPPT</td>
<td>Serpong</td>
<td>300,000</td>
</tr>
<tr>
<td>3</td>
<td>Eterindo</td>
<td>Tangerang and Gresik</td>
<td>120,000</td>
</tr>
<tr>
<td>4</td>
<td>Sumiash</td>
<td>Bekasi</td>
<td>40,000</td>
</tr>
<tr>
<td>5</td>
<td>Dharma</td>
<td>Tangerang</td>
<td>4,000</td>
</tr>
<tr>
<td>6</td>
<td>PTPN IV</td>
<td>Medan</td>
<td>4,000</td>
</tr>
<tr>
<td>7</td>
<td>RAP Bintaro</td>
<td>Tangerang</td>
<td>1,650</td>
</tr>
</tbody>
</table>

Source: Priyarsono, 2007

In additions, the number of public fuel stations managed by PT Pertamina, an oil producing state-owned enterprise, was 265 units, which spread in Jakarta, Surabaya, Malang and Bali. The number of power generators using biofuels as the sources was 96 million watts (MW), which spread in the provinces of North Sumatra, Riau, Riau Islands, Lampung, all provinces in Kalimantan, Maluku, Bali and West Nusa Tenggara.

Among four main crops, oil palm is relatively the most rationally available to be converted into biofuels compared to jathropha, sugarcane and cassava. In 2008, the area planted for oil palm in Indonesia is estimated to reach 6 million hectare, while the production is about 18.6 million ton, which has passed the palm oil production of Malaysia (Table 4). However, the palm oil industry remains facing the pressing environmental issues of replacing the natural forest, increasing oil palm monoculture which threatens the biodiversity in the country. Specifically, the industry also faces a high and unstable price of crude palm oil (CPO) in the world market due to increasing demand to be converted into biofuels. The share of Indonesian palm oil is 44.3 percent of the total world production of palm oil. Industry’s response to this high demand is that the total CPO export increased significantly in the last years, reaching nearly 13 million ton in 2007, and will continue to increase. Consequently, the domestic cooking oil industry has to fight very hard to improve the continuity of CPO supply, which leads to the price rise of cooking oil in the retail markets. The government has increased the export tax of CPO as much as 20 percent to discourage the export and to stabilize the domestic price of cooking oil, but so far with no success (see Arifin, 2007b).

Table 4. World Production of Palm Oil, 2004-2008 (in million ton)

<table>
<thead>
<tr>
<th>Countries</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indonesia</td>
<td>12.38</td>
<td>13.97</td>
<td>16.05</td>
<td>16.70</td>
<td>18.60</td>
</tr>
<tr>
<td>Malaysia</td>
<td>13.97</td>
<td>14.80</td>
<td>15.88</td>
<td>15.82</td>
<td>17.30</td>
</tr>
<tr>
<td>Thailand</td>
<td>0.76</td>
<td>0.80</td>
<td>0.86</td>
<td>1.02</td>
<td>1.17</td>
</tr>
<tr>
<td>Other Countries</td>
<td>3.88</td>
<td>4.11</td>
<td>4.35</td>
<td>4.59</td>
<td>4.95</td>
</tr>
<tr>
<td>World Total</td>
<td>30.99</td>
<td>33.68</td>
<td>37.14</td>
<td>38.13</td>
<td>42.02</td>
</tr>
</tbody>
</table>

Note: * data for 2008 is an estimate
Source: Oil World and GAPKI-Indonesian Palm Oil Association, 2008
Biofuels development in palm oil sector is also implemented through the policy called domestic market obligation (DMO), by putting priority of CPO production for domestic market of cooking oil industry and for biofuels. In additions, the government is also trying to set up dedicated areas for oil palm plantations for biofuel, such as explained earlier. However, because the world price of CPO increased sharply in recent years and reached nearly US$ 1,300 per ton, the effectiveness of such DMO policy is in question, as the high price remains to become major incentives to increase the CPO export.

More importantly, the price difference between the market buying-price of biodiesel and the subsidized selling of diesel is quite wide. Pertamina, a state-owned enterprise that has been assigned to buy biofuels products has to pay at Rp 9,000 per liter of market price, but has to sell the diesel at Rp 4,300 per liter of subsidized, especially for transportation sector. A price margin of Rp 4,700 per liter is not a good sign of proper pricing structure, as the more biodiesel sold in the market would mean more losses to Pertamina. In this case, biofuels could lead to worsening efficiency level at this state-owned enterprise fuel producer in the country.

Beyond palm oil, the government is considering pushing other new technologies and crops to promote biofuels supply. In this spirit, a new policy effort is encouraging the use of *Jatropha curcas*, a crop which has been widely known by local farmers across the country. Under the biofuels development packages (Presidential Instruction 1/2006, Presidential Decree 5/2006, etc), the targeted area of jatropha plantation is 340 thousand hectares. However, because the market-pricing structure has not yet developed, the progress of jatropha-based biodiesel production is quite slow.

Similar case could happen in bio-ethanol production as the current sugar production of 2.8 million ton is far less behind the domestic consumption of 3.7 million ton or more. Indonesia has to depend on imported sugar to fulfill the food demand, which could trigger the price rise at the domestic retail market as the world price of sugar increased significantly. Finally, cassava production in Indonesia is about 20 million ton, and cassava is also known as inferior commodities due to agronomic characters requiring a large amount of nutrients. In this case, the prospect of bio-ethanol for mass and commercial development is very limited, at least in the short term.

**Impacts on Food Security and Rural Development**

By the time of this writing, there is no comprehensive rigorous research addressing the impacts of biofuels development on food security and rural development. Some argues that provisions on laws, decrees, and government commitments shall imply that biofuels development will exceeds energy security objectives. Biofuels development in Indonesia also is aimed at contributing to employment-generating activities and poverty alleviation, and regional development. Others, however, argue that expansion of oil palm plantation for biofuels development could also have large impacts on land use changes and land-holding structures. Conversion from natural forests into monoculture plantation of palm oil might threaten the ecological functions of tropical forests, hence reducing the capacity of ecosystem services they provide.

Biofuels development does not only contribute to the debates between forestry and agricultural development, but also stimulate policy priority between food and fuels and the environment. Concerns over Indonesia's environmental quality and the trade-off competition between foods and fuels also grow as biofuels development becomes the agenda of public debates and academic discussions. Specifically, the wide spread burning of natural forests and peat-based forestry plantation have caused Indonesia to become the world's greatest emitters of carbon. Ideally, biofuels is supposed to be carbon neutral. But, if widespread burning of the rainforests is needed to clear the way for the new palm oil plantations, the net effect of the plantation expansion could worsen the carbon emission of Indonesia.

An estimate about the impacts of biofuels on food security could be proxied by the following simple calculation. Using the production estimate of palm oil is 18.6 million ton, a 2 million kiloliter biodiesel production is equivalent to 9.68 percent of palm oil production. Meanwhile, the domestic consumption of biodiesel in Indonesia is only 16 thousand kiloliters (Tjakrawan, 2008), which equals to only 0.086 percent of palm oil production. Assuming the roadmap of biofuels development is fully implemented, the consumption level of biodiesel in Indonesia would be 1.29 million ton, which only equals to 6.9 percent of palm oil production.

Similar analogy could be employed to bioethanol production of 160 kiloliters, out of 1.4 million ton of ethanol and 800 thousand ton of molasses, which equals to only 10.28 percent of ethanol production. Current level of domestic consumption of bioethanol is 1000 kiloliters (Tjakrawan, 2008) which equals 0.057 percent of the ethanol production in Indonesia. If the biofuels roadmap is fully implemented, the consumption level of bioethanol in Indonesia would be 800 thousand kiloliters or equals to 57.14 percent.

Although more rigorous estimates and economic modeling have to be conducted to examine the impacts of biofuels development, the implementation of biofuels policy has so far no significant impacts on food security and rural development. In facts, policy supports for biofuels development have seems to decline significantly as the production process of biodiesel and bioethanol has to face limited access of palm oils and ethanol as the feedstock.

Moreover, biofuels development in Indonesia has additional objectives on generating employment and regional economic development. By 2010, the government has targeted about 3.5 million jobs created by biofuel development. It also is possible (though not certain) that this could contribute to increasing both on-farm and off-farm income related to biofuel sectors. Another targets of biofuels development policy is establishment of 1000 energy self-sufficient villages (ESSV= Desa Mandiri Energi) and 12 special biofuel zones (SBZ) all over the country. Investors on the biofuel industry are encouraged to involve community participations, small farmers, and micro and small enterprises (MSE) under public-private partnership (PPP) modalities.

Once these instruments are fully implemented, biofuels policy would have positive impacts on rural income, hence on food security and rural
development. In short, the balanced principles and optimal resource allocation between food and energy security and water sustainability (FEWS) should become the priority focus in biofuels development in Indonesia.

**Closing Remarks: Challenges faced by Biofuels Development**

The paper has examined issues on biofuel development in Indonesia, covering recent policies, trends on biofuels production, and their impacts on food security and rural development. Simple estimates have shown that biofuels development in Indonesia has no significant impacts on food security and rural development, although more rigorous estimates and economic modeling have to be conducted very soon. After the sharp increase of world oil price in the last two years, the future for Indonesian biofuels development is really in question. The world demand on palm oil and sugar also increases significantly, leading to price increase of these important raw materials of biofuels. Consequently, the domestic production of biodiesel and bioethanol in Indonesia is threatened to decline considerably as the biofuels producers have to face limited access of palm oils and ethanol as the raw materials.

Major challenges faced by biofuels development is on research and development on the trade-offs between food, fuels, forest and feeds. Capacity building for policy makers, researchers and academic community, private sectors and government agencies, is really required to sharpen the policy formulation, organization, and implementation of biofuels development. This should include modeling in inter-linkages in resource allocation and product use, as well as broader perspectives on international trades and dynamic modeling in the biofuels industry.

Another important challenge includes incorporation of macroeconomic elements, trade and development as the downstream industrial development of resource-based products requires long-term visions. Proper implementation of revitalizing agriculture is really required if the final objectives are to contribute to employment and income multipliers, thus reducing poverty level significantly in both rural and urban areas. Finally, biofuels development – such as any other development policies – also requires improvement of social capital, governance principles and enforcement structures at all level. Policy makers and government administration have to develop the property rights systems in order to improve the predictability of economic decision-making procedures by biofuels stakeholders.

**Table Appendix 1. Roadmap for Biofuels Development in Indonesia 2005 - 2025**

<table>
<thead>
<tr>
<th></th>
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<th></th>
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</thead>
<tbody>
<tr>
<td><strong>Biodiesel</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biodiesel Utilization</td>
<td>10% of Diesel Fuel Consumption</td>
<td>14.1 million</td>
<td>15% of Diesel Fuel Consumption</td>
</tr>
<tr>
<td><strong>Bioethanol</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bioethanol Utilization</td>
<td>5% of Gasoline Consumption</td>
<td>1.48 million</td>
<td>15% of Gasoline Consumption</td>
</tr>
<tr>
<td><strong>Bio-oil</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bio-oil - Biokerosene</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biokerosene Utilization</td>
<td>1 million</td>
<td>1.5 million</td>
<td>2.5 million</td>
</tr>
<tr>
<td>Bio-oil - Pure Plantation Oil Power Plant</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PPO Utilization</td>
<td>1.5 million</td>
<td>2.5 million</td>
<td>5 million</td>
</tr>
<tr>
<td><strong>BIOFUELS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BIOFUELS Utilization</td>
<td>2% of energy mix</td>
<td>2 million</td>
<td>5% of energy mix</td>
</tr>
</tbody>
</table>

**Figure 1. Targets of Energy Mix in 2026 (based on Presidential Decree 5/2006)**
Development of the Biodiesel Industry in Malaysia

The beginning of the third millennium witnessed the transition of the biodiesel technology in Malaysia from a research endeavor to a worldwide commercial enterprise. In line with the existing ‘Five-fuel Diversification Policy’, the Malaysian Government has launched the National Biofuel Policy in August 2005. The implementation of this policy came after many years of research in developing technology and improving the viability of palm based methyl ester (palm biodiesel), on a commercial scale, developed by the Malaysian Palm Oil Board (MPOB). The National Biofuel Policy consists of three important strategies; (1) production and utilization of biofuel for transportation, (2) production of biofuel for export, especially to the European market, and (3) commercialization of biofuel technology as a local technology.

Objectives behind Engaging in Biofuels Production

Malaysia participation in biofuel production sets the platform for achievement of the following objectives:

(i) Generate energy for the transportation and industrial sectors: The energy consumption in Malaysia grew at a fast rate of 5.6 percent, during the period 2000 -2005 to stand in the vicinity of 38.9 Mtoe ² in 2005. Oil, which is mainly utilized in the transport and industrial sectors, accounted for a big portion (63 percent) of the energy consumption. According to Energy Information Administration (IEA) estimations, the production of oil in Malaysia dropped to about 703,000 barrel per day in 2007, down from 862,000 barrels per day in 2004, whereas during 2007, Malaysia consumed an estimated 515,000 bbl/d of oil, 8 percent higher than the 2002 level (Figure 1 and Annex 1). Proven oil reserves were expected to last another 19 years, at 2005 production levels (EIA, 2008 b). Considering this situation, Malaysia has set the Five-fuel Strategy which recognizes renewable energy resources as Malaysia’s fifth fuel after oil, coal, natural gas and hydro. The Ninth Malaysia Plan (2006-2010) emphasizes the security, reliability and cost-effectiveness of energy supply, while focusing on sustainability (Government of Malaysia, 2006).

Figure 1. Malaysia’s Oil Production and Consumption, 2002-2007


1. Director and Research Fellow at the Institute of Agricultural and Food Policy Studies respectively, Universiti Putra Malaysia, fatimah@econ.upm.edu.my
2. Mtoe denotes million tonnes of oil equivalent
The introduction of biodiesel as an alternative fuel will help supplementing the depleting the local supply of fossil fuels and reduce and reduce the country’s imports of them. This will benefit the government through saving hard currency spent on these imports and reducing government spending on fuel subsidies which increased with recent higher oil prices.

(ii) Biofuel for Export: Alongside generating export revenues, producing palm-based biodiesel for export, will help reducing palm oil stocks, which safeguard against accumulation of stocks that might lead to price depression especially during periods of low export demand i.e. it helps in stabilizing and ensure remunerative the prices of the Malaysian palm oil.

(iii) Malaysia is one of the signatory countries to the Kyoto Protocol Malaysia who ratified to reduce greenhouse gas emissions. The use of palm biodiesel is expected to help reduce the use of fossil fuel and indirectly reduce the emissions of greenhouse gases.

(iv) Additionally, the move to produce palm biodiesel is assumed to promote rural development through creating more employment opportunities.

Policies for the development of biodiesel production and consumption

In order to promote the production of palm biodiesel, it is included in the list of products/activities that are encouraged under the Promotion of Investments Act 1986 according to which the biodiesel projects are qualified for Pioneer Status or Investment Tax Allowance. Additionally, if they meet particular measure, they may also be considered for other incentives such as Incentives for Strategic or High Technology projects and Incentives for Commercialisation of Research and Development findings of the public sector in resource based industries.

Moreover, the Government formulated the Malaysian Biofuel Industry Act 2006 to promote the domestic use of biodiesel. It was supposed to introduce a B-5 (EnvoDiesel, a 5% palm diesel oil blend) mandate, equivalent to a biodiesel demand of 500,000 tonnes, from 2008. However, the implementation of the Act has been delayed due to soaring palm oil prices (Milbrandt, 2008). The use of biodiesel among the public will be encouraged through giving out incentives for oil retail companies to supply biodiesel pumps at stations (Wikipedia, 2008).

Malaysian Biodiesel Industry Growth

Late 2005, Malaysia jumped on the biodiesel industry wagon calling for bids from companies to set up 3 biodiesel plants based on MPOB technology. As part of the government’s incentive to boost the new industry, the plants have been built by MPOB in collaboration with the private sector. Since then and despite the concerns developing in the palm oil industry that the biodiesel business may lose its viability if crude oil prices fall below the US$ 50 per barrel level, the interest in the biodiesel business has been growing. By the end of 2006, the Malaysian Industrial Development Authority (MIDA) had received more than 98 applications for licenses to build plants, of which 61 licenses to produce up to 6.3 million tonnes of biodiesel per year were issued and there were five plants in operation, of which, two belonged to private sector which could produce about 300,000 tonnes of fuel annually using refined palm oil as the basic raw material. Based on market information, 11 plants were operating by the end of 2007 (Rabobank, 2007). Globally, 600,000 tonnes of crude palm oil were used for biodiesel production in 2005 and this was estimated to grow to one million tonnes in 2007 (Chowdhury, 2007).

Exporting biodiesel is a major thrust for the biodiesel industry in Malaysia. In August 2006, Malaysia started its exports with 8,000 tonnes to stand at about 48,000 tons by the end of the year and in 2007 the volume of exports jumped to 95,000 tonnes (MPOB, 2008), mainly imported by USA (58%) and Europe (28%), with less shares in Australia and Asia (Table 2).

<table>
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<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Applied License (tonnes)</td>
<td>1(3,000)</td>
<td>2(6,000)</td>
<td>3(18,000)</td>
<td>98(10,537,430)</td>
<td>&gt;100</td>
</tr>
<tr>
<td>Approved License (tonnes)</td>
<td>1(3,000)</td>
<td>2(6,000)</td>
<td>3(18,000)</td>
<td>61(6300,000)</td>
<td>91</td>
</tr>
<tr>
<td>Installed Capacity (tonnes)</td>
<td>3000</td>
<td>6000</td>
<td>18000</td>
<td>300,000</td>
<td>970,000</td>
</tr>
<tr>
<td>Biodiesel Production (tonnes)</td>
<td>3000</td>
<td>6000</td>
<td>12000</td>
<td>78,000</td>
<td>399,000</td>
</tr>
</tbody>
</table>

Source: (Basiron, 2005 and 2008) and (Suki, 2006).

3. Actual figure for 2007 is not available.
Table 2. Malaysia: Export Volume (Tonnes) and Value (RM Mn); 2006 and 2007

<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>34,406</td>
<td>87.2</td>
<td>51,953</td>
<td>136.1</td>
</tr>
<tr>
<td>EU</td>
<td>12,598</td>
<td>31.4</td>
<td>24,696</td>
<td>60.4</td>
</tr>
<tr>
<td>Australia</td>
<td>0</td>
<td>0.0</td>
<td>6,065</td>
<td>16.5</td>
</tr>
<tr>
<td>Puerto Rico</td>
<td>0</td>
<td>0.0</td>
<td>6,001</td>
<td>20.2</td>
</tr>
<tr>
<td>Singapore</td>
<td>0</td>
<td>0.0</td>
<td>5,665</td>
<td>18.0</td>
</tr>
<tr>
<td>Others</td>
<td>982.0</td>
<td>2.3</td>
<td>633</td>
<td>2.0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>47,986</strong></td>
<td><strong>121</strong></td>
<td><strong>95,013</strong></td>
<td><strong>253</strong></td>
</tr>
</tbody>
</table>


Palm Oil Production

Palm Oil Growers

The palm oil plantations in Malaysia are mainly based on the estate management system and organized smallholders under Government schemes (Annex2). This has proved to be successful as it provides better utilization of resources. Furthermore, it has been essential in the application of advanced management, planting techniques and highly yielding material throughout most of the plantations and organized smallholders (Mohammad Jaafar, 1994). Independent smallholders with varying sizes of oil palm smallholdings also produce fruits bunches.

Private estates are owned and managed by large companies who often operate mills for oil extraction. They vary considerably in size, from a few hundred hectares to more than 100,000 hectares (Hai, 2002). Supported or organized smallholders grow palm oil with the direct support of government agency which gives technical assistance and inputs such as planting material, fertilizers and pesticides (sometimes partially subsidized by government), on a loan basis. There may be a verbal or written contract defining the agreement and probably encloses guarantees of sales and terms for calculating the mill price. Independent smallholders grow palm oil without direct support from the government and they are free to sell their crop either to independent dealers (middlemen) or directly to the mills (Annex3) (Vermeulen and Goad, 2006).

Of the total planted area in 2007, about 60 percent (about 2.6 mn ha) were under private estates. Government schemes comprise Federal Land Development Authority (FELDA), Rubber Industry Smallholder Development Authority (RISDA), Federal Land Consolidation and Rehabilitation Authority (FELCRA) and state schemes. They accounted for around 29 percent of the total area under oil palm in the same year, while the independent smallholders’ share was around 11 percent (Annex 2).

Production Growth

The oil palm plantings in Malaysia during the last decade have shown a dramatic growth (Figure 2, see pg. 37). From 3.8 million hectares in 1998, the oil palm planted area has expanded to around 4.3 million hectares by 2007 occupying two thirds of the agricultural land in the country (Basiron, 2007). In recent years, most of the expansion took place in the East Malaysian states of Sarawak and Sabah due to the declining availability of land in Peninsular Malaysia (Ming and Chandramohan, 2002).

The rapid expansion in oil palm cultivation resulted in a higher upsurge in palm oil production from about 8.3 million tonnes in 1998 to about 16 million tonnes in 2007 i.e. almost double. Now, Malaysia tops the list of the world major producers of palm oil, accounting for 44 percent of world production on average for the five years ending 2007.

Productivity

Setting a target of producing 20 million tonnes of palm oil in 2020 is a challenging job for Malaysia taking into consideration the stagnation of the average oil yield at around 3.6 t/ha over the last two decades (Figure 3), which represents yield gap of about 60% as oil palm has the potential of producing 8.8 tonnes oil per hectare (Jalani et al., 2002). In order to remain competitive, productivity, namely oil extraction rate (OER) and fresh fruit bunches (FFB) yield, has to be improved. It is the vision of the Government that the oil palm industry should strive to achieve FFB annual yield of 35 tonnes per hectare and a 25% OER by 2020 (Basiron and Simeh, 2005).

---

4. Smallholders are defined as family-based enterprises producing palm oil from less than 40.5 ha of land (Hai, 2002 and Vermeulen and Goad, 2006).
The main reasons for stagnating FFB yield and OER resulting in lower productivity are:

(i) Expansion into marginal areas with unsuitable soils.

(ii) Inadequate use of the agronomic inputs required for maintaining yields, which occur sometimes, especially during low palm oil prices affects productivity (Soh and Goh, 2002).

(iii) Low replanting rate has contributed to the present high percentage of old palms, has posed harvesting difficulties and hence lowered productivity.

A yield improvement of 10% - 20% can be expected in the near future through the introduction of clonal hybrids and clones with better oil-to-bunch improved and adaptability to different environmental and/or agronomic situations (Basiron and Simeh, 2005). Efforts towards improving productivity and better management practices are going on to improve both FFB yield and OER in Malaysia.

Cost competitiveness

There is general consensus that - in the absence of subsidies - palm oil is the most competitive vegetable oil for the production of biodiesel (Thoenes, 2006). According to Rabobank estimates, the price of palm bio-diesel in the EU - if produced in Malaysia- will be about US$784-804/tonne (Table3). The estimated average production costs for rapeseed and soybean bio-diesels are US$1,037/tonne and US$841/tonne, respectively. According to the same study, the comparable reported consumer bio-diesel price in Germany was, based on a three-month average, US$1,332 (Cherie Tan, 2007)). So far, even at the current soaring vegetable oil prices, there is still an advantage for palm oil which trades at a considerable discount to rapeseed oil and soybean oil (Figure 4).
Table 3. Estimated Biodiesel Production Cost Comparisons (USD/tonne)

<table>
<thead>
<tr>
<th>Cost Component (USD/tonne)</th>
<th>Palm Oil</th>
<th>Rapeseed Oil</th>
<th>Soybean Oil</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feedstock (FOB at producing country)</td>
<td>547</td>
<td>800</td>
<td>601</td>
</tr>
<tr>
<td><strong>Bio-diesel Production Cost:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solvents, acids and chemicals</td>
<td>47</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other costs</td>
<td>35</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjustment for Energy Parity with petroleum diesel (based on 90% of kj/kg of energy of petro-diesel)</td>
<td>55</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>137</td>
<td>196</td>
<td>150</td>
</tr>
<tr>
<td>Cost of palm oil based biodiesel (FOB Malaysia)</td>
<td>684</td>
<td>996</td>
<td>751</td>
</tr>
<tr>
<td>Est. freight &amp; insurance cost to Rotterdam</td>
<td>70</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total landed cost in EU</strong></td>
<td>754</td>
<td>996</td>
<td>801</td>
</tr>
<tr>
<td>Local Distribution</td>
<td>~30-50</td>
<td>~30-50</td>
<td>~30-50</td>
</tr>
<tr>
<td><strong>Total Cost EU (at petrol Kiosk)</strong></td>
<td>784-804</td>
<td>1,029-1,046</td>
<td>831-851</td>
</tr>
<tr>
<td>Price of Retail Bio-diesel (Germany)a</td>
<td></td>
<td>1,332</td>
<td></td>
</tr>
</tbody>
</table>

Notes: Assuming production plant with capacity > 100,000 tonnes/year; other figures based on pricing as at March 2007.

a: F O Licht based on UFOP Markinformation (3month) average retail prices from November 2006 to January 2007.

Source: Rabobank (2007).

Impacts on Rural Development

Rural development is usually a major motivating factor for developing a biofuel industry. Biofuel industry in Malaysia has significant potential to promote rural development through its impacts on the palm oil industry. Although primarily an estate crop, the Malaysian oil palm industry has been successfully adapted to fit the needs of smallholders, and has proved a successful instrument for poverty eradication in Malaysia (Fairhurst and Mutert, 1999). Now, the industry, including the downstream sectors, provides employment to 860 thousand people, both directly and indirectly, (MPOC and MPOB, 2008). The land schemes are provided with basic facilities such as piped water, electricity, communications, roads, schools, healthcare services as well as greater employment opportunities generated in the economic activities. The expected economic development benefits to the palm oil industry resulting from the introduction of the palm oil-based biodiesel production will be reflected on
those involved in the industry along the palm oil value chain, including the producers (Annex 3). For example, the impact of creating new and rapidly growing market might be to push up the price of palm oil, which could be good for producers in general and smallholders in particular. Additionally, the establishment of biodiesel projects with all its related services in rural areas will directly improve the living standards through job creation, both directly and indirectly, and, as a result, increased local revenue generation. Moreover, the rural community in the neighborhood will benefit from the project related services, including education, health care and infrastructure.

Challenges

Despite its impressive development, there is a host of issues and challenges are facing the Malaysian biodiesel industry. High on the agenda are:

(i) Uncertainty in oil and feedstock prices. Palm biodiesel will lose its viability if crude oil prices fall below USD80/barrel against CPO price of above RM1,422/tonne. To promote biodiesel, some form of subsidy needs to be provided.

(ii) Food vs. fuel issue. Escalation of the currently muted food versus fuel debate may negatively impact palm oil in future, it is even feared that palm oil could be channelled for energy purposes, thus depriving its usage for food. There is a need to strike a balance on feedstock for both.

(iii) Sustainability issues. Currently Roundtable on Sustainable Palm Oil (RSPO) focuses on food and the EU is emphasizing on the sustainable production of feedstock for biofuel.

(iv) Limited available land. To keep the area under oil palm within the projected 4.5 million by 2020, the focus should be on increasing productivity.

(v) Second generation and non-food biofuels pose threat to inter alia palm biodiesel market potential; new sources of biofuels including the production of bioethanol from new sources viz jathropa, nipah, sago and oil palm biomass should be explored. New technologies must be scientifically proven and commercially viable which need new non-tariff barriers. Importing countries are establishing trade barriers in the form of standards for biofuels including factoring in sustainable sources and excluding palm based biofuels from domestic tax credits.

Conclusions

The implementation of the biofuel policy came after many years of research in developing technology and improving the viability of palm based methyl ester (palm biodiesel). The objective of the policy is to encourage the production and usage of palm oil biofuel as an environmentally friendly alternative energy source, reducing the country’s fuel import bill, promoting further the demand for palm oil which will be the primary commodity for biofuel production (alongside regular diesel), as well as to stabilize the price of palm oil especially during periods of low export demand.

Despite present challenges, the future of the palm biodiesel industry remains bright. The competitiveness of palm oil in terms of bio-diesel costing lends an opportunity for the Malaysian palm biodiesel industry to pursue comparative advantages over other feedstock. Sustainability concerns as well as import-market potential in terms of consumption and production volumes, growth and the structure of the fuel industry in the importing countries.

Legislation and government support remain a key element for the expansion of the biodiesel Industry. The government should support public and private research to lower the cost of biofuel production through raising feedstock yields per area and biofuel yields per tonne of feedstock, and to stimulate development of new technologies to improve technical properties of biofuels from existing and new feedstock. Policymakers must also be vigilant of economic tradeoffs, such as the impacts on the intensity of land use.


<table>
<thead>
<tr>
<th>Item</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
</tr>
</thead>
<tbody>
<tr>
<td>Production</td>
<td>698</td>
<td>738</td>
<td>755</td>
<td>631</td>
<td>613</td>
<td>588</td>
</tr>
<tr>
<td>Consumption</td>
<td>463</td>
<td>480</td>
<td>508</td>
<td>501</td>
<td>501</td>
<td>501</td>
</tr>
</tbody>
</table>

Source: EIA, 2008a

5. Currently, there are no contractual agreements between the farmers and the biodiesel industry in Malaysia.
6. It has been reported that a major motivation for smallholders in Malaysia to join the supported schemes is guaranteed sales in international markets with more price stability than local markets (IDEAL, 2001)
(‘000 ha and percentages)

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<tbody>
<tr>
<td></td>
<td>Area</td>
<td>%</td>
<td>Area</td>
<td>%</td>
</tr>
<tr>
<td>Private Estates</td>
<td>557.7</td>
<td>52</td>
<td>912.1</td>
<td>45</td>
</tr>
<tr>
<td>Government Schemes:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FELDA</td>
<td>316.6</td>
<td>30</td>
<td>608.1</td>
<td>30</td>
</tr>
<tr>
<td>FELCRA</td>
<td>18.9</td>
<td>2</td>
<td>118.5</td>
<td>6</td>
</tr>
<tr>
<td>RISDA</td>
<td>20.5</td>
<td>2</td>
<td>32.6</td>
<td>2</td>
</tr>
<tr>
<td>State Schemes</td>
<td>85.5</td>
<td>8</td>
<td>174.5</td>
<td>9</td>
</tr>
<tr>
<td>Independent Smallholders</td>
<td>70.4</td>
<td>6</td>
<td>183.7</td>
<td>9</td>
</tr>
<tr>
<td>Total</td>
<td>1069.5</td>
<td>100</td>
<td>2029.5</td>
<td>100</td>
</tr>
</tbody>
</table>

Sources: PORLA and MPOB (2008).

Annex 3. Palm Oil Value Chain in Malaysia

Private estates → Government Schemes → Independent small holders

FFB → Middlemen → CPO
Estate - owned mills → FELDA, RISDA mills → Independent mills

Estate - owned refineries → FELDA independent refinaries → Manufactures

Exporters

* Includes Crude Palm Stearin and Olein; RBD palm oil, Stearin and Olein and Palm fatty Acid Distillate.
Source: Adapted from Vermeulen, S. and Goad, N. (2006)
Introduction

The recent interest on biofuels is induced by two global development trends. The first is the continued acceleration of the price of fossil fuels. The second is focused on environmental concern: the build-up of carbon dioxide emissions.

From a steady below US $30 price per barrel from 1990 to 2003, the world price of crude oil escalated to US $119 per barrel, by the end of the first quarter of 2008 (Table 1). These crude oil price increases were due to the high global demand of energy, and the oligopolistic nature of crude oil production, i.e. supply is controlled by the Organization of Petroleum Exporting Countries (OPEC).

There is also global concern on the steady rise of carbon dioxide (CO2) emissions. CO2 emissions from fossil fuel burning rose from 6,195 million tons of carbon in 1990 to 8,556 million tons in 2007 (Figure 1), or an average of about two percent per year (U.S. Department of Energy).

The alternative global response to the increasing prices of fossil fuels and carbon dioxide emissions are biofuels (bioethanol and biodiesel). As clear alternative to fossil fuels, the supply of biofuels is still inadequate for a major substitution. However, there is also the global issue on land use for food versus biofuels exacerbated by the current food crisis in the developing countries of the world.

The Philippines, like any petroleum import dependent economy, is also locked in on the issues related to food security, energy security, renewable energy and global warming. How to balance the trade offs on food biofuels and environmental concerns, and develop a doable national development strategy to address them are the challenges to the present leadership in the Philippines today.

Strategies in engaging in biofuels production

As a declaration of policy, the Philippines is engaged in biofuels production to reduce dependence on imported fuels, with due regard to the protection of public health, the environment and natural ecosystems consistent with the country’s sustainable economic growth that would expand opportunities for livelihood, and mandate the use of biofuels as a means to:

- Develop and utilize indigenous renewable and sustainable clean energy sources to reduce dependence on imported oil;
- Mitigate toxic greenhouse gas (GHG) emissions;
- Increase rural employment and income; and
- Ensure the availability of alternative and renewable clean energy without detriment to the natural ecosystems, biodiversity, and food reserves of the country (RA No. 9367).

A National Biofuels Board (NBB) was also created by RA No. 9367, Chaired by Secretary of the Department of Energy (DOE), and composed of six selected Heads of Agencies as members. The NBB will also be assisted by a Technical Secretariat in monitoring the implementation of the National Biofuels Program, or Alternative Fuels Programs (AFP).

The AFP is one of the five key components of the Arroyo Administration’s Energy Independence agenda, which outlines the roadmap that will lead to the country’s attainment of 60% energy self-sufficiency by 2010. Moreover, AFP has four major subprograms, namely: Biodiesel Program, Bioethanol Program, Natural Gas Vehicle Program for Public Transport (NGVPPT), and the Auto gas Program. Other technologies advocated under the program are hybrid, fuel cell, hydrogen, and electric vehicles (DA, 2008).

1. Founding President and Chairman of the Board, Society Towards Reinforcing Inherent Viability for Enrichment (STRIVE), al@strivefoundation.com
Policies for the development of biofuels market

In July 2006, President Gloria Macapagal-Arroyo signed RA 9367, popularly known as the Biofuels Law. Central to the provision of the Biofuels Law is the phasing out of the use of harmful gasoline additives, not limited to Methyl Tertiary Butyl Ether (MTBE) such as:

Bioethanol
Within two years upon affectivity of the Biofuels Law, at least five percent bioethanol blend; and within four years, minimum of 10 percent blend.

Biodiesel
Within three months of the affectivity of the Law, minimum one percent, and within two years, two percent blend.

The Biofuels Law also encourages investments in the production, distribution, and use of locally-produced biofuels by providing the following incentives:

- **Specific Tax.** The Law provides **zero Specific Tax** on local and imported biofuels component of the blend per liter. The gasoline and diesel component shall remain subject to specific tax rates.
- **Value Added Tax.** The sale of raw material used in the production of biofuels such as but not limited to, coconut, Jathropha, sugarcane, cassava, corn, and sweet sorghum, **shall be exempt from value added tax.**
- **Water Effluents.** All water effluents, such as but not limited to distillery slops from the production of biofuels used as liquid fertilizers and for other agricultural purposes are considered **“reuse”** and therefore **free of wastewater charges.**
- **Financial Assistance.** Government financial institutions such as the Development of the Philippines, Land Bank of the Philippines, Quedancor, and other government institutions providing financial services shall accord **high priority** to the entities with at least sixty percent (60%) of capital stock belonging to citizens of the Philippines. These shall engage in activities involving production, storage, handling and transport of biofuels and biofuels feedstock, including the blending of biofuels with petroleum, as certified by the Department of Energy.
- **Other Provisions.** The DOE shall also endorse qualified biofuels producers to the Board of investment for them to avail for appropriate fiscal incentives. Likewise, the Tariff Commission of the Philippines will also create and classify, in coordination with the appropriate agencies, a tariff line for biofuels and biofuels-blend in consideration of WTO and AFTA agreements.

The role of oil companies was also defined by the Biofuels Law in the blending of biofuels, supply and distribution of biofuel blends in accordance to Philippine National Standards, and in the importation of bioethanol in the event of shortage of locally – produced bioethanol during the first four-year effectiveness of the Law.

DOE will accredit the biofuels producers based on accreditation guidelines. Finally, the importer end-users, who are direct importers of diesel or gasoline, shall also be subjected to the required use of the mandated biofuel blend.

Production Of Biofuels in the philippines

The energy sector has projected in 2005 the continued demand for the consumption of fossil fuels (diesel and gasoline). For the 2005-2014 planning period, the Philippine energy plan estimated the transport's sector use of fuels to increase at an annual rate of 4.7 percent. Gasoline demand is projected to increase from 22 million barrels of fuel oil equivalent (MMBFOE) in 2004 to 37 MMBFOE in 2014 (Figure 2), while diesel demand was projected to increase from 41 MMBFOE in 2004 to 59 MMBFOE in 2014 (Figure 3). Diesel is the dominant fuel used in the transport sector and therefore, the competitive production of domestic biodiesel can free the country's dependence on imported diesel fuels. Likewise, domestic production of bioethanol to substitute for gasoline will have the same effects as biodiesel.

Biodiesel production

The major feedstock for biodiesel production in the Philippines are coconut oil and palm oil. Jathropa and Moringa are also evolving as potential sources of biodiesel because of their oil-rich seeds. However, there are no actual processing plants to date in the Philippines demonstrating their economic viability. So in effect, the major raw material providers of biodiesel are the coconut oil (CNO) converted into coconut methyl ether (CME) and palm oil.

Since the Biofuels Program has just started in mid – 2007, the actual production of CME’s for domestic use is very negligible.

However, the global and domestic demand for biodiesel induced four companies to increase their aggregate capacity for coco-diesel production to 151 million liters per year in 2007. Chemrez and Senben Fine Chemicals dominate the coco-diesel production in the Philippines.

The projected domestic demand for biodiesel for 2015 was around 5,544 million liters (Table 2). At the mandated 2 ½ blend coconut oil requirement was only 8 percent of projected demand by 2015 (DOE). The excess domestic production can be reported to Europe, U.S., China and Australia.
Bioethanol

Bioethanol or ethyl alcohol, is a clear liquid alcohol produced by the fermentation of simple sugars. There are two main types of ethanol fuel. The first type is the anhydrous ethanol, which does not contain water, and is used in blends with gasoline in various proportions, 5% (E5) to 85% (E85). The second type is the hydrous ethanol, which contains approximately 2.5% water by volume, and is used to fuel specifically modified engines. Hydrous ethanol is a total fossil fuel substitute. Brazil, US, and Canada are the top producers of bioethanol.

In the Philippines, sugarcane is the most favored feedstock for bioethanol. Another crop, sweet sorghum is evolving as alternative feedstock source. Corn, which is the major feedstock for ethanol in the US is not being contemplated as a feedstock for bioethanol in the Philippines. Corn is considered as food crop especially white corn, while yellow corn is a core feed ingredient in the production of poultry and livestock. There are other potential sources of bioethanol in the Philippines like cassava and other root crops, but their economic viabilities are still not confirmed.

Sugarcane

The sugarcane industry is a major industry cluster in the Philippines, worth around PhP58 million, and accounting for eight percent of agriculture GVA in 2006 (Amara, et. al, 2007). Area planted to sugarcane is around 392,000 hectares, employing around 500,000 workers, with aggregate output of 2.23 million mt of which 85% is consumed domestically. The remaining 15% (330, 000 mt) is exported in the world market.

The use of sugarcane as a feedstock in the production of bioethanol is very strategic for the sugarcane industry. The commodity is currently classified as sensitive commodity under AFTA whose tariff level will be substantially reduced in 2010. Using it as a feedstock for bioethanol rather than exporting it at a loss at the World market is a better alternative for the sugarcane industry.

The SRA estimates that a sugarcane area of 59, 000 hectares will be needed to produce about 3.8 million mt of sugarcane biofuel feedstock, at 4,550 liters of ethanol per hectare, to meet the five percent (E5) minimum bioethanol blend by 2009. SRA also projects that from crop years 2007 to 2011, some 15 stand alone bioethanol distillery plants will be constructed to expand the sugarcane areas dedicated to bioethanol production. However, to date, these proposed distillery plants are not yet operational, and therefore no domestic production of ethanol is supplied in the market.

Impact on rural development

The biofuel program has just started in 2007 and thus there are no empirically driven quantitative indicators to measure its impact. However, given some known facts about energy and food security in the Philippines to date, we can deduce probable impacts within the context of the policy objectives of the Biofuels Law.

First, on mitigating carbon emissions and climate change. This is a global concern and the Philippines is a minor contributor to the planet earth CO₂ emission problems. Philippines has a low per capita CO₂ emission of less than 1 mt per annum. The Philippines is also essentially carbon neutral and therefore, “the use of biofuels for transport to mitigate global climate change is great but as a country, we cannot do much about it” (Javier, 2008).

Second, on reducing dependence on imported fuel. To some extent, substitution of domestically produced biofuels with fossil fuels has minor effects considering that the blends range from two percent (biodiesel) to 10% (bioethanol). Targeting 60% energy self sufficiency in 2010, can better be achieved by a broader approach of “energy conservation more oil and gas exploration, fuller utilization of coal resources, and geothermal exploitations” (Javier, 2008).

Finally, increasing rural employment and incomes. This analysis supports the prognosis of Javier that the biofuels program can act as a productively shifter to reduce poverty incidence in the countryside.

The Javier’s basic arguments are quoted below:

“Among the hierarchy of national development goals, the elimination of poverty is paramount and since poverty in the Philippines is largely a rural phenomenon, biofuels production creates an additional window to create livelihoods, raise incomes and improve overall productivity in the countryside. Therefore, the principal rationale for the country’s biofuels program has to be to increase rural employment and raise incomes for the rural poor with which to buy food, clothing, shelter, medicines, and other life necessities.

The policy debate on biofuels in order to be more focused and meaningful therefore ought to be rephrased: How can biofuels create livelihoods, raise incomes, and improve productivity in the Philippines countryside?”

Therefore, the creation of livelihood, the increase in incomes and improvement of overall productivity in the countryside should be the basic rural development impact indicators by which we will measure the biofuels program in the medium to long term.

Challenges faced by the biofuels program

The Philippines is faced with three basic constraints that militate against the biofuels program. These among others, include: limited natural resource endowments and deteriorating rural infrastructures, unbridled population growth, and effective governance.

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Limited Natural Research Endowments

The Philippines is a small country with very limited land, water, and forest resources. The introduction of a new program like biofuels will necessarily stir policy debates relative to the alternative uses of land, like food production. In addition, the rural infrastructures to facilitate the efficiency of production distribution and utilization of goods and services in the rural sector are under funded and inadequate. This inadequacy constrains most productivity enhancing development activities in the rural sector.

Majority of the policy makers recognize that to optimize the positive convergence of food and energy policy, basic rural infrastructures and support services which are food and biofuel neutral should be in place. A major component of these neutral public investments will be in research and development that will enhance productivity in both food and biofuel crops.

Unbridled Population Growth

Population is a demand shifter in the utilization of any good or service. However, it can also be the source of human capital that can shift in the long run, the supply curve of the same good or service. In providing basic public goods and services, unbridled population growth becomes an initial strain to public expenditures leading to higher cost and eventually loss of global competitiveness in any economic sector. Given limited natural resource endowments and public financial resources, there is a need to rationalize population policies in the country.

Ineffective Governance

The Philippines has no good track records in public and corporate governance. Ineffective governance leads to lack of confidence in public sector and hence, disincentive for foreign direct investments. The biofuels program needs foreign direct investments that can facilitate the efficient production, processing, and distribution of both food and biofuels products to have multiplier effects on poverty alleviation.

Figures

**Figure 1. Trends in Global Carbon Dioxide Emission from Fossil Fuel Burning and Crude Oil Prices, 1990 to 2008.**

![Graph showing trends in CO2 emission and crude oil prices from 1990 to 2008.]

Source: U.S. Department of Energy

**Figure 2. Demand Forecast for Diesel, 2002-2014**

![Bar chart showing demand forecast for diesel from 2002 to 2014.]

Source: PEP 2005

**Figure 3. Demand Forecast for Gasoline, 2002-2014**

![Bar chart showing demand forecast for gasoline from 2002 to 2014.]

Source: PEP 2005

<table>
<thead>
<tr>
<th>Year</th>
<th>Carbon Dioxide Emission from Fossil Fuel Burning(a) (Million Tons of Carbon)</th>
<th>Atmospheric Concentration of Carbon Dioxide (Parts Per Million)</th>
<th>World Crude Oil Prices(b) (Million Barrels per Day)</th>
<th>World Crude Oil Prices(c) (Million Barrels)</th>
<th>Ethanol Price(d) (Anhydrous Ethanol (US$ / Barrel))</th>
<th>World Biodiesel Production(f) (Million Liters)</th>
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<td>1990</td>
<td>6.196</td>
<td>354.16</td>
<td>60.5</td>
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<td>18.9</td>
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<td>95.3</td>
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</table>

\(a\) Source: 1990 to 2004 emissions came from the Carbon Dioxide Information Analysis Center - US Department of Energy. 2005 and 2006 emissions was calculated by Earth Policy Institute, Statistical Review of World Energy, London. 2007 and 2008 emissions are estimates based on past trends and atmospheric concentration of carbon dioxide.

\(b\) Source: Energy Information Administration - US Department of Energy. 1990 to 2007 data are actual production. The 2008 level is an outlook estimate.

\(c\) Source: Energy Information Administration - US Department of Energy. 1990 to 2007 prices are yearly averages. The 2008 data is the average price up to April 18, 2008.


\(e\) Source: Centro de Estudos Avançados em Economia Aplicada (CEPEA), Brazil. Fuel ethanol prices in Brazil refer to averages for the São Paulo market (mills, distilleries, distributors, intermediaries). Hydrous ethanol is used as a substitute for gasoline and Anhydrous ethanol is mixed with gasoline.


### Table 2. Biodiesel Demand Projections, 2007 - 2015

<table>
<thead>
<tr>
<th>Year</th>
<th>Mandated Blend (%)</th>
<th>Demand(a) (in million liters)</th>
<th>Req(t) (in million liters)</th>
<th>Req(t*) (in million liters)</th>
<th>Percent Coconut Oil Req(t*) (%)</th>
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<tbody>
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<td>1</td>
<td>4,121</td>
<td>41</td>
<td>41</td>
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<tr>
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<td>4,274</td>
<td>85</td>
<td>85</td>
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<td>2</td>
<td>4,447</td>
<td>89</td>
<td>89</td>
<td>6</td>
</tr>
<tr>
<td>2010</td>
<td>2</td>
<td>4,586</td>
<td>92</td>
<td>92</td>
<td>7</td>
</tr>
<tr>
<td>2011</td>
<td>2</td>
<td>4,786</td>
<td>96</td>
<td>96</td>
<td>7</td>
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<tr>
<td>2012</td>
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<td>2015</td>
<td>2</td>
<td>5,544</td>
<td>111</td>
<td>111</td>
<td>8</td>
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</tbody>
</table>

\(a\) DOE Estimates Demand for Diesel

\(t\) Assumption Coconut Oil Conversion to CME 1:1

\(t*\) Based on latest available data, coconut oil production is approximately 1.4 billion liters
Introduction
Since the oil crisis in 1979, the Thai governments have introduced a series of oil policy reforms and liberalisation. The Ministry of Energy has set a clear policy to produce and secure alternative sources of energy, e.g., gas, coal, solar and wind energy, imported hydro-electricity and gas from neighbouring countries, and biofuel, etc. With a rapidly rising oil price to US $ 60-70 in 2006 and more than USD 100 in 2007, biofuels have become competitive with petroleum in Thailand. Yet the higher agricultural prices of agricultural feedstock relative to that of oil and the recent decline in oil prices affect the competitiveness of biofuels. The challenge is to what will be an appropriate biofuel policy that will benefit the farmers in the long-run without creating unnecessary distortions.

After discussing the government’s rationale for the biofuel policy, this paper will summarise the strategies and some key components of the biofuel policy. The second objective of this paper is to describe the development of the ethanol market and gasohol market and some key policy issues. The third objective, which is the main focus of this paper, is to explain the pattern and trend of the production of feedstock crops, the feedstock policies and then to analyze qualitatively the impact of the ethanol policy on the farmers.

The paper will try to address two main questions, i.e., (a) whether or not there will be adequate supplies of feedstock crops to meet the targeted ethanol policy which aims at substituting 2.2 % of final energy requirement by biofuels by 2011 (Energy Policy, v. 78, October-December 2007, p. 63); and (b) will the small farmers benefit from the ethanol policy and what is its impact on poverty? The environmental impact will also be briefly outlined.

Why did the Thai government introduce the biofuel policy?
The Thai government first launched the biofuel policy in 2003 before the oil prices began to rally. Its main concern was that the Thai economy depended excessively on imported oil. Net energy import is now as high as 64 percent of total primary commercial consumption. The net oil import is projected to increase from 75 percent of oil consumption in 2002 to 95 percent in 2020. Since 38 percent of energy consumption is in the transportation sector and 80 percent of the energy used in transport is for land transport, the success of biofuel policy will significantly reduce Thailand’s oil import needs.

In addition to the energy security, other rationale, though less important, for biofuel policy include environment and agricultural development. The rapid increases in energy production and energy consumption have generated more green-house gas and other toxic emissions, e.g., CO₂ from the energy sector jumped from less than 100 million ton in 1992 to 190 million tons in 2005. By replacing the MTBE-blended with ethanol-blended gasoline, the biofuel policy can help reducing carbon emission. The biofuel policy will also result in an increase in demand for agricultural feedstock required for the production of biofuels; contribute to the agricultural development, and thus a brighter future for the Thai farmers.

Since 2003, the governments have issued a series of cabinet resolutions regarding the biofuel development policy. The targets and strategies have been ambitiously and clearly set. Alternative energy use is targeted at 12.2% of final energy requirement in 2011 (Energy Conservation Plan 2008-2011). The biofuels are expected to supply as much as 2.2 percent of the energy requirement. The targeted production of ethanol is to increase from 1 million liters per day in 2006 to 3 million liters per day in 2011, comparing to the 4 million liters of daily consumption of gasohol 95 in 2005. There are two phases of ethanol strategy, i.e., the MTBE replacement followed by the gasohol mandate. The government strategy was first to replace the Octane 95 gasoline, which is a highly polluted MTBE-blended fuel, by the more environmental friendly ethanol-blended gasoline (or gasohol 95 and E10). To reach the target, the Ministry of Energy (MOE) encouraged the private sector to build the ethanol plants through several measures. The most important incentive is the excise tax incentives for the producers of ethanol and the users of gasohol, amounting to 3.5-4.0 baht (or 9.7-11.1 cent) less than those of gasoline 95. In addition to the establishment of the reference price of ethanol,
There are two main feedstock for ethanol production, i.e., molasses and cassava, the former being the cheapest and most popular feedstock. The biofuel policy also contains the institutional and development strategies. The government sets up a new Biofuel Committee as the monitoring agency. After a series of consultation with the cassava and sugar associations, it also sets the “reference price” of ethanol based upon the CIF price in Brazil plus freight, insurance and other costs. Other institutional and development measures include specification of pure alcohol, gasohol 95 and gasohol 91; government cars have to use gasohol; excise tax reduction by 5% for new cars that use E-20; liberalization of alcohol factory on 2 September 2006; and liberalization of alcohol export in December 2006, etc.

Although the policy and strategies have been determined in a process which involved the officials from various ministries, scientists and stakeholders from the private sector, it cannot be denied that the Ministry of Energy played the most influential role in response to the dictate of the then-prime minister. Detailed examination of the policy and strategies show that they were not carefully thought out as many constraints were not properly addressed. This explains why many ethanol producers who have already spent billions of baht in their investment are now loudly criticizing the government, especially the uncertainties of its policy stance and commitments.

The development of markets for ethanol and gasohol

After the implementation of the biofuel policy, 49 projects of ethanol plants were approved by the government, with the total production capacity of 12.805 million liters per day. As of the end of the first quarter of 2008, eleven ethanol plants were in operation with the total production capacity of 1.675 million liters per day. Most factories use molasses Actual production of ethanol was almost relatively constant in 2006 and began to surge after the mid 2007 (see Figure 1).

Despite the price differential between the 95-octane gasoline and the 95 gasohol, the sale of 95 gasohol has not picked up until an oil company advertised that it promised to reimburse the car owners any damage from gasohol use in 2005. An increase in the number of gas stations selling gasohol in 2005 is also a contributing factor. But in 2006 the monthly consumption remained constant. The ethanol producers began to complain that the price of ethanol was too low comparing to the rising cost of the feedstock. In response to the oil price increase, the government lowered the excise tax rate and oil fund contribution for gasohol, resulting in a widening price gap between gasohol 95 and octane-95 gasoline from 4.17 cents to 9.7-11.1 cent per liter in mid 2007 (see Table 2). Consequently, the gasohol sale surged again in 2007.

Despite the rapid increase in gasohol consumption, there was excess supply of ethanol beginning in the early 2008. Consequently, the market price of ethanol (44.4 cents) was lower than the “reference price” (47.2cents). Many ethanol producers are complaining that despite the increase in feedstock prices, they are forced to sell ethanol at the discount price to a few oil producers who have more bargaining power.

There are several reasons for the current problem of excess supply of ethanol* i.e., a shift in government policy not to ban the sale of Octane-95 gasoline which was scheduled on January 1, 2007; forty percent of passenger cars in Bangkok cannot use gasoline since they are older than 10 years; and the export constraints.

The current excess supply of ethanol will be only temporary. If the government can successfully encourage most of the new buyers to buy the E20-cars in the second phase, the existing capacity of ethanol production (2.875 million liters per day) will not be enough to satisfy the future needs, estimated at 3 million liters, assuming that 50 % of the passenger cars will use the E-20. The shortage will not arise if those entrepreneurs who have already received their permit decide to build the new plants as scheduled. However, the total capacity of 49 approved ethanol projects will not be enough to satisfy the requirement of the E-85 cars in the third phase.

Impact of the ethanol policy on the production of feedstock crops

There are a few critical questions about the potential supplies of feedstock that need to be addressed for a success of the biofuel policy, e.g., will there be adequate supplies of cheap feedstock to meet the future increases in the demand for ethanol?; what will be the impact on food production, poverty and environment?

There are two main feedstock for ethanol production, i.e., molasses and cassava, the former being the cheapest and most popular feedstock.
Although Thailand is a major exporter of sugar, it does not use sugar cane to produce ethanol due to the legal constraint imposed by the revenue-sharing agreement between the sugar cane growers and sugar millers. Since molasses is not included in the revenue-sharing agreement and its price is the cheapest, it is now the main feedstock supply for the ethanol production. The low molasses price is due to its abundant supply of molasses. It is mainly used for the production of alcohol, mono-sodium glutamate and animal feed, and yet as much as 43% of molasses is exported. On the other hand, there is only one ethanol factory that use cassava as their feedstock. There are two reasons why cassava is not the competitive input, i.e., its price is high relative to that of molasses; and the higher processing cost. A surge in the cassava price to more than 6.9 cents per kilogram in 2008 made it not commercially competitive as the input for ethanol production.

However, if the E-20 and E-85 policy are successful, the supply of molasses will not be adequate. Additional supplies of feedstock have to come from the expansion of sugar cane and cassava production. If all the passenger cars use E-20, the required molasses of 5.62 million tons will exceed the existing production of 3 million tons. The required supplies of sugar cane (20.86 million tons) and cassava (8.11 million tons) will be still be enough to satisfy the demand for ethanol as they will still account for 30% of sugar cane output (70 million tons) and cassava output (27 million tons). Given the fact that productivity improvement and acreage expansion have resulted in the expansion of sugar cane output (by 5.1% per year) and cassava production (4.2% per year) during the 1990-2007 period, there should be adequate supplies of sugar cane and cassava for the production of E-20. Since the ethanol production will require as much as one third of the production of feedstock, the required feedstock supplies will be at the expense of reduction in export. Sugar export accounts for 40% of sugar production while cassava export is 70% of production. This implies that the farmers will have more alternative markets for their output. If the feedstock prices increase, there will be less pressure on export as there will be more supplies of feedstock. However, two constraints have to be tackled. Firstly, the agreement between the sugar millers and farmers has to be renegotiated so that millers have incentive to invest in the ethanol production. Secondly, the ethanol firms may have to enter into the contract with cassava farmers to ensure that the firms have adequate supplies of cassava for their ethanol production.

The feedstock and the consequent land requirements for the E-85 policy will greatly exceed the existing production of sugar cane and cassava. The sugar cane production has to increase to 86.4 million tons, which is 12.3% higher than the actual production; while the cassava production has to jump from 27.5 million tons to 34.5 million tons. If the productivity is to remain constant, the land requirement for sugar cane will have to double from one million hectares to 1.904 hectares. Similarly, the acreage expansion for cassava also has to jump from 1.17 million ha to 2.1 million ha. Even if productivity can be increased by 2-3 percent per year, the land requirements will be an impossible dream even though there will be a large increase in the relative prices of sugar cane and cassava that will induce farmers to switch land from other food crops, especially rice.

Are there land for further expansion of cassava and sugar cane so that Thailand can produce enough supply to satisfy the E20 target and some production of E85? The potential will come from the Northeast and the North where there are still large upland areas and vacant land. The main production regions for both crops are the Northeastern, Lower Northern, Lower Central regions and a few Western provinces. The shares of cassava and sugar cane land account for 58.1 percent of upland crop land in the Northeast, 66.6 percent in the Central and 32.8 percent in the North. Therefore, in term of availability of agricultural land, the regions that have the highest potential for further land expansion of either crops will be the North which has 0.944 million ha of other upland crops, and the Northeast which has 0.75 million ha of other upland crops. In addition, the Northeast still has the largest paddy land (6.0 million ha), some of which can be converted to cassava and sugar cane. The Central Plains and the South have the least potential.

In addition to the competition for land used by other crops, it is possible that the increase in the demand for cassava and sugar cane may cause the farmers to bring idle farm land and forest land to grow these crops. If the prices remain high as it is today, it is possible that more idle land may be brought into cassava production, rather than sugar cane because the investment of the former crop is lower. Moreover, since cassava does not require much nutrients (Charoensak 1995), it is likely that most of the idle lands which are of low quality, will be used for cassava production.

Although there are forest lands in the provinces that grow cassava and sugar cane, it is very difficult for the farmers to expand production into the forests since most forests are conservation forests which are tightly monitored by the Forestry Department. The labor shortage also makes it costly to clear the forest land.

Land availability is not the only constraint affecting the expansion of biofuel crops.

Since the late 1980’s, the Thai agriculture has experienced a serious labor shortage. Between 1989 and 2006, more than 4.4 million young workers (aged 15-24) left agriculture and did not return to their farms, resulting in labor shortage and rising real wages. In addition to the use of illegal alien workers from Myanmar, Laos and Cambodia, the farmers have mechanized most of the farm tasks, as evidenced by the sharp increase in the farm mechanization.

Impact of ethanol policy on food security and poverty

Since Thailand is a major food exporter, the ethanol policy raises two concerns. The first concern, which is a global one, is that the aggressive
ethanol policy may replace lands that are used to grow food export. How much food and export (especially animal feed, pork and sugar) will be reduced is a separate but also urgent research topic.

The second concern is what will be the distributional impact of higher food prices (which are partly caused by the ethanol policies in both the developed countries and large developing countries). In case of Thailand, higher food price would be beneficial for the economy as a whole because the positive impact on farmers’ income should outweigh the negative impact on poverty because there are smaller numbers of poor than the number of farmers. Since the food expenditures of the poorest 10% households account for 48% of total expenditure, comparing to only 20% for the richest 10 percent families, a 10 percent increase in food prices will raise the food expenditure of the poor by almost 5 percent, other things being equal. Yet there are 15 million farmers (some of whom are poor) which are 2.5 times more than the number of poor. Among those farmers, 0.22 million households grow sugar cane and 0.47 million households grow cassava. Most of the main cassava-producing areas and sugar cane provinces are also poor provinces. The coefficients of rank correlation between poverty incidence and cassava acreage by provinces are 0.39 for cassava and 0.25 for sugar cane. Therefore, the higher crop prices will not only raise the farmers’ income (and thus GDP) but will also reduce poverty incidence in the cassava-producing and sugar cane-producing areas because a 10% increase in farm price will reduce poverty by 4% (Poapongsakorn 2006). Therefore, the higher food prices should have net positive impact on the economy. The exact magnitude will have to be determined by a computable general-equilibrium model.

Given the limited knowledge and information, the environmental impact of expansion of biofuel crops cannot be determined and further research is needed. Yet the author believes that its environmental impact may be small because cassava and sugar cane are grown in the rain-fed areas and thus need small amount of chemical fertilizer. The expansion of farm land into the forest is also limited by the shortage of farm labor and the strict enforcement of the conservation forest.

Conclusion and policy implications

The biofuel policy will benefit the Thai farmers, especially the cassava and sugar cane small holders in the poorest North Eastern and Northern regions. Despite the comparative advantage in cassava and sugar cane, the ethanol policy that aims at replacing the gasoline by E85 is too ambitious because of the huge additional land requirement. Even with a softening ethanol policy with lower target, say E20 target, almost 50% more land for cassava or sugar cane will be needed. However, the E20 target is still achievable if there is a serious and more effort in the following areas: (1) genetic research and improved cultural practices to enhance farm productivity; (2) mechanization of the harvesting tasks for cassava digging and sugar cane harvesting; (3) the land policy which will encourage farmers to settle on the state idle land or to invest in their own idle land; (4) research on the processing technology to convert cassava into ethanol; and (5) providing right incentives for the ethanol producers and the industry by more appropriate pricing and regulatory framework as well as the consistency of policies that can restore policy credibility.

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2. Note that food security in Thailand is the impact on the cost of living of the poor, and not the unavailability of food.
Table 1. Ethanol projects and production capacity

<table>
<thead>
<tr>
<th>Quarter/Year</th>
<th>New Producers</th>
<th>Capacity (liters/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q4/2007</td>
<td>9</td>
<td>1.355</td>
</tr>
<tr>
<td>Q1/2008</td>
<td>2</td>
<td>0.320</td>
</tr>
<tr>
<td>Q2/2008</td>
<td>7</td>
<td>1.200</td>
</tr>
<tr>
<td>Total 2008</td>
<td>18</td>
<td>2.875</td>
</tr>
<tr>
<td>2009</td>
<td>31</td>
<td>9.930</td>
</tr>
<tr>
<td>Total approved projects</td>
<td>49</td>
<td>12.805</td>
</tr>
</tbody>
</table>

Source: Trade Association of the Thailand Ethanol Producers

Table 2. Effect of tax differentials on prices of gasoline and gasohol

<table>
<thead>
<tr>
<th></th>
<th>Benzin</th>
<th>Gasohol 95</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factory price of gasoline</td>
<td>21.6085</td>
<td>21.1689</td>
<td>0.4396</td>
</tr>
<tr>
<td>Excise tax</td>
<td>3.6850</td>
<td>3.3165</td>
<td>0.3685</td>
</tr>
<tr>
<td>Municipal tax</td>
<td>0.3685</td>
<td>0.3317</td>
<td>0.0368</td>
</tr>
<tr>
<td>Oil fund</td>
<td>4.0000</td>
<td>0.3000</td>
<td>3.7000</td>
</tr>
<tr>
<td>Energy conservation fund</td>
<td>0.0700</td>
<td>0.0630</td>
<td>0.0070</td>
</tr>
<tr>
<td>VAT (wholesale)</td>
<td>2.0812</td>
<td>1.7626</td>
<td>0.3186</td>
</tr>
<tr>
<td>Wholesale price</td>
<td>31.8132</td>
<td>29.9426</td>
<td>4.8706</td>
</tr>
<tr>
<td>Marketing margin</td>
<td>1.0063</td>
<td>1.8200</td>
<td>-0.8137</td>
</tr>
<tr>
<td>VAT (retail)</td>
<td>0.0704</td>
<td>0.1274</td>
<td>-0.057</td>
</tr>
<tr>
<td>Retail price</td>
<td>32.89</td>
<td>28.89</td>
<td>4.0</td>
</tr>
</tbody>
</table>


3. Note: 100 Baht equals USD 2.70 in December 2008.
SUMMARY OF BIOFUEL POLICIES

Overall observations

Strategies

On the whole, the ALARN members have different reasons for engaging in biofuels production. First and foremost, it is to supply the domestic market with alternative fuels that are becoming increasingly important as traditional fuel sources become more expensive, especially when the country imports much petroleum (e.g., India). Secondly, rural development, together with creating options of products that farmers can sell, are reasons for these countries to begin producing biofuels. And of least priority is to reduce GHG emissions or increase foreign revenues from exports of these alternative fuels.

Policies for the development of biofuels market

A look at the policies developed and being formulated for the national biofuel sectors shows some common features in the countries.

Even though the biofuel sectors of the nine ALARN countries find themselves in different stages of maturity, we can identify some policies that are being used by most of these developing countries. These are:

- Government funded research into varieties of feedstock and their energy content, in order to decide which ones to use in producing biofuels. This may also involve trial testing of processing mill and distribution of the biofuel in specific locations, so as to measure the feasibility of such programs.

- Tax incentives or preferential credit for initial investments in biofuel processing mills.

- Price-setting of biofuel purchasing by state-owned distribution company, to guarantee minimum returns to farmers and processors, and often subsidized lower selling price to the consumers.

After the biofuel sector has received that initial incentive, different policies are often adopted by each country. These policies depend on the importance given to biofuels in the country, the investment climate, and the land availability for agricultural expansion. Nonetheless, the most prevalent policies used are tax exemption on the sale of biofuels and mandatory blending with regular fuel. In the case of the former, the tax exemption is often in proportion to the approximate price difference between the biofuel and regular fuel, so as to make the alternative fuel more economically viable. It is often considered acceptable by society to grant this preferential treatment, since it is considered a cleaner fuel. The latter is a policy that is considered essential to create a market for the biofuel, since it ensures a guaranteed market. Without mandatory blends, uncertainty resides for consumers and producers as to whether there will be a market for buying and selling the biofuel.

The three Latin American countries offer some kind of tax exemption for their biofuels, while in Asia China, Thailand and the Philippines also do so.

Mandatory blending is being applied or considered in most countries around the world, including most of the nine countries. Needless to say, in the early stages of development of the sector, lower levels of mandatory blending are applied. The beginning level is often between 2% and 5%, which require minimal changes to the motors of the automobiles. This is a testing stage on a larger scale, whereby the distribution of the biofuel to the gas stations, the pricing levels and other concerns are put into practice.

Production

Several countries in Asia and Latin America have high potential for production of biofuels from feedstock such as corn, sugarcane, cassava, jatropha carcus or oil palm. Some of these countries are in the very early stages of development of a biofuels sector and so it is difficult to
determine their real potential to expand production. Even in the countries where the sector was developed earlier, several factors can complicate a forecast of their production level in the coming years. Among the factors are: uncertainty of the market for biofuels; pricing of biofuels in the domestic and global market; cost of production; and consumer boycott due to environmental concerns or impact on food prices.

Growing investments in the plantations in Southeast Asian countries have been observed, both from national and foreign sources. The latter type of investors may have the intention to export the biofuel for consumption in their own countries, as is the case of European investors of palm oil plantation in south-east Asia.

While some countries are investing more on research to develop newer varieties of feedstock, dissemination of these seeds to farmers is needed. Growing concerns of sustainable management practices to reduce pressure on farmland and on food security is taking place in most countries, the pressure coming mainly from international NGO’s.

**Rural integration**

Some of the countries have stipulated in their policies that the development of a biofuels sector should promote the rural sector through better integration of small farmers. This is especially the case where the rural population is larger than the urban population.

In Thailand, for instance, the impact of dedicating oilseeds to biodiesel production will have a net positive effect for the population. Although the negative impact of higher prices for the poor will affect 6 million people, the better income to the farmers will involve 15 million people. While the poor will have 5% higher food expenditure, approximately 0.7 million farm households (i.e. around 3 million people) grow cassava and sugarcane and should receive higher income from the biodiesel production surge.

It has been proposed in some of the papers that mechanisms should be developed, together with the legal and institutional arrangements, for contract farming arrangements between the feedstock growers and the biofuel mills. On the whole, the authors expect there to be some contribution to the rural development in their countries, especially when smaller farmers participate in the biofuel production chain.

**Challenges faced by the biofuel sector**

Although some of the biofuel feedstock can be irrigated, this practice is not common. India irrigates its sugarcane plantations, however only a small part of it goes to biofuel production.

In the countries where the biofuel sector is well developed, expansion of land for growing the feedstock is being criticized by several groups for threatening the environment. This is the case in Brazil, Indonesia and Malaysia, where the forests and biodiversity are said to be under pressure from this agricultural expansion. Also, some practices like burning the leaves for harvesting sugarcane cause air pollution and health problems to the neighboring cities. In the case of Malaysia and Indonesia, the threat is to the habitat of endangered species such as the orangutans. Also, unsustainable biofuel production through the use of peat and deforestation in order to extend arable land for biofuels will exacerbate the GHG emissions significantly, rather than reduce them.

**Conclusions and recommendations**

The nine countries are investing in the establishment of biofuel sectors, with different sizes and levels of importance to their economies. Although each country is using different policies and feedstock, the exchange of experiences among the countries can be useful is better understanding which instruments to use. As countries become increasingly interested in ways of developing alternative fuels for their economies, as a way of tackling GHG emissions, the emphasis on effective policies for developing biofuel market nationally becomes more perceivable.

Policy-makers should focus on creating a predictable and growing market for bioenergy. Collaboration to establish international fuel quality standards: in order to develop a large international biofuel market, the quality standards of biofuels need to be agreed upon and enforced at the international level. Nonetheless, this should be done in multi-stakeholder discussions, without prejudice to any groups and through scientific methods of analyzing the impacts of the different biofuel production and usage mechanisms. Also, accessible financing, public-private partnerships, improvement of transportation infrastructure and logistics are policies that can be considered key to these biofuel sectors.
## Overview of Biofuel policies in the ALARN countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Feedstock / processing subsidy</th>
<th>Tax exemption (feedstock, processing)</th>
<th>Mandatory Blend</th>
<th>Price-setting for feedstock/biofuel</th>
<th>Accelerated capital depreciation</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argentina</td>
<td>Biodiesel exemption (est. 2001) Decree 1396/01</td>
<td>5% compulsory blend for ethanol and biodiesel</td>
<td></td>
<td>Shorter depreciation periods for biofuel investments</td>
<td></td>
<td>Differential export tax for biodiesel (20%) in relation to vegetable oil (33% - 40%)</td>
</tr>
<tr>
<td>Brazil</td>
<td><strong>Certain policies were implemented in the early development stage.</strong></td>
<td>Biodiesel sale: depends on sourcing from family farms in northeast regions and type of feedstock.</td>
<td>Between 20 and 25% ethanol blend. 2% compulsory biodiesel blend raised to 3% in July 2008.</td>
<td></td>
<td>grants for start-up projects on renewable energy (including biofuel) production.</td>
<td></td>
</tr>
<tr>
<td>Chile</td>
<td>Proposal being discussed of tax exemption on blended biofuel in proportion to mix with regular fuel</td>
<td>Trial cases: total refund of VAT tax.</td>
<td>Trial case of 10% blending in specific region.</td>
<td></td>
<td>Trial programs: four mills were constructed, tested and research done on improving feedstock use and yield. This included VAT return, fixed subsidy for ethanol.</td>
<td></td>
</tr>
<tr>
<td>China</td>
<td>Flexible subsidy for plants (must reserve funds to offset risks). Subsidy to plants that use stalks to make electricity.</td>
<td>Flexible subsidy for plants (must reserve funds to offset risks). Subsidy to plants that use stalks to make electricity.</td>
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<td></td>
<td>Flexible subsidy for plants (must reserve funds to offset risks). Subsidy to plants that use stalks to make electricity.</td>
<td></td>
</tr>
<tr>
<td>India</td>
<td></td>
<td>Mandatory 5% blending in Oct 2007. Plans to have 20% blending from jatropha by 2011-12</td>
<td></td>
<td>Government procurement policy, sets price.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indonesia</td>
<td>Subsidized buying price of biodiesel.</td>
<td></td>
<td></td>
<td></td>
<td>R&amp;D in developing new higher-yielding seeds</td>
<td></td>
</tr>
<tr>
<td>Malaysia</td>
<td>Exemption for biofuel mills construction; other incentives for technology R&amp;D on biofuels.</td>
<td>Proposal for blending biodiesel 5% in diesel (currently in Congress)</td>
<td></td>
<td></td>
<td>Incentives to biofuel distributors at petrol stations.</td>
<td></td>
</tr>
<tr>
<td>Philippines</td>
<td>Tax exemption for the biodiesel or ethanol component of the fuel. Exemption of VAT in feedstock sale.</td>
<td>5% compulsory blend of ethanol; 2% for biodiesel.</td>
<td></td>
<td></td>
<td>Financial assistance (loans). Fiscal incentives.</td>
<td></td>
</tr>
<tr>
<td>Thailand</td>
<td>Minimum price of sugar is stipulated by government. Consumers subsidize higher prices to the farmers/ mills. Reference price for ethanol.</td>
<td>Excise tax advantages for producers of ethanol and the consumers of gasohol.</td>
<td>Planned to blend, but government reversed its decision.</td>
<td>Minimum price of sugar is stipulated by government. Consumers subsidize higher prices to the farmers/ mills. Reference price for ethanol.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Grants for start-up projects on renewable energy (including biofuel) production.*
The Institute for International Trade Negotiations (ICONE), supported by the Willian and Flora Hewlett Foundation, is coordinating a project that created a platform for the interaction of agricultural trade specialists in Latin America and Asia. Agricultural researchers and institutions in nine countries were carefully selected to create the Asia Latin America Agrifood Research Network (ALARN), whose members are from China, India, Indonesia, Malaysia, the Philippines, Thailand, Argentina, Brazil and Chile. Herein are short analysis papers of the biofuel sectors of the nine countries, covering the production of biofuels, the policies under analysis and in place, whether the investments in biofuels were effective and which policies were promoting the proper development of the sector, as well as the challenges faced by these sectors regarding social and environmental impacts.