CHAPTER 6

ECONOMIC COMPETITIVENESS

Key Findings

- Biofuels produced in Thailand are generally competitive with fossil fuels.
- Feedstock costs are the deciding factor of the economic competitiveness of biofuel production in Thailand.
- Improving the yields of key biofuel feedstock crops will provide an avenue to reduce feedstock costs and boost economic competitiveness.

6.1 OVERVIEW OF ANALYSIS

The purpose of this element of the analysis was to examine the economic competitiveness of biofuels produced in Thailand from each of the key biofuel feedstock crops. The economic competitiveness of each fuel type is assessed using two main criteria namely, the final production cost per unit of biofuel and the internal rate of return.

6.2 COMPETITIVENESS OF SUGAR-BASED ETHANOL

The sugar-based ethanol production configurations assessed in this chapter are presented in Table 6.1.

TABLE 6.1

Characteristics of sugar-based ethanol configurations

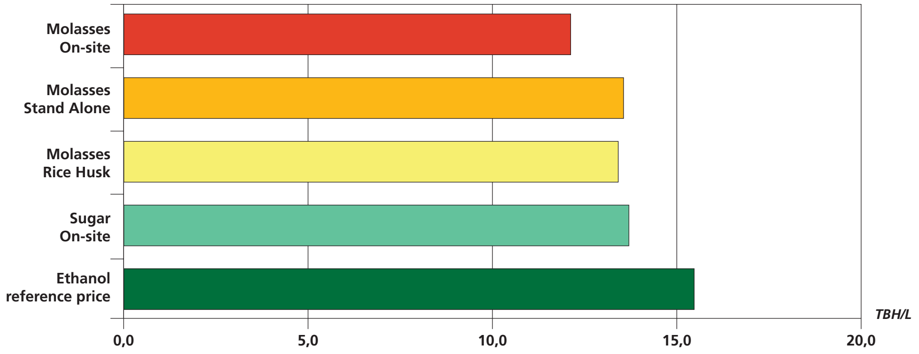
Production scenario	Description
Sugar – On-site	■ 182.5 million litre capacity powered by renewable energy (bagasse) plant attached to sugar mill ■ Ethanol produced from sugar juice ■ Theoretical scenario – no actual example in Thailand
Molasses – Rice Husk	■ 73 million litre capacity powered by renewable energy (rice husk cogeneration plant) ■ Molasses transported to off-site refinery for processing
Molasses – Stand Alone	■ 73 million litre capacity powered by renewable energy (bagasse) plant attached to sugar mill ■ Additional feedstock is sourced from surrounding suppliers
Molasses – On-site	■ 73 million litre capacity powered by renewable energy (bagasse) plant attached to sugar mill ■ Energy and feedstock are made available at internal prices

Source: JGSEE.

From Figure 6.1 it can be observed that production costs for sugar ethanol are found to be competitive under each feedstock scenario. Production costs are below the ethanol reference price of 19.3 THB/L (0.60 $/L) for each configuration and well below the fossil gasoline 91 reference price of 35 THB/L (1.10 $/L). The internal rate of return for each configuration is high ranging between 28 percent for the molasses stand alone configuration and 42 percent for the molasses on-site configuration before accounting for tax. The lowest production costs are recorded for molasses-based ethanol using an on-site refinery, which allows for substantially reduced transport costs and the ability to source energy supplies from a co-located sugar mill. This configuration describes most existing ethanol production operations in Thailand indicating that the industry is already highly competitive.

FIGURE 6.1

Comparison of sugar-based ethanol production costs



Source: JGSEE.

6.3 COMPETITIVENESS OF CASSAVA-BASED ETHANOL

In the BEFS Thailand analysis particular focus is directed towards cassava ethanol. This focus is warranted because, as noted previously, cassava ethanol is anticipated to constitute an increasing proportion of Thailand's ethanol targets. Unless cassava ethanol production generates sufficient returns for producers it cannot be assumed that there will be enough cassava ethanol supplied to meet the long-term demand anticipated by the AEDP targets.

TABLE 6.2

Characteristics of cassava-based ethanol configurations

Production scenario	Description
Low efficiency fossil (LEF)	■ 36.5 million litre capacity powered by coal and electricity grid ■ Ethanol produced from fresh cassava root
Medium efficiency fossil with waste water management (MEF)	■ 73 million litre capacity powered by coal and electricity grid ■ Biogas plant established to generate additional energy from waste water flows ■ Ethanol produced from cassava chips
Renewable energy (RE)	■ 73 million litre capacity powered by renewable feed electricity plant attached to co-located sugar mill ■ Biogas plant established to generate additional energy from waste water flows ■ Ethanol produced from cassava chips with capacity to switch to molasses

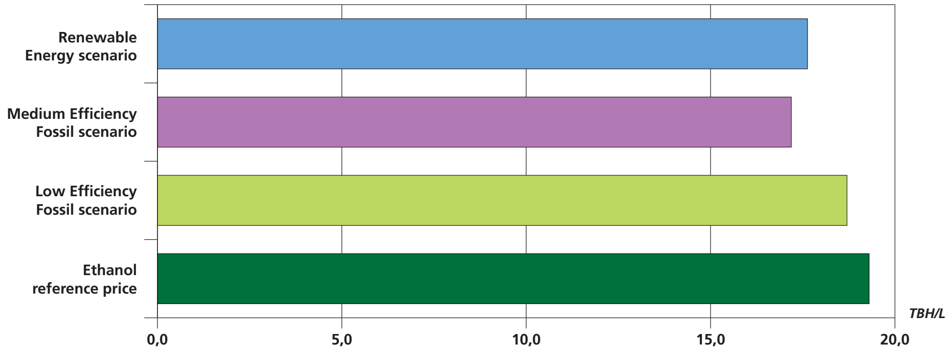
Source: JGSEE.

The cassava-based ethanol production configurations assessed in this chapter are presented in Table 6.2. Each of the configurations described have been implemented in the Thai context, although the RE configuration is a relatively new addition to the industry.

Figure 6.2 shows that production costs for cassava ethanol are found to be competitive under each scenario. Production costs are below the ethanol reference price of 19.3 THB/L (0.60 $/L) for each configuration with a cassava root price of 1.8 THB/kg (0.06 $/kg), which is higher than the OAE reference price of one THB/kg (0.03 $/kg). Cassava ethanol production under existing practices is found to create enough of a margin to generate a profit for farmers. The internal rate of return (IRR) of the configurations assessed ranges between 18.8 percent for the MEF configuration and 23.3 percent for the RE configuration before accounting for tax. However, small changes in product sales or the price of raw materials exert large influence on the economic competitiveness of cassava ethanol (Figure 6.3).

FIGURE 6.2

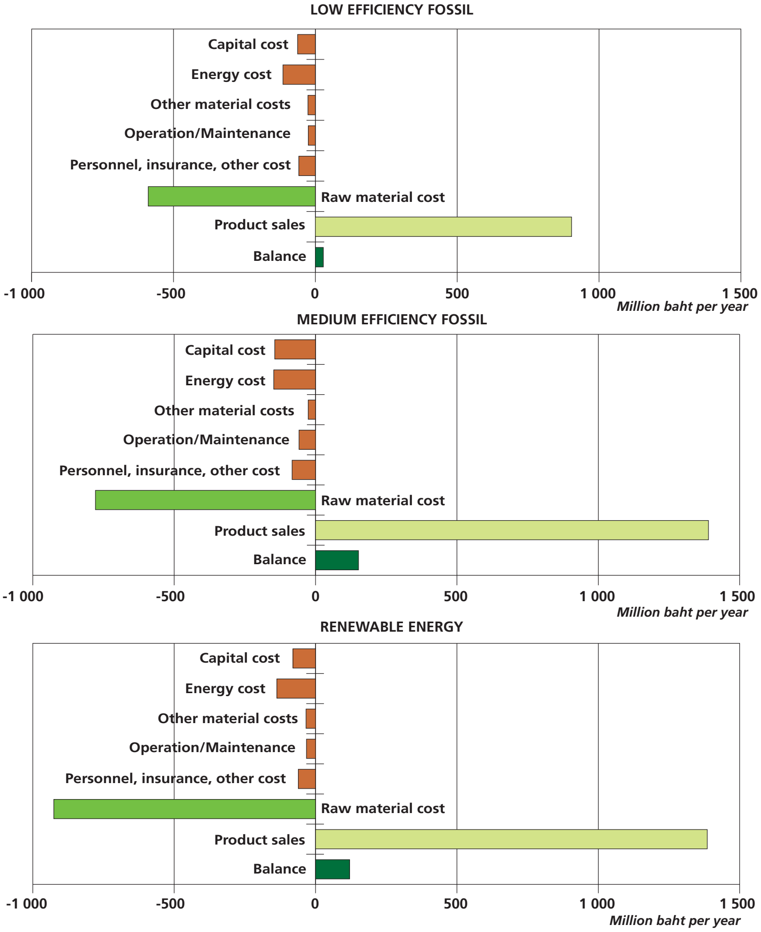
Comparison of cassava-based ethanol production costs



Source: JGSEE.

FIGURE 6.3

Cost and benefit summary for cassava-based ethanol scenarios



Source: JGSEE.

A 20 percent increase in feedstock cost for each scenario results in a final product cost above the ethanol reference price and a significant decline in IRR. A reduction of the ethanol sale price by one Thai baht per litre reduces the potential range of IRR to between 2.8 percent for the LEF configuration and 14 percent for the RE configuration.

Looking at the feedstock component in more detail it is found that costs associated with fertilizers are the largest contributor to final feedstock cost followed by land preparation and then labour costs. However, it was observed that slightly higher inputs lead to better yields and larger net profits. There may also be opportunities to reduce fertilizer costs through increased use of organic products. Field testing by LDD has indicated that use of cheaper organic fertilizers in place of chemical varieties can also improve yields in some instances.

Generally it was found that prices received for cassava root are above the OAE national reference price. This results in revenues per farmer higher than those estimated by OAE. It was also found that the average yield in surveyed areas was higher than the OAE national average of 21 tonnes per hectare. In most cases cassava farmers are small-holders with equally small operations. Improved returns from cassava crops via improved yields and stable prices could deliver considerable benefits to these farmers.

6.4 COMPETITIVENESS OF BIODIESEL

The biodiesel production configurations assessed in this chapter are presented in Table 6.3.

TABLE 6.3

Characteristics of biodiesel configurations

Production scenario	Description
CPO – Large Scale	■ 146 million litre capacity powered by grid electricity and/or coal ■ CPO is produced in location proximate to oil palm plantation ■ CPO transported to off-site biodiesel refinery
Multi-Feed – Large Scale	■ Feedstock includes CPO, refined palm oil, stearine and waste cooking oil
CPO – Small Scale	■ 365 thousand litre capacity powered by grid electricity and/or coal ■ Batch operation
Waste Cooking Oil – Small Scale	■ 365 thousand litre capacity powered by grid electricity and/or coal

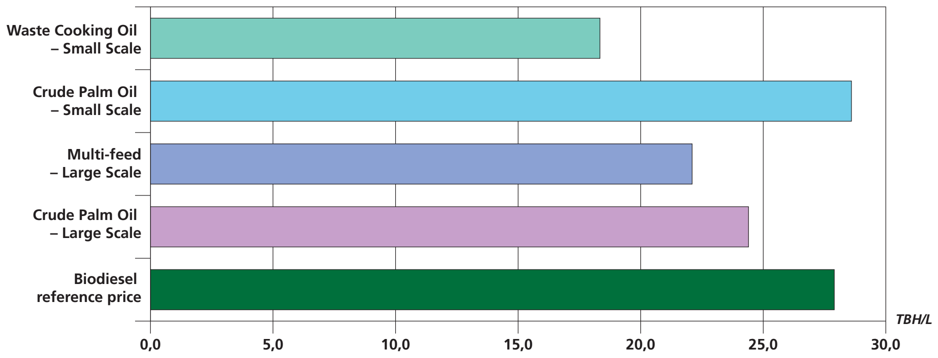
Source: JGSEE.

From Figure 6.4 it can be observed that production costs for palm oil biodiesel are found to be competitive under most feedstock scenarios. Generally, production costs are below the biodiesel reference price of 27.9 THB/L (0.87 $/L) for each configuration and below the fossil diesel reference price of 27 THB/L (0.84 $/L) per litre. The IRR before tax is above 50 percent for each configuration except the small-scale, crude palm oil configuration. Generally the findings indicate that strong returns are possible for biodiesel producers in Thailand. This should provide the necessary incentives to attract additional investment and new entrants to expand production capacity in line with the AEDP biodiesel target.

Interestingly, the small-scale configuration using crude palm oil as feedstock is found to be economically unviable. This is because the conversion process is less efficient – requiring more inputs per unit of output. At present, the Thai biodiesel industry employs a large-scale, crude palm oil configuration.

FIGURE 6.4

Comparison of biodiesel production costs

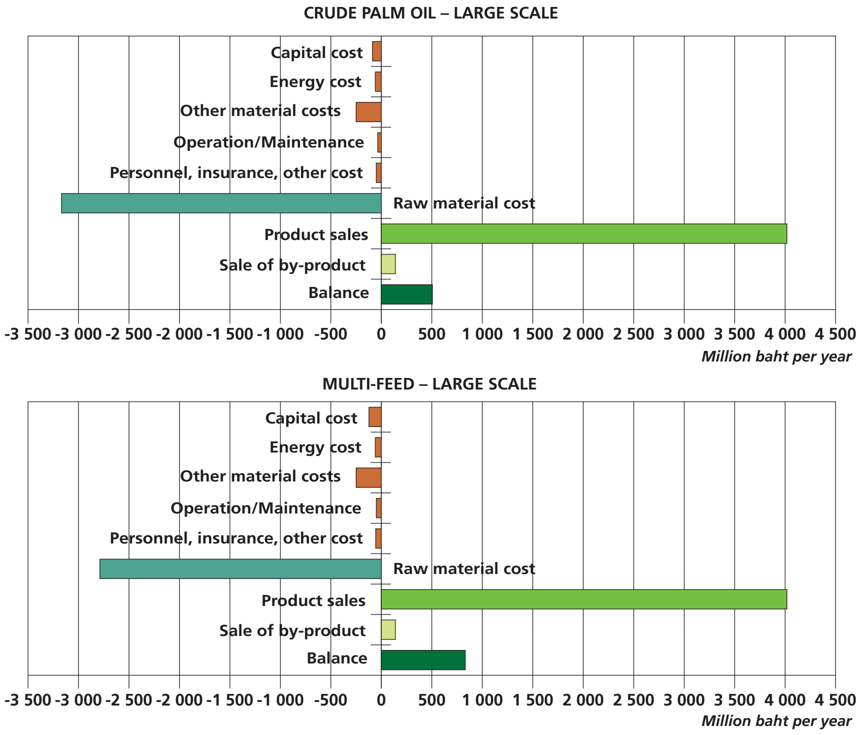


Source: JGSEE.

As already seen in the case of cassava, feedstock costs are also a key determinant of the economic competitiveness of biodiesel production in Thailand (Figure 6.5). Strategies to reduce the cost of this component for biodiesel producers will dramatically improve the economic competitiveness of Thai biofuel producers.

FIGURE 6.5

Cost and benefit summary for large scale biodiesel scenarios



Source: JGSEE.

CHAPTER 7

CLIMATE CHANGE MITIGATION

Key Findings

- Biofuels produced in Thailand display measurable GHG benefits when compared to fossil fuels.
- The refining process is the most critical determinant of the overall GHG balance of biofuels.
- Agriculture is also a key contributor to the GHG profile particularly when land use and crop changes are involved.
- The Thai biofuel sector could reduce emissions through better agricultural practices and by using wastes and by-products for energy.

7.1 OVERVIEW OF ANALYSIS

The purpose of this element of the analysis was to assess the impact of biofuels produced in Thailand in terms of greenhouse gas emissions and energy balance. To complement and build on the analysis presented in the previous chapter, a full life cycle analysis (LCA) was developed for each of the biofuel production configurations examined in the economic analysis. An LCA is a tool for the systematic evaluation of potential environmental impacts associated with a product, process or activity, from the production of raw materials through to its final disposal. In this case, the LCA focused on the emission of greenhouse gases and energy required at every stage of the biofuel production chain from the farm to the refinery gate. The calculated GHG emissions for the fuels produced from each production configuration assessed in this chapter are expressed as grams of carbon dioxide equivalent per megajoule (gCO_{2eq}/MJ).

7.2 GHG EMISSIONS OF SUGAR-BASED ETHANOL

For the purpose of comparison hypothetical scenarios were developed that use fossil energy as the main source of power for the refining step. These scenarios are presented in Table 7.1.

TABLE 7.1

Additional sugar-based ethanol processing scenarios

Production Scenario	Description
Sugar – Fossil	■ 182.5 million litre capacity powered by grid, electricity and/or coal ■ Ethanol produced from sugar juice in off-site facility ■ Theoretical scenario – no actual example in Thailand
Molasses – Fossil	■ 73 million litre capacity powered by grid, electricity and/or coal ■ Theoretical scenario – no actual example in Thailand

Source: JGSEE.

Figure 7.1 presents the life cycle GHG balances of different sugar ethanol production configurations in Thailand. It can be observed that in most cases ethanol production in Thailand either from molasses or from sugar juice offers considerable GHG reductions when compared to threshold values for fossil gasoline and the EU sustainability directive. The research also suggests that ethanol production in Thailand offers net fossil energy savings when compared to fossil gasoline.

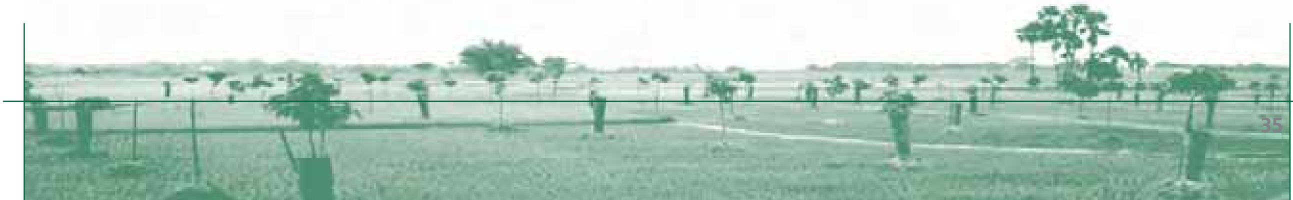
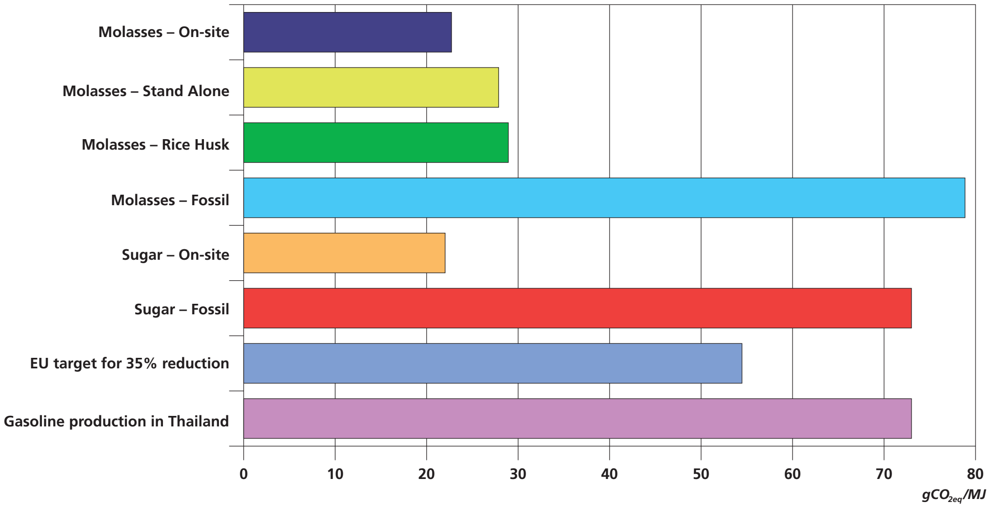


FIGURE 7.1

GHG emissions of different sugar-based ethanol configurations

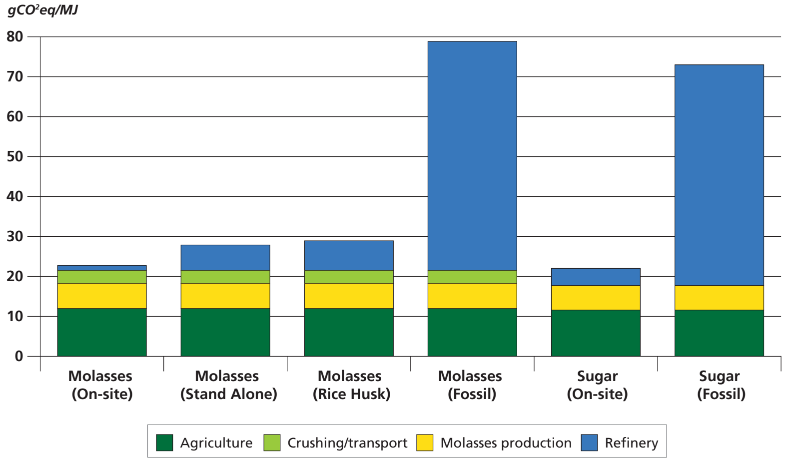


Source: JGSEE.

The use of fossil energy in the refining process is a key variable determining the sustainability of each ethanol scenario in terms of climate and energy balance. In scenarios where fossil energy is used, the refining process is the main contributor of GHG emissions. But in the case where only renewable energy is utilized in this step, the largest GHG contributor is agriculture (Figure 7.2). This suggests that policies to improve the GHG balance of sugar ethanol could be targeted toward both better utilization of renewable biomass for power generation and encouraging more efficient agriculture.

FIGURE 7.2

Breakdown of GHG emissions by step for sugar-based ethanol scenarios



Source: JGSEE.

7.3 GHG EMISSIONS OF CASSAVA-BASED ETHANOL

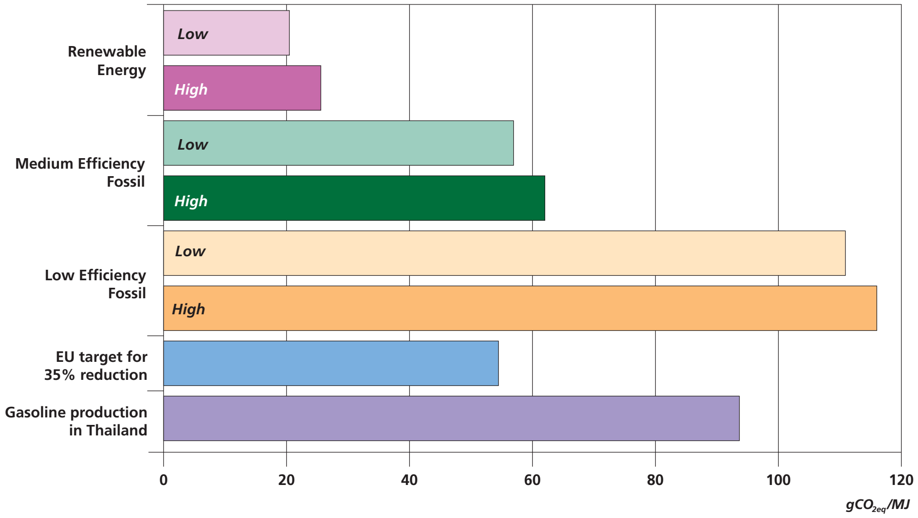
As with the economic analysis, the potential climate impacts of cassava ethanol were given special attention in the BEFS Thailand analysis. In terms of life cycle analysis, Thai cassava ethanol has previously been less scrutinized than sugar-based ethanol and palm oil biodiesel.

Figure 7.3 presents the life cycle GHG balances of the different cassava ethanol production configurations. It indicates that the GHG emissions profile of cassava ethanol varies dramatically. Cassava ethanol produced using inefficient fossil fuel configurations is found to result in greater GHG emissions than fossil gasoline. More efficient fossil fuel configurations, i.e. MEF, display reduced emissions but fail to meet the EU emissions reduction target. This could have implications if Thai cassava ethanol producers were to look for future export markets in Europe. The most efficient configuration in terms of GHG is the renewable energy configuration, co-located with an existing sugar mill. From Figure 7.3 it can be observed that this configuration also meets the EU emissions threshold.

Cassava ethanol's demand for energy during the production process is greater than fossil gasoline if the inefficient fossil fuel configurations are employed. Otherwise the energy balance of cassava ethanol is superior to fossil gasoline.

FIGURE 7.3

GHG emissions of different cassava-based ethanol configurations



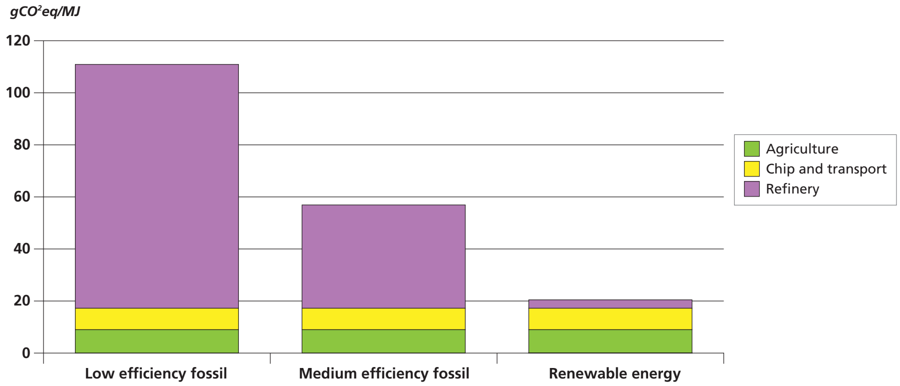
Source: JGSEE.

The location of the ethanol refinery and energy configuration employed is the most important determinant of the final GHG balance of cassava ethanol. Figure 7.4 clearly displays the importance of refinery configuration to final GHG emissions from cassava ethanol.

Generally, the contribution of agriculture to the GHG profile of cassava ethanol is low (Figure 7.4). It can be observed in Figure 7.3 that the difference in emissions between low and high input farming in the cassava sector is minimal. Further it was found that increases in yields generally offset the subsequent increase in emissions from adding further inputs. However, in the event that significant land use or crop changes are involved in cassava feedstock production, the contribution of agriculture to the GHG emissions profile increases – in some cases dramatically.

FIGURE 7.4

Breakdown of GHG emissions by step for cassava-based ethanol scenarios

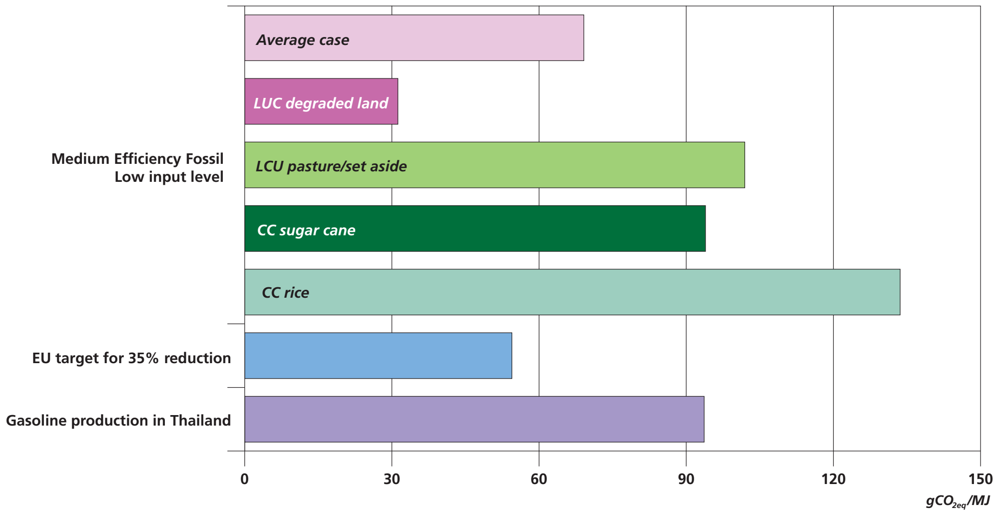


Source: JGSEE.

In Chapter 3 it was indicated that a sizable increase in cassava plantings, particularly on land currently allocated to rice, may be necessary to meet the anticipated feedstock demand for cassava ethanol if yields were unable to grow at rates required by the AEDP. Figure 7.5 presents a comparison of GHG emissions from cassava ethanol when land use or crop changes are involved in the agricultural process under the MEF configuration. The change in GHG emissions is dramatic – particularly for crop changes from rice to cassava. Based on the findings presented here and in Chapter 3, it is clear that caution will be required to ensure that this type of activity is minimized if cassava ethanol produced in Thailand is to retain its GHG mitigation potential and benefit the climate.

FIGURE 7.5

Influence of LUC and CC on the medium efficiency fossil scenario



Source: JGSEE.

7.4 GHG EMISSIONS OF BIODIESEL

Two additional biodiesel scenarios were developed for the purpose of the LCA analysis. Further details of these scenarios are available in Table 7.2.

TABLE 7.2

Additional biodiesel processing scenarios

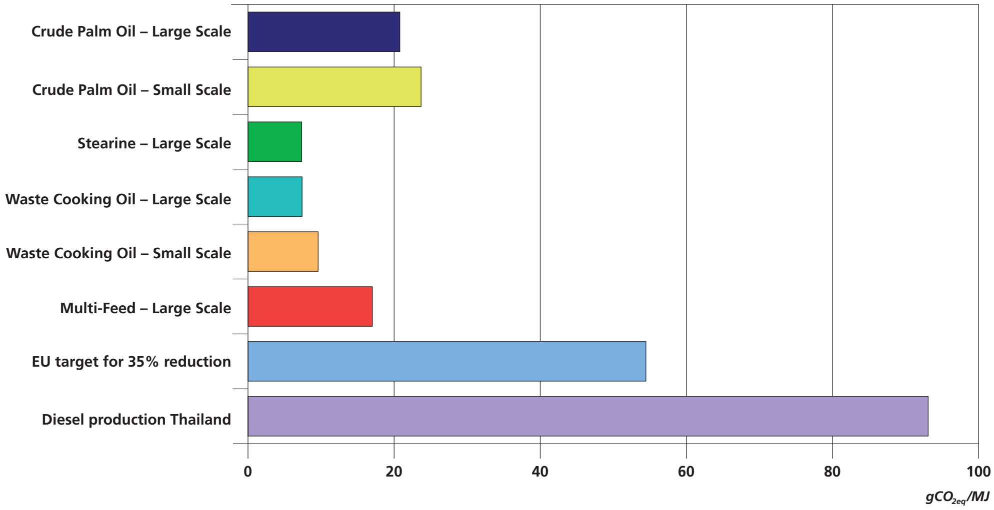
Production scenario	Description
Stearine – Large Scale	■ 146 million litre capacity powered by grid, electricity and/or coal
Waste Cooking Oil – Large Scale	■ 146 million litre capacity powered by grid, electricity and/or coal

Source: JGSEE.

From Figure 7.6 it can be seen that the production of biodiesel from palm oil in all cases generates less GHG emissions when compared to fossil diesel over the life cycle. Interestingly the small-scale biodiesel production scenarios are less efficient in terms of GHG emissions and energy balance when compared to industrial scale operations. This is largely due to the fact that small-scale production has higher energy requirements per unit of energy produced. Small-scale production also entails higher demand for methanol inputs per unit of energy produced.

FIGURE 7.6

GHG emissions of different biodiesel configurations

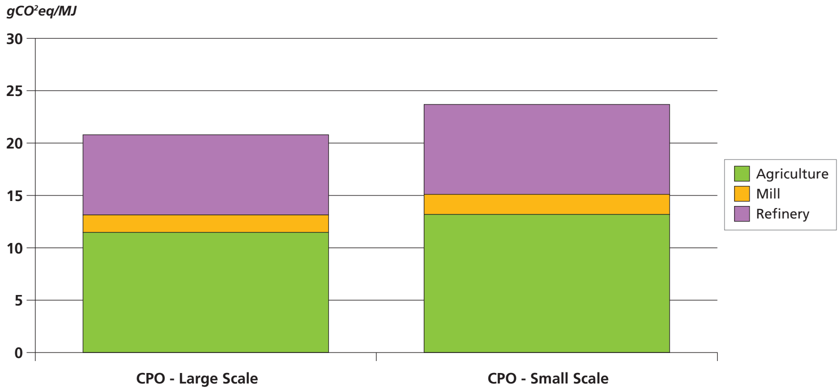


Source: JGSEE.

The research also indicates that biodiesel production is generally more energy efficient than ethanol production. This is because the energy demand for ethanol refining is high; particularly when fossil energy refineries are employed. For biodiesel the largest contributor to GHG emissions is agriculture – except in the scenarios where waste cooking oil and stearine are used as feedstock. The significant contribution of agriculture to overall GHG emissions results from the application of fertilizers, use of fossil fuels on farm and product transport (Figure 7.7). If the effects of land use change are incorporated, GHG emissions increase dramatically when forested land is converted to oil palm plantations. However, converting degraded land to oil palm plantations would increase carbon stocks and may produce an overall benefit in the form of reduced emissions.

FIGURE 7.7

Breakdown of GHG emissions by step for crude palm oil biodiesel scenarios

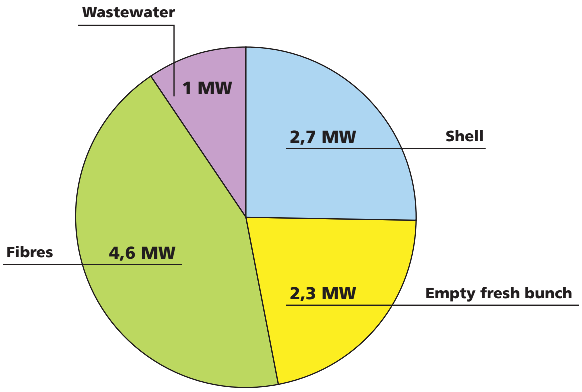


Source: JGSEE.

Generally there is considerable scope to improve the efficiency of existing systems by utilizing biomass wastes from the feedstock production process to generate energy that can fuel the biodiesel production process. Figure 7.8 provides an overview of the estimated additional energy in megawatts (MW) that could be sourced from by-products in the production of CPO at a medium sized processing mill that processes 45 tons of fresh fruit bunch per hour. The integration of processes and systems to manage wastes and other flows to produce energy could result in significant additional gains for overall efficiency and, ultimately, sustainability.

FIGURE 7.8

Renewable energy potential of medium sized CPO mill



Source: JGSEE.

CHAPTER 8

SOCIO-ECONOMIC ASPECTS

Key Findings

- Any increase in agricultural prices that arise from development of the biofuel industry could lead to increased incidence of poverty in Thailand.
- Strategies that aim to locate biofuel feedstock producing opportunities in poorer communities could have a positive effect and reduce the incidence of poverty.
- Higher agricultural prices will lead to growth in the agriculture sector.
- Further investigation and monitoring is required to understand the true impact of the biofuel sector on households and the Thai economy.
- Small-scale bioenergy systems may offer benefits for rural development, but require assistance to establish and operate.

8.1 OVERVIEW OF ANALYSIS

The purpose of this element of the analysis was to consider how the Thai Government's plans for the biofuel and bioenergy sectors could affect Thai households and the broader economy. This analysis was conducted in two parts. The first element of the analysis attempts to investigate the potential socio-economic effects of biofuel development by estimating how changes in the price of agricultural crops, and biofuel crops in particular, could impact on both households and the economy more broadly. This implies that the analysis is conducted at both the microeconomic and macroeconomic level. A key assumption underlying this type of analysis is that biofuels will create a new source of demand for biofuel feedstock crops and that this demand will result in a rise in the price of these commodities and, possibly, other agricultural commodities.

For further details regarding the methodologies underpinning the analysis in this chapter and their limitations please refer to "*Bioenergy and Food Security – The BEFS analysis for Thailand*".

The second element of the analysis evaluates the potential benefits of small-scale bioenergy systems and barriers to their wider adoption in Thai rural communities. Unlike biofuels, which have been the focus of the BEFS analysis in Thailand and generally aim to provide an additional source of income for agriculture-based communities, small-scale bioenergy systems can benefit rural communities by reducing energy expenditures and increasing the value of otherwise discarded biomass wastes.

8.2 POVERTY SITUATION IN THAILAND

Before examining the potential impacts of biofuels and bioenergy on households in more detail it is useful to present some background information on poverty and household economic conditions in Thailand to contextualize the analysis. The poverty situation in Thailand has improved dramatically over the past two decades (Figure 8.1). However, pockets of poverty still exist throughout the country.

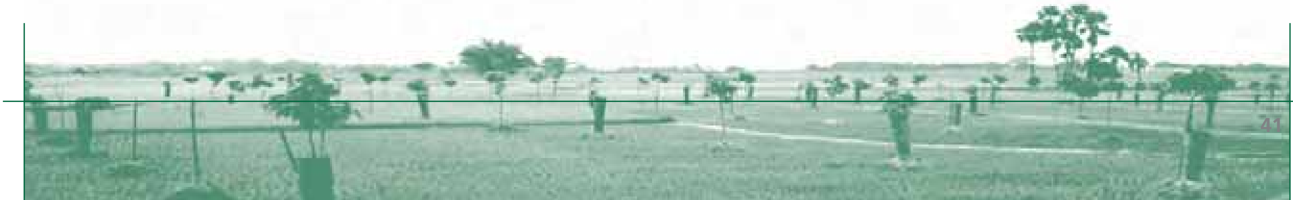
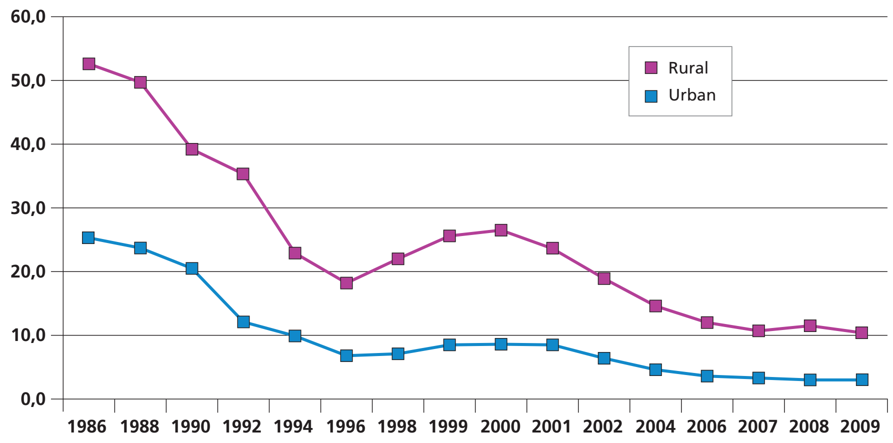


FIGURE 8.1

Poverty incidence by area, 1986-2009



Source: NSO - calculated from 2009 Socio-Economic Survey.

As can be seen in Table 8.1, the incidence of poverty in Thailand in 2009 was 8.12 percent with the vast majority of poor located in the North and Northeast regions of the country. The average food poverty line is generally higher than the non-food poverty line, except in Bangkok where there is a bias in consumption patterns toward more non-food items. A poverty line is the minimum amount of expenditure, expressed in baht per person per month (THB/person/month), on a category of goods required for a household to be considered out of poverty.

TABLE 8.1

Per capita income and expenditure, poverty line and incidence by region in 2009

Region			Average poverty line			Poverty incidence	
	Income	Expenditure	Food	Non-food	Total	Income	Consumption
	THB/person	THB /person	THB/person/ month	THB/person/ month	THB/person/ month	%	%
Bangkok	13 446	8 463	917	1 218	2 135	1.84	0.86
Central	7 080	5 094	893	760	1 652	3.06	2.54
North	4 965	3 420	929	556	1 485	9.49	11.08
Northeast	4 339	3 127	957	517	1 473	13.89	13.67
South	6 707	4 464	970	577	1 547	5.22	4.72
Total	6 239	4 308	934	652	1 586	8.18	8.12

Source: NSO – calculated from 2009 Socio-Economic Survey.

In Thailand, the incidence of poverty is also greatest amongst agricultural households. Over 75 percent of Thailand's poor are engaged in agricultural production. While this could imply that biofuel production may provide an opportunity to lift some of Thailand's agricultural producers out of poverty, the largest segment of Thailand's agricultural poor produce rice as their only crop. If these farmers are unable to diversify their source of farm income then the poverty reduction potential of the biofuel sector is severely reduced. The incidence of poverty could even worsen if development of the sector were to lead to a broad increase in food prices for poor rice farmers.

Generally, for households with no farm income, growth in the food poverty line might cause them to fall into poverty if their total income is only marginally above the poverty line to begin with. However, the extent to which food price changes affect the poverty situation of households with farm income depends on whether the increase in farm income compensates for the increase in the poverty line.

As noted above, both a microeconomic and macroeconomic analysis were undertaken to assess these potential issues in more detail.

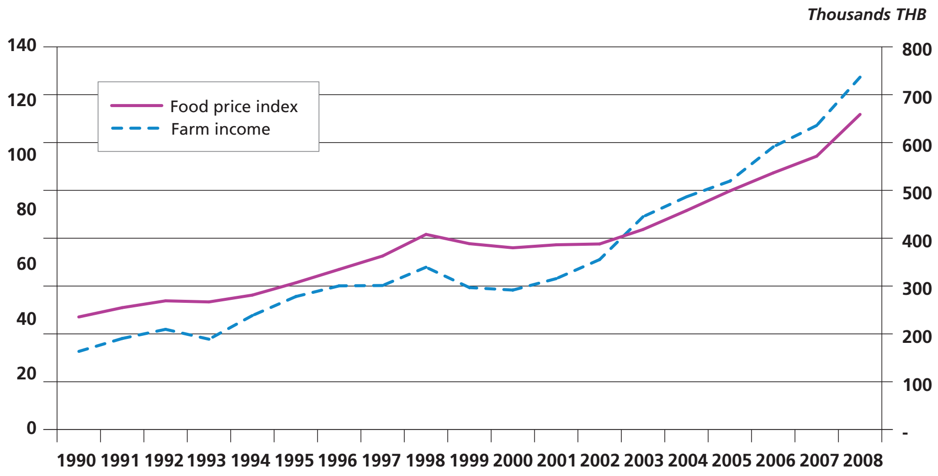
8.3 IMPACT OF BIOFUELS ON HOUSEHOLDS

The microeconomic analysis focuses on how movements in the price of agricultural commodities and biofuel crops could impact on Thai household income, consumption and poverty. At the household level it is assumed that these impacts will exert themselves through two channels, namely the cost of living and income from agriculture.

To simulate an increase in the cost of living, three scenarios of possible food price increases were tested ranging from three to ten percent. To estimate the potential impact of a price increase on farm income it is first required establishing a link between food prices and farm income. As can be seen in Figure 8.2 the two variables are correlated.

FIGURE 8.2

Food price and farm income 1990-2008



Source: TDRI.

As a result, a simple equation was developed to describe farm income as a function of food prices and agricultural production and a number of scenarios were tested. The assumptions of all six scenarios tested are shown in Table 8.2. These scenarios were then applied to household data from the 2009 Socio-Economic Survey and the results broken down by region and by household type.

TABLE 8.2

Scenario assumptions

Scenarios	Food price increase	Farm income increase	
		Elasticity = 1.10	Elasticity = 1.25
	%	%	%
S1	3.00	3.30	3.75
S2	5.00	5.50	6.25
S3	10.00	11.00	12.50

Source: TDRI.

Following a rise in food prices the incidence of poverty was found to increase in all regions under the vast majority of scenarios tested. When looking at the impact by type of household, rice only farmers are hit hardest by rising food prices under each scenario (Table 8.3). This could be because rice only households are generally closer to the food poverty line than the other household types considered. Interestingly, the incidence of poverty among non-agriculture households generally increases at a rate greater than the agricultural households not producing rice and the ones producing rice and other crops. In fact, under the second elasticity case, the incidence of poverty in latter household types grows at a rate less than the other two household types and even declines for the household producing rice and other crops.

TABLE 8.3

Changes in poverty incidence by household type

Household Type	Elasticity = 1.00			Elasticity = 1.25		
	S1	S2	S3	S1	S2	S3
Non-agriculture	0.11	0.19	0.54	0.08	0.17	0.53
Agriculture – No rice	0.11	0.18	0.36	0.01	0.09	0.05
Agriculture – Rice only	0.31	0.58	1.14	0.23	0.43	0.66
Agriculture – Rice and other crop	0.17	0.16	0.46	0.04	-0.09	-0.31
Total	0.16	0.28	0.65	0.10	0.19	0.40

Source: TDRI.

This finding would seem to indicate that growth in farm income resulting from higher food prices may, under certain scenarios, offset the change in the food poverty line and lead to benefits for some households. In Chapter 4, the land suitability analysis indicated that rice, while very important for food security and Thai agricultural exports, is a relatively low value crop. Taking into account the findings above, assistance provided to poorer farmers to expand their plantings of biofuel feedstock crops could feasibly provide a valuable opportunity to improve earnings and even reduce the incidence of poverty.

However, in the absence of interventions that aim to provide poor farmers better access to opportunities in biofuel feedstock markets, this analysis indicates that a general increase in food prices leads to greater incidence of poverty. This is because poorer households will still tend to spend a large proportion of their slightly greater income on now more expensive food products.

8.4 IMPACT OF BIOFUELS ON THAI ECONOMY

The macroeconomic analysis focuses on how movements in the price of agricultural commodities and biofuel crops can impact directly and indirectly on the Thai economy as indicated by measures such as economic growth, average price levels, household consumption and income and aggregate trade and investment levels. To conduct this assessment a computable general equilibrium (CGE) model was employed. CGE models are simulation-based economic models where economic agents optimize their consumer preferences and interact with other agents in a market-clearing equilibrium manner.

As the CGE model employed for this analysis was not built specifically to study biofuels, the sectors involved in biofuel production are not separated out from those involved in food crop production. Fortunately, the production techniques of agricultural crops and biofuel crops generally differ only concerning the end use. Since the supply of agricultural produce for food and for energy is almost perfectly substitutable, it is assumed that biofuel crop prices will move also almost in unison with food crop prices.

As noted previously, it is assumed that as biofuels produced in Thailand will create an additional source of demand for biofuel crops, the effect of implementing the AEDP biofuel targets will be an increase in the price of these crops and food crops in general. In the absence of a separate biofuel sector, the CGE simulates this price increase via the world price of biofuel and food crops. Table 8.4 presents the outputs of the CGE model following a simulated increase of the price of food imports by one percent.

TABLE 8.4

Impact of one percent increase in import food price on economic growth and price levels

	Percent change from the base year
Overall GDP growth	-0.07
Agriculture sector	1.32
Industrial sector	-0.30
Service sector	-0.16
Price level	
Consumer index	0.47
GDP deflator	0.04

Source: TDRI.

Table 8.4 displays the impact in terms of economic growth and price levels. The agricultural sector clearly benefits from higher prices of imported food increasing production by 1.32 percent. However, industrial and service sectors suffer as they use agricultural products as inputs and increased prices for these products translate into increased production costs. General prices rise along with import prices. Consumer prices are more greatly affected than the GDP deflator because the consumer price index includes a higher proportion of food items than the GDP deflator.

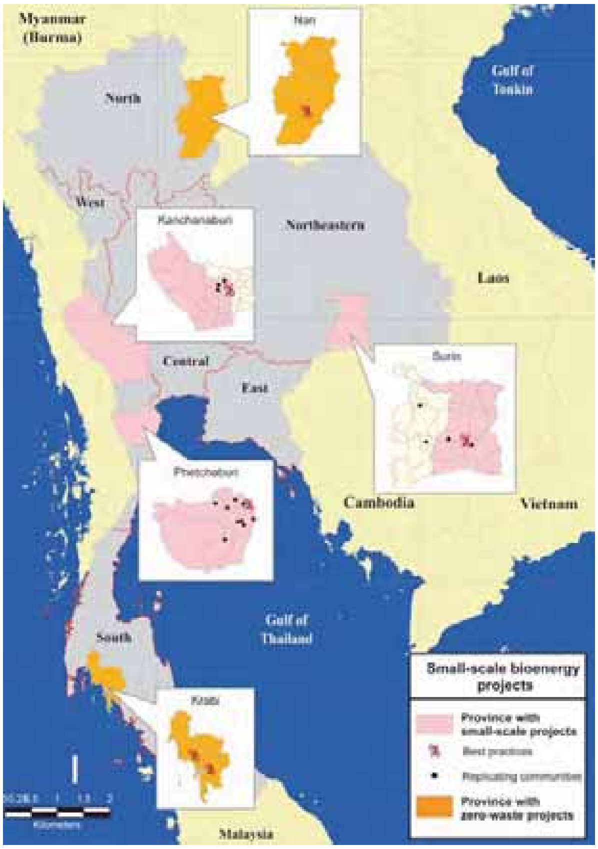
To assess the specific impacts of the rise in consumer prices on household incomes, households were disaggregated into 20 groups by income class and by farm versus non-farm households. Most farm households, with the exception of the poorest were found to gain in terms of real income while all non-farm households experienced reduced real income. The likely reason that the poorest farm households show no gains in terms of real income is because the share of food consumption among these households is higher compared to other groups. These results are generally consistent with those of the microeconomic analysis presented in Section 8.3.

8.5 SMALL-SCALE BIOENERGY AND RURAL DEVELOPMENT

For the purpose of the small-scale bioenergy assessment 20 communities were surveyed including three ‘best practice’ bioenergy communities, which served as example cases. The communities surveyed were located in five provinces encompassing a range of different technologies including biogas, biodiesel, high-efficiency charcoal kilns, thermal power generation and advanced wood stoves. Figure 8.5 shows the locations of each project surveyed.

FIGURE 8.3

Location of small-scale bioenergy projects



In general, the successful communities surveyed were satisfied with their bioenergy initiatives. These respondents indicated that as a result of their bioenergy initiative expenditures on external energy sources had been reduced and that, in some instances, the availability of bioenergy was believed to lead to improved health and local environmental outcomes. Some of the communities surveyed also reported success in selling energy and other outputs to neighbouring communities and provinces.

Generally, most of the projects surveyed required some form of external assistance to establish the operation and also maintain the bioenergy system. While this is a serious shortcoming, there was evidence that over time some communities would be able to support their bioenergy operations from revenues generated. Key elements of success common to effective projects were the availability of strong community leadership and access to technical knowledge and community finance. The key barriers identified by survey respondents were lack of access to government funding and lack of access to resources and knowledge.

To complement the survey of 'best practice' bioenergy communities, a financial analysis was conducted on three zero-waste bioenergy systems. Zero-waste bioenergy systems use a particular bioenergy feedstock to produce a range of outputs including energy, fertilizers and consumer goods. The financial analysis found that all assessed zero-waste projects were financially unviable at this stage unless they will get some kind of external support. The jatropha-based zero-waste system in Nan province was found to have the least potential in terms of viability because labour costs were particularly high when compared with the revenue that could be generated from the sale of jatropha seed or biodiesel produced from crude jatropha oil.

One limitation of the financial analysis was that revenues from the sale of other by-products such as fertilizers could not be assessed due to a lack of data regarding market prices for these outputs. In the future, if a market for these by-products develops and communities are able to sell them at a reasonable price, then the financial viability of these systems would improve. This is consistent with the findings of the survey analysis which found that the most successful rural bioenergy projects produce a range of outputs. These outputs can be substituted for other commodities that the communities would otherwise have to purchase such as liquefied petroleum gas, pesticides and fertilizers. The sale of by-products could be a valuable alternative source of revenue for rural communities and will be a key determinant of the success and viability of small and community scale bioenergy projects.

Interestingly, each community assessed for the financial analysis reported other benefits to the community associated with small-scale bioenergy operations such as self-sufficiency and improved cohesiveness within the community. This suggests that there may be other benefits derived from the implementation of small-scale systems that do not lend themselves to traditional financial analysis. It was determined that future assessments of these projects should attempt to monetize the external impacts of these operations to assess their true cost and/or benefit to rural communities.

The AEDP makes provision to support the development of small-scale bioenergy through investment grants for biogas and soft loans for small-scale bioenergy demonstration facilities. This support will provide interested communities with essential means to establish small-scale bioenergy systems. However, based on the survey and financial analysis conducted for BEFS, this assistance may not address challenges associated with long-term operation and system maintenance. Overcoming these challenges will require education and regular access to technical assistance.

CHAPTER 9

RECOMMENDATIONS

As noted in Chapter 1, BEFS aims to strengthen the capacity of target countries to balance the trade-offs associated with bioenergy development. This chapter considers how the BEFS analysis can inform Thailand's existing policy framework for bioenergy and biofuels in particular, so that benefits flowing from the implementation of future policies will be sustainably procured and managed equitably.

The principle underlying the BEFS approach is that policy enacted to influence one element of the bioenergy sector can have impacts – both positive and negative – on other elements of the sector, the broader economy and the environment. In contrast to the other BEFS countries, Thailand has a rapidly growing biofuel sector and a comprehensive policy framework for its further expansion. As a result, the BEFS analysis aims to provide an external assessment of the trade-offs involved with Thailand's current array of policy choices and provide information regarding key issues and recommendations for further policy action.

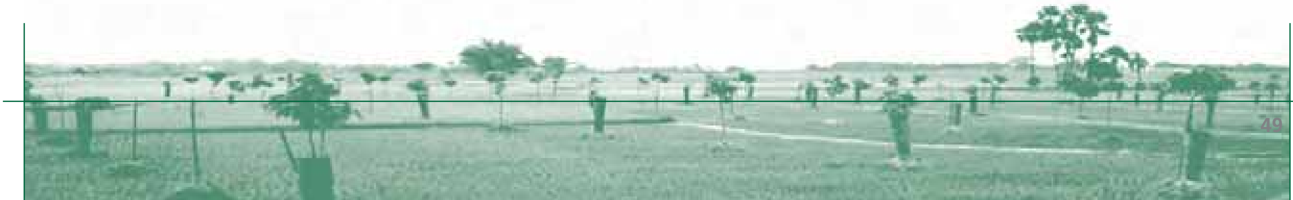
Revisiting the framework of the BEFS analysis in Thailand as presented in Chapter 1, the BEFS analysis in Thailand is underpinned by the Thai Government's AEDP bioenergy targets. These targets will have an impact on Thailand's future agricultural outlook and implications for Thailand's natural resources base, the competitiveness of the bioenergy sector, Thai households, the broader Thai economy and the climate. How the Thai Government manages the pressures that the bioenergy sector will exert on its natural resources, agricultural markets and the general populace will determine the future sustainability of biofuels and bioenergy as alternative energy sources.

9.1 NATURAL RESOURCES

Recommendation 1: *Initiatives to sustainably improve the productivity of Thai farmers should be prioritized through R&D, extension services and incentives.*

Improvements in agricultural yields are an important feature of the AEDP roadmap for biofuels. For each key biofuel crop increase in agricultural productivity is envisaged to meet the AEDP biofuel targets. The analysis in Chapter 4 indicates that there is potential to improve the output of Thailand's farmers; in some cases substantially. At present, agricultural productivity is below world standards for a wide range of crops.

As most Thai farmers are smallholders with poor access to information and modern sustainable farming practices, these findings imply a large role for government in expanding assistance to farmers, strengthening agricultural extension services and improving agricultural practices. Success in this regard will require significant public investment and better links between organizations involved in the dissemination of information, finance and support services to farming communities. Such organizations include local and provincial governments, agricultural research institutions, universities and national technical bodies such as OAE and LDD.



From a policy perspective, the provisions in the AEDP for R&D activities and the recent MoU between MoE and MOAC indicate that the Thai Government is already working in this direction. Implementing these measures that will encourage a sustainable improve in agricultural productivity in Thailand is an important strategy because it will unlock multiple dividends.

The BEFS analysis finds that improved yields could lead to better returns for smallholder farmers by increasing potential revenues. This will have positive implications for rural incomes, rural development and the potential of poorer farmers to regularly access more nutritious foods. It will guarantee more stable and efficient agricultural output over the longer term that it will also enhance the economic competitiveness of the biofuel sector, as described in Chapter 6. Given the relatively high contribution of agriculture to biofuels GHG profile, lifting agricultural productivity is also an important way to reduce emissions per unit of production and strengthen the sustainability of these fuels, as confirmed in Chapter 7. More sustainable agricultural practices could also help to restore the productivity and limit an irreversible degradation of Thailand's soil.

Recommendation 2: *Clear guidance should be developed and provided to Thai farmers regarding land use and crop changes to ensure that threats to food security are avoided and excessive harmful greenhouse gas emissions and biodiversity loss are mitigated.*

Chapters 4 and 5 confirmed that in the short term the AEDP biofuel targets could result in additional utilization of Thailand's land and water resources. While the magnitude of the additional strain on Thailand's natural resource base is projected to be modest in the case of land and minimal in the case of water there are potential issues that require specific attention to ensure that biofuels do not threaten food security and the environment.

Expansion of agricultural land to facilitate biofuel production could result in reductions of land area dedicated to other crops; particularly rice. As rice is Thailand's staple food crop and the main source of income for poor farmers, care needs to be taken to ensure that any expansion of biofuel crops does not threaten or worsen the food security situation of Thai people; particularly the poor and vulnerable. Expansion of the land area for biofuel crop production also implies land use and/or crop change. In Chapter 7 it was demonstrated that some land use and crop changes are more damaging in terms of the environment and GHG emissions; particularly in the case of rice. Guidance is needed for farmers in conjunction with the provision of technical assistance to minimize emissions from land use and/crop changes.

Recommendation 3: *Initiatives to improve agricultural productivity in Thailand should include an assessment of the potential benefits, costs and barriers to the expanding sustainable irrigation practices.*

As discussed in Chapter 5 an alternative method to improve the agricultural productivity of biofuel feedstock producers in Thailand is to expand or re-allocate irrigation networks. While expansion of irrigated land in Thailand is not anticipated to have a large impact on the country's TRWR, it is a process that takes time and careful planning. However, as the vast majority of Thailand's biofuel feedstock production areas are not currently under irrigation and in light of its potential to improve productivity, the possible costs and benefits of expanding irrigation for biofuel feedstock crops in a sustainable manner should be investigated further.

Recommendation 4: *Research should be commissioned into the potential impact of ineffective wastewater treatment on water systems proximate to biofuel production facilities for the purpose of developing a sector-wide wastewater management strategy.*

While the expansion of biofuels production is not expected to strain water resources in terms of volume, it may have serious impacts on water quality near processing facilities as described in Chapter 5. Biofuel production processes generate a large quantity of wastewater. As biofuel production grows in line with the AEDP targets the amount of wastewater requiring treatment will grow dramatically. Although the Thai Government has a zero discharge wastewater policy, local water systems could still be affected due to leaching from treatment ponds. This could have a significant negative effect on local groundwater systems and subsequently on neighbouring streams.

9.2 BIOENERGY SECTOR'S ECONOMIC COMPETITIVENESS

Recommendation 5: *Measures to improve the public perception of biofuels and develop the flexible-fuel ethanol vehicle market should be prioritized to ensure that domestic market demand for biofuels grows to meet the anticipated production.*

In Chapter 6 it was found that the biofuel sector in Thailand is highly competitive particularly when measured against the prevailing cost of fossil fuel prices and in terms of return on investment. Continuing high prices in energy markets will help maintain the competitiveness of the sector over the life of the AEDP. As noted above, improving agricultural productivity is an important way to reduce feedstock costs and a key challenge for the industry. However, a possibly even greater challenge to the long-term competitiveness of the biofuel sector will be ensuring that market demand for these fuels grows to meet the production targets; particularly in the case of ethanol.

In Chapter 3 it was noted that without significant changes to the gasoline automobile market, the Thai ethanol market will be constrained to a level below the anticipated growth in production. If the ethanol market fails to meet the growth in output then investments in agricultural productivity and production capacity could drive down prices with potentially negative implications for farmers and the future of the domestic ethanol industry. The AEDP aims to tackle this problem by investigating opportunities to increase the market for flexible fuel vehicles. Making the transition toward flexible-fuel vehicles is a huge endeavour that will require appropriate incentives for consumers, which in-turn needs effective coordination among the Ministries of Energy, Industry and Finance.

If policy support is maintained for ethanol supply in the absence of growth in the domestic ethanol market, export opportunities for Thailand's ethanol producers may be available as long as biofuel production satisfies any required product and sustainability standards. While the analysis in Chapter 7 indicates that ethanol produced in Thailand generally meets the EU sustainability thresholds, ethanol produced from cassava that involves certain land use or crop changes and/or employs fossil fuels in the refinery process exceeds these values. One way to address this issue is through the greater use of renewable energy in the production process. The implications of this are considered further in the section below on GHG, energy balance and climate change.

9.3 NATIONAL ECONOMY AND CONSUMER PRICES

Recommendation 6: *Further investigation and monitoring should be commissioned to better understand the impact of the biofuel sector on households and the Thai economy and develop more appropriate strategies to ensure that biofuel developments benefit poorer communities and do not lead to further incidence of poverty and a worsening of food security.*

In Chapter 8 it was shown that biofuel developments that affect agricultural and consumer prices could have significant impact in terms of poor agricultural households and the national economy. Despite significant progress in reducing poverty in Thailand, pockets of poverty still exist in certain regions of the country. Any increase in agricultural prices that arise from development of the biofuel industry could lead to increased incidence of poverty in Thailand; particularly in households that are living just above the poverty line or rely solely on the sale of rice crops for income. Policy makers should ensure that strategies are in place to assist poorer households cope with potential growth in agricultural prices arising from development of the biofuels sector.

One strategy to assist poorer households cope with potential growth in agricultural prices could be to direct biofuel crops producing opportunities toward poorer communities. The analysis presented in Chapter 8 indicates that households which produce a wider range of agricultural products will benefit more from any increase in agricultural prices. Development of the biofuel sector may present opportunities to encourage more crop diversification amongst poorer households providing additional sources of income and potentially lifting some households out of poverty.

Some of the most suitable regions identified for an expansion of biofuel feedstock crops in Chapter 4 were located in the North and North-East of Thailand, which also corresponds with the country's remaining pockets of poverty. However, for such a strategy to be effective government would need to ensure that farmers were afforded appropriate support to manage the transition into new biofuel feedstock crops.

The findings presented in this report are only the result of a partial analysis of what could occur if development of the biofuel sector were to lead to general growth in agricultural prices. The availability of better datasets and more comprehensive models will provide a clearer picture of the true impact of the biofuel sector on households and the potential for poverty reduction.

9.4 GHG, ENERGY BALANCE AND CLIMATE CHANGE

Recommendation 7: *Support and incentives to encourage biofuel producers to adopt renewable energy technologies should be continued and strengthened as instruments to improve the environmental sustainability and competitiveness of biofuels produced in Thailand.*

As discussed in Chapter 7, biofuel refineries which employ fossil fuels as an energy source were found to have considerably larger GHG emissions per unit of biofuel produced than those using renewable energy sources or a combination. It was also found that refineries which make use of wastes and by-products for energy generation had significantly less impact in terms of GHG emissions and preserved local environmental conditions. Interestingly, production processes that are more sustainable in terms of GHG emissions were also generally found to be more economically competitive.

Developing policies and regulations to encourage better integration of renewable energy in the biofuel sector will be necessary to ensure its future sustainability. Promoting more efficient agriculture and refinery configurations that improve the overall sustainability of Thailand's biofuels in terms of economic competitiveness and GHG emissions will also open up opportunities should Thai biofuel producers look to capture new export markets in the future that will increasingly be subject to sustainability standards. The Thai Government already provides a number of incentives and support programs for industry to adopt renewable energy technologies and processes. Based on the findings presented in this report there is good evidence to suggest that these measures should be continued and strengthened.

9.5 MANAGEMENT POLICIES

Recommendation 8: *A regular, multi-stakeholder review of progress toward the AEDP targets should be established to ensure that the targets are being met sustainably and not at the expense of food security and the environment.*

The AEDP will employ a wide range of demand and supply levers to achieve its biofuel targets. Maintaining the AEDP and creating policy certainty will be an important element of its future success. Implementation of the AEDP will provide the government with a strong mandate to investigate and enact the types of agricultural development necessary to meet the various biofuel targets. It will also provide a clear signal to investors to continue to invest in and develop the sector. If the biofuel targets were removed or revised significantly downward it could lead to large oversupplies in the market driving prices down and prompting feedstock growers to abandon biofuel feedstock production for other more lucrative opportunities.

But while policy certainty will be crucial in overcoming a number of the challenges inherent in the AEDP, the Thai Government must retain the ability and capacity to regularly assess progress toward the targets and re-evaluate policy in the face of changing circumstances.

At present, the AEDP focuses strongly on utilizing domestic bioenergy crop production to grow the market for biofuels. Adherence to the plan over the long-term should provide the right signals to improve agricultural productivity and encourage farmers to direct bioenergy crop production toward domestic biofuel production as opposed to international commodity markets. But regular assessment is required to ensure that farmers will not be worse off due to potential missed opportunities. Alternatively, new opportunities may be created for neighbouring countries in the region to supplement supply of these commodities in Thailand.

It is certain that over the life of the AEDP, the circumstances under which it was developed will change. The Thai Government needs to monitor progress toward the AEDP targets and carefully assess if and how policy should change. The BEFS tool may be of particular use in this regard.

CHAPTER 10

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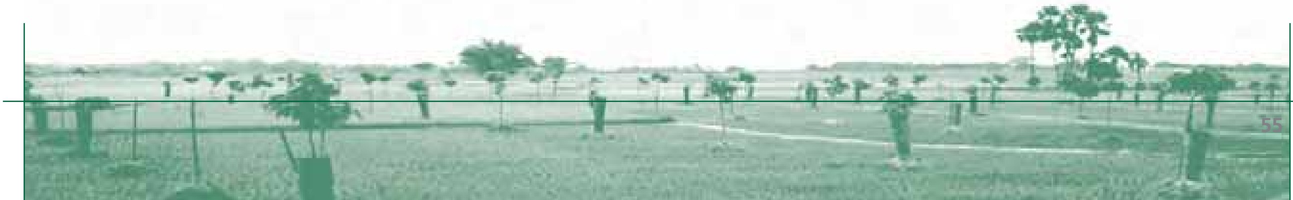

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The Government of Thailand, through its Alternative Energy Development Plan, has set a target to increase biofuel production to five billion litres by 2022. The Thai Government sees this expansion as a way to strengthen the country's energy security, foster rural development and reduce greenhouse gas emissions. The FAO Bioenergy and Food Security (BEFS) project aims to strengthen the capacity of developing countries to balance the trade-offs associated with bioenergy development and mitigate the impact of bioenergy on food security. The analysis presented in this document includes the main findings and recommendations for policy-makers on how to achieve Thailand's envisaged biofuel targets in a sustainable way without threatening food security. The targets are found to impact on Thailand's future agricultural outlook and lead to additional utilization of Thailand's natural resources. Growth of the sector in line with the targets has the potential to affect the national economy and households through various channels such as the price of food made from biofuel feedstock crops. How the Thai Government manages the potential pressures that the bioenergy sector will exert on its natural resources and agricultural markets and the general populace will determine the future sustainability of biofuels and bioenergy as alternative energy sources in Thailand. Full details of the methodologies and data employed to produce the material in this document are being published in a separate volume entitled "*Bioenergy and Food Security – The BEFS analysis for Thailand*".

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