

# Chapter 8

## Socioeconomic Impacts of Biofuels in East Asia



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### 8.1 Introduction

This chapter discusses the social and economic impacts of biofuels in East Asia by analyzing four country case studies. Three case study countries are large Asian rapidly developing countries which were expected to be large consumers and producers of biofuels at the beginning of the biofuel boom in the late 2000s: Indonesia, India, and China. All three of these countries developed ambitious initial biofuel promotion plans. The fourth country case is a developed country, Japan. Japan has some domestic production potential, although it is quite small compared to potential domestic demand, so many expected that Japan might become a significant importer of biofuels or biofuel feedstocks, especially from the Asian region.

The main potential positive impacts for all four countries include employment, income, rural development, and energy security. Rural electrification and increasing energy access for poor people are important objectives for developing countries. Air pollution reduction is another potential benefit, although this varies by the type of fuel and feedstock. The main potential negative impacts include competition with food and other land uses; negative impacts on ecosystem services, particularly related to deforestation and water usage; and social impacts such as land tenure rights (e.g., if land of poor farmers is taken over by large producers without consent or fair compensation).

Several important factors should be taken into account when analyzing impacts. First, the potential effects vary significantly by feedstock, market structure and conditions, and other local conditions such as geography, social structure, etc. Second, there may be difficult trade-offs between economic costs and desired socioeconomic impacts. For example, maximizing employment and income for farmers and

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workers may require labor-intensive, smaller-scale production methods with higher wages. In contrast, biofuel producers will generally prefer large-scale production methods to minimize costs and maximize profits, including labor-saving technology. Moreover, large-scale production, which is generally more cost-efficient and profitable, may result in large-scale deforestation and significant negative effects on ecosystem services. Third, impacts (both positive and negative) may be shifted to other countries if biofuels and/or feedstocks need to be imported or if domestic production of biofuels displaces other domestically produced goods and services. Fourth, measurement of impacts is often difficult and hampered by a lack of data.

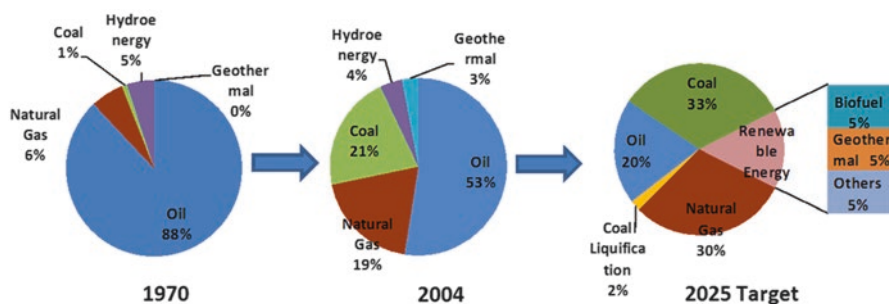
The rest of this chapter surveys the four country cases. Each case includes an overview of each country's main biofuel-related policies and market conditions, discussion of the main socioeconomic impacts, and consideration of the perspectives of different stakeholders. The chapter concludes with a comparison, synthesis, and a discussion of the policy implications.

## 8.2 Indonesia

### 8.2.1 *Overview of Indonesia's Main Policies*

Indonesia's energy policy has been focused on the goals of energy security and promoting access to energy in the face of sharply rising energy consumption due to rapid economic growth. It used to be an OPEC member with a significant oil surplus, but it became a net importer in 2004. Indonesia has subsidized fossil fuels for transport and cooking heavily since 1967. By 2005, the burden of these subsidies became very high as the government spent more than \$8 billion to subsidize the market price of petroleum fuels (IEA 2008). Facing declining oil reserves and mounting subsidies, the government enacted Presidential Decree No.5/2006, the so-called Mixed Energy Policy, to diversify Indonesia's energy sources to include renewable energy and biofuels. The transport sector uses at least 30% of liquid fuels in Indonesia. Electricity access in rural areas is low with over 70 million Indonesians estimated to be unconnected to power grids (Jayawardena 2005). The potential of biofuels as a transport fuel substitute, source of fuel in rural areas, and low agricultural commodity prices at that time motivated the government to pursue biofuel development. The export potential of biofuels also appeared to be highly lucrative as Annex 1 countries sought cleaner fuel alternatives to meet their Kyoto Protocol carbon emission reduction targets.

Presidential Instruction No.1/2006 aimed to accelerate biofuel utilization as a fossil fuel substitute. Presidential Regulation No.5/2006 on National Energy Policy expected the share of oil in national energy consumption to be reduced to 20% by 2025, while the share of biofuels should increase to at least 5% in the national energy mix as shown in Fig. 8.1.



**Fig. 8.1** Energy mix trends and targets in Indonesia

**Table 8.1** Indonesia's roadmap for biofuel development

Biofuel Type	Unit	2005–2010	2011–2015	2016–2025
Biodiesel	Percent consumption (of diesel fuel)	10%	15%	20%
	Amount (million kL)	2.41	4.52	10.22
Bioethanol	Percent consumption (of gasoline)	5%	10%	15%
	Amount (million kL)	1.48	2.78	6.28
Bio-oil/bio-kerosene	Amount (million kL)	1	1.8	4.07
Bio-oil/pure plantation oil (PPO)	Amount (million kL)	0.4	0.74	1.69
Biofuel	Percent consumption (of energy mix)	2%	3%	5%
	Amount (million kL)	5.29	9.84	22.26

Source: Legowo 2009

Presidential Decree No. 10/2006 established the National Team for Biofuel Development for poverty and unemployment alleviation which was mandated to draft the national blueprint for biofuel development. The road map of biofuel development (refer to Table 8.1) in Indonesia identified crude palm oil (CPO) and *Jatropha curcas* as the main feed stocks for biodiesel, and sugarcane and cassava as the main feed stocks for bioethanol (Kusdiana 2006). The Indonesian government set blending mandates at 10% for biodiesel effective from 2010 and 20% for bioethanol starting in 2015 with the target of producing 17.3 billion liters of bioethanol and 29 billion liters of biodiesel by 2025. To kick start the program, the government instructed the national oil company, Pertamina, to start selling biodiesel with a 5% blend produced from palm oil.

According to the plan, biofuel development was expected to enhance the rural economy, job creation, and poverty alleviation. The plan expected that 3.5 million jobs would be created by 2010, which could increase up to 6.9 million jobs in 2025. In the long run, the generation of energy from locally available renewable sources through the Energy Self-sufficient Village (ESSV) program and the Special Biofuel

**Table 8.2** Progress of biofuel development in Indonesia

As of early 2009	
Installed capacity for bioethanol production (as of June, 2008)	192,349 kL/year
Installed capacity for biodiesel production (as of December, 2008)	2,529,110 kL/year
Energy self-sufficient village (ESSV) (as of early 2009)	150 villages
Biofuel power generator by state-owned electricity company (PLN) installed capacity (as of June, 2008)	96 MW
Biofuel utilization in industry (as of November, 2008)	5%
Biofuel utilization in electric sector by PLN (PLTGU Gresik 19 MW started in 31 January 2009)	8 kL/day
Projection:	
Bioethanol development: Projection up to 2010	~4,000,000 kL/year
Biodiesel production: Projection up to 2010	~5,000,000 kL/year
Biofuel power generator by PLN in 2009–2010	220,000 kL biodiesel in all biofuel power generators all over Indonesia

Source: Legowo 2009

Zone (SBZ) program by encouraging each region to develop its biofuel potential were expected to contribute to national energy security.

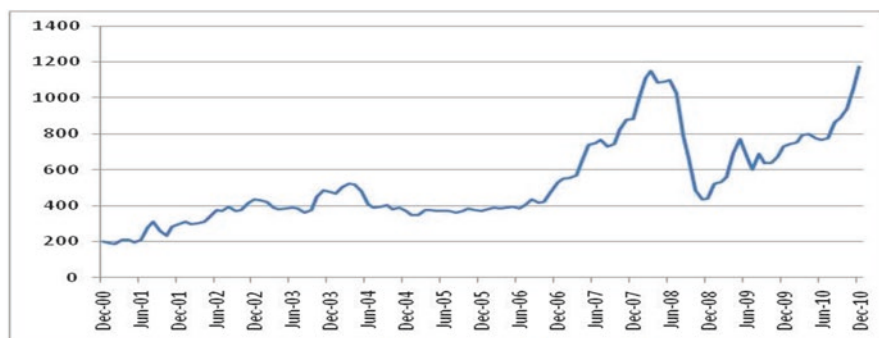
The progress of the implementation of the biofuel development plan in Indonesia as of early 2009 is illustrated in Table 8.2 above.

## 8.2.2 Overview of Main Biofuel Market Conditions in Indonesia

### 8.2.2.1 Biodiesel from Palm Oil and *Jatropha*

For biodiesel, palm oil is the main feedstock, based on Indonesia's well-established palm oil industry, with a total plantation area estimated to be over 6 million hectares. Indonesia surpassed Malaysia to become the world's largest palm oil producer in 2008, producing 18 billion liters (OECD-FAO 2008).

The global price of palm oil soared from mid-2006 to the middle of 2008, partly due to its popularity as a major biodiesel feedstock. As a result, biofuel production from palm oil became unprofitable. Initial estimates that palm oil-based biodiesel would be competitive to conventional oil at \$400 per metric ton, or about \$54 per barrel, proved to be wrong. When oil prices peaked above \$140 per barrel, the price of palm oil rose even higher making biofuels more expensive to produce. Pertamina suffered losses from its biofuel blends because the government required it to sell



Source: Commodity Price Indices. <http://www.indexmundi.com/>

**Fig. 8.2** Palm oil monthly prices in US dollars per metric ton

biofuels at the same price as subsidized petroleum but did not provide additional subsidies to cover the higher costs of biofuel production (GSI 2008a, b). Therefore, Pertamina reduced the biodiesel content to barely 1%.

Palm oil is also very important for cooking in Indonesia, so the government became very concerned about surging prices. In response, export taxes were imposed on crude palm oil to discourage exports and prioritize its use for cooking, and the government also imposed a 2% export tax on biofuels (Leow 2008; Commodity Online 2008).

The government also became concerned about the contentious debate on the environmental impacts of biofuels – especially relating to the conversion of forests to biofuel feedstock monoculture plantations – and concerns about their role in raising food prices also grew worldwide (e.g., Fargione et al. 2008; Searchinger et al. 2008; Pimentel et al. 2007). Land use change and deforestation in Indonesia were identified as so significant that the country ranked third in total GHG emissions globally. In 2008, the EU reviewed its biofuel mandate and stopped importing oil palm from Indonesia and Malaysia citing environmental concerns (USAID-Asia 2009). The high price of palm oil and questions about its sustainability had a significant impact, and many refineries stopped operations and stalled plans for expansion and new development. When palm oil prices declined in the later part of 2008, biofuel production levels increased once again, but this was short-lived as prices increased again as shown in Fig. 8.2 (Reuters 2007; GSI 2008).

The government also promoted *Jatropha* as a biodiesel feedstock, recognizing the volatility of palm oil prices, to avoid the food–fuel conflict. The biofuel roadmap initially set a target of 1.5 million hectares of previously logged and nonproductive land to be planted with *Jatropha*, as shown in Fig. 8.3, but as of 2008, only 10% was planted. Initial demand for *Jatropha* seeds to make seedlings significantly raised their price, generating interest from many investors and farmers. When demand for seeds stabilized, actual yield was low (only about one-fourth of the initial estimates of at least 5 tons per hectare per year), making it unprofitable to process them for biodiesel. Research to create high-yielding varieties has continued.



Fig. 8.3 Target areas for *Jatropha* plantation in Indonesia

### 8.2.2.2 Bioethanol from Sugarcane and Cassava

Fuel ethanol in Indonesia is produced from sugarcane molasses. Total ethanol production in Indonesia was about 212 million liters in 2008 (OECD-FAO 2008), produced by four fuel ethanol plants operating with a combined capacity of 14 million liters per year (GSI 2008b). To comply with the initial 10% blending mandate in 2010, the goal was to produce nearly 4 billion liters (APEC 2008). The mandatory blending ratio was reduced to 3% in 2010.

There may be some scope to increase the efficiency of sugarcane production. About 2 million hectares of land is used for sugarcane production in Indonesia. However, 50% of sugarcane producers are small holders, and the average farm size is barely half a hectare, so there is room to increase the scale of farms. In addition, there are many small sugar mills which still use outdated technology. The government also considered cassava as alternative ethanol feedstock. In 2006, about 650,000 hectares were planted with cassava. As in the case of sugarcane, producers are mostly small holders producing cassava chips, while the large processors produce starch. A high-yield variety was initially introduced in Java to improve the current harvest yield of 15–18 tons/ha. Only 0.5% of cassava is used for bioethanol as it is mainly used for direct consumption and food processing. In addition, there are not many fully functional bioethanol plants utilizing cassava yet. The situation may change, and more cassava could be used for bioethanol production if bioethanol producers would offer a higher price to farmers than the food processing industry. MEDCO inaugurated Indonesia’s first bioethanol plant utilizing cassava as feedstock in Lampung in late 2009, and it is now operating at full scale. They pay a premium to ensure availability of cassava to maintain their operations.

### 8.2.3 *Socioeconomic Impacts*

Biofuel production in Indonesia, regardless of feedstocks used, is not yet economically viable under current conditions and requires heavy subsidies. Economic sustainability is essential for long-term biofuel development plans like Indonesia's, especially in light of the country's increasing fiscal constraints. In order to justify support from the government budget, the social benefits of biofuels need to be demonstrated. In this context, the government also considered how to use biofuels to promote rural development.

The government launched the Energy Self-sufficient Village (ESSV) program in 2006 targeting 1000 villages in remote areas to be self-sufficient in their energy needs by utilizing their own local renewable energy resources. Of the 1000 villages, 500 will produce their own supply of biofuels from *Jatropha*, cassava, or sweet sorghum to run basic equipment for lighting and farm activities and to replace the use of kerosene for cooking purposes. The other 500 villages will harness their water resources to develop mini-hydro or pico hydropower and install solar photovoltaics (PV). As of 2010 the biofuel-based project was implemented in almost 150 villages.

For this study, three pilot ESSV projects were visited and surveyed – Karangtengah village in Wonogiri utilizing cassava for bio-kerosene production, Purwantono village in Wonogiri utilizing sweet sorghum for bio-kerosene production, and Way Isem village in Lampung utilizing *Jatropha* for biodiesel production. The farmers in Karangtengah have sufficient experience in planting cassava which they sell for processing as food or animal feed. The village allocated some common land to increase cassava plantation to be used for bio-kerosene production. At the time of the survey, the mini-processing plant had been constructed but was still undergoing intermittent testing to achieve consistency in the desired blend (~70% ethanol). The potential to produce bio-kerosene out of cassava was welcomed eagerly by farmers, but the project remained a community experiment, and how it would be managed and sustained remained to be seen. The case in Purwantono was more complicated because the farmers had no prior knowledge in planting sweet sorghum. The mini-processing plant had also been built, but even the necessary testing was difficult to conduct because of a lack of feedstock. In Way Isem, farmers planted *Jatropha* as hedges and in idle plots. Initially there was high demand for seeds and seedlings, so many farmers planted *Jatropha*. However, farmers did not want to become full-time *Jatropha* farmers because they earned more from planting other crops. From the limited operations in Way Isem, and also because of a lack of *Jatropha* seeds, farmers valued more the *Jatropha* waste that could be used to produce biogas for cooking than the straight *Jatropha* oil.

Overall, the success rate of ESSV was lower than expected despite the government's assistance providing the necessary processing equipment. The feedstock supply was too unstable to operate continuously. Coordination among agencies

involved in the implementation was weak. What the farmers in the villages primarily needed was the know-how to improve production yields either by having access to high-yield varieties or by improving their farming practices sufficiently for them to be encouraged to plant the required biofuel feedstocks for energy purposes. However, government funding was mostly allocated for procuring equipment and building mini-processing facilities. To ensure a stable supply of feedstocks, farmers should be assisted to improve their productivity and there should be more efforts to help farmers understand the agricultural and energy benefits of biofuels (Romero 2010).

### 8.2.4 Analysis

In 2006, Indonesia drafted a comprehensive national biofuel development policy with the dream of becoming the “Middle East of biofuels.” The policy was undermined even before it was fully implemented by the events leading to the sharp rise and fall of oil prices in 2008. By 2009, the government, industry, civic organizations, and farmer groups were reconsidering their euphoric expectations for biofuels. The government’s flexible response to reduce blending targets was laudable, as rigidly adhering to the initial targets likely would have meant more losses.

In hindsight, the policies assumed that the groundwork for establishing the biofuel industry had already been laid. Initially, most policy discussions focused on trade and investment, neglecting the vital role of the agriculture sector. Moreover, important assumptions underlying the expectations of the economic viability of biofuel projects were proved to be incorrect. In the case of palm oil, it was assumed that the palm oil price would be lower than the oil price. Farmers gained when the price of palm oil went up, although the nascent biodiesel industry nearly collapsed. For *Jatropha*, the actual yield of *Jatropha* seeds was only about one-fourth of what had been projected, but the necessary agricultural inputs were more than initially estimated. Small holders were the ones most adversely affected since they did not have much capital to offset their losses.

Overall, Indonesia still has the potential to build a flourishing biofuel industry. To achieve it, lessons learned should be incorporated in rethinking the national biofuel policy. Action plans to complement the national policies should be included, as the lack of action plans caused confusion and competition instead of coordination among relevant agencies. Capacity training and R&D measures should be strengthened. And the most critical of all is to eliminate fossil fuel subsidies and shift the funds to support cleaner energy sources.



## 8.3 India

### 8.3.1 *Overview of India's National Policies on Biofuels*

Indian national biofuel policy, in 2009, was cautiously optimistic in nature. It aimed to achieve a 20% blending of biofuels with gasoline by 2017, mainly from ethanol. However, the 10% ethanol blending target set in October, 2008, was not achieved in the country, and the 20% target seemed quite challenging. In the national policy, ethanol was envisaged as the major source of biofuels in the country, while the other plant-based biofuels (mainly biodiesels) were considered as secondary sources.

The major obstacle to maintaining a stable supply of ethanol for biofuel production was the instability of sugarcane production. The pricing of ethanol-based biofuels was also very controversial, and disagreements between the sugar industry, the major producer of ethanol (from its by-product molasses), and the oil marketing companies, the main distributors of the biofuels, were not resolved. National policy briefly mentioned pricing, but the government gave no clear indication regarding how it will handle the issue except to pass the responsibility to the Biofuel Steering Committee. Uncertainty about the pricing policy was a serious obstacle to the promotion of the bioethanol industry in India.

Regarding biodiesel production, the national policy stated that no food-producing land should be used, and biodiesel should be produced only from nonedible oilseed plantations on lands which were considered wastelands, degraded, or marginal. However, it was not clear just how much wasteland was available. Land availability is a serious problem in India where food shortages are increasing. Definitions of degraded and wasteland vary according to productivity and length of fallowness. Agricultural experts in the country claimed that technology is available to convert a majority of the so-called wasteland to at least mono-cropping land provided required inputs are given. Moreover, most of the degraded lands are either forest lands, which are difficult for farmers to access, or village common lands belong to the panchayats and communities which are used by the landless and tribal communities for cattle grazing and other purposes. The Ministry of New and Renewable Energy, the implementing agency of the national biofuel policy, has little ability to procure wasteland to produce biodiesel because land is under the jurisdiction of other ministries and departments. The land may seem to be “wasted” and “barren” to outsiders, but in reality much of it provides sustenance for millions of poor and marginalized rural people. Most of these wastelands are classified as common property resources (CPRs) and are used as grazing ground for the village cattle. So on one hand, ethanol supply fluctuates, and on the other hand, availability of wasteland for nonedible oil seed production is also uncertain under India's new national policy. Therefore, two of the pillars of biofuel policies (ethanol and wasteland) have been uncertain for India. Nevertheless, the policy also ensured the use of the National Employment Guarantee Act (NREGA) to provide financial support for the labor costs of biofuel production. Unfortunately, NREGA was the only source

of funds for rural employment available for many government activities within the village areas (not only biofuel policy), so there was a shortage of funds for biofuel activities.

Apart from the central government's policy on biofuels, there was also a variety of initiatives by state governments, mainly with private sector partnerships. For example, the state of [Andhra Pradesh](#) entered into a formal agreement with [Reliance Industries](#) to plant *Jatropha* on 200 acres (0.81 km<sup>2</sup>) of land at [Kakinada](#) for high-quality [biodiesel](#). The state of [Chhattisgarh](#) decided to plant 160 million saplings of *Jatropha* in all of its 16 districts with the aim of becoming a biofuel self-sufficient state by 2015, and it planned to earn Rs. 40 billion annually after 2010 by selling seeds. In September 2007, the [Hindustan Petroleum Corporation Limited](#) (HPCL) and the [Maharashtra State Farming Corporation Ltd.](#) (MSFCL) created a *Jatropha* seed-based biodiesel joint venture with a 500 acre *Jatropha* plantation in the so-called degraded forest areas of the state. [Indian Railways](#) has started using biodiesel from *Jatropha* for its diesel engines. However, despite these initiatives, no commercial production of biodiesel on a national scale has been recorded.

### 8.3.2 *Status of the Indian Biofuel Market*

With the gradual increase in demand for renewable energy, the biofuel sector in India has taken the necessary steps toward large-scale commercial production of fuel crops. With the primary objective of increasing the production of biofuels, namely, biodiesel and bioethanol, the Government of India took the lead and formulated the National Mission on Biodiesel in July 2002. In order to avoid creating a food–fuel conflict in the country, the government from the beginning encouraged the use of fermented sugarcane molasses and nonedible oil seeds. So, in India ethanol is produced through fermentation of sugarcane molasses, and biodiesel is produced through transesterification of nonedible oils from *Jatropha curcas*, pongamia, neem, etc.

#### 8.3.2.1 **Bioethanol from Sugarcane**

Due to robust economic growth in India, transport fuel demand has also increased at a very high rate. Moreover, demand for ethanol has also increased to meet the blending target of 5% of total transport fuel set by the National Government in 2003. Table 8.3 shows the projected demand and supply of ethanol in the Indian market. This clearly indicates that 5% blending seems feasible but 20% blending only from ethanol may be quite difficult and unrealistic.

In order to meet the ethanol-based biofuel target, it would be necessary for India to maintain a steady production level of sugarcane over the target's time period. However, the yield of sugarcane in India varies from an average of 77 tons/ha in tropical states to about 52 tons/ha in subtropical states, and it also varies under

**Table 8.3** Projected demand and supply of ethanol for 5% blending in petrol

Year	Petrol demand (Mt)	Ethanol demand (M L)	Molasses prodn. (Mt)	Ethanol production (M L)			Ethanol utilization (M L)		
				Molasses	Cane	Total	Potable	Industry	Balance
2001–2002	7.07	416.14	8.77	1775	0	1775	648	600	527
2006–2007	10.07	592.72	11.36	2300	1485	3785	765	711	2309
2011–2012	12.85	756.36	11.36	2300	1485	3785	887	844	2054
2016–2017	16.4	965.3	11.36	2300	1485	3785	1028	1003	1754

Source: Planning Commission (2003)

The above information is based on the following assumptions:

- a-1. The area under cane cultivation is expected to increase from 4.36 Mha in 2001–2002 to 4.96 Mha in 2006–2007 which would result in an additional cane production of 50 MT.
- a-2. About 30% of cane goes for making gur (jaggery) and khandsari (unrefined sugar). If there is no additional increase in khandsari demand, sugar and molasses production would increase.
- a-3. The present distiller capacity is for 2,900 million liters (M L) and appears to be sufficient for 5% blend until 2016–2017.
- a-4. Annual demand growth of 3% for potable ethanol and 3.5% for industrial ethanol.

different irrigation conditions. The average yield of sugar is approximately 105 kg per ton of cane, and about 40 kg of molasses is produced per ton of cane from which about 10 l of ethanol can be obtained. If the sugarcane is directly and fully used in ethanol production, the yield of ethanol is 70 l per ton (Gonsalves 2006).

The production cost of ethanol in India in 2009 was between Rs.14 and 20 per liter, depending upon the source, which is still comparable to the market price of gasoline. However, this cost is before tax. After sales, excise, and other direct and indirect taxes, the ethanol price is as high as other fuels and may need a selling price subsidy to compete with the standard fuels to meet the 5% blending target. It has been observed that the major reason for the high production cost of ethanol is the increasing cost of sugarcane production in India. Unfortunately, the cost of sugarcane production in India is expected to continuously increase mainly due to a shortage of water resources and its impact on reduced productivity, continued use of low-quality sugarcane species, unscientific sugarcane cultivation methods, and lack of a market-based pricing mechanism for sugar. In addition, increasing the efficiency of sugarcane processing, including juice extraction and fermentation, is also important to bring down the final cost of ethanol production. Finally, although sugarcane-based ethanol is commercially a viable option for India to produce biofuels, the increasing costs of producing ethanol are a serious threat to its economic viability in the long run.

### 8.3.2.2 Biodiesel From Nonedible Oilseeds

According to the national policy on biofuels, plant-based nonedible oilseeds were expected to supply biodiesel along with bioethanol together to meet the national target of 20%. It was envisaged that around 400 different types of nonedible oilseeds are available in India which could produce the necessary amount of biodiesel. However, biodiesel in India has been virtually a nonstarter. *Jatropha* is one of the major feedstocks for biodiesel production in India, but unfortunately it has performed poorly. The reasons for this include the following technical problems and policy deficiencies:

- There is a lack of infrastructure for seed collection and oil extraction. In the absence of infrastructure and available oilseeds, it will be difficult to persuade entrepreneurs to invest in transesterification plants. Collection of nonedible oilseeds is a manual operation, and for a large biodiesel plant, it is a logistical nightmare. In 1 day, a person can collect up to 80 kg of seeds, which can produce 20–23 l of oil. The collection is done for 3 months, once or twice a year. For a plant with a capacity of 100 tons per day (8 million gallons per year), 15,000 people are necessary to collect the seeds. Organizing such a large part-time labor force is a major challenge.
- The *Jatropha* plant takes 24–30 months to flower and produce seeds. To promote widespread *Jatropha* farming, the livelihood of the farmers in the intervening period, without an income from the *Jatropha* crop, must be secured. At the time of this research there was no way to achieve this in the market except for privately funded projects. In particular, this is a problem for landless farmers and laborers who do not qualify for any interim payments since they do not own the land.
- There have been some uncertainties about how much inputs (irrigation, fertilizers) are needed to realize commercially viable yields on land unfit for food production. Several different types of climatic zones exist across India, so knowledge generated in one area is often not appropriate for other areas. Thus, knowledge transfer of *Jatropha* cultivation methods and their economics is yet another challenge (Wani and Chander 2012).
- There was no minimum support price or guaranteed purchasing for the *Jatropha* seeds. This was a problem since these kinds of supports were provided to many other commodities in India, putting biodiesel at a relative disadvantage. As a result, the price of *Jatropha* seeds was very high because most of them are used for plantation purposes rather than oil extraction. At this price, the manufacturing cost of biodiesel was three times the pump price of conventional diesel.
- Even though the consumption of edible oils in India was high, the availability of used cooking oil was very small, since it is typically reused until it disappears. Thus, there is no possibility to use waste cooking oil to produce biofuel in India.
- The use of lamp oil has been increasing rapidly in India, as there is no electrical power supply for 10–14 h a day in most rural areas. When the price of edible oils increases, people turn to the cheaper nonedible oils. The requirement of this

sector is more than 15 million tons (bio-kerosene). Since seeds can be collected and crushed, using hand-operated expellers, on a small scale in remote villages, the use of nonedible oils for lighting was rapidly expanding and creating a shortage of supply to the biodiesel industry.

- Most of the edible oils used are stable and do not decompose much in storage. Therefore these are preferred for the transesterification process. In contrast, nonedible oils are not very stable and require significant pretreatment with additional cost, so these are less preferred by the oil-producing companies.
- The cottage washing soap industry can use vegetable oils with a high content of free fatty acids. Since the prices of edible oils have doubled, many soap manufacturers in this unorganized sector are using nonedible oils since these are somewhat cheaper. This contributes to the supply shortage for biofuel producers.

### 8.3.3 Socioeconomic Impacts of Biofuels in India

When India's biofuel policy was adopted, one of the major motivations was to support social development through rural empowerment and development. The policy aimed to generate rural employment and achieve energy self-sufficiency and security in addition to environmental improvement. However, after a decade of efforts, Indian biofuel policies have contributed little toward these objectives.

Regarding rural employment generation, biodiesel was expected to contribute more than ethanol-based biofuels, using the National Rural Employment Guarantee Act (NREGA) program. Unfortunately, in most cases, the NREGA funds for biofuels were inadequate, either because money was allocated to competing government programs running in parallel in the same location, or because of bureaucratic problems in getting the funds to the right place at the right time. For the *Jatropha* plantation program, NREGA supported several initial activities for the first couple of years of the program but could not create enough interest among the farmers to continue in the program until seeds were available. As a result, a majority of the programs failed in the middle, and a large amount of money was wasted under this scheme.

It has become clear that *Jatropha* and other nonedible oil seed plantations need considerable regular agricultural care to cultivate it at an economic level of production, so the process is not cost-free. In addition, since *Jatropha* is a new crop, farmers also need new technical and economic knowledge to cultivate it effectively.

Over the last few years, all of the major *Jatropha* projects have produced significantly fewer seeds than planned, and quality has also been lower than expected. As a result, India's current oil extraction capacity of 600,000 t/day is running under 40% utilization, and plant operators are suffering large investment losses. The myth of *Jatropha* and other plant-based nonedible oil seeds as miracle crops for biodiesel has collided with reality in India. It is important to understand that these crops have to be recognized as regular and standard agricultural crops just like others. They incur production costs just like other crops, and they cannot be cultivated carelessly

with little or no effort. Although the biofuel policy was supposed to support the rural landless laborers and farmers, in reality it supported partial employment for women and children mainly due to its irregularity and wage structure with below market rates. In most cases, it was observed that during the plantation process and seed collection, the involvement of rural women and children, for whom this was a part-time activity, reduced productivity. This further indicates the lack of incentives in the program to engage the rural male population.

Regarding the goal of promoting energy self-sufficiency and national energy security, it seems difficult for first-generation plant-based biofuels to make a significant contribution. With the burgeoning total fossil fuel demand in the country, the absolute amount of biofuels that would be required by the 20% target is also rapidly increasing and at a much faster rate compared to the pace of increase in biofuel production. Finally, the goal of improving environmental quality through biofuels remains a lower priority, as large-scale market production has not been achieved.

Uneven availability of market information, which is related to underdeveloped regulation, is another problem. The majority of the market information still lies with the downstream stakeholders starting from the seed crushers to the oil marketing companies. However, a severe lack of information still persists among the upstream stakeholders including the farmers and field workers. Such information asymmetries have created opportunities for middle traders in the market who are distorting the pricing system. It has been recorded that in some places *Jatropha* seeds are sold ten times the market price to the mill owners, while the farmers and producers are still getting a below average price (even lower than the minimum selling price).

India's national biofuel policy and its mission were well-intentioned, but many details were not developed, so they were not well-implemented. Many aspects of the policy were either vague or not well developed, especially in comparison with other industrial promotion policies, particularly related to pricing.

### 8.3.4 Analysis

As the first-generation biofuels have come under global scrutiny in the context of their sustainability in terms of net energy gain, emission reduction potential, and resource utilization, the Indian biofuel program has also not been free from those concerns. India has been suffering from a severe water crisis and lack of irrigation facilities. India's bioethanol production is highly vulnerable to water shortages since it is heavily dependent on water-intensive sugarcane production. Sugarcane is one of the most water- and energy-intensive crops, and unfortunately in India, sugarcane is being produced in the most water-stressed regions and with complete groundwater irrigation. Given the limited availability of natural resources in India, especially land and water, it is doubtful that the country can produce enough surplus sugarcane in the coming years to satisfy the potentially huge demand for ethanol.

Moreover, the land categorized as wastelands designated for nonedible oil seeds production is either available only in remote locations or above 1500 m in altitude. Wastelands in either of these cases would be unsuitable for oil seed production and its commercial utilization. Remoteness of location would create huge additional expenses for transportation of saplings, seeds, and human resources as well as hamper the regular maintenance of the trees which is essential to achieve a minimum acceptable seed yield.

Finally, for a country like India, first-generation biofuels are still a luxury in the sense that India still has severe food shortages and millions of people are suffering from malnutrition. Every effort should be made in India to produce more foods and edible oils by utilizing every piece of land. However, alternative sources of bioenergy could be explored such as algae. In India, algae-based biofuel production research has been conducted for a long time, but it needs continuous encouragement from the government as well as from the industries to make it faster. It is also not clear how much land and water will be required.

## 8.4 China

### 8.4.1 *Overview of China's Main Policies: Promotion of Renewable Energy*

In 2010, China was the second largest energy-consuming country in the world (EIA 2010). The majority of China's primary energy came from abundant domestic coal to meet domestic demand, not only for households but also industrial use (Martinot and Junfeng 2007; Zhang and Siang 2007). In response to its rapid increase in energy use, the nation has made a major effort to gear up its use of renewable energy. As of 2007, China received only 8% of its primary energy from renewable energy, and its target shares were set at 10% and 15% by 2010 and 2020, respectively (NDRC 2007). To meet these ambitious goals, China enacted the Renewable Energy Law in 2005. This law has several objectives including improving energy structure, diversifying energy supplies, safeguarding energy security, protecting the environment, and realizing the sustainable development of economy and society, and it covers a comprehensive list of renewable energy sources. Short-term (2010) and long-term (2020) renewable energy targets are summarized in Table 8.4. China's renewable energy policies stress the large-scale provision of electricity nationwide in the midst of rapid industrialization. As of 2010, biofuels' contribution as a renewable energy source was relatively small in China—the large majority of investment in renewable energy was for wind power (70%), followed by other renewables (17%) and solar (8%), and biofuels accounted for only 3.6% (Pew Charitable Trusts 2010).

**Table 8.4** China's targets for annual renewable energy utilization and supply in 2010 and 2020

Form Source	Source	Electricity utilization (share in total electricity utilization, %)	Gas/heat supply	Biofuel utilization
Short term (2010) <sup>a</sup>	Non-biomass source	Hydro: 190 GW (92.3%)	Heat supply by solar and geothermal: 100 million J	
		Wind: 10 GW <sup>c</sup> (4.9%)		
		Solar: 0.3 GW (0.1%)		
	Biomass source	Biomass (solid and gas): 5.5 GW (2.7%)	Biogas supply: 19 billion cubic meters	Bioethanol from nonedible food sources: 2 million tons
			Solid biomass: 1 million ton	Biodiesel: 0.2 million tons
Medium and long term (2020) <sup>b</sup>	Non-biomass source	Hydro: 300 GW (82.9%)	No information	
		Wind: 30 GW (8.3%)		
		Solar: 1.8 GW (0.5%)		
	Biomass source	Biomass (solid and gas): 30 GW (8.3%)	No information	Bioethanol from nonedible food sources: 10 million tons
			Biodiesel: 2 million tons	

Source:

<sup>a</sup>Developed based on the Renewable Energy Development Plan for the 11th Five-year Period (NDRC 2008)

<sup>b</sup>Developed based on the Medium- and Long-Term Development Plan for Renewable Energy in China (NDRC 2007)

Notes:

<sup>c</sup>5 GW in the Medium- and Long-Term Development Plan for Renewable Energy in China

## 8.4.2 Overview of Main Biofuel Market Conditions in China

### 8.4.2.1 Bioethanol

China's bioethanol production in 2007 was the third largest in the world at 1.33 million tons (Huang et al. 2008). Estimated 2008 production totaled 1.55 million tons, of which 1.42 million tons of bioethanol were derived from corn and wheat produced at four designated plants operating at almost full capacity (84–100%) (USDA 2008). The remaining 130,000 tons of bioethanol came from cassava whose plant operates at only 65% of its capacity (USDA 2008).



Bioethanol production initially utilized old grains in stock. The production was mainly from corn and partially from wheat at four designated state-owned plants in Heilongjiang, Jilin, Henan, and Anhui provinces. However, in May 2007, bioethanol production from corn and wheat was capped by the government, which stopped approving new bioethanol production from food for fear that food-based ethanol production would cause food prices to increase (Sun 2007; Huang et al. 2008).

To supplement biofuel production, cassava was identified as one of the most promising nonfood feedstocks to produce bioethanol. In 2008, the government approved a new state-owned facility to produce bioethanol from cassava in Guangxi province (USDA 2008). The province was once known for its large-scale cassava-producing region, but the cassava industry was suffering from low prices for fresh cassava as well as starch. Therefore, biofuel production from cassava was expected to create employment and improve livelihoods in the region. However, the production of cassava has not been enough to meet domestic demand, and actually the bioethanol company imported feedstock from Thailand and Vietnam (GSI 2008; USAID 2009). The reality is that the majority of bioethanol will be produced from corn and wheat for the near future (GSI 2008).

Bioethanol blending mandates have been implemented in ten provinces, including one autonomous region. Province-wide blending mandates (E10) were first introduced in 2005 in five provinces (Heilongjiang, Jilin, Liaoning, Henan, and Anhui) which have bioethanol plants located in or near the province (GTZ 2006). Blending mandates then expanded to additional cities in four neighboring provinces (Hebei, Hubei, Shandong, and Jiangsu). In April 2008, after the government capped bioethanol production from food, Guangxi Zhuang Autonomous Region became the tenth province to introduce province-wide blending mandates. It was the first case of ethanol production from cassava (People's Daily Online 2008).

#### 8.4.2.2 Biodiesel

The total volume of biodiesel produced in 2007 was reported at 300,000 tons, which was on a smaller scale compared to bioethanol (ERI 2008; USDA 2008; F.O. Licht 2009). There were a dozen operating plants using waste oil as a feedstock and 20 planned plants which will operate on not only waste oil but also other feedstocks such as *Jatropha* as of 2008 (Huang et al. 2008; Morimoto 2008; USDA 2008). The production capacity of each plant is relatively small due to an insufficient supply of feedstock. China is a net importer of vegetable oil, and there are difficulties in feedstock collection and marketing (Huang et al. 2008; USDA 2008). Unlike bioethanol, there are no blending mandates for biodiesel. There are voluntary standards for 100% biodiesel (JIE 2008; USDA 2008), and a standard for 5% (B5) was introduced in 2010.

Nevertheless, a number of large companies planned to invest in biodiesel production. In 2008, the NDRC approved three state-owned plants to produce biodiesel from *Jatropha* to be implemented by either PetroChina or Sinopec in Sichuan, Guizhou, and Hainan provinces. Out of 32 plants (both operating and planned),

**Table 8.5** Changes in agricultural labor availability in China

Labor	2000	2005
Rural labor [1000 persons]	479,821	504,050
Indexed rural labor change (2000 = 100)	100	105.0
Agricultural labor [1000 persons]	327,975	299,755
Indexed agricultural labor change (2000 = 100)	100	91.4
Indexed agricultural labor share change (2000 = 100)	100	87.0

Source: China Statistical Yearbook 2007

seven plants were operated by China's largest biodiesel producer Gushan Environmental Energy Limited based in Hong Kong (Morimoto 2008; PetroChina 2008). Some biodiesel feedstocks, industrial waste oil and palm oil, have been imported from Malaysia (PetroChina 2008).

*Jatropha* was regarded as one of the most promising feedstocks for biodiesel. In 2007, the State Forestry Administration (SFA) and PetroChina signed a contract to cooperate on a 40,000 ha *Jatropha* project in Yunnan and Sichuan and with COFCO (China National Cereals, Oils and Foodstuffs Corporation) in Guizhou. Foreign investment also flowed in from the UK to Guangxi and Yunnan, from the USA to Sichuan, and from Germany to Yunnan (Mang 2008).

#### 8.4.2.3 Emerging Research on Second-Generation Biofuels

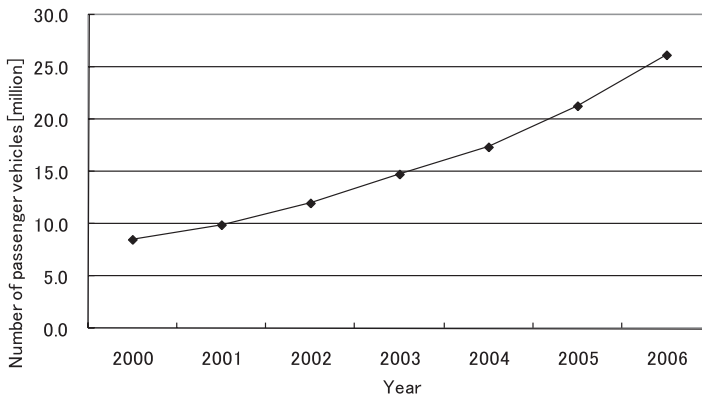
With abundant agriculture and forestry residues available in China, a considerable amount of second-generation biofuels was expected. However, there were only two second-generation biofuel pilot plants operating using corn stover as feedstock as of 2010 (IEA 2010). Water use and wastewater for/from the process could potentially cause environmental problems (IEA 2010).

### 8.4.3 Socioeconomic Impacts

#### 8.4.3.1 Employment

Agricultural labor availability in rural China has been rapidly decreasing, and more labor has been absorbed by non-agricultural sectors as the nation's economy developed (see Table 8.5). According to one estimate, biofuels were predicted to create more than nine million jobs in China (Dufey 2006). The NDRC estimated that 1,000 people could be hired at a 100,000 ton-scale ethanol plant (GSI 2008).

In the case of *Jatropha* production, potential labor shortages could become more severe if more labor is needed to harvest in the future when *Jatropha* trees mature. The additional labor needed for harvesting *Jatropha* might be diverted from food



**Fig. 8.4** Number of passenger vehicles in China (Source: National Bureau of Statistics and NDRC 2007)

crops, and this in turn could lead to a shortage in food production—a possible two-step food–fuel conflict (Sano et al. 2012).

#### 8.4.3.2 Rural Development

To what extent biofuel production could contribute to rural development depends on whether or not the rural economy can supply sufficient feedstock to biofuel producing factories. In this sense availability of inputs for production such as natural resources and labor mentioned above are crucial. Water is one of the crucial inputs, and potential shortages are an important concern.

In order to generate additional income for rural households, business coordination between a large number of farmers and a few state-owned enterprises and biofuel processing firms would be important. For overall improvement of welfare in rural communities, however, liquid biofuels in general may have a smaller direct contribution compared to potential alternatives, because they have fewer other applications besides use in transport sector unlike other forms of biomass utilization such as biogas and solid biomass. For instance, solar and biogas cookers could lower the energy expense for households according a case study conducted in rural region of Gansu province (Li et al. 2009).

#### 8.4.3.3 Energy Security

Biofuels might be able to make some contribution to the diversification of energy forms in the transport sector; however, the extent is expected to be limited since the rapid increase in vehicle ownership (see Fig. 8.4) is likely to be higher than the potential for expansion of biofuels. Thus, by themselves, biofuels would have negligible effect in reducing China’s oil consumption or energy security (GSI 2008).

Rapid development of new-generation vehicles (hybrid, electronic vehicles, etc.) might achieve larger changes in the consumption patterns of fuels in the sector.

#### **8.4.4 Stakeholder Perspectives**

One of the unique characteristics of China's biofuel industry is that it is dominated by the government through a few state-owned companies, not only for feedstock production but also for the production and distribution of biofuels. One of the advantages of this situation is the strong financial base of these state-owned enterprises. In general, development in the energy sector is shaped by large state-owned companies which have much greater investment and technological capabilities compared to small- and medium-sized companies, and this is also case in the bioenergy (Gan and Yu 2008). In 2006, PetroChina provided five million RMB to initiate four demonstration projects in Yunnan (ICRAF China 2007). Another advantage is that state-owned companies can manage supply chains more easily. In this sense, standard setting and implementation would be also relatively easier.

On the other hand, the biggest disadvantage is that the market is relatively closed and dominated by a few companies, making the market more uncompetitive and inefficient. Bioethanol for fuel is not a market-driven segment of the economy, and there are only a few licensed companies. In addition, the pricing regime discourages the private sector's investment in fuel ethanol production and ensures limited competition for existing producers (GSI 2008; Huang et al. 2008; USDA 2008). This situation may cause technological innovation by the private sector to be slow. Also, there is a high probability that related decision-making by the central government does not fully consider local conditions or implications for local economies. Energy policies are under the jurisdiction of the Energy Bureau of the NDRC, which has a higher position than other bureaus in NDRC's internal hierarchy, but it is heavily influenced by large energy-related state-owned companies (Takamizawa 2009).

#### **8.4.5 Analysis**

Although China's biofuel production is relatively large on a global scale, it has a relatively smaller role in renewable energy promotion within China itself. Moreover, in China, biofuel promotion tends to be more closely related to agricultural policies than renewable energy or climate change policies. China, as one of the largest grain producers in the world, made a timely policy response to address food–fuel conflict concerns in 2007. Partially because of the government's strong grip on both biofuel production and distribution, a significant food–fuel conflict feared by many researchers has been avoided. However, this has dampened the high hopes for biofuel promotion in China.

Still, China has made advances in feedstock diversification for the first-generation biofuels (*Jatropha*, cassava, sweet sorghum, etc.), invested in the development

of second-generation biofuels, and explored production outside its territory, for example, the potential for palm oil plantations in Africa. In order to meet its skyrocketing energy demand, China must continue to explore all forms renewable energy, even those with a relatively smaller scale. China has a large potential for second-generation biofuels (Eisentraut 2010). Second-generation biofuels could play a more significant role as related technologies become more advanced, more capital becomes available, especially including overseas investment, and associated potential problems such as water scarcity are solved.

Biofuel production calls for close attention to the local conditions because natural resource availability, especially water and land, suitable agricultural/farming technologies, and socioeconomic conditions vary greatly across locations. Knowledge and assessment of local biofuel producing conditions are essential. Attention to labor availability is also important considering the increasing numbers of migrant workers and aging workers in the rural labor market.

More opportunities may arise for biofuels to contribute to sustainable development if the scope of biofuel industries expands to explore by-products, diversified products, or alternative feedstocks, including second generation. These would create more options for local economies. For instance, residues from *Jatropha* production can be used as fertilizers or for pest management, and glycerol produced during transesterification as a by-product can be used for soaps and lubricants (ICRAF China 2007). The use of biodiesel for rural electrification may not be as relevant to China compared to other developing countries, since the country has already achieved over 98% electrification in rural areas (Jiahua et al. 2006). Still, biodiesel could be used for grinding wheat (ICRAF China 2007) or as an alternative to coal or firewood, helping to reduce indoor air pollution, labor needed to collect fire wood, and the threat of deforestation. The cassava industry could start selling diversified starch-based products in the market as well, although this could potentially affect feed markets. The government's role in supporting R&D would be critical if China continues to rely on state-owned enterprises. Thus, state-owned enterprises have a critical role to play in influencing the socioeconomic impacts of biofuels.

## 8.5 Japan

### 8.5.1 Overview of Japan's Main Policies

Japan started to promote biofuels from the mid-2000s by setting national strategies and plans to promote biofuels including the "Biomass Nippon Strategy"<sup>1</sup> (2002, revised in 2006), the "Kyoto Protocol Target Achievement Plan"<sup>2</sup> (2005), and the "New National Energy Strategy"<sup>3</sup> (2006).

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<sup>1</sup>"Baiomasu Nippon Sogo Senryaku".

<sup>2</sup>"Kyoto Giteisho Mokuhyo Tassei Keikaku".

<sup>3</sup>"Shin Kokka Enerugi Senryaku".

**Table 8.6** Targets for bioethanol to be introduced by oil refiners (to meet the requirements of the Law for the Sophisticated Structure of Energy Supply)

FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017
210,000 kL	210,000 kL	260,000 kL	320,000 kL	380,000 kL	440,000 kL	500,000 kL

(In crude oil equivalent)

The specific short-term numerical target related to biofuel introduction was set at 500,000 kL in oil equivalent by 2010, incorporated in both the Kyoto Protocol Target Achievement Plan and the revised Biomass Nippon Strategy. For the period after 2010, the targets for biofuel introduction were set in the Basic Energy Plan in 2010. Its midterm target by 2020 intended to increase the share of bioethanol in gasoline to more than 3% nationwide, with the conditions that GHG emissions should be reduced sufficiently and economic viability should be ensured. The Plan further aimed to increase the use of biofuels to the maximum extent by 2030 using next-generation biofuel technologies such as biofuels from cellulosic materials and algae.

A roadmap was published in 2010 which requested oil refiners to introduce 500,000 kL of ethanol (in crude oil equivalent) by 2017 (Table 8.6). This roadmap takes the 2020 target into consideration and aims to implement the “Law to Promote Utilisation of Non-fossil Fuel Energy Sources and Efficient Use of Fossil Energy Raw Materials by Energy Suppliers” (“Law for the Sophisticated Structure of Energy Supply”)<sup>4</sup>, which was enacted in 2009 and required energy suppliers to promote biofuels and biogas as non-fossil energy, assuming that biofuels can reduce GHG emissions by more than 50%.

Other policies to promote biofuels include an import tax exemption on ethyl tertiary-butyl ether (ETBE), a fuel tax exemption for bioethanol, and various financial and tax support measures for the producers of feedstocks and biofuels.

### 8.5.2 Overview of Main Biofuel Market Conditions

In the area of domestic production, the roadmap of *the Large-Scale Expansion of Domestic Biofuel Production* set a target to produce 50,000 kL of ethanol (30,000 kL in oil equivalent) domestically by FY 2011. Financial support for pilot projects and research and development (R&D) of advanced biofuels also has been provided by relevant ministries including the Ministry of the Environment (MOE), the Ministry of Agriculture, Forestry and Fisheries (MAFF), and the Ministry of Economy, Trade, and Industry (METI). The nationwide annual production was approximately 15,000 kL as of the end of the fiscal year (FY) 2009, increasing from 200 kL in the

<sup>4</sup>“Enerugi Kyokyu Jigyosha ni yoru Hi-kaseki Enerugi-gen no Riyo oyobi Kaseki Enerugi-genryo no Yuko na Riyo no Sokushin ni kansuru Horitsu” (“Enerugi Kyokyu Kozo Kodo-ka Ho”).

previous FY (MAFF 2009).<sup>5,6,7</sup> Feedstocks used in domestic production vary from edible crops (high-yielding rice, substandard flour, sugar beets, etc.) to waste materials (construction waste timber, saw mill waste, food waste, etc.). Major fuel ethanol pilot projects in Japan as of FY 2008 are listed in Table 8.7.

In contrast, biodiesel production in Japan has not been mainstreamed into the national policy. Production of biodiesel has been mainly based on waste cooking oil, through projects carried out by local governments or nongovernmental organizations. The total amount of biodiesel production as of March 2008 was estimated at 10,000 kL, which was double the amount from the previous year (MAFF 2009). A few examples of biodiesel utilization on a relatively larger scale are found in Kyoto City, Toyama City, and Iwaki City (Fukushima Prefecture) and Shiogama City (Miyagi Prefecture).

Sales of bioethanol-blended gasoline were started in 2007. The number of service stations retailing ETBE-blended gasoline was 1,710 as of 10 December 2010. In contrast, the number of service stations selling E3 was 18 in Osaka Prefecture and 6 in Kanagawa, Chiba, Ibaraki, and Aichi. Even if the Kyoto Target Achievement Plan could be achieved, this would amount to approximately 1% of gasoline consumption.<sup>8</sup>

### 8.5.3 Socioeconomic Impacts

The Biomass Nippon Strategy envisions the socioeconomic benefits of biomass utilization would be in the areas of contribution to the creation of a sound material-cycle society, incubation of new industries, revitalization of rural economies, and global warming mitigation. This section discusses the impacts of biofuels relating to a sound material-cycle society, rural development, and energy security.

The promotion of biofuels derived from unutilized materials and wastes is expected to enhance material recycling in resource-poor Japan. In fact, waste utilization has played an important role in biodiesel production in Japan through projects carried out by local governments or nongovernmental organizations to collect waste cooking oil and mix it with diesel fuel. Projects to produce waste-based ethanol also have been launched in some areas of Japan, utilizing materials such as food waste and waste construction timber. Data shows that there is still a significant amount of unutilized biomass which could be converted to ethanol. However, there are challenges related to difficulties in collection from small-scale waste generators. In addition, especially in the case of construction waste timber, competition with

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<sup>5</sup>The exact amount of production by each company is not published.

<sup>6</sup>The Japanese fiscal year starts on 1 April and ends on 31 March.

<sup>7</sup>Koji Okura, Deputy Director of the Biomass Policy Division, MAFF, replied to the question by the author at the Biomass Expo 2010, 18 November 2010.

<sup>8</sup>500,000 kL in oil equivalent is 561,797.8 kL in gasoline, and the actual gasoline consumption is 2008 was 57,473,000 kL.

**Table 8.7** Major pilot projects for fuel ethanol in Japan

Area	Implementer	Related ministry	Project outline
Shimizu Town, Hokkaido	Hokkaido Bioethanol Co. Ltd.	MAFF	Production from sugar beets, flour, etc.
Tokachi Area, Hokkaido	Tokachi Area Promotion Organisation	MOE, MAFF, METI	Production from substandard flour, corn, etc. and demonstration of gasoline blended with 3% ethanol (E3)
Tomakomai, Hokkaido	Oenon Holdings, Inc.	MAFF	Production from rice, etc.
Shinjo City, Yamagata Prefecture	Shinjo City	MAFF	Production from sorghum and E3 demonstration
Niigata City, Niigata Prefecture	National Federation of Agricultural Cooperative Associations	MAFF	Production from rice and E3 demonstration
Kanto Region	Petroleum Association of Japan (PAJ)	METI	Demonstration of ETBE
Sakai City, Osaka Prefecture	Bioethanol Japan Kansai, Osaka Prefecture	MOE	Production from construction waste timber and E3 demonstration
Maniwa City, Okayama Prefecture	Mitsui Engineering & Shipbuilding Co. Ltd, Okayama Prefecture, Maniwa City	METI	Production from lumber waste, etc., and E3 demonstration
Kitakyushu City, Fukuoka Prefecture	Nippon Steel Engineering Co. Ltd.	METI, MOE	Production from food waste and E3 demonstration
Ie Island, Okinawa Prefecture	Asahi Breweries, Ltd., National Agricultural Research Center for Kyushu Okinawa Region (KONARC)	MOE, MAFF, METI, Cabinet Office	Production from molasses with a high biomass amount and E3 demonstration Production from molasses and E3 demonstration
Miyakojima Island, Okinawa Prefecture	Ryuseki Corporation	METI, MOE, MAFF, Ministry of Land, Infrastructure, Transport and Tourism (MLIT), Fire and Disaster Management Agency, Cabinet Office	

Source: Committee for Eco-fuel Utilisation Promotion (2008a, b)



other uses has intensified as the wood chip market has experienced drastic fluctuations due to an increase in demand for biomass energy and a reduction in supply of construction waste timber due to stagnation in the construction market (Matsumoto and Sano 2011).

The effects of biofuel crop production on rural development would depend on which crops are cultivated in the future and the location where they are planted. In 2005, the area of “abandoned cultivated lands” (lands which are no longer being cultivated) was 386,000 ha, which is equivalent to 9.7% of total cultivated land (the sum of cultivated lands under management and abandoned cultivated lands) (Saigo 2008). Utilization of such abandoned cultivated lands as well as marginal lands could bring opportunities for rural development.<sup>9</sup>

The potential of biofuels to improve energy security seems very limited. In 2011, Japan’s production target was much smaller than its introduction target. For example, for FY 2011, the government aimed to increase biofuel production up to 50,000 kL (30,000 kL of oil equivalent from both bioethanol and biodiesel).<sup>10</sup> According to the roadmap to achieve the Basic Energy Plan, the targeted amount of bioethanol introduction for that year was 210,000 kL in crude oil equivalent. This indicates that even if the Japanese producers could successfully achieve the targeted level of production, it is far short of the targeted level of introduction, and the rest would need to be imported. It could be argued that biofuel imports might contribute to energy security by diversifying the energy sources and supplying countries, considering the fact that about half of Japan’s total energy supply comes from imported oil, of which almost 90% is imported from the Middle East, and that the transport sector is almost entirely dependent on oil. However, potential suppliers of bioethanol are limited to a few countries, and Brazil is currently regarded as the only country with the potential capability to export significant quantities in a stable manner. In addition, when the GHG reduction potential is considered, Brazil is the only foreign supplier which could have some possibility to reduce GHG emissions by more than 50%.

## **8.5.4 Stakeholder Perspectives**

### **8.5.4.1 Government**

As biofuels encompass several different policy areas, including agriculture, energy, industry, and environment, various government ministries have introduced related national strategies, plans, and policies. For example, the Biomass Nippon Strategy

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<sup>9</sup>For example, there is a rural revitalization project in Ibaraki Prefecture involving the cultivation of sweet sorghum in abandoned agricultural land to produce bioethanol.

<sup>10</sup>Specified in the roadmap entitled the “Large-Scale Expansion of Domestic Biofuel Production” (Kokusai Baionenryo no Ohaba na Seisan Kakudai) (Biomass Nippon Strategy Promotion Committee 2007).

is an initiative of the Ministry of Agriculture, Forestry and Fisheries (MAFF) in cooperation with other ministries. MAFF promoted increased domestic production of bioethanol, with a strong emphasis on the technology development in the area of soft cellulose. The Ministry of the Environment (MOE) established a Committee for Eco-fuel Utilisation Promotion and promoted pilot projects to introduce E3. The Basic Energy Plan, which set a target to increase the share of bioethanol in gasoline to more than 3% by 2020, was developed by the Ministry of Economy, Trade, and Industry (METI). As shown in Table 8.2, those ministries have supported production projects for fuel ethanol from various feedstocks, independently in some cases and jointly in others.

In the area of introduction, that is, blending ethanol into transport fuel (especially gasoline), promotion policies were introduced without a full agreement between the MOE and the Petroleum Association of Japan (PAJ) on the blending method: whether ethanol should be directly blended or should be first processed into ethyl tertiary-butyl ether (ETBE) and then blended. This led to two different markets of ethanol-blended gasoline, one for E3 and one for ETBE-blended gasoline (so-called biogasoline). The lack of the agreed national blending policy was noted in the screening process to reduce the national budget in 2010 and as a result the MOE's budget related to E3 promotion was recommended to be halved.

#### **8.5.4.2 Oil Industry**

PAJ was requested by the government to increase the introduction of biofuels to 210,000 kL in oil equivalent (840,000 kL in bio ETBE) as a part of the effort to achieve the Kyoto Protocol Target Achievement Plan (a total of 500,000 kL in oil equivalent for liquid transport fuel), and it is likely to achieve the goal. However, the oil industry has opposed large-scale introduction of biofuels for several reasons such as limited supply, concerns about the stability of supply, expected high infrastructure investment costs (such as oil refineries), and the potential for food–fuel conflict. PAJ insisted on waiting for the commercialization of production technology before discussing the expansion of biofuel introduction.<sup>11</sup>

#### **8.5.4.3 Automobile Industry**

Many Japanese auto manufacturers have already started exporting E10-compliant vehicles, and manufacturers such as Toyota, Honda, and Nissan have already been selling new vehicles compatible with E10 (Sakata 2009). In addition, some companies have already launched sales of flex-fuel vehicles in Brazil, and vehicles compatible with E85 in the United States, and E20 in Thailand. The Japan Automobile Manufacturers Association (JAMA) published its position statement on both ethanol-blended gasoline and FAME-blended diesel and stated that it has

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<sup>11</sup> Presentation made by the PAJ on the Medium- and Long-Term Roadmap on 3 June 2010.

consistently supported the use of biofuels complying with appropriate sustainability criteria as part of an integrated approach to the reduction of CO<sub>2</sub> emissions. However, it also emphasized the need to ensure that biofuels are equivalent in quality to conventional fuels so as to achieve satisfactory safety and emission performance of vehicles. It also emphasized the need for clear and harmonized fuel quality standards.<sup>12,13</sup>

#### 8.5.4.4 Consumers

The results from an annual website questionnaire survey conducted by the PAJ in 2010 indicated that the image of biofuels had turned more positive, compared to the one conducted in 2008 when global food prices soared. In 2010, 63% of 4390 respondents supported the statement that “use of biofuels for transportation should be promoted if it is within the range that does not affect other issues such as the food problem,” which was a 6.5% decrease from the previous year. In comparison, the ratio of respondents who replied that “I support the proactive promotion of biofuels in order to prevent global warming” increased by 4% from the previous year and reached 29.9%.

#### 8.5.5 Analysis

Although the domestic production of biofuels has been increasing, the ability of biofuels to contribute to Japan’s energy security is constrained by the potential scale of domestic production and availability of imports. In contrast, biofuels might play a more significant role in the revitalization of rural economies and the development of a sound material-cycle society (Matsumoto et al. 2009). The success of such efforts relies on the future development of technologies and socioeconomic infrastructure.

The introduction targets that the oil refiners have been requested to meet (from FY 2011 to 2017: see Table 8.1) are larger than the scale of domestic production. Thus, Japan will need to continue to import a significant amount of biofuels at least for the next decade. Under these circumstances, it is necessary to set appropriate sustainability criteria for biofuels. The Japanese government has been in the process of developing such a standard and examined a 50% GHG reduction as a criterion.

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<sup>12</sup>JAMA Position Statement, FQ-01, 2009.10.30 “Quality of Bioethanol and Use of Ethanol-blended gasoline”.

<sup>13</sup>JAMA Position Statement, FQ-02, 2009.10.30 “Quality of Biodiesel (FAME) and Use of FAME-blended diesel”.

### **8.5.6 Policy Implications**

Considering the limitation of feedstock production and the state of ethanol production technologies, it seems reasonable to maintain the modest introduction target. In the area of revitalization of local economies through the promotion of biofuels, decisions on the location of cultivation and the choices of energy crop species are crucial. For a sound material-cycle society to be realized, although second-generation biofuel production technologies to utilize rice straw and unutilized woody biomass are being advanced, further development is necessary to reduce production costs and make them commercially viable. In addition, developing efficient collection systems including small-scale waste generators is crucial. Finally, setting appropriate sustainability criteria would be especially important in Japan as it needs to import ethanol from overseas to meet the introduction targets.

## **8.6 Conclusion**

Major biofuel promotion policies in the case study countries started from the mid-2000s and had largely similar objectives, although with different emphases. All four countries emphasized rural development, but Japan placed comparatively more emphasis on the goal of reducing GHG emissions, while the other three countries placed more emphasis on energy security. Somewhat surprisingly, several major aspects of biofuel policies converged among the four countries, despite significant differences in their situations. The initial biofuel targets set by Indonesia and India were overambitious, but these countries have since backed off of these targets, while those of Japan and China were more conservative from the early stages. Partly, this reflected the now widespread sensitivity among governments about the potential for biofuels to cause a food–fuel conflict. The governments of all four countries have been very sensitive to this issue. Biofuel promotion policies in Indonesia and India in particular tended to focus on promoting specific biofuel feedstocks, but later all four countries recognized that overdependence on one or a few feedstocks is not desirable. In all cases, the biofuel boom of the 2000s was supported by high oil prices, and the subsequent oil price fall and global financial crisis severely harmed the economic viability of biofuels. Nevertheless, governments of all four countries, albeit to different extents, have engaged in research and testing of alternative feedstocks and second-generation biofuels. Finally, all four countries have recognized the limitations of biofuels for energy security and placed more emphasis on their potential to contribute to rural development.

Biofuels may have some potential to contribute to rural development, even in developed countries such as Japan. However, the case studies in China, India, and Indonesia showed that biofuels are not likely to be a “miracle solution” to promote rapid rural development, and the idea of growing nonfood crops on wastelands is too good to be true. Much “wasteland” would need significant inputs of fertilizer

and water in order to produce a significant quantity of biofuels. In any case it is not clear how much wasteland actually exists, and often it is actually being used for some other economically valuable purpose, especially by lower income people, or providing ecosystem services. Farmers have various crop alternatives, and biofuel crops, especially nonfood crops with limited alternative uses, are often not very attractive options without significant economic support, which governments have been reluctant to provide.

Regarding energy security, these case studies of relatively large countries show that the ability of biofuels to contribute to energy security could be modest but is fundamentally limited. Biofuels may contribute to supply diversification to some extent. However, even the achievement of modest targets in China, Japan, and India will require imports. In Indonesia, despite the ambitions of some for the country to become the “Middle East of biofuels,” the main large-scale crop, palm oil, is too important for food purposes for the government to allow its significant diversion to other uses, and this was the case even before the biofuel boom. It is already a significant challenge for Indonesia to produce enough fuel domestically to meet its targets. Moreover, other than Brazil, potential sources for imports are unclear.

Biofuels do seem useful for recycling waste materials, especially in Japan, although in some cases, biofuels compete with alternative uses for recycling the wastes. In developing countries like India, cooking oil is often reused until it disappears, so other waste sources would have to be considered.

Several policy implications can be drawn from these cases. First, it may be desirable to adopt a cautious stance and avoid setting high unrealistic targets. Large-scale, rapid expansion of biofuels could pose high risks of food–fuel conflict and may not be feasible due to limited supplies of land, water, and labor. If targets cannot be met by domestic production, imports would be necessary. Too high targets risk encouraging unsustainable production, deforestation, water shortages, food–fuel conflict, and inappropriate appropriation of land used by poor people. Modest targets, near existing utilization rates, may be more sustainable.

Second, all countries dealt with the question of how much biofuels should be promoted through special economic incentives such as subsidies, mandatory targets, or price regulations. This is an especially important issue in countries like India and Indonesia, where many sectors receive special treatment—particularly fossil fuels, which is the main sector competing with biofuels. Therefore, a lack of special promotion measures becomes in effect a disincentive policy, so the governments of India and Indonesia in particular have been under strong pressure from businesses interested in promoting biofuels to adopt these kinds of measures. In principle, such measures could be justified if biofuels provide important social benefits, but since these benefits have been shown to be still unclear, the caution displayed by India and Indonesia seems justified. To be sure, subsidies and other special promotion measures for fossil fuels are also problematic from the point of view of environment and sustainability (UNEP 2008), and reducing them is widely viewed as beneficial, but nevertheless, reducing fossil fuel subsidies would serve to make agricultural prices more closely linked to fuel prices in these countries and create a more level playing field with biofuels.

Finally, it is desirable to promote the use of sustainability standards, given the remaining large uncertainties about the impacts of biofuel production and availability of inputs such as land and water, the great variation in local conditions, and the likelihood that biofuels will be globally traded. Standards can enable individual biofuel stakeholders to demonstrate that their particular production methods in their particular circumstances is sustainable. To be sure, these standards have various limitations, but sustainability standards seem to be the main possibility to demonstrate the potential for biofuel sustainability on a case-by-case basis, taking into account local conditions.

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