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Impact Analysis of Expanding Biomass Energy Use to Rural Poverty in Tropical Asia

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List of Abbreviations

BBN	Biofuel *(Bahan bakar nabati)*
CAPSA	Centre for Alleviation of Poverty through Secondary Crops' Development in Asia and the Pacific
CD4CDM	Capacity Development for CDM
CDM	Clean Development Mechanism
CER	Certified Emission Reduction
DOE	Designated Operational Entity
EU	European Union
GHG	Greenhouse Gas
GOI	Government of Indonesia
GRDP	Gross Regional Domestic Product
ha	hectare
HGU	Approved cultivation right *(Hak guna usaha)*
ICFORD	Indonesian Centre for Food Crops Research and Development
IEA	International Energy Agency
IFPRI	International Food Policy Research Institute
IPCC	International Panel on Climate Change
JIRCAS	Japan International Research Center for Agricultural Sciences
kCERs	Kilo Certified Emission Reduction
KCl	potassium chloride
kg	kilogram
kl	kilolitre
l	litre
mJ	mega Joule
$MtCO_2$-eq	million tonnes CO_2 equivalent
NC-CDM	National Commission for CDM
OECD	Organization for Economic Co-operation and Development
R/C	ratio of total returns to total costs
SP-36	Super phosphate
UNCTAD	United Nations Conference on Trade and Development
UNFCCC	United Nations Framework Convention on Climate Change

Foreword

Since the Kyoto Protocol came into effect in 2005, more attention has been paid to the development of biomass recourse use. The tropical Asian countries have large potential for biomass production. It is expected that in the near future various large-scale projects for the production of energy crop (e.g. cassava, oil palm, sugar cane) will be implemented at the initiatives of industrialized countries – through Clean Development Mechanism (CDM) schemes – and by tropical Asian countries themselves. To ensure sustainable use of biomass resources in a way that is compatible with rural poverty alleviation, it is crucial to analyse how the expanding demand for biomass energy will affect rural society, especially small-scale farmers and the rural poor who are the potential beneficiaries.

From April 2006 to March 2008, the Japan International Research Center for Agricultural Sciences (JIRCAS) conducted a research project in collaboration with the Centre for Alleviation of Poverty through Secondary Crops' Development in Asia and the Pacific (CAPSA) entitled "Impact Analysis of Expanding Biomass Energy Use on Rural Poverty in Tropical Asia (BIOMASS)". The major objective of the project was to identify the impacts of expanding biomass energy use in the tropical Asian countries, focusing on secondary crop farmers and the rural poor in particular. It is a pleasure for CAPSA to publish the report of this study: "Impact Analysis of Expanding Biomass Energy Use on Rural Poverty in Tropical Asia". The report presents the prospects for biofuel projects and the possible impacts on rural society based on a case study of bioethanol production from cassava in Indonesia.

I would like to thank the lead author, Mr. Masdjidin Siregar, for his hard work in producing the report, Mr. Tomohide Sugino who contributed Chapter 4 and Section 6.5, and all other members of the study team for their efforts.

Finally, I would like to express my sincere appreciation to Dr. Kenji Iiyama, President of JIRCAS for his Center's support for the study.

November 2008

Yap Kioe Sheng
Officer-in-Charge
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The officials in North Lampung Agriculture, Forestry and Fisheries Office, North Lampung District and East Lampung Agricultural Office, East Lampung District deserve special thanks for their assistance with our rural surveys. We would like to also thank staff members of *Madu Sari* company and *Medco* company for their assistance with our surveys and data collection. We are deeply grateful to the farmers in the study sites of North Lampung District and East Lampung District for their kindness in co-operating with our interviews. Thanks also to Geoff Thompson, CAPSA, for his assistance in English editing.

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Masdjidin Siregar, UNESCAP-CAPSA
Tomohide Sugino, JIRCAS

Executive Summary

In order to reduce imported fuel, the Government of Indonesia is attempting to find alternative renewable energy, particularly in the form of biofuel. It is stated in the Road Map for Biofuel Development that biofuel will be 2 per cent of the country's total energy mix by 2010, bioethanol will be 5 per cent of gasoline mix, and biodiesel will be 10 per cent of diesel fuel mix. It is planned that cassava and sugar cane will be the major feedstock for bioethanol, while oil palm and jatropha will be the major feedstock for biodiesel. Biofuel producers under the co-ordination of the National Team for Biofuel Development have planned to expand the feedstock area up to 6.45 million hectare by 2010, consisting of 782,000 ha of cassava, 698,000 ha of sugar cane, 3.4 million ha of oil palm, and 1.5 million ha of jatropha. It seems that the National Team for Biofuel Development will propose the use of forest area currently devoted to plantation for expanding the area of feedstock production, particularly the use of forest area for which cultivation rights have been approved. So far, such areas are primarily used for plantation of oil palm. However, the expanded area required for oil palm is 3.4 million ha by 2010, which is much larger than the area of approved cultivation right (*hak guna usaha* = HGU) that has not yet been used. In order to avoid further deforestation, cassava and jatropha can be grown on degraded or critical land if each of the crops needs to be expanded. It is estimated that the areas of critical land both inside and outside forest area are about 19.4 million and 14.8 million ha respectively.

The case studies in East Lampung and North Lampung districts, Lampung Province, Indonesia, where the farmers produce cassava under the partnerships with bioethanol companies showed that although the yield of *Mukibat* grafted cassava was slightly higher than those of the other two conventional varieties, the net returns in the case of *Mukibat* grafted cassava were somewhat lower than the net returns in the others due to the lower than expected yield and higher cost of the plant materials. In spite of the unsatisfactory outcome of the partnership between farmers and the company in East Lampung, about 75 per cent of the sample farmers in East Lampung were willing to continue the partnership for several reasons. Firstly, they still believe that the yield of *Mukibat* can be increased if they can properly improve the use of fertilizers and other agronomic practices. Secondly, for the second and third planting of cassava they do not need to buy plant material of *Mukibat* because they can use cuttings from their own crop of the first year. Thirdly, they feel more secure under the partnership because they will have credit from the company for producing cassava, while the determination of cassava price and moisture content during the harvest period will be a transparent process.

If Lampung Province tries to meet the national target for increased cassava production for biofuel (an increased cassava production of 3.2 million tons annually) by increasing the cassava yield (in the all the planted areas) up to 40 tons/ha, which was the highest observed yield of *Mukibat* grafted cassava in this study, it means only 79 per cent of the current cassava field will be necessary to meet the cassava demand. Expanded cassava production will definitely benefit local farmers and economies. If Lampung Province increased its cassava production by 3.2 million tons annually, it would contribute to provincial Gross Regional Domestic Product (GRDP) by Rp. 864-1,078 billion, which means a 2.2-2.7 per cent increase of the current GRDP. It would also generate full employment for 44-57 thousand persons per year, which comprises 1.0-1.2 per cent of the population of productive age (15-64 years old) in the province.

It can be concluded that biofuel projects are in principle eligible under the CDM. To be included in CDM projects, however, biofuel projects have several barriers: (a) establishment of approved baseline and monitoring methodologies which are a necessary requirement for validation, (b) certified emission reduction (CER) revenues will in most cases only cover part of the additional cost of biofuels compared to conventional fuels, and (c) CO_2 abatement costs of biofuels are in general higher than current CER prices. If these barriers could be overcome, biofuel projects may be an opportunity to develop projects with strong sustainable development components, and therefore contribute strongly to the twin objectives of the CDM: sustainable development in developing countries and achievement of part of the Kyoto target of developed countries.

1. Introduction

1.1 Background

Since the Kyoto Protocol came into effect in 2005, more attention has been paid to the development of biomass recourse use. This has occurred not only in the industrialized countries, which have an obligation to reduce greenhouse gas emissions under the Kyoto Protocol, but also in developing countries such as Indonesia, which has become a net oil importer and suffers from a huge burden of subsidies for transportation fuels.

The various mechanisms approved under the Kyoto Protocol will attract capital flow to developing countries for investment in renewable energy projects. The Clean Development Mechanism (CDM) is a part of the ‘flexibility mechanisms’ of the Kyoto Protocol. CDM allows industrialized countries to fulfil their commitments to the greenhouse gas emission reduction targets. Though developing countries have no obligation under the current protocol, if an industrialized country assists a developing country in reducing emissions, it can be counted as an achievement by the industrialized country. The mechanisms are expected to promote investment in renewable energy development in developing countries, especially in the disadvantaged areas that are production centres of secondary crops used as raw materials for biomass energy.

The tropical Asian countries have a large potential for biomass production. It is expected that various projects of large-scale energy crop production (e.g. cassava, oil palm, sugar cane, etc.) will be implemented in the near future under the initiatives of both industrialized countries, through CDM schemes, and tropical Asian countries themselves. The Government of Indonesia will set a biofuel (bioethanol and biodiesel) target of about 10 per cent of the country’s energy portfolio by 2010. The government also expects the sector to create around 3 million jobs and cut foreign exchange expenditure for importing fuel by US$ 10 billion by 2010. To this end, the government will allocate 6.5 million ha of idle land for investors interested in planting energy crops. Of the total land allocation, some 3 million ha will be allocated for oil palm, 1.5 million ha for jatropha, 0.5 million for sugar cane and 1.5 million ha for cassava (*The Jakarta Post*, 25 July 2006).

We can safely say that the expanding use of biofuel will provide precious opportunities for rural people to improve their welfare, since most of the energy crops are mainly produced by small-scale farmers who are vulnerable to price fluctuations. An increasing demand for energy crops has the potential to contribute to increased and stabilized prices of their produce. Moreover, the installation of biofuel processing plants will increase job opportunities, mainly for rural poor people. This is because the biofuel production should be done near the feedstock production areas, due to the high transportation costs of bulky raw materials. On the other hand, if the government fails to manage the biomass resource development appropriately, some negative impacts will occur such as natural forest destruction, conflict with food production, and contamination of natural water systems by excess inputs into farmlands.

To ensure the sustainable use of biomass resources is compatible with rural poverty alleviation, it is crucial to analyse how the expanding demand of biomass energy will affect rural society, especially small-scale farmers and poor people who are the potential beneficiaries. The Government of Indonesia has established a national body responsible for issuing approvals for CDM projects in Indonesia, based on an Environmental Ministry Decree of 2005. This national body is known as the National Commission for CDM in Indonesia. When an application for CDM is submitted, the Commission evaluates the project proposal based on the national sustainable development criteria and indicators, which are formulated to evaluate environmental, economic, social and technological sustainability of the proposed CDM projects. These criteria and indicators can work as practical benchmarks to design sustainable biomass resource management systems. If we can estimate the possible impacts of the biomass energy use in some specific areas, it will provide useful lessons and information that can be used for policy formulation to support more sustainable use of local resources and a larger contribution to poverty alleviation.

Since the increasing oil prices are currently burdensome for all countries, and the poorest people in each country are often most affected, the interest in biofuels has been increasing. As long as the prices of biofuels are considerably below the price of fossil fuels (spot prices for oil were as high as US$ 141 per barrel on 1 July 2008), biofuels offer an economically viable alternative to fossil fuels. Countries of the Organization for Economic Co-operation and Development (OECD) have already taken the lead in increasing biofuel production. The USA, for instance, is now planning to introduce 45 per cent ethanol blends by 2011 to meet the energy needs of its transportation sector. Similar movements also take place in European Union (EU) and other countries such as India and China.

The production of biofuel feedstock provides an opportunity for many countries to capture part of the global fuel market share by investing in production and upstream refining, both to save foreign currency and to earn from exports. Biofuels also provide a unique and vast market to link remote, generally uneconomic and degraded areas, where many of world's poorest people live, to global markets.

These trends not only open a vast area of opportunity for the poor, many of whom live in areas well-suited to biofuel production, but they may also cause some basic shifts in agricultural production patterns as land is diverted from food crop production to production of biofuels to meet the increasing energy needs of the world.

Although the Government of Indonesia (GOI) has issued a national energy policy through Presidential Decree No. 10/2005 (on energy saving), the government has not been able to significantly reduce energy use. The government has also planned to diversify energy but the results are still insignificant. In 2006, the government issued Government Regulation No. 5/2006 (on national energy policy) that sets a target of 2 per cent biofuel in the total use of fuel by 2010. This will require 720 thousand kilolitres of biodiesel for diesel fuel and 420 thousand kilolitres of bioethanol for gasoline in 2010. Based on this regulation, the Ministry of Energy and Mineral Resources has predicted that the use of biofuel will be increased to 5 per cent in 2025. To encourage the use of biofuel, the government allows the use of 10 per cent bioethanol in gasoline without lead (with octane 91) and 10 per cent biodiesel in diesel fuel.

Based on the background described above, a collaborative research project “Impact Analysis of Expanding Biomass Energy Use on Rural Poverty in Tropical Asia (BIOMASS)” was implemented by the Japan International Research Center for Agricultural Sciences (JIRCAS) and the Centre for Alleviation of Poverty through Secondary Crops’ Development in Asia and the Pacific (CAPSA), from April 2006 to March 2008. The project was performed through Special Co-ordination Funds for Promoting Science and Technology of the Ministry of Education, Culture, Sports, Science and Technology, the Japanese Government. This Working Paper presents a report on the results and analysis of the BIOMASS Project.

1.2 Objectives

The major objective of the project was to identify the impacts of expanding biomass energy use in the tropical Asian countries, especially by focusing on secondary crop farmers and rural poor people. The expected ultimate results of the project were: expanded use of biomass energy, especially bioethanol and biodiesel, with environmental, economical, social and technological sustainability; the incorporation by local governments of local policy aimed at sustainable biomass energy use which benefits small-scale farmers; and dissemination of the results to other locations and regions. All the findings are presented in this Working Paper, which, along with other media, will be disseminated to policy planners as practical information to design pro-poor biomass resource management systems through various CAPSA and JIRCAS's channels.

1.3 Methodology

The expected changes in rural society and environment were identified under several different scenarios of biomass energy development. The overall results were evaluated based on the sustainability criteria and indicators of the national Clean Development Mechanism (CDM).

The impacts of increased biomass resource use as alternative energy should be evaluated from the perspective of four aspects of sustainability: environmental sustainability, economic sustainability, social sustainability and technological sustainability. Environmental sustainability will ensure the sustainability of local ecological functions. Economic sustainability should ensure better income and job opportunities of community members. These two criteria directly relate to rural poverty alleviation, while social and technological sustainability will provide fundamental underpinnings to rural community development.

Indonesia was selected as a participating country on the basis of its large potential for biomass production, and policy concerns for alternative energy development. The project focused on the selected regions, which have potential to be developed as production centres of biomass energies. Among the biomass energies, two major alternative fuels, namely bioethanol and biodiesel were selected for evaluation of their impact on poverty alleviation. Evaluation results and project lessons will be shared with other countries through web-based knowledge management (including CAPSA's regular dissemination methods) and linkages to the analytical work of CAPSA.

The strategy chosen for the project had two steps. First, CAPSA staff, together with national counterpart staff, collected information on the evaluation process of CDM proposals in the National Commission for CDM in Indonesia. This was done by examining the previous CDM evaluation report and interviewing the technical team members in the National Commission. Detailed procedures of evaluation (especially identifying the data necessary to judge the fulfilment of respective criteria) were clarified. Second, an impact analysis was done under the different assumptions, e.g. a) 10 per cent of GOI target achieved (biofuel would account for 10 per cent of the energy portfolio); b) 50 per cent of target achieved; and 3) 100 per cent of target achieved. The expected changes to land allocation, input use, labour absorption and the income structure of rural communities was estimated in the specific target areas. The positive and negative impacts on rural poor households were identified in each scenario. The overall results were evaluated based on the national CDM sustainability criteria and indicators.

1.4 Sample sites and respondents

In this study, East Lampung and North Lampung districts have been chosen for case study because the *Madu Sari* Company in East Lampung and *Medco* Company in North Lampung plan to produce bioethanol using cassava as the feedstock. In each district, 30 farmers were randomly chosen from those who have signed a contract with the company to produce cassava. *Madu Sari* and *Medco* have been co-operating with cassava farmers by helping them to acquire input credits. The two companies, however, have not yet produced ethanol. *Madu Sari* has prepared the land for the site of their processing plant, while *Medco* has accomplished about 75 per cent of their plant construction. As the companies are not yet producing ethanol, farmers currently sell their cassava to tapioca processing units.

1.5 Organization of the report

The next chapter in this report is devoted to presenting The Road Map for Biofuel Development in Indonesia and the possibility of achieving the government’s energy-mix and gasoline-mix targets with each type of feedstock for biofuel development. Input use, costs and returns of cassava production under the partnership between cassava farmers and the companies that will produce bioethanol are described in Chapter 3. This includes the possibility of increasing cassava production for biofuel production. Chapter 4 presents detailed information about the partnerships between the companies and farmers, and their prospects for increasing production. Chapter 5 is a discussion on the prospects of biofuel projects in general and bioethol projects in particular under the CDM. A review on the possible impacts of biofuel development is presented in Chapter 6. Finally, Chapter 7 presents the conclusions and recommendations from this study.

2. A Road Map for Biofuel Development in Indonesia

Like most countries in the world, Indonesia has to find alternative energy for many reasons. First, reserves of fossil fuel are not unlimited. Second, the price of fossil fuel is increasing, while 40 per cent of diesel fuel is imported. Third, the use of fossil fuel increases greenhouse gas (GHG) emissions. Bioenergy seems to be an appropriate alternative energy because the country has relatively abundant sources of bioenergy, and its processing technology is manageable. That the government is striving to develop biofuel production can be seen from several policies such as:

a. Presidential Decree No. 5/2006 (25 January 2006) on National Energy Policy. This decree sets the target for the national energy mix in 2025 as follows: fossil fuel 20 per cent, natural gas 30 per cent, coal 33 per cent, biofuel 5 per cent, geothermal energy 5 per cent, coal liquefaction 2 per cent, and other renewable energy 5 per cent (see Appendix 1). In order to reach the target, the Minister of Energy and Mineral Resources has been assigned to establish a blueprint for national energy management as the basis for the development and use of various types of energy, including renewable energy.
b. Presidential Instruction No. 1/2006 (25 January 2006) on Supply and Uses of Biofuels. This instruction assigns particular tasks for the relevant ministers, governors, and district/municipality chiefs in biofuel development.
c. Presidential Decree No. 10/2006 (24 July 2006) on the Establishment of a National Committee for Biofuel Development to Reduce Poverty and Unemployment. In this decree, a team is assigned to develop the Road Map for Biofuel Development to accelerate the reduction of poverty and unemployment, follow up the Presidential Decree No: 1/2006, collaborate with the Agency of Technology Assessment and Application and government-owned companies, and evaluate the biofuel development programme as a whole.

In order to reduce imported fuel, the government of Indonesia is attempting to find alternative renewable energy, particularly in the form of biofuel. It is stated in the Road Map for Biofuel Development that biofuel will be 2 per cent of the nation’s energy mix by 2010, bioethanol will be 5 per cent of gasoline mix, and biodiesel will be 10 per cent of diesel fuel mix (see Appendix 2). For the transportation sector, the government has set a target for 2010 in which biodiesel and bioethanol will respectively be 10 per cent of diesel fuel mix and 10 per cent gasoline mix (see Appendix 3).

It is planned that cassava and sugar cane will be the major feedstock for bioethanol, while oil palm and jatropha will be the major feedstock of biodiesel. According to the National Team for Biofuel Development, the total area of feedstock in 2007 was 583,000 ha, consisting of 52,200 ha of cassava, 400,000 ha of sugar cane, 10,000 ha of oil palm, and 121,200 ha of jatropha (Table 2.1). However, the information on the breakdown of these areas by growers – whether it is grown by biofuel producers as nucleus plantation or by farmers with or without a partnership arrangement with biofuel producers – is not available.

It seems that the competition in the use of land has been increasing because up until 2007 no significant area expansion has been implemented for the production of feedstock for biofuel. In the case of cassava, for example, the companies that plan to produce bioethanol have been initiating partnerships with farmers even though they have not yet begun to produce bioethanol. The sugar cane plantation area also had not significantly expanded; this was because ethanol producers had used cane molasses not cane juice for producing sugar cane-based bioethanol. In the case of oil palm, the area that was used as feedstock for biodiesel in 2007 was also very small. Information on jatropha as a feedstock is still scarce because it is a new crop for this purpose (see also Hambali, 2007).

Table 2.1 also indicates that biofuel producers under the co-ordination of the National Team for Biofuel Development have the commitment to expand the feedstock area up to 6.45 million ha in 2010, consisting of 782,000 ha of cassava, 698,000 ha of sugar cane, 3.4 million ha of oil palm, and 1.5 million ha of jatropha. However, it is really hard to predict whether such a required large area will result in significant area expansion, or whether each type of feedstock will be mostly collected from the existing crop area. Comparing the required area for 2010 with the existing crop area in 2006, one may come to a conclusion that, if the required area is only 10 per cent fulfilled, there will be no expansion area required. If the required area is only 50 per cent fulfilled each type of feedstock will require area expansion except for cassava. If the required area is 100 per cent fulfilled, each type of feedstock will require significant area expansion. In the case of cassava, about half of cassava required for feedstock may be collected from the existing crop area while the rest may come from area expansion.

Table 2.1 Realization of feedstock area for biofuel production up to December 2007 and commitment up to 2010 ('000 ha per year)

Feedstock	Type of biofuel	Existing crop area in 2006 [a] ('000 ha/yr)	Area for feedstock [b]			
			Realization in 2007 ('000 ha/yr)	Possibility of commitment up to 2010 ('000 ha/yr)		
				100% fulfilment	50% fulfilment	10% fulfilment
Cassava	Bioethanol	1 227	52	782	391	78.2
Sugar cane	Bioethanol	384	400	698	349	69.8
Oil palm	Biodiesel	3 683	10	3 430	1 715	343
Jatropha	Biodiesel	no data	121	1 540	770	154
Total			583	6 450	3 225	645

Source: [a] Statistical Yearbook of Indonesia, 2007.
[b] National Biofuel Development Team (Timnas BBN). Round-table discussion, Ministry of Agriculture, April 2008.

It seems that the National Team for Biofuel Development will propose the use of forest area devoted to plantation for the expansion of feedstock production, particularly the use of forest area where cultivation rights have been approved. So far, such an area is used for plantation of oil palm. However, the area expansion for oil palm will require 3.43 million ha in 2010 (Table 2.1), which is much larger than the area of approved cultivation right (*hak guna usaha* = HGU) that has not been used. As an illustration, the area of HGU that had not been used in 2007 was only 807,000 ha (Table 2.2) which is just enough to meet 24 per cent of the target for palm oil feedstock. This implies that in order to satisfy 3.43 million ha of oil palm in 2010, more cultivation rights will be needed from forest area devoted to plantation. Alternatively, some proportion of the feedstock may be supplied from the existing plantation, but this possibility depends on the price of crude palm oil in the international market.

If production of the four types of feedstock is to be expanded on forest area devoted to plantation, another 5.643 million ha of new cultivation rights will be needed from forest area currently devoted to plantation. In order to avoid further deforestation, if the area of cassava and jatropha crops needs to be expanded, these crops can be grown on degraded or critical land. It is estimated that the areas of critical land inside and outside forest area are about 19.4 million and 14.8 million ha respectively (Statistics of Forestry, 2006). If cassava and jatropha can be grown in a sustainable manner on the critical land, some of the environmental problems relating to groundwater, erosion, and greenhouse gas emission can be significantly reduced. However, research on the viability of cassava and jatropha production on such land needs to be carried out first before the area of jatropha and cassava on degraded land is expanded.

According to *Kompas* (17 September 2005), deforestation in Indonesia reached about 25 million ha in 2005 – with an alarming rate of 3 million ha per year – and has resulted in negative environmental impacts such as erosion, low ground water level, climate change, and GHG emission. To reduce the negative impacts, the government will grow *Jatropha curcas* on critical land in many provinces in Sumatra, Java, Sulawesi and Nusa Tenggara by inviting private and foreign investors. The target will be 1 million ha by 2007, 5 million ha by 2008 and 10 million ha by 2009. The road map for Jatropha is expected to reduce poverty of 36.1 million people, increase employment and farmers' income, and reduce the use of diesel fuel. However, it seems that it will not be easy to reach the target, and information on the implementation of the road map is not available.

Table 2.2 Approved cultivation right (HGU) of forest area devoted to plantation, 2007

Islands	Forest area devoted to plantation			Approved cultivation right (HGU) area			
	Total (ha)	Approved cultivation right (HGU) area		Being used		Not being used	
		ha	%	ha	%	ha	%
1. Sumatera	3 496 371	1 488 808	43	1 161 207	78	327 601	22
2. Java	0	0	0	0	0	0	0
3. Kalimantan	4 296 918	766 832	18	412 894	54	353 938	46
4. Sulawesi	260 499	109 666	42	37 544	34	72 122	66
5. Bali and NT[a]	1 702	0	0	0	0	0	0
6. Maluku and Papua	731 429	70 970	10	17 465	25	53 505	75
Indonesia	8 786 919	2 436 276	28	1 629 110	67	807 166	33

Source: National Team for Biofuel Development (Timnas BBN), Round-table discussion, Ministry of Agriculture, April 2008.
Note: [a] NT = Nusa Tenggara.

Although most of the companies that will produce cassava-based bioethanol had not yet produced bioethanol up until mid-2008, in preparation they have been initiating partnerships with farmers in producing cassava by providing the farmers with input credits. Since the producers have not produced bioethanol, farmers sell their cassava to the nearest tapioca processors. Table 2.3 shows that the area of cassava production under such an arrangement was about 52,000 ha in 2007, and about 80 per cent of this was in Lampung, the largest cassava producing province in Indonesia. The ethanol producers will expand the cassava area up to 782,000 ha in 2010 for cassava-based bioethanol production in Lampung, East Java, Kalimantan and Sulawesi.

Table 2.3 Realization of cassava area by bioethanol producers up to 2007 and commitment up to 2010

Companies	Realization up to December 2007		Commitment up to 2010	
	Area (ha)	Location	Area (ha)	Location
Medco	10 000	Lampung	70 000	Lampung, East Java, Kalimantan
Sungai Budi	25 000	Lampung	70 000	Lampung
Molindo	5 000	Lampung	60 000	Lampung, Kediri, Pacitan
BPPT	2 000	Lampung	2 000	Lampung
Lebak Government	50	Lebak	-	-
KIB	20	Cicurug	-	-
ICMI & PTPN 8	125	Garut, West Java	-	-
Sampurna	10 000	Pawonsari	280 000	Pawonsari, Madiun, Kalimantan
EN3 (South Korea)	-	-	50 000	South Sulawesi
Sorini Tbk	-	-	150 000	South-East Sulawesi
Satria, Bronzeoak, BP	-	-	100 000	Kalimantan
Total	52 195	-	782 000	-

Source: National Team for Biofuel Development (Timnas BBN), Round-table discussion, Ministry of Agriculture, April 2008.

Table 2.4 provides information on the action plan for the sugar cane production area for bioethanol production. In 2007, sugar cane production for bioethanol covered about 400,000 ha but the proportion of sugar cane production that goes directly to bioethanol production is not so clear. It seems that most sugar cane production is still being used for sugar production. As shown in Table 2.5, all bioethanol producers used molasses rather than sugar cane juice to produce bioethanol in 2007. In 2010, the area of sugar cane for bioethanol is planned to be 698,000 ha (Table 2.4) and the total production of ethanol is planned to increase from 139,600 kl/year in 2007 (Table 2.5) to 3,772,500 kl/year in 2010 (Table 2.6). The proportions of sugar cane-based feedstock from cane molasses and directly from sugar cane juice in 2010 are not clear.

The production of feedstock for biofuels may become an opportunity to diversify agriculture, but if it displaces food crops it may lead to a food security risk. However, this is not necessarily always the case because some feedstock for biofuels can be grown on degraded land, or some feedstock may displace crops intended for export, thus reducing the risks of worsening food security. More importantly, biofuels could give developing countries a better return for their agricultural activity, thus stimulating agricultural output (UNCTAD, 2006).

Table 2.4 Realization of sugar cane area by bioethanol producers up to 2007 and commitment up to 2010

Companies	Realization up to December 2007		Commitment up to 2010	
	Area (ha)	Location	Area (ha)	Location
Salim Group	10 000	South Sumatra	70 000	South Sumatra
Angel Product	100	S. E. Sulawesi	8 000	S. E. Sulawesi
Sugar Group	700 000	Lampung	200 000	S. Sumatra, Lampung, Kalimantan
RNI, PTPN 2,8,8,9,10,11,14	320 000	N. Sumatra, Lampung, S. Sulawesi, Jawa	100 000	N. Sumatra, Lampung, S. Sulawesi, Java, E. Nusa Tenggara
Wilmar Group	*	*	70 000	Lampung, S. Sulawesi
Mitsui Petrobras	*	*	200 000	Papua, Kalimantan
Satria & Bronzeoak UK	*	*	50 000	Belu & Central South Timor, E. Nusa Tenggara
Total	400 100	*	698 000	*

Source: National Team for Biofuel Development (Timnas BBN), Round-table discussion, Ministry of Agriculture, April 2008.

Table 2.5 Production capacity of fuel-grade bioethanol in Indonesia (up to December 2007)

Producers	Location	Capacity[a]	Feedstock[b]	Producer category
Sugar Group	Lampung	70 000 kl/year	Molasses, integrated	Large
Molindo Raya	Malang	50 000 kl/year	Molasses ex PTPN	Large
Tridaya	Cilegon	3 000 l/day	Molasses	Small
Blue & Mononutu	Minahasa	25x200 l/day	Sugar palm	Small
Blue	Balikpapan	200 l/day	Molasses & sorghum	Small
Panca	Cicurug	200 l/day	Cassava & molasses	Small
Bekonang	Solo	nx100 l/day	Molasses	Small
BPPT	Lampung	2 500 kl/year	Cassava	Research

Source: National Team for Biofuel Development (Timnas BBN), Round-table discussion, Ministry of Agriculture, April 2008.

Note: [a] Total production is about 139,600 kl/yr.
[b] Molasses is a by-product of sugar refining in the form of thick, dark syrup.

Table 2.6 Planned production capacity of fuel-grade bioethanol in Indonesia in 2010

Producers	Location	Capacity (kl /year)	Feedstock
Salim Group	South Sumatra	70 000	Sugar cane
Mitsui Petrobras	Papua, Kalimantan	500 000	Sugar cane
Angel Product	S.E. Sulawesi	10 000	Sugar cane
Wilmar Group	Lampung, South Sumatra	70 000	Sugar cane
Sugar Group	Lampung, S. Sumatra, Kalimantan	500 000	Sugar cane
Satria & Bronzoak	E. Nusa Tenggara, Kalimantan	300 000	Sugar cane
RNI, PTPN 2,8,8,9,10,11,14	N. Sumatra, Lampung, S. Sulawesi, Java, E. Nusa Tenggara	200 000	Sugar cane
Sungai Budi	Lampung	120 000	Cassava
Molindo	Lampung, East Java	150 000	Cassava
Sampurna	Madiun, Pawonsari	600 000	Cassava
Sorini Tbk	S.E. Sulawesi	200 000	Cassava
Medco	Lampung, West Java, Kalimantan	270 000	Cassava
EN3 Korea	South Sulawesi	180 000	Cassava
BPPT	Lampung	2 500	Cassava
Bioethanol Skala Rakyat	W. Java, E. Kalimantan, N. Sulawesi	600 000	Cass & others
Total		3 772 500	

Source: National Team for Biofuel Development (Timnas BBN), Round-table discussion, Ministry of Agriculture, April 2008.

To be successful, the implementation of the Road Map for Biofuel Development requires the involvement of the government and private companies that should be involved in a comprehensive and integrated strategic plan for biofuel development in Indonesia. Nurdyastuti (2006) argues that such a document is not yet available for the following reasons. First, land use planning designed by both the Ministry of Agriculture and Ministry of Forestry have not yet directly linked to national biofuel development planning. Second, the involvement of private investors in biofuel development is not clear. Third, the marketing of biofuel products has not been established. All such information is important for investors interested in biofuel development.

3. Existing Cassava Farming under Partnership Arrangements

3.1 Prevailing input use in cassava production

The sample farmers in each study site (East Lampung and North Lampung) were cassava farmers engaged in partnership with a company that will produce bioethanol after 2008. Although the companies in the two study sites had not been producing bioethanol, they have been initiating partnership with farmers by providing them with input credits and technical support.

Most of the sample farmers in East Lampung grew cassava on their own land but some of them did it on rented land. In North Lampung, about 37 per cent of the sample farmers farmed on rented lands. Table 3.1 indicates that the average cultivated land size (own and rented land) in East Lampung (1.99 ha) was larger than that in North Lampung where the average cultivated land sizes were 1.35 ha and 0.63 ha respectively, for those who grew *Kasertsart* and Thailand varieties. Small farmers tend to grow Thailand variety rather than *Kasertsart* variety because the farmers can harvest Thailand variety after eight months, while for *Kasertsart* they must wait 12 months.

Since farmers' incomes from cassava farming are relatively small and most of cassava farm activities are undertaken by hired and contract labourers, more than half of the sample farmers in the study sites have off-farm activities to earn other income. Those who have relatively small amounts of cultivated land, particularly in North Lampung, also work as contract workers for harvesting of cassava crops and other farm activities. The average number of livestock per farmer (see Table 3.1) indicates that livestock have not been an important source of household income in the study sites.

The company that was initiating partnerships with farmers in East Lampung asked the farmers to grow grafted cassava, which was initially called *Mukibat*, after the name of the inventor. About three quarters of the sample farmers in the site bought the plant material from farmers who grew it themselves while the remaining one quarter prepared the material themselves. The company in North Lampung, unlike the one in East Lampung, suggested the farmers grow *Kasersart* variety, but about 40 per cent of the sample farmers grew Thailand variety due to the limited availability of plant material of *Kasertsart*. Moreover, some farmers were reluctant to grow *Kasertsart* variety because it usually needs at least 12 months before it can be harvested, while Thailand variety needs only eight months. Before the initiation of the partnership, most cassava farmers grew Thailand variety.

Table 3.1 Characteristics of sample farmers by cassava varieties in the study sites, 2008

Items	East Lampung	North Lampung	
	Mukibat grafted cassava (n = 30)[a]	*Kasertsart* variety (n = 17)[a]	Thailand variety (n = 13)[a]
1. Age	44	41	40
2. Number of household members:			
a. Total	4.4	4.9	5.0
b. Helping in farming	2.8	1.9	1.8
3. Proportion of samples having off-farm occupations (%)	57	65	69
4. Land ownership:			
a. % of farmers owning land	100	63	77
b. Number of land parcels	2.0	1	1
c. Average size (ha)	1.67	0.89	0.49
5. % of farmers not owning land	0	47	23
6. Average cultivated land size			
a. Own land (ha)	1.67	0.89	0.49
b. Rented-in land (ha)	0.32	0.46	0.14
c. Total (ha)	1.99	1.35	0.63
7. Average number of livestock			
a. Cattle	1.2	0.2	0
b. Goats	0.7	1.2	1.4

Source: Field survey.
Note: [a] n = number of sample farmers.

Table 3.2 indicates that the number of grafted cassava (*Mukibat*) plants per unit of land in East Lampung was about one quarter of that in North Lampung. This was because the company in East Lampung suggested that the planting distance should be 125x125 cm^2, while the planting distances for *Kasertsart* and Thailand varieties in North Lampung varied considerably from 50x30 cm^2 up to 100x90 cm^2. For this reason, the sample farmers in East Lampung were able to carry out planting by using family labourers only, while the sample farmers in North Lampung accomplished planting by using hired and contract labourers.

In general the total amount of fertilizer per ha applied by the sample farmers in East Lampung for *Mukibat* grafted cassava was not significantly different from that in North Lampung for both *Kasertsart* and Thailand varieties. Table 3.2 also indicates that compost was rarely used by the sample farmers, though it is an important organic fertilizer to improve soil fertility and structure.

To save the use of labour in weeding, most of the sample farmers in East Lampung applied herbicides, but the proportion of the sample farmers in North Lampung who applied herbicides was smaller. Consequently, the average amount of herbicide per unit of land in East Lampung was higher than that in North Lampung (Table 3.2).

Land preparation for growing cassava in the study sites is usually accomplished by hired or contract labourers using mini tractors. Only a small proportion of farmers hire draft animals for land preparation. Harvesting and marketing are the other activities that are usually accomplished by using contract labourers. Although most of the sample farmers used hired and contract labourers, many of their family members worked as hired or contract labourers on other farmers' land.

Table 3.2 Material input use and yield of cassava production per hectare by varieties in the sample sites, 2008

Material inputs and yield	East Lampung	North Lampung	
	Mukibat grafted cassava (n = 30)[a]	*Kasertsart* variety (n = 17)[a]	Thailand variety (n = 13)[a]
Quantity			
Plant material (stick/ha)	3 956	16 373	13 414
Urea (kg/ha)	192	133	196
SP (kg)	139	110	92
KCl (kg/ha)	98	100	123
Compost (pack/ha)	0	0	19
Herbicides (Rp/ha)	3.0	2.2	0
Yield (kg/ha)	27 341	24 827	23 431
Price			
Plant material (Rp/stick)	312	21.9	26.1
Urea (Rp/kg)	1 272	1 365	1 289
SP (Rp/kg)	2 247	3 377	3 400
KCl (Rp/kg)	3 121	3 199	3 095
Compost (Rp/pack)	na	na	5 366
Herbicides (Rp/ha)	29 770	60 000	na
Yield (Rp/kg)	350	392	388
Values			
Plant material (Rp/ha)	1 234 272	358 467	350 000
Urea (Rp/ha)	244 224	181 110	252 644
SP (Rp/ha)	312 333	371 854	312 800
KCl (Rp/ha)	304 744	319 870	380 685
Compost (Rp/ha)	0	0	102 804
Herbicides (Rp/ha)	88 416	130 469	0
Yield (Rp/ha)	9 569 350	9 732 184	9 086 422

Source: Field survey.
Note: [a] n = number of sample farmers.

3.2 Costs and returns in cassava production

Although the yield of *Mukibat* grafted cassava was higher than those of the other two varieties (see Table 3.2), the net returns were only Rp 5.09 million, which was somewhat lower than the net returns in the case of *Kasertsart* variety (Rp 5.7 million) and Thailand variety (Rp 5.2 million) (see Table 3.3). This was particularly caused by the differences in the costs of plant material. These differences stemmed from the differences in planting distance and the price of plant material itself.

Table 3.3 Costs and returns of cassava production in the study sites

Components	East Lampung			North Lampung					
	Mukibat grafted cassava (n = 30)[a]			*Kasertsart* variety (n = 17)[a]			Thailand variety (n = 13)[a]		
	Value (Rp'000/ ha)	Ratio to total costs (%)	Ratio to total returns (%)	Value (Rp'000/ ha)	Ratio to total costs (%)	Ratio to total returns (%)	Value (Rp'000/ ha)	Ratio to total costs (%)	Ratio to total returns (%)
1. Total returns	9 569	214	100	9 732	242	100	9 086	237	100
2. Total costs	4 481	100	47	4 025	100	41	3 834	100	42
a. Material inputs:	2 184	49	23	1 362	34	14	1 399	36	15
Plant material	1 234	28	13	358	9	4	350	9	4
Urea	244	5	3	181	4	2	253	7	3
TSP	312	7	3	372	9	4	313	8	3
KCl	305	7	3	320	8	3	381	10	4
Compost	0	0	0	0	0	0	103	3	1
Herbicides	88	2	1	130	3	1	0	0	0
b. Labour inputs:	2 297	51	24	2 663	66	27	2 435	64	27
Daily wages	0	0	0	0	0	0	0	0	0
Contract works	188	4	2	188	5	2	484	13	5
3. Net returns	5 088	114	53	5 707	142	59	5 252	137	58

Source: Field survey.
Note: [a] n = number of sample farmers.

As shown in Table 3.2, the number of *Mukibat* grafted cassava plants was only about one fourth of that of the *Kasersart* variety. However, the price of *Mukibat* grafted cassava was about 13 times of that of *Kasertsart* and Thailand varieties. Consequently, the cost proportions of plant material in the case of *Mukibat*, *Kasertsart* and Thailand varieties were respectively 49 per cent, 34 per cent and 36 per cent of the total costs (Table 3.2). Since farmers can use the same grafted seedlings in the three successive cropping seasons, the real difference of the plant material cost between the grafted cassava and conventional cassava could be lower than the nominal one.

The discussion above indicates that the costs of plant material in the study sites significantly affect all indicators related to costs and returns of cassava production such as net returns and the ratio of total returns to total costs (R/C). An analysis of comparisons in such indicators by variety, however, would be impartially carried out if the analysis took the time frame or duration into account because the three varieties have different durations before they are harvested.

Assuming that *Mukibat, Kasertsart* and Thailand varieties were harvested after 12, 10 and 8 months respectively, then the net returns per ha per month that could be earned by the sample farmers would be about Rp 424,000 for *Mukibat* grafted cassava, Rp 570,700 for *Kasertsart* variety, and Rp 656,500 for Thailand variety. Since these levels of returns to family resources from cassava farming are not sufficiently high, at least 60 per cent of the sample farmers have off-farm activities to supplement their income.

As indicated in Table 3.3, the R/C in the case of *Mukibat, Kasertsart* and Thailand varieties were respectively 2.14, 2.32 and 2.37. This implies that for each Rupiah the sample farmers spent in working capital for producing cassava, they would receive Rp 2.14 after 12 months if they grow *Mukibat* grafted cassava, or Rp 2.32 after 10 months if they grow *Kasertsart* variety, or Rp 2.37 after 8 months if they grow Thailand variety.

3.3 Prospects of partnerships

The discussion in Section 3.2 indicated that *Mukibat* grafted cassava has not had a competitive advantage compared to the other two varieties. This is particularly caused by the fact that the *Mukibat* technology has not been carefully assessed or tested for suitability to local situations before it was applied to farmers' fields. Note that *Mukibat* grafted cassava could potentially increase cassava yield up to 3-6 times if its production management satisfied several conditions. Prihandana *et al*. (2007) stated that in order to have the highest yield of *Mukibat,* it requires at least a large amount of organic and inorganic fertilizers and more labour for more intensive land preparation.

In order to achieve a tremendous increase of cassava yield, the company's leaflet actually recommended applications of 200 kg/ha of urea, 100 kg/ha of SP-36, and 300 kg/ha of KCl, which are much higher than the actual application of chemical fertilizers presented in Table 3.2. Not to mention that the partnership entirely failed to follow the leaflet's recommendation for the use dolomite (300 kg/ha) and compost (1,000 kg/ha). Since all these conditions had not been met by the partnership between the farmers and the company in East Lampung, the yield of *Mukibat* was around 27 tons per ha.

In spite of the unsatisfactory outcome of the partnership between farmers and the company in East Lampung, about 75 per cent of the sample farmers in East Lampung are willing to continue the partnership for several reasons. Firstly, they still believe that the yield of *Mukibat* can be increased if they can properly improve the use of fertilizers and other agronomic practices. Secondly, for the second and third planting of cassava they do not need to buy plant material of *Mukibat* because they can use material from their own crop of the first year. Thirdly, they feel more secure under the partnership because they will have credit from the company for producing cassava, while the determination of cassava price and moisture content during the harvest period will be transparently decided. Similar prospects of partnership will also occur in North Lampung. The detail of the farmers' and the companies' prospects for grafted seedling technology and their partnerships will be described in Chapter 4.

3.4 Possibility of increasing cassava yield for bioethanol production

Comparing cassava, sugar cane and corn as the feedstock of bioethanol, Rajagopal and Zilberman (2007) concluded that sugar cane offers the highest energy and CO_2 benefits, followed by cassava, while ethanol from corn offers relatively modest energy and environmental benefits. In terms of feedstock production, however, Sriroth *et al.* (2003) found that cassava has major advantages over molasses and sugar: (a) cassava is well known as having the ability to adapt well to a wide range of growing conditions with minimal inputs; (b) unlike sugar-based distilleries that are operated seasonally, the cassava-based ethanol industry can be put in operation continuously because of its unbound time for growing and harvesting, plus its capability to be stored as dried chips; (c) high demands for molasses in both domestic and international markets have resulted in a supply shortage and, consequently, strong price fluctuation; and (4) technical developments in ethanol conversion from grains available elsewhere in the world can be readily applied to cassava. This would help to boost input energy efficiency and reduce production costs.

Assuming that all bioethanol production that has been planned for 2010 in Indonesia is produced from cassava alone, and assuming that the average yield of cassava is 15 tons/ha, 1,846 kl of targeted bioethanol in 2010 will require 800,000 ha of cassava (Table 3.4), which is still lower than the total area of cassava in Indonesia in 2006 (Table 3.5). Nevertheless, if the plan is to be met, cassava area will need to be expanded in 2010 for two reasons. First, the area of feedstock production should be concentrated near bioethanol conversion plants to avoid high transportation cost of feedstock. Second, since cassava is used to produce many kinds of products, the increase in the demand for cassava feedstock for ethanol production will tremendously increase the price of cassava when no area expansion is made. If this is the case, it will negatively affect the production of cassava-based bioethanol because more than 60 per cent of bioethanol production cost is the cost of feedstock.

Table 3.4 Required cassava area by different targeted amounts of bioethanol in 2010 and by different yield levels

Assumption about % of the target reached	Amount of targeted bioethanol (kl)[a]	Required amount of cassava ('000 tons)[b]	Assumption about cassava yield (tons/ha)	Required cassava area ('000 ha)
100% reached	1 846	12 000	15	800
	1 846	12 000	20	600
	1 846	12 000	25	480
50% reached	923	6 000	15	400
	923	6 000	20	300
	923	6 000	25	240
10% reached	185	1 200	15	80
	185	1 200	20	60

Note: [a] the amount of targeted bioethanol in 2010 is 1,846 kl (Djaya, 2007).
[b]1 litre of bioethanol requires 6.5 kg of cassava.

From the environmental viewpoint, most expansion of any feedstock area will negatively affect the environment unless it can be implemented intentionally to improve the environment of degraded or critical land without resulting in further deforestation. Therefore, it would be more environmentally friendly if the increasing demand for cassava caused by the expansion of bioethanol could be met from increasing yield. Table 3.5 indicates that the average yield of cassava in Indonesia was around 16 tons/ha in 2006, while it was around 19 tons/ha in the study province of Lampung. Using *Mukibat* grafted plant material, the sample farmers in South Lampung could reach a yield level of around 29 tons/ha. Potentially, the yield could be much higher if appropriate production practices are applied.

In order to encourage the supply of cassava as the feedstock for bioethanol production, the Indonesian Centre for Food Crops Research and Development (ICFORD) offers cassava production practices including land preparation, preparation of plant materials, time and planting practices, erosion control, weed control, fertilizing, pest control and harvesting. It is recommended that the cassava varieties for bioethanol production have some characteristics such as having a high starch content, high yield, resistance to biotic and non-biotic stresses and flexibility in cropping period. Four varieties presented in Table 3.6 have such characteristics.

Table 3.5 Growth rate of cassava area, production and yield in Indonesia and Lampung Province, 1986-2006

Items	Year 1986	1996	2006	Growth rate for 1986-2006 (%/year)
1. Indonesia:				
Area ('000 ha)	1 169.9	1 415.1	1 227.5	0.4
Production ('000 tons)	13 312.1	17 002.5	19 986.6	2.3
Yield (tons/ha)	11.4	12.0	16.3	1.9
2. Lampung:				
Area ('000 ha)	65.1	257.4	283.4	10.7
Production ('000 tons)	787.2	2 898.7	5 499.4	13.8
Yield (ton/ha)	12.1	11.3	19.4	2.8
3. Ratio of Lampung to Indonesia:				
Area (%)	5.6	18.2	23.1	na
Production (%)	5.9	17.0	27.5	na
Yield (%)	106.3	93.7	119.2	na

Source: Statistical Yearbook of Indonesia, 2007. Based on cassava area by province, the major cassava producing provinces are Lampung (23%), East Java (19%), Central Java (17%), West Java (9%) and East Nusa Tenggara (7%).

Table 3.6 Characteristics of four cassava varieties for bioethanol feedstock

Variety	Cropping period (months)	Yield (ton/ha)	Starch content (%)	Conversion rate[a] (kg/l)
Adira	8	25-40	25-30	4.45
Malang-6	9	36	25-32	4.68
UJ-3	8	30-40	25-30	4.70
UJ-5	9-10	25-38	20-30	4.35

Source: Prihandana *et al.*, 2007 (see also Wargiono *et al*., 2006).
Note: [a] From fresh root to bioethanol.

4. Prospects of Cassava Yield Increase by Application of Improved Technologies (Grafted Seedlings)

4.1 Introduction

As discussed in Chapter 2, if energy crops could be grown in a sustainable manner on critical lands (19.4 million ha inside forest areas and 14.8 million ha outside forest areas), Indonesia could meet its target for biofuel development without major environmental problems. However, the definition of critical land, which is supposed to be abundant or non-productive land, is not very clear. Therefore, it should be noted that even if the area of critical land is much larger than the farmland area that will be necessary for energy crop production, the improvement of crop yields is still a crucial factor in the development of biofuel in a sustainable manner that doesn't threaten food security.

The use of grafted cassava (*Mukibat*) is a prominent technology for increasing cassava yield. The potential maximum yield of grafted cassava is around 100 tons/ha, which is more than six times higher than the current average cassava yield in Indonesia. If grafted cassava is appropriately applied to cassava farmers, the land requirement to meet the government's target of biofuel production could be achieved without significant farm area expansion. Some cassava farmers in East Lampung used grafted cassava according to the recommendations of the company with which they have partnerships. As was shown in Chapter 3, the average yield of the surveyed farmers' grafted cassava was approximately 27 tons/ha, which was just slightly higher than the yield of the farmers in North Lampung, who planted conventional cassava (Table 3.3). The survey result indicated that the potential yield of the grafted cassava was yet to be achieved in the study area.

As discussed in Chapter 3, the major reasons for the lower yield and the lower net return of the grafted cassava were inappropriate fertilizer application and a higher cost of the seedlings. On the other hand, in spite of the unsatisfactory outcome of grafted-seedling cassava cultivation, most of the farmers who join a partnership are willing to continue the partnership. This chapter introduces the results of the interview surveys with the biofuel companies and the cassava farmers. This information will help to evaluate the prospects of the technology and the partnerships.

4.2 The company's prospects with grafted cassava

An interview survey with staff members of the biofuel company, *Madu Sari* Company in East Lampung, was conducted in March 2008. The company started its partnerships with local farmers in 2006 and they have used grafted cassava since 2007. The company suggested insufficient fertilizer application was a major reason of low yield of grafted cassava. In the first year of grafted cassava application, the company provided the farmers with credit up to Rp 5 million per ha with an interest rate of 1.5 per cent per month. However, due to the high price of grafted cassava seedlings (Rp 500 per stick, as at the time of the interview), the credit was not enough to cover the fertilizer cost for the recommended dosages. Most of the farmers did not apply manure in the same reason. At the time of the interview, the price of manure in the study area was Rp 250-300 per kg not including transportation costs. The number of livestock kept by the farmers was not sufficient to provide enough raw materials for manure in the cassava production. Therefore, manure had to be purchased from outside the household if the farmers were to apply the recommended dosage of manure.

Another important factor that restricted the cassava yield was the low quality of cassava seedlings. The company itself produces grafted cassava seedlings and provides them to the farmers. Besides the company, there are many graft seedling producers in the area who provide the seedlings not only to the farmers in nearby areas but also to other areas including West Java. Since there are no quality standards for grafted seedlings, some producers provide low-quality seedlings, which can be dead after planting. When seedlings died, farmers replanted them, and this increased the cost of plant materials. To improve the quality of seedlings, the company occasionally organized training courses to teach seedling producers the appropriate way to produce grafted seedlings.

The company suggested that some of the crop-management practices in the first cropping season were not appropriate due to the lack of experience. Since the grafted cassava develops a wider canopy than conventional cassava, at the beginning of the cropping season the company recommended that the farmers plant the seedlings with a planting distance of 150x150 cm^2; this was later proved too wide an area to realize the potential yield of grafted cassava. The standard distance of cassava planting was later corrected from 150x150 cm^2 to 125x125 cm^2.

Due to its higher growth, the canopy of grafted cassava should be pruned in a manner that prevents the plants from falling down. Periodical earthing and use of support rods were also recommended for the same reason. However, few farmers followed these instructions and fallen cassava plants also contributed to the lower yield.

To avoid the loss of fertilizer, the company recommended that the farmers apply fertilizer into soil, rather than scattering in on the soil surface. Also, it was recommended that fertilizer be applied in three instalments – the first, third and fifth month after planting – however, most farmers applied all the fertilizer as a basal dressing. It was also recommended that land preparation be done in three stages to break up soil particles, but farmers usually did this only twice.

Because of lower yields, some farmers face difficulty in repaying their loan from the company. In such cases, the company provided two options to the farmers. The first option was to terminate the contract and to pay back all the debt. The second option was to continue the contract and extend the repayment deadline. In the second option, farmers were allowed to plant conventional cassava if they were not confident about planting grafted cassava.

Based on these constraints experienced by farmers in the first season, the company intends to strengthen its efforts to instruct the farmers to implement appropriate farming practices. The staff members of the company visited the farmers' fields almost everyday and if they found the farmers faced any problems in their cassava cultivation, the technical staff of the company immediately tried to propose countermeasures. The conditions of the partnerships with the company seem to be attractive for the farmers. While the farmers receive a loan from the company, they can sell their product freely to cassava processors because the company is yet start producing biofuel in the area. After the bioethanol factory in the area starts operation, the farmers are obligated to sell all the products to the company. The price of cassava is determined by the market price while a floor price is guaranteed in case the market price slumps. The company gives price incentives to farmers whose cassava quality exceeds the standards. If the starch content in cassava root exceeds the standard (25 per cent) by 1 per cent, the price of cassava will be increased by 4 per cent. On the other hand, if the starch content is below the standard, 4 per cent is deducted from the cassava price for every 1 per cent drop from the standard. The starch content will be measured in every transaction and the result will be disclosed, with high transparency, to the farmers.

According to the interviews with the company, it seemed that the company had clear ideas about the reason for lower grafted-cassava yield in the first season. The company is trying to solve the problems by intensifying technical support to the farmers. On the other hand, it is not very clear if the farmers can afford the fertilizer required in the second cropping season because the company has no plan to increase the limit of loans to the farmers.

In the next Section, the farmers' prospects in the partnership with the company and with grafted cassava will be introduced.

4.3 The farmers' prospects with grafted cassava

Four farmers who had joined the partnership with the company were interviewed to learn about their prospects in the partnership and with the grafted cassava technology. One of the farmers also produced grafted cassava seedlings himself.

The first interviewed farmer harvested his first grafted cassava in the fifteenth month after planting, which was much longer than the usual harvest period of 12 months. He harvested a small area of cassava on a trial basis at the twelfth month, however, because he found an insufficient development of tubers, he postponed the harvest until the fifteenth month. The yield was around 30 to 40 tons/ha. The fertilizer application was 250 kg/ha of urea, 100 kg/ha of SP36, 250 kg/ha of KCl, and 20 tons/ha of manure, which almost satisfied the company's recommended dosages (200, 100, 300 and 1,000 kg/ha, respectively). The dosage of manure far exceeded the recommendation but it would not be a problem because the recommended dosage (1,000 kg/ha) was very low.

Though this farmer was not satisfied with the last season's yield, he was willing to continue his partnership and planting the grafted seedlings because he expected a better harvest in the next cropping season. Though he experienced some difficulty in crop management of the grafted seedlings, he was confident that he could manage the crops in better ways in the next season thanks to his experience in the last season. As for plant management, the working conditions in the grafted cassava field might be better than the conventional cassava field due to the wider distance among the plants, which made plant management much easier.

On the other hand, he thought that small-scale farmers would face difficulty in applying the grafted seedlings without appropriate financial support. This was mainly due to the larger capital needs which enable farmers to apply a sufficient amount of fertilizer.

The second interviewed farmer applied 600 kg/ha of chemical fertilizer in total, and he didn't apply any manure. The cassava yield was around 40 ton/ha. He suggested that poor soil quality, which was too hard for cassava root enlargement, plus the absence of manure application, as the major reasons got the lower-than-expected yield. He harvested the cassava 12 months after planting but he felt he should have waited until 14 months, in order to increase the yield. He suggested the low plant density (150x150 cm^2) might be another factor in the lower yield.

Besides planting cassava, he also produced grafted seedlings himself. He is the Head of a farmers' group (*Kelompok Tani*) that consists of 14 farmers. He produced seedlings for local farmers and also sold them to other areas including West Java. To guarantee the quality, he sold the seedlings 15 days after grafting, when he confirmed that the seedlings had survived in his fields. He also conducted an experiment to determine the best quality seedlings, because this would affect the plant growth and durability.

The third farmer applied 200 kg/ha of urea, 100 kg/ha of SP36 and 100 kg/ha of KCl. No manure was applied in the last cropping season. The yield was only around 15 tons/ha, which was much lower than the other two farmers. He applied all the chemical fertilizer as a basal treatment, contrary to the company's recommendation. He suggested the absence of top dressing and manure application as major reasons for his low cassava yield. Based on his experience in the last cropping season, he applied manure (2 tons/ha) and he expected the yield would be improved in the second and third cropping season. He produced the grafted seedlings himself. Since he joined a training course on graft seedling production, the survival rate of the seedlings had not been a problem in his field.

The last farmer interviewed has recently started using grafted seedlings and he has not harvested the cassava yet. He also experienced difficulty in crop management of grafted cassava, but he wants to continue to use grafted seedlings in the second and third year.

4.4 Prospects of cassava yield increase by use of grafted cassava

As found in the interview surveys, in spite of a relatively low yield in the first cropping season, all four surveyed farmers were willing to continue their use of grafted seedlings and partnership with the company. Grafted seedlings can be used for three years and since the seedlings become thicker, the yield will increase year by year because thicker seedlings help the plant growth in early stages of cassava cultivation. In addition, from their experience in the first season, the farmers had a good understanding of the problems involved in growing the grafted plants

The responses from the company also helped persuade the farmers' to continue the use of the grafted seedlings. The suggestions by the technical staff of the company were useful in solving the problems faced by the farmers. The debt rescheduling offered by the company was a relief for the farmers who failed to achieve sufficient profit in their first trial of grafted seedlings.

If there is insufficient input use, especially a lack of manure application, which was a constraint on cassava yield, the company should increase the limit of the loan provided to farmers. However, at the time of the interview, the company did not have such a plan. Most farmers could not produce manure by themselves but need to buy it from other manure producers, so farmers who have insufficient capital to buy manure, will again observe a low yield in the next cropping season.

Several large-scale cassava processors have dominated the cassava market in Indonesia, especially in Lampung Province. In spite of the efforts by the government, it has been difficult to change the oligopolistic characteristics of the market to improve the welfare of cassava farmers. Nevertheless, due to the increasing demand for cassava, some significant changes to this situation have been observed. Various companies have shown interest in producing biofuel, and the emergence of the newcomers, including the companies surveyed in this study, could be an opportunity to breakthrough the current oligopolistic cassava market. These companies offer farmers not only a cassava floor price and credit but also various other services to attract the farmers, including the dissemination of grafted seedlings.

The emergence of the newcomers is expected to motivate the conventional cassava processors to change their current business practices, which are sometimes disadvantageous to the farmers. It can be concluded that in spite of various difficulties, the grafted seedlings have sufficient potential to warrant continued partnership with the biofuel company. In addition, it can be concluded that the increasing demand for cassava will attract more companies to the processing business. With the tightening competition among the companies, the successful increase of cassava productivity in the study area will raise the companies' confidence that the investment in supporting activities of farmers will result in an improved output, thus ensuring their investments are worthwhile. This in return will contribute to the farmers' welfare through improved profit from cassava production.

5. Prospects of Bioethanol Projects under the Clean Development Mechanism

5.1 CDM characteristics and criteria

The Clean Development Mechanism (CDM), set up under the 1997 Kyoto Protocol, is a co-operative mechanism by which industrialized countries (Annex I Countries) may engage in economically and environmentally competitive emission reduction projects in developing countries. Thus, CDM is aimed at helping industrialized countries to achieve their GHG reduction targets under the Protocol and simultaneously assist developing countries to achieve sustainable development (UNEP/RISOE, 2002).

Projects that will be implemented through the CDM have to satisfy both international and national criteria. While national criteria are defined by a national framework of host countries, the international criteria focus mainly on technical aspects of the carbon mitigation activities. The internationally agreed criteria, specified by Article 12 of the Kyoto Protocol, consist of three principles: (i) CDM projects must assist Non-Annex I Parties in achieving sustainable development and contributing to the ultimate objective of the Convention; (ii) CDM projects must result in real, measurable and long-term benefits related to the mitigation of climate change; and (iii) CDM projects must result in reductions in emissions that are additional to any that would occur in the absence of the certified project activity (UNEP, 2004a). The Marrakech Accords stipulate more criteria that must be met by potential CDM projects. These international criteria are meant to ensure that the expected benefits related to the mitigation of climate change are real, measurable and additional (UNEP RISØ Centre, 2002).

Bakker (2006) identified the other specific characteristics of CDM as follows: (i) participation in CDM activities is voluntary; (ii) CDM investment is market driven; (iii) both public and private parties are eligible to participate; (iv) CDM activities must result in measurable emission reduction that will be transferable to investors in the form of certified emission reductions (CERs) upon a third party's quantification and certification; (v) emission reduction must be additional to any that would occur in the absence of the project activities; and (vi) the host country has the prerogative to define sustainable development or how CDM projects contribute to it.

It is worthwhile to note that the funding channelled through the CDM should assist developing countries in reaching sustainable development objectives such as land-use improvement and cleaner air and water, accompanied by social benefits such as rural development, employment, poverty alleviation, and reduced dependence on imported fossil fuels (UNEP, 2004a; Center for Research on Material and Energy, 2001). Annex I countries may use the certified emissions reductions (CERs) issued by the CDM Executive Board to meet their Kyoto commitments (UNEP, 2004a)

A sound evaluation process will increase the probability of having projects successfully validated and certified as CDM projects, and reduce the perceived and real risks faced by national and foreign investors in developing and implementing carbon mitigation projects. It can also create incentives for specific project types or for priority sectors. The evaluation process also provides the main filter for ensuring that projects pursue CDM objectives consistent with relevant national policies, strategies and priorities.

The host country has the prerogative to decide whether a project assists in achieving sustainable development, and therefore should develop national criteria and requirements to ensure a coherent, justifiable and transparent assessment. Key elements could include: compliance with existing political and legal frameworks; compatibility with local priorities; consideration of comments by local stakeholders directly and indirectly involved with the project; local availability of qualified human resources and adequate institutional resources; and the potential for local institutional enhancement and national capacity building. In deciding which of these criteria are to be adopted, the host country should consider the direct relationship between requirements and transaction costs. The more requirements imposed on project developers, the higher the preparation costs. In a carbon market where the CDM already has many prerequisites, host countries should balance information requirements necessary for quality control with rising preparation costs.

For national criteria, each host country is responsible for defining sustainable development criteria. In general, a three-dimensional approach is used to illustrate sustainability: environmental, economical and social. Sometimes additional dimensions such as technological or cultural sustainability are also suggested, although one could argue that those can be included in the first three (Gnansounou *et al.*, 2005, UNEP, 2004b). In the case of Indonesia, the National Commission for CDM (NC-CDM) classifies the sustainable development criteria into four categories (environment, economic, social and technology) and each criterion has its indicators (see Appendix 4).

Among the four categories of sustainable development established by NC-CDM in Indonesia, environmental criteria and indicators seem to be the most difficult to fulfill, especially when the area of feedstock for biofuel has to be expanded. As has been discussed in a previous section, if the entire Action Plan is fulfilled in 2010, another 5.357 million ha of new cultivation rights will have to be taken from forest area currently devoted to plantation, particularly for palm oil. Since this land use change will cause deforestation, the international community may consider that the area expansion is not environmentally sustainable.

Alvarez (2006) noted that one initial question about biofuel projects is the direct or indirect impact of biofuel feedstock plantation on deforestation. This implies that for investors in biofuel projects that plan to supply their feedstock from forest area in Indonesia, the environmental criteria and indicators will ultimately become the major obstacle to project certification by CDM Executive Board. In other words, it will ultimately be difficult for the National Team for Biofuel Development to meet the targets of the Action Plan for Biofuel Development in Indonesia because investors might be less interested in biofuel projects without CERs from the CDM Executive Board.

As biofuel projects under CDM have to support sustainable development by reducing local atmospheric pollution, providing rural people with additional revenues, and creating new employment opportunities, it is necessary that all types of biofuel feedstock in Indonesia be grown on critical lands by using sound agricultural practices. It is worthwhile to note that the area of critical land in Indonesia is about 33 million ha (Forestry Statistics, 2006). Before biofuel crops are expanded onto critical lands, however, it is necessary to carry out comprehensive agronomic, economic and social research and development projects suitable for local conditions and this requires public support.

5.2 Prospects of biofuel projects under CDM

If biofuel can be developed through CDM in developing countries, it potentially has several merits. First, CDM offers an incentive to implement climate-friendly projects. Second, project investors can sell the certified emission reductions (CERs) to industrialized countries. Third, co-operation between developed and developing countries may offer financial benefits, attract loans and promote transfer of technology (Bakker, 2006). Additionally, biofuel development may support the development of agriculture by providing rural people with additional incomes, creating new employment opportunities, and reducing local atmospheric pollution, and thereby promoting sustainable development (Gnansounou *et al.,* 2005). This implies that biofuel projects potentially qualify for CDM projects because they satisfy the dual goal of CDM. To qualify for CDM projects, however, bioethanol projects have to demonstrate that they meet specific CDM criteria and follow the rules set up by the

CDM Executive Board. In this regard, it is worth presenting the results of a suitability analysis of biofuel projects carried out by Bakker (2006) using CDM criteria derived from the standard Project Design Document as follows:

1. Significant greenhouse gas reduction

   Greenhouse gas (GHG) reduction in the CDM framework is measured against a baseline. The baseline GHG emissions are those that would occur in the absence of the proposed CDM project. In this respect, the question of 'leakage' must be addressed: GHG reduction within the project boundary should not lead to an increase in GHG emissions outside the project boundary. Most important GHG emission sources in the biofuel cycle are nitrogen-based fertilizer use, transport of biofuel, land use, land-use change, and the biofuel processing plant. In order to determine emission reductions by the project, a credible baseline has to be established (*ex-ante* and *ex-post*, in the monitoring methodology). Up to 2006, five such baseline methodologies for biofuel projects have been proposed and submitted to the CDM Executive Board, but none have been approved (UNFCCC, 2006). Approved methodologies are a crucial step in successful implementation of biofuel CDM projects.

2. Additionality proof

   Additionality proof is a key element for a CDM project. Basically, it must clearly explain why registration of the project as a CDM project is required to make the project feasible. While additionality proof is essential for the purpose of CDM, its interpretation in general remains a delicate issue for all stakeholders involved. Although a tool comprising five steps that can be used to demonstrate additionality has been developed (UNFCCC, 2005), proving additionality is still not easy. Important points to consider are economic analyses for project proponents as well as end-users and the barrier analysis, which entails an examination of technological, policy, social or other barriers faced by the project proponents.

   To make production and use of biofuels financially attractive, biofuel projects in general require financial support. Therefore CER revenues may contribute significantly to the attractiveness of the biofuel project. In this respect, additionality can be proven based on conventional investment analysis or through a barrier analysis. Since the production of biofuels involves a relatively new technology, more experience is necessary to create confidence among project developers and investors.

3. Monitorability

   In order to ensure real climate benefits, the variables that determine the emission have to be monitored accurately. This will be verified by a Designated Operational Entity (DOE) to increase transparency and provide robust evidence of real climate benefits. For biofuel projects, the monitoring requirements may be substantial because there are many sources of GHGs. There are two important issues in monitoring biofuel projects. First, establishing a credible methodology for both baseline determination and monitoring is difficult. Second, since the list of variables to be monitored can be quite extensive, this may imply a relatively large cost to the project as compared to most other types of CDM projects.

4. Contribution to sustainable development

   In addition to GHG reduction, biofuel projects contribute significantly to the second aim of CDM: sustainable development. This includes reduction of pollutants, enhancing energy security, promoting employment, and transfer of new technologies. In this regard, it is important to note that biofuel projects may be one way the sustainable development component of CDM can be enhanced. The only question may relate to its impact on the natural environment, which may be positive or negative depending on the source of feedstock. Unsustainable palm oil production in rainforest sites, for example, may have negative impacts on biodiversity. On the other hand, if feedstock is produced from sustainably managed land or forest, the impact on biodiversity and water resources may be positive.

Up to mid-2006, over 800 projects were in the validation stage under CDM. These CDM projects will account for more than 1,000 mtCO_2-eq reduction up to 2012, but no biofuel projects were included in the CDM project portfolio (Bakker, 2006). The number of CDM projects has been increasing fast. The CDM pipeline prepared by Capacity Development for CDM (CD4CDM, 2008) indicates that there were 3,403 projects in the CDM validation stage on 1 May 2008, and these projects will account for 2.57 million kCERs by 2010 (Appendices 5 and 6). Among these projects, there were 531 biomass energy projects; 6 of them were biodiesel projects, but no bioethanol project had been included in the CDM project portfolio (Table 5.1).

Table 5.1 Number of biomass energy projects by subtypes and CDM stages (up to May 2008)

Subtypes used in CDM projects	Number of projects by CDM stages				MW total
	At validation	Request registration	Registered	Total	
Bagasse power	83	11	67	161	3 680
Palm oil solid waste	22	1	15	38	275
Agricultural residues: other kinds	75	7	58	140	1 588
Agricultural residues: rice husk	58	6	40	104	694
Agricultural residues: mustard crop	2	0	4	6	46
Agricultural residues: poultry litter	1	0	1	2	7
Black liquor	2	0	5	7	103
Irrigation	1	0	0	1	0
Forest residue: sawmill waste	10	1	8	19	185
Forest residues: other	21	1	7	29	188
Forest biomass	7	0	1	8	22
Industrial waste	2	1	0	3	32
Gasification of biomass	6	0	1	7	8
Biodiesel	6	0	0	6	0
Ethanol	0	0	0	0	0
Total	296	28	207	**531**	6 828

Source: Adopted from CD4CDM, 2008, CDM Pipeline, UNEP/RISOE.
Note: MW = mega watt.

Up to May 2008, the only baseline methodology[1] for biofuel projects that had been approved by CDM Executive Board was the baseline methodology for the production of biodiesel based on waste oils and/or waste fats of biogenic origin (Table 5.2). This implies that the limited number of biofuel projects in general and bioethanol projects in particular that have been included in the CDM project portfolio is caused by the fact that no crop-based biofuel baseline methodology has been approved by the CDM Executive Board (Table 5.2). Aside from baseline and monitoring methodology, the other barriers for biofuel projects to be included in CDM projects portfolio are additionality proof, calculation of the GHG reduction by the project, and high abatement costs (Bakker, 2006). While additionality proof and calculation of the GHG reduction have been elaborated above, high abatement costs need further explanation as follows.

The International Energy Agency (IEA, 2004) found that CO_2 abatement costs for both biodiesel and ethanol for most regions is estimated to be higher than US$ 100/tCO_2-eq, with Brazil being an exception (in Brazil it is between US$ 10-30/tCO_2-eq). Compared

[1] Baseline: Emissions that occur in the absence of CDM project activities e.g. carbon dioxide released from burning petro-based fuels;
Additionality: Proof that emissions are reduced due to activities that would not have occurred in the absence of the CDM project activities;
Methodology: A predefined method for calculating the CERs generated by a project and how the additionality of the project should be determined (Alvares, 2006).

with current CER prices which are in the range of € 5-20/tCO_2-eq (Bakker, 2006), the current abatement cost is so high that investors are less attracted in investment of biofuel CDM projects. In the case of Thailand, for example, cassava-based ethanol has a GHG abatement cost of US$ 99 per ton of CO_2. Regardless of the high abatement costs, Nguyen (2006) found that cassava-based ethanol would be a good substitute for gasoline since it has positive energy balance of 22.4 mJ/l and net avoided GHG emission of 1.6 kg CO_2eq./l, and it is effective in fossil energy saving and GHG reduction.

Table 5.2 Approved CDM baselines and monitoring methodologies for biomass and biofuel projects (up to May 2008)

Methodology number	Sectors covered	Number of projects
	Biomass: (not applicable for non-renewable biomass, EB21)	
AM4 (ver 2)	Grid-connected biomass power generation that avoids uncontrolled burning of biomass	2
AM7	Switch from coal/lignite to seasonal agro-biomass power	0
AM15	Bagasse-based cogeneration connected to an electricity gird	29
ACM3 (ver 7)	Emission reduction through partial substitution of fossil fuels with alternative fuels in cement manufacture	15
ACM6 (ver 6)	Grid-connected electricity from biomass residues (includes AM4 & AM15)	185
AM27 (ver 2.1)	Substitution of CO_2 from fossil or mineral origin by CO_2 from renewable resources in production of inorganic compounds	1
AM36 (ver 2)	Fuel switch from fossil fuels to biomass residues in boilers for heat generation	8
AM42	Grid-connected electricity generation using biomass from newly developed dedicated plantations	0
	Biofuels:	
AM47 (ver 2)	Production of biodiesel based on waste oils and/or waste fats from biogenic origin for use as fuel	2

Source: Adopted from CD4CDM, 2008. CDM Pipeline, UNEP/RISOE.

6. Possible Impacts of Biofuel Development

6.1 Impacts on food security

In recent years, many studies have come to a conclusion that biofuel production has affected and will continue affecting food prices and food security. The role of biofuels as a source of demand for grain has also been a significant element of recent food price rises. UN Energy (2007) reported that biofuel production could threaten food security as land, water and other resources were diverted from food production. Similarly, food access could be compromised by higher basic food prices resulting from increased bioenergy feedstock demand, thus driving the poor and food insecure into even greater poverty. In spite of the fact that production of raw materials for biofuels is an opportunity to diversify agricultural production, the UN Energy report stresses that policymakers should ensure that food security considerations are given priority.

Although increasing biofuel production is blamed for food price increases, other factors such as stock levels, exchange movements, weather and intangible factors such as speculation also affect price increases of commodities (Raswant *et al.,* 2008; Evan, 2008). Having reviewed many articles, Evan (2008) concluded that the growth in emerging economies and the relative inelasticity of supply are also factors causing food price increases, and noted that the high-income growth in emerging economies is probably the single most significant factor. Joachim von Braun, Director General of the International Food Policy Research Institute (IFPRI), argues that high-income growth accounts for perhaps half of the recent increases in food prices. In addition, Raswant *et al.* (2008) argue that the high energy prices have caused high costs of fossil fuel-based inputs such as diesel, fertilizers and pesticides, particularly in countries that employ intensive farming practices. Eventually, the high costs of inputs have lowered output levels and hence caused higher prices. Now, with rising energy prices and improved bioenergy conversion technologies, energy prices and feedstock prices are increasingly being linked. These linkages are more readily visible in the more integrated markets of sugar and bioethanol in Brazil but most probably will soon emerge in other feedstock prices as well.

In the longer term, Evan (2008) points out four more fundamental supply-side factors that will cause an increase in food prices. These factors are collectively termed ‘scarcity issues’.

1. The costs of agricultural inputs, especially energy, are rising. For example, the cost of urea has almost tripled since 2003, while oil prices will stay relatively high over the medium to long term. Since food can now be converted into fuel, there is effectively an arbitrage relationship between the two, implying an ongoing linkage between food and fuel prices.
2. Water scarcity is likely to become a more pressing issue, particularly in relation to depletion of limited ground-water resources, while the global demand for water has tripled in the last 50 years.
3. Land availability is an issue. Some commodity analysts argue that whereas historical increases in demand have been met through increasing yields, in future an expansion of acreage will also be required.
4. Climate change is perhaps the most fundamental factor. Overall, the International Panel on Climate Change (IPCC) projects that global food production could rise if local average temperatures increase by between 1 and 3 degrees Celsius, but could decrease if temperatures are above this range. The IPCC predicts extreme weather, rather than temperature, is likely to make the biggest difference to food security.

Accepting that biofuel production will increase the price of food because energy crops may displace food crops on agricultural lands, Rajagopal and Zilberman (2007) argue that the ultimate impact will depend on several factors including the intensity of cultivation of biofuel crops and the extent of trade in food-related commodities. Developing countries that are net importers of food will be negatively affected due to higher food prices irrespective of whether they adopt biofuels or not. Rajagopal and Zilberman then argue that if biofuel crops are cultivated exclusively on set-aside lands or marginal lands with little competition with food crops, the impacts on food prices will be theoretically minimal. In line with this, the report from UNCTAD (2006) suggests that to reduce risks of worsening food security, feedstock for biofuels could be cropped on degraded land, pasture land that has the least efficient land use, or it could displace crops intended for exports. In reality, however, biofuels may still compete for other resources like water or labour and thus impact food production.

Growing non-edible feedstock for biofuels, e.g. jatropha, is another way to reduce the negative effect of biofuel production on food crops. This is also true for the second generation of biofuel technologies such as lignocellulosics that use woody crops as feedstocks. When these two options have not yet been possible, efforts to increase land

and labour productivity in developing countries are critical in order to avoid competition between feedstock for biofuels and food crops in use of land (Peskett *et al.,* 2007).

According to von Braun (2007), the question of whether or not biofuel crop production will reduce food insecurity remains controversial for two reasons. First, new ways of combining food production with energy production have been developed: crop residues can be converted into biogas, ethanol, and electricity; energy crops can be grown on marginal lands; and food and energy crops can be rotated. Second, food insecurity is a result not simply of a lack of food availability, but poverty. Still, risks for food security remain, particularly if the biofuel sector is not well managed and if oil price instabilities drive food price instability. Thus the effects of biofuel expansion on food security depend heavily on policies related to technology and trade.

To reduce trade-offs between bioenergy crops and food production in developing countries, Hazell (2007) has several suggestions as follows:

1. Develop biomass crops that yield higher amounts of energy per unit of land and water. Biotech could be very useful.
2. Focus on food crops that generate byproducts that can be used for bioenergy, and breed crops for larger amounts of byproducts.
3. Develop and grow biomass in less-favoured areas rather than in prime agricultural lands – an approach that would benefit some of the poorest people but which will depend on more efficient conversion of cellulose-rich materials.
4. Invest in increasing the productivity of food crops themselves, since this would free up additional land and water.
5. Remove barriers to international trade in biofuels. The world has enough capacity to meet food needs and grow large amounts of biomass for energy use, but not in all countries and regions. Trade is a powerful way of spreading the benefits of this global capacity while enabling countries to focus on growing the kinds of food, feed, or energy crops for which they are most competitive.

6.2 Environmental impacts

Since most biofuels emit fewer greenhouse gasses than fossil fuels when used for energy, biofuels certainly mitigate the effect on climate change. The debate is about the net carbon savings: the amount of fossil-fuel energy needed to produce the biofuel energy throughout its entire production cycle. In this regard, Kartha (2006) concludes that the right choice of biomass crops and production methods can lead to favourable carbon and energy balances and a net reduction in greenhouse gas emissions. Raswant *et al.* (2008) point out that feedstock production using less fertilizer and more labour results in more carbon savings. In other words, small farming of biofuel production is more environmentally friendly than large-scale commercial mono-cropping operations, because small farming tends to use less fertilizer and it rarely uses mechanized farm equipment that consumes polluting fossil fuels.

When land is cleared for planting biofuel crops, the effect can be harmful to the environment because expansion of biofuel crops can displace other crops or threaten ecosystem integrity by shifting from biodiverse ecosystems and farming systems to industrial monocultures (Raswant *et al.,* 2008). In Brazil, for example, it is feared that future sugar cane expansion might involve fragile areas. In Indonesia and Malaysia, 14 to 15 million ha of peat lands have been cleared for the development of oil palm plantations. Since a change in land use such as cutting forests or draining peat land can cancel GHG emissions savings ‘for decades’, Kartha (2006) suggests that bioenergy crops should be grown on lands currently under annual row crops or on lands undergoing degradation.

Some feedstocks, such as sugar cane, require considerable quantities of water while others such as jatropha require less. Improvement in crop productivity and the shift from high water-use biofuel crops (such as sugar cane) to drought-tolerant crops (such as sweet sorghum) are also options to address the issue of water scarcity. Water is also required in processing energy crops into biofuels. On the other hand, although conversion plants offer options for controlling water pollution, existing processing facilities can discharge organically contaminated effluent. All agrochemical run-off and sediments are problematic, but these problems apply as much to food crops as they do to biofuel crops.

Impact on soil is another environmental concern, but is not unique to biofuels. The types of fertilizers, whether crop waste and manure or external inputs, will affect soil fertility and structure. However, jatropha and pongamia that grow on marginal lands have the potential to improve soil quality and reduce erosion while their oilcakes can provide organic nutrients for improving soil. Life cycle analysis of potential environmental impacts of different biofuel production systems is needed to ensure that the development of biofuel programmes is environmentally friendly.

6.3 Impacts on access to land

Biofuel crops are not different from other cash crops in the sense that high demand and rapid expansion of biofuel production could increase conflict over land rights and land use. If land tenure systems are weak, there is risk of appropriation of land by large private entities interested in the lucrative biofuel markets. The poor, who often farm under difficult conditions in remote and fragile areas and generally have little negotiating power, may be tempted to sell their land at low prices, or where land is owned by the state, find their land allocated to large, outside investors (Raswant *et al.,* 2008). In this regard, Peskett *et al.* (2007) provide examples from Brazil and South East Asia. In Brazil, access to land for poor people continues to be reduced under biofuel production because producers seek to meet economies of scale and resulting in land concentration. In Malaysia and Indonesia, although palm oil production improves land administration, the palm oil expansion could strengthen claims to land where land rights are not recorded. Therefore, appropriate policies for biofuels should be developed and integrated into a broader strategy of protecting land rights of the poor and disadvantaged. Raswant *et al.* (2008) also suggest that improvement of land policies and land administration systems should be prioritized to maximize the benefits for poor smallholder farmers.

Peskett *et al.* (2007) point out that the important factors in assessing the impact of biofuel development on land access for poor people are:

- whether the crop is perennial or annual and whether it can be grown in combination with other crops – flexibility in land use has strong implications for land leasing and rental markets and the requirements of tenure arrangements;
- how far the feedstock can be grown on degraded land or used to revitalize degraded soils – if crops like jatropha can be produced on degraded land, conflict over land is likely to be reduced in the short term, though in the long term, as soils improve, new claims on land may emerge.

In order to ensure land access for farmers and the poor, Cotula *et al.* (2008) provide several pointers for policy and practice by governments and the private sector at local, national and international levels as follows:

- Governments need to develop robust safeguards in procedures to allocate land to large-scale biofuel feedstock production. Safeguards should be applicable across agricultural and land use sectors rather than specific to biofuels.

- Since large-scale privately owned plantations are not the only economically viable model for biofuel feedstock production, policy instruments based on financial incentives can help provide for inclusion of small-scale producers in the biofuel industry.
- Clearer definitions of concepts of idle, under-utilized, barren, unproductive, degraded, abandoned and marginal lands are required to avoid allocation (or dis-allocation) of lands on which local user groups depend for livelihoods.
- Land access for rural people requires policy attention not only to land tenure but also to the broader circumstances that determine land use and agricultural economics.
- International policy arenas also influence the impact of biofuel expansion on land access. Attention may need to be given to eligibility rules regarding land use change under the Clean Development Mechanism of the Kyoto Protocol and its successor. International governance of trade and investment will continue to be a major determinant of the economic potential of different forms of land use in producer countries.
- Policies, laws and institutions matter; but in contexts characterized by strong power asymmetries, they are likely to achieve little if they are not accompanied by sustained investment in building people's capacities to claim and secure their rights.
- Local, national and international NGOs and civil society organizations have a continued role to play in holding governments and industry to account regarding their promises on protection of land access and food security to specific communities and the community more generally.
- Finally, 'biofuels' is a term for a set of very different crops and cropping systems, end-products, policy goals (e.g. commercial production versus energy self-sufficiency), business models (different combinations of ownership and benefit-sharing among large-scale and small-scale operations) and local contexts – all of which significantly affect land access outcomes. A better understanding of this diversity will promote a more balanced and evidence-based debate.

Biofuel development can enrich farmers by helping to add value to their products, but it can also result in concentration of ownership that could drive the world's poorest farmers off their land and into deeper poverty. According to UN Energy (2007), biofuel development in the future will be characterized by a mix of production types, some dominated by large, capital-intensive businesses, some marked by farmer co-ops that compete with large companies, and some where liquid biofuels are produced on a smaller scale and used locally. Regardless of the scale of production, however, one thing is clear: the more involved farmers are in the production, processing and use of biofuels, the more likely they are to share in the benefits.

6.4 Impacts on poverty

In assessing the impact of biofuel development on poverty, von Braun (2006) argues that biofuel production could result in higher incomes for farmers and employment in rural areas[1]. In some cases, farmers can also grow energy crops such as *Jatropha curcas* on degraded or marginal land that is not suitable for food production. The extent to which farmers will be able to realize the benefits depends on many conditions, including access to markets and access to technological innovation. Beside the potential benefits, biofuels also pose challenges because increased production of energy crops may result in concentrating benefits on people who are well off. It can also lead to deforestation, a loss of biodiversity, and excessive use of fertilizers and pesticides, thereby degrading the land and water that poor people depend on.

Policymakers have recognized that the high demand for energy and the apparent enormous potential of biofuels do not guarantee a positive impact on poor people and developing countries. To develop a biofuel sector that is sustainable and pro-poor, von Braun (2006) argues that actors at the international, national, and local levels have crucial roles to play:

- International institutions must help transfer to poor countries knowledge and technology for developing an efficient and sustainable biofuels industry. By subsidizing their domestic agriculture and their biofuel industries, the OECD countries are raising the price of grains and feedstock in their own countries and are distorting the opportunities for biofuel production and trade in developing countries.
- At the national level, policymakers must take steps to create a well-functioning market for biofuels and to regulate land use in line with socio-economic and environmental goals. They must also provide farmers who wish to grow energy crops with the same kinds of support needed for other forms of agriculture, such as research and extension services, credit and infrastructure.
- Finally, local institutions must participate in designing and managing projects to develop biofuels so that poor people and small farmers can gain benefits as both biofuel producers and consumers. With sound technology and trade policies, as well

[1] See Peskett *el al.* (2007) for employment creation in biofuel production in several countries.

as social protection policies, win-win solutions – that is, positive outcomes for food security of the poor as well as for energy efficiency and security – are possible with biofuels in developing countries.

6.5 Possible impacts of biofuel development in the study area

In the previous sections in this chapter, possible impacts of biofuel development on food security, environment, access to lands and poverty were described. This chapter concludes with a discussion of the possible impacts of biofuel development in the study area in Lampung Province, based on the survey results that were introduced in the previous chapters.

As suggested in Section 5.1, in Indonesia, environmental criteria and indicators for sustainable biofuel development seem to be the most difficult to fulfil, especially when the area of feedstock for biofuel has to be expanded. The other impacts such as impacts on food security and access to land are also largely dependent on the possible expansion of farmland for use in energy crop production. As shown in Table 3.4, assuming that all bioethanol production that has been planned for 2010 in Indonesia is produced from cassava alone, 12 million tons of cassava is required.

The cassava production area in Lampung Province occupies around 27 per cent (5.5 million tons) of the total national cassava production (19.9 million tons) as of 2006 (BPS, 2007). Assuming that 27 per cent of the required 12 million tons of cassava is produced in Lampung, then Lampung will need to produce an additional 3.2 million tons of cassava annually. The possible scenarios to fulfil this requirement are shown in Table 6.1.

Table 6.1 Required cassava production area expansion under different scenarios

No	Assumption	Required area expansion ('000 ha)	Expanded area as proportion[a] of current harvested area (252,984 ha[b])	Expanded area as proportion[a] of current fallow land (86,499 ha[b])
1	Maintain the current provincial average yield (19 tons/ha) in area expanded	168	67	195
2	Observed grafted cassava yield (27 tons/ha) in area expanded	119	47	137
3	Potential grafted cassava yield (40 tons/ha) in area expanded	40	32	92
4	Potential grafted cassava yield (40 tons/ha) in area expanded/current area	-53	-21	-

Notes: [a] units expressed as percentage.
[b] As of 2005 (BPS Provinsi Lampung, 2006).

If Lampung province tries to meet the target (increase cassava production by 3.2 million tons annually) by area expansion while maintaining the current average yield in the province (19 tons/ha), then the cassava production area must be expanded by 168 thousand ha, which exceeds the current fallow land area in the province. This situation is almost the same in the second scenario, i.e., the yield in the expanded planted area would increase by 27 tons/ha, which is the observed average grafted cassava yield in this study. Under both scenarios, the necessary land expansion exceeds the current amount of fallow land. Without development of new farmland, it would be impossible to meet the increasing cassava demand and concerns will be raised that the development of new farmland may induce environmental problems, conflicts with local communities and other problems, and that it would not be sustainable from the environmental and social viewpoints.

In the third scenario, in which the cassava yield in the expanded planted area would be increased up to 40 tons/ha (the highest observed yield in this study), the required area expansion would be relatively small. It is less than the current fallow land area. If the province successfully increased the cassava yield to this level in all the current cassava-planted area, then only 79 per cent of the current cassava field will be necessary to meet the cassava demand.

Based on the observation in Chapter 4 of this study, we can safely say that the assumed cassava yield of 40 tons/ha is a realistic one if appropriate technical and financial support is provided to farmers. On the other hand, it should be noted that an intensive fertilizer application is indispensable to achieve this yield: the required application is nearly twice as much as the current application for cassava. So far, no environmental problems have been reported in the field of grafted cassava. However, it is not clear if it will still be environmentally friendly when more farmers use the grafted seedlings with intensive fertilizer application over a longer time frame. Careful observation and monitoring will be necessary to determine its sustainability in the future.

As for the impacts on poverty, the expanded cassava production will definitely benefit local farmers and economies. The observed added value (net returns plus labour inputs) in the cassava production in this study was Rp 270,000-328,000 per ton of cassava (Table 6.2.). Therefore, if Lampung province increased its cassava production by 3.2 millions tons annually, it would contribute Rp 864-1,078 billion to provincial Gross Regional Domestic Product (GRDP). This means a 2.2-2.7 per cent increase of the current GRDP (Rp 39,834 billion, as of 2005 (BPS Provinsi Lampung, 2006)). This could be recognized as a significant contribution to the local economy.

The observed labour inputs for cassava production were Rp 84,000-107,000 per ton of cassava. Using the minimum monthly wage in Lampung province (Rp 505,000 as of 2005 (BPS Provinsi Lampung, 2006)), one ton of cassava production generates 0.17-0.21 month's employment for one person. Therefore, the full achievement of the cassava production target (3.2 million tons) would generate full employment for 44,000-57,000 persons per year This comprises 1.0-1.2 per cent of the population of productive age (15-64 years old) in the province (4,620,857 persons, as of 2005 (BPS Provinsi Lampung, 2006). It can be concluded that the development of biofuel would also be effective for the expansion of job opportunities in the study area.

Table 6.2 Added value in the study areas

	East Lampung	North Lampung	
	Mukibat grafted cassava (n = 30)[a]	*Kasertsart* variety (n = 17)[a]	Thailand variety (n = 13)[a]
Net returns ('000 Rp/ha) (1)	5 088	5 707	5 252
Labour inputs ('000 Rp/ha) (2)	2 297	2 663	2 435
Added value ('000 Rp/ha) (1+2)	7 385	8 370	7 687
Yield (tons/ha)	27.3	24.8	23.4
Added value ('000 Rp/tons of cassava)	270	337	328
Labour inputs ('000 Rp/tons of cassava)	84	107	104

Source: Calculated by author, based on Table 3.2 and Table 3.3.
Note: [a] n = number of sample farmers.

7. Conclusions and Recommendation

Based on the Action Plan established by the National Team for Biofuel Development, the total area of biofuel crops in Indonesia will be about 6.45 million ha in 2010, consisting of 782,000 ha of cassava, 698,000 ha of sugar cane, 3.43 million ha of oil palm, and 1.54 million ha of *Jatropha curcas*. It seems that the action plan is unrealistic for several reasons such as high investment costs, a lack of financial institutions interested in biofuel development, and a lack of strong and clear action from institutions relating to policy, finance and technology.

It seems that the National Team for Biofuel Development has planned to expand the area of feedstock for biofuel in forest area devoted to plantation. Accordingly, another 5.643 million ha of new cultivation rights will be needed from forest area currently devoted to plantation, and this will undoubtedly worsen deforestation in Indonesia. To avoid further deforestation, it is recommended that all feedstock area expansion for biofuel development be grown on degraded or critical lands, which have reached a total area of about 33 million ha in 2006. This is an important area of agricultural research and development that ultimately can provide technology resulting in feasible feedstock farming for biofuel development, and more importantly increased income and employment in rural areas.

The case study of cassava farming in partnership with companies that plan to produce ethanol in Lampung indicates that this arrangement is good for farmers because it increases the price of cassava. If cassava as feedstock for bioethanol is grown on the existing agricultural land, its effect on food security would be minimal because cassava is not a staple food and some of it is exported. How cassava yields can be significantly increased, and this is another field of agricultural research and development.

The simulation results from this study showed that if the Lampung province successfully increased cassava yield by 40 tons/ha (the highest observed yield of the grafted cassava in this study) in all the current cassava-planted areas, only 79 per cent of the current cassava field will be necessary to produce sufficient cassava feedstock to meet the target of the National Biofuel Development Plan. The achievement of this target means that the province could increase its provincial Gross Regional Domestic Product (GRDP) by 2.2-2.7 per cent and generate full employment job opportunities equivalent to 1.0-1.2 per cent of the population of productive age in the province every year.

From the review of ethanol-related articles, it can be concluded that biofuel projects are in principle eligible under the CDM. However, biofuel projects have several barriers to inclusion in CDM projects: (i) establishment of approved baseline and monitoring methodologies, which are necessary requirements for validation; (ii) certified emission reduction (CER) revenues will in most cases only cover part of the additional cost of biofuels compared to conventional fuels; and (iii) CO_2 abatement costs for biofuels are in general higher than current CER prices. Nevertheless, biofuel projects may be an opportunity to develop projects with strong sustainable development components, and therefore contribute strongly to the twin objectives of the CDM: sustainable development in developing countries and achievement of part of the Kyoto target in developed countries.

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Appendices

Appendix 1. Energy mix based on Presidential Directive No.5/2006

Sources of energy	Energy mix 2005 (%)	Targeted mix 2025 (%)
Oil	54.4	20
Gas	26.5	30
Coal	14.1	33
Geothermal	1.4	5
Biofuel	0	5
Others (Biomass, hydro, nuclear, wind, solar, coal liquefaction)	3.6	7
Total	100	100

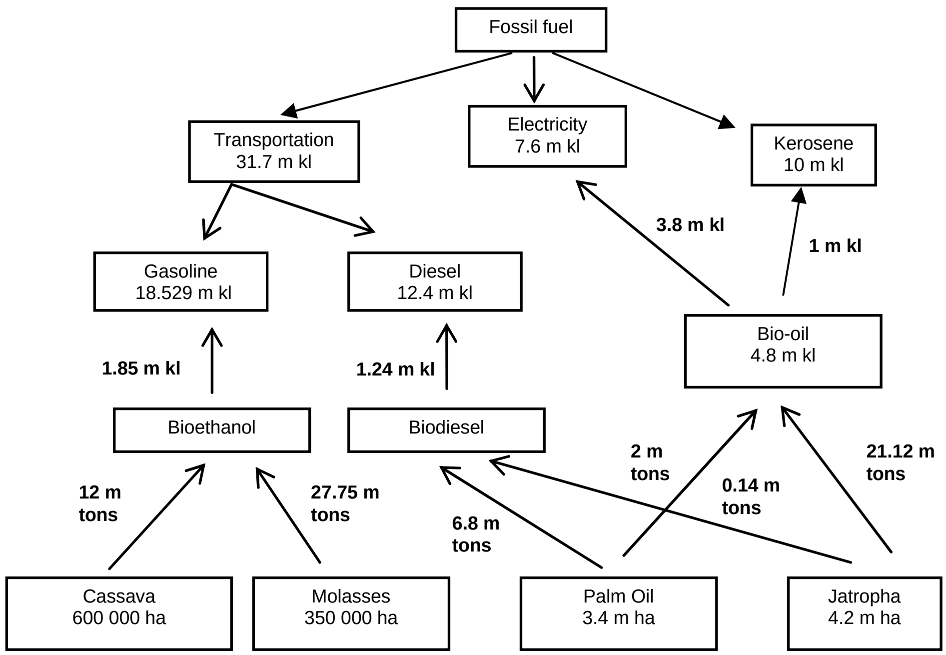
Source: Djaya, 2007.

Appendix 2. Road map of biofuel development in Indonesia

Years	2005-2010	2011-2015	2016-2025
Biodiesel	10% of diesel fuel (2.41 million kl)	15% of diesel fuel (4.52 million kl)	20% of diesel fuel (10.22 million kl)
Bioethanol	5% of premium (1.48 million kl)	10% of premium (2.78 million kl)	15% of premium (6.28 million kl)
Bio-oil:			
. Biokerosene	1 million kl	1.8 million kl	4.07 million kl
. Pure plantation oil	0.4 million kl	0.74 million kl	1.69 million kl
Total Biofuel	2% of energy mix (5.29 million kl)	3% of gasoline (9.84 million kl)	5% of gasoline (22.26 million kl)

Source: Yusgiantoro, 2007.
Note: [a] Pure plantation oil (for power plants).

Appendix 3. Targeted 10% biofuel in 2010



Source: Djaya, 2007.
Note: m kl = million kl; m ha = million hectares.

Appendix 4. Sustainable Development Criteria and Indicators in Indonesia[1]

The sustainable development criteria and indicators for assessing a proposed CDM project in Indonesia are categorized into four groups: environmental, economic, social and technological sustainability. The first three types of criteria concern local impacts of the proposed CDM project; therefore the evaluation boundary is local. Specifically, the scope of evaluation for environmental sustainability is the area having direct ecological impacts from the project. The scope of evaluation for economic and social sustainability is the administrative border of regency. If the impacts cross boundaries, the scope of evaluation includes all impacted regencies. The scope of evaluation for technological sustainability, however, is national.

A proposed project must pass all individual indicators that are applicable in order to be approved. The 'checklist' method is used in the evaluation of CDM projects. A project proponent has to provide an explanation and justification that the proposed project fulfils all the indicators. Wherever possible the explanation in the application form should include a comparison of a) conditions if the project goes ahead to b) conditions if the projects do not go ahead. The supporting data for justification can be qualitative or quantitative. The explanation may also refer to the current regulations related to the indicators, or refer to any supporting documents attached to the application. The Technical Team and Expert Advisor(s) must tick each indicator with 'yes', 'no', or 'not applicable'. The proposed project will pass the sustainability criteria if 'no' is never ticked.

Environment

The scope of evaluation is the area receiving direct ecological impacts from the project.

- Criterion: Environmental sustainability by practising natural resource conservation or diversification
  - Indicator: Maintain sustainability of local ecological functions
  - Indicator: Not exceeding the threshold of existing national, as well as local, environmental standards (not causing air, water and/or soil pollution)

[1] Source: Adopted from National Commission for Clean Development Mechanism (2006), Indonesia.

- Indicator: Maintaining genetic, species, and ecosystem biodiversity and not permitting any genetic pollution
- Indicator: Complying with existing land use planning.

- Criterion: Local community health and safety
  - Indicator: Not imposing any health risk
  - Indicator: Complying with occupational health and safety regulations
  - Indicator: There is a documented procedure of adequate actions to be taken in order to prevent and manage possible accidents.

Economy

The scope of evaluation is the administrative border of regency. If the impacts are cross boundary, the scope of evaluation includes all impacted regencies.

- Criterion: Local community welfare
  - Indicator: Not lowering local community's income
  - Indicator: There are adequate measures to overcome the possible impact of lowered income of community members
  - Indicator: Not lowering local public services
  - Indicator: An agreement among conflicting parties is reached, conforming to existing regulations, dealing with any lay-off problems.

Social

The scope of evaluation is the administrative border of regency. If the impacts are cross boundary, the scope of evaluation includes all impacted regencies.

- Criterion: Local community participation in the project
  - Indicator: Local community has been consulted
  - Indicator: Comments and complaints from local communities are taken into consideration and responded to.
- Criterion: Local community social integrity
  - Indicator: Not triggering any conflicts among local communities.

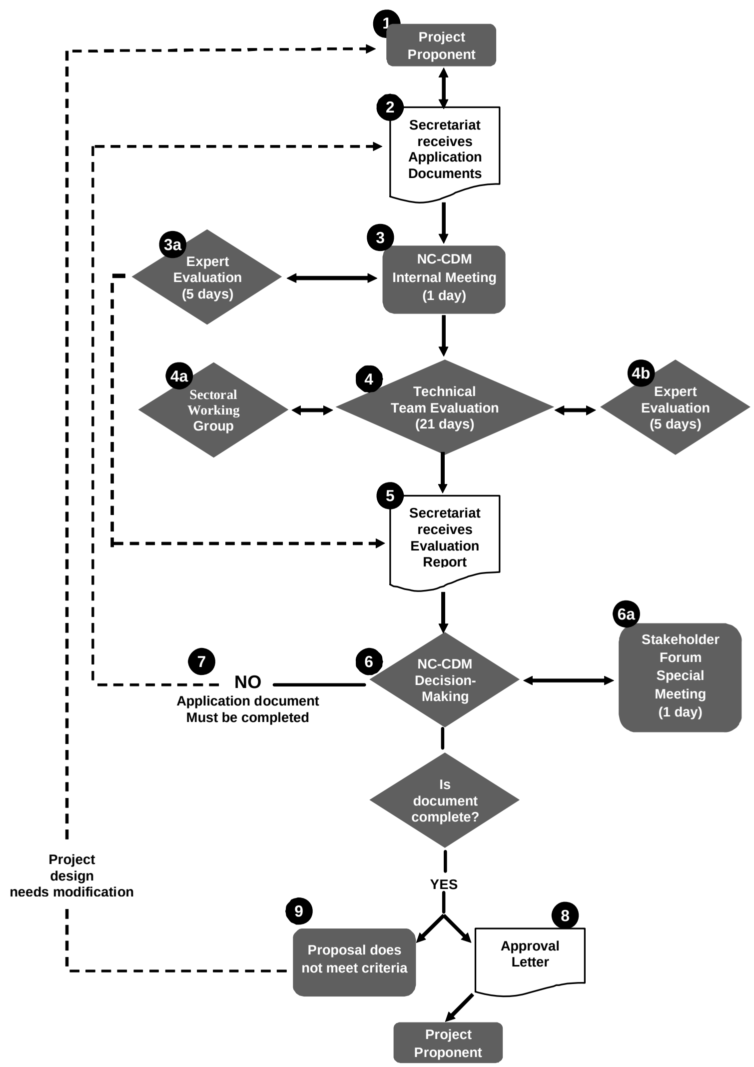
Technology

The scope of evaluation is the national border.

- Criterion: Technology transfer

- Indicator: Not causing dependencies on foreign parties in knowledge and appliance operation (transfer of know-how)
- Indicator: Not using experimental or obsolete technologies
- Indicator: Enhancing the capacity and utilization of local technology.

Flowchart of approval process by the National Commission of CDM



1. A project proponent (or together with a consultant) prepares application documents that consist of: (i) the National Approval Application Form, which includes an explanation about the project proposal's conformability to the criteria of Sustainable Development; (ii) the Project Design Document; (iii) an EIA report (where required); (iv) notes on public consultation; (v) a recommendation letter from the Ministry of Forestry, (only for forestry CDM project proposals); and (vi) other supporting documents to justify the project.
2. The application documents are submitted to the Secretariat to be processed. The Secretariat has to make sure that the application documents are complete. (1) Executive Secretary posts the Project Proposals at the National Commission website to invite comments from the public and stakeholders. Each comment will be posted at the National Commission website.
3. The Executive Secretary submits and presents the Project Proposals that have been received by the Project Proposal Submission closing date, to the National Commission for CDM's Internal Co-ordination Meeting (2). The Internal Co-ordination Meeting last no longer than one day.
   - 3a. If required by the National Commission, the Executive Secretary will assign experts to perform an Additional Evaluation to Project Proposals as a second opinion (2a). Experts should complete evaluations within 5 days.
4. The National Commission assigns members of the Technical Team to evaluate Project Proposals based on Sustainable Development Criteria and Indicators. (3)
   - 4a. If required, the Technical Team members of the same sector as the Proposed Project may take the application document to the Sectoral Technical Team meeting that has been previously established in the relevant ministries (3a).
   - 4b. If required by Technical Team, with the approval from the National Commission, the Executive Secretary will assign experts to assist the Technical Team (3b). If the Technical Team or experts determine that the data given are not complete, they will write a note on the data needed to be completed and attach it to the Evaluation Report to be submitted to the National Commission.
5. The Technical Team submits the Evaluation Report of Project Proposal to the Secretariat to be passed on to the National Commission (4). The Technical Team's Evaluation Report will be posted at the National Commission website.

6. The National Commission receives the Secretariat's report on the results of the Project Proposals Evaluation and stakeholders' comments that are communicated through the National Commission website or sent directly to the Secretariat. After considering all inputs, the National Commission makes a decision whether the Project Proposal will be given Approval or Rejection (5). The National Commission Decision-making Meeting lasts no longer than one day.
   6a. If there is any essential difference of opinion between the stakeholders who are in favour of and those who are against the Project Proposal, through its Special Meeting, the National Commission may hold a Special Meeting of Stakeholders Forum (5a). At the Special Meeting of Stakeholders Forum, the National Commission conveys the controversial Project Proposal and compiles aspiration, support and criticism from participants at the Special Meeting of Stakeholder Forum. The Special Meeting of Stakeholders Forum lasts no longer than one day.
7. If the National Commission cannot give an Approval because of incomplete data in the Project Proposal, according to the note made by Technical Team and Experts, the Project Proponent is given 3 months to resubmit the revised Project Proposal. The Secretariat will process the revised Project Proposal documents with the same procedures for new Project Proposal. However, the Technical Team or experts will re-evaluate only the part of the proposal with the new data. The process of returning the Project Proposal by theTechnical Team or Expert Group to be revised by the Project Proponent, and this may only be done once for every proposal.
8. Secretariat submits National Commission Approval to the Project Proponent. If the Proposed Project does not meet the criteria, it may be resubmitted for National Approval after modification of the project design.

Appendix 5. Project types breakdown into the subtypes (May 2008)

Type	Subtypes used in CDM projects	Number of projects: At validation	Request registration	Registered	Total	MW total
Biomass energy total: **531**	Bagasse power	83	11	67	**161**	3 680
	Palm oil solid waste	22	1	15	**38**	275
	Agricultural residues: other kinds	75	7	58	**140**	1 588
	Agricultural residues: rice husk	58	6	40	**104**	694
	Agricultural residues: mustard crop	2	0	4	**6**	46
	Agricultural residues: poultry litter	1	0	1	**2**	7
	Black liquor	2	0	5	**7**	103
	Irrigation	1	0	0	**1**	0
	Forest residues: sawmill waste	10	1	8	**19**	185
	Forest residues: other	21	1	7	**29**	188
	Forest biomass	7	0	1	**8**	22
	Industrial waste	2	1	0	**3**	32
	Gasification of biomass	6	0	1	**7**	8
	Biodiesel	6	0	0	**6**	0
	Ethanol	0	0	0	**0**	0
Landfill gas total: **266**	Landfill flaring	36	4	45	**85**	3
	Landfill power	51	2	33	**86**	480
	Combustion of MSW	9	0	0	**9**	146
	Gasification of MSW	1	0	1	**2**	6
	Composting	74	1	9	**84**	7.35
Biogas: **391**	Biogas flaring	83	3	111	**197**	0
	Biogas power	310	2	62	**194**	244
Hydro total: **861**	Run of river	397	36	144	**577**	14 138
	Existing dam	29	3	27	**59**	2 501
	New dam	187	17	21	**225**	10 920
N2O total: **59**	Adipic acid	0	0	4	**4**	0
	Nitric acid	23	8	23	**54**	0
	Caprclactam	1	0	0	**1**	0
Solar total: **17**	Solar PV	7	0	2	**9**	20
	Solar water heating	3	0	0	**3**	0
	Solar cooking	3	0	2	**5**	26
EE industry total: **149**	Chemicals	26	1	11	**38**	12
	Petrochemicals	20	1	9	**30**	36
	Paper	7	1	6	**14**	50
	Cement	6	2	5	**13**	0
	Iron and steel	8	0	2	**10**	8
	Machinery	6	0	1	**7**	0
	Textiles	8	0	1	**9**	83
	Electronics	4	0	2	**6**	5
	Food	6	0	1	**7**	1
	Building materials	4	1	2	**7**	0
	Glass	2	0	1	**3**	2
	Non-ferrous metals	2	0	1	**3**	0
	Coke oven	1	0	0	**1**	18
	Mining	0	0	1	**1**	0
	Construction	0	0	0	**0**	0
	Metal products	0	0	0	**0**	0
	Wood	0	0	0	**0**	0

Source: Adapted from CD4CDM, 2008. CDM Pipeline, UNEP/RISOE.

Appendix 6. CDM projects in the pipeline (up to May 2008)

Type	All CDM projects in pipeline		CDM project with CERs issued		
	Projects	Expected kCERs in 2012	Projects	Issued kCERs	Issuance success (%)
Afforestation	4	1 860	0	0	0
Agriculture	172	43 506	38	3 135	45
Biogas	221	54026	6	317	84
Biomass energy	528	172 319	88	8 873	86
Cement	35	34 931	5	781	80
CO_2 capture	1	29	0	0	0
Coal bed/mine methane	51	121 697	1	76	29
Energy distribution	4	1 053	0	0	0
EE households	9	1 436	0	0	0
EE industry	149	30 104	16	587	74
EE own generation	293	247 488	18	7 445	97
EE service	6	301	1	2	63
EE supply side	32	23 854	3	159	93
Fossil fuel switch	114	185 238	11	1 220	86
Fugitive	26	60 426	2	5 039	111
Geothermal	12	13 560	2	125	33
HFCs	19	501 209	14	72 560	104
Hydro	861	381 386	55	4 378	91
Landfill gas	267	249 658	18	3 610	39
N2O	59	254 483	4	27 492	124
PFCs	2	597	0	0	0
Reforestation	14	4 989	0	0	0
Solar	17	2 150	0	0	0
Tidal	1	1 104	0	0	0
Transport	6	3 460	1	59	51
Wind	421	181 079	52	3 562	78
Total	3 324	2 571 944	335	139 420	96.3

Source: Adapted from CD4CDM, 2008. CDM Pipeline, UNEP/RISOE.