

FY2007 CDM/JI Project Research

Feasibility study on Jatropha based biodiesel-fuel production project in Madagascar

Summary

1 Background of planning

It is known well that Madagascar is an island with rich biodiversity, having various climate zones such as savanna and tropical, and having high ratio of endemic species including original monkeys that evolved with great peculiarity. However, by artificial influence for long time, the forest bringing up the biodiversity has been weakened rapidly from the viewpoint of environment, and has been changing to the meadow.

The principal reason of deterioration and decrease of the forest is assumed to be the deforestation for the fuel material and spread of the fire in slash-and-burn farming. ¹

Madagascar does not have enough infrastructures in addition to chronic energy scarcity. And then almost facilities of electricity generation/distribution are old, and cannot fill the electric power demand which has increased in recent years.

The electric power diffusion rate stays in about 21% in whole land. Many electric power generation facilities are already in the saturated condition. Moreover, almost 100% of the oil demand is covered by import, though the oil section plays a big role in the development of the country.

Oji Paper Co., Ltd. is now planning the AR-CDM project in order to secure the resources of the paper manufacture industry in Toamashina state locating in the east part of the country. The project is to produce Jatropha based biodiesel-fuel (BDF) in Madagascar and to supply it to the electricity generation section and oil section of the country as B100 (biodiesel fuel 100%). The plantation of Jatropha is planned to be entrusted to the local farmers, and its area to be the non-forest land excluding from eligibility of the AR-CDM, which is now projected in Madagascar by Oji Paper Co., Ltd.

If the proposed project is implemented together with the AR-CDM project by Oji Paper Co., Ltd., following effects are expected.

- (1) Promotion of industry by both private investment projects
- (2) Synergy effect by the both credit acquisition from exhaust source origin and absorption source origin
- (3) Control of field fire which is now principal cause of deforestation and threatening biodiversity
- (4) Contribution to the country and regional balance of CDM development projects that have concentrated in China, India, and Latin America.

¹ "Renewable biomass plantation in Toamasina province, Madagascar" (Global Environment Centre Foundation FY2003 F/S Report by Oji Paper Co., Ltd.)

2 Details of the project

The project is planting *Jatropha*, harvesting the seeds, and then producing BDF with *Jatropha* oil extracted from the seeds. However, *Jatropha* is a plant which requires about 3 years to have seeds of enough content of oil. Therefore, at first the seeds for squeezing oil are imported. Produced BDF is supplied to the electricity generation plants in and around Toamasina, and is used as B100 there.

The project chart is shown in Figure-1 and BDF production plan in Table-1.

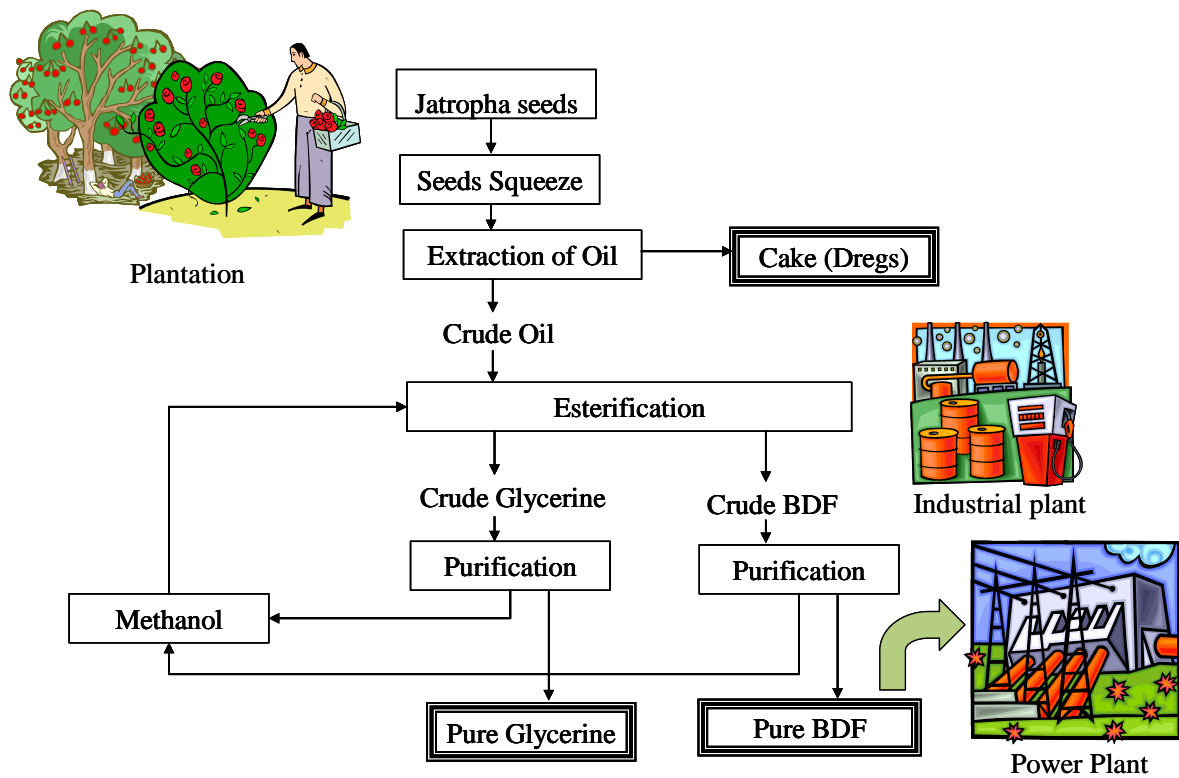


Figure-1 BDF production plan

Table-1 BDF production plan

	Contents	Remarks
Duration of the project activity	15 years	The left figure equal to the depreciation periods of the equipments in the plant
Product	BDF based on Jatropha oil	
Sub-product	Crude glycerine (Purity:80%) and Cake (squeezing dregs of Jatropha oil)	
Raw material	Jatropha seeds	
Production of BDF	The first year : About 10,000 tons/year	
	The 2nd yeat : About 18,000 tons/year	
	The 3nd yeat : About 23,000 tons/year	
	The 4nd yeat : About 24,000 tons/year	
	The 5nd yeat : About 32,000 tons/year	
	The 6th year – the 15th year : About 33,000 tons/year	
Operation time	24 hours (3 shifts/day)	The left shows the value at full operation.(from the 6th year to the 15th year)
Operation days	330 days/year	The left shows the value at full operation.(from the 6th year to the 15th year)
Initial investment	US\$25million	The left shows the value at full operation.(from the 6th year to the 15th year)

3 Sales of products

In addition to BDF, the prime product, crude glycerin and the cake (squeezing dregs of Jatropha seeds) are produced as sub-products in the project. These 3 items are sales products in the project.

Whole quantity of BDF produced in the plant plans to be supplied JIRAMA (JIRO SY RANO MALAGASY: Madagascan electric power and water supply company). The power plants of JIRAMA

where BDF is supplied are assumed total 31 plants located in Toamashina City, outskirts districts of Toamashina City, southeast district of Madagascar, and middle-east districts of Madagascar.

The total capacity of the 31 power plants, the total power generated by them, the total consumption of diesel oil, and the total consumption of heavy oil are estimated at 14, 536kW, 63,067,657kWh, 7,563,168 liter, and 10,024,752 liter respectively. And an amount of BDF necessary for substitution of all of these diesel oil and heavy oil is calculated as 22,368 ton/year.

Glycerin is a chemical used in wide fields such as cosmetics, soap, food, pharmaceutical, cigarette, polyurethane, and alkyd resin. In the project, export for Europe is mainly planned.

The cake from the *Jatropha* seeds contains oil of about 11% and crude protein of 58%-60% (pure protein of 53-55%), and the content of the main amino acid excluding lysine shows higher value than the reference value of FAO². However, the cake from *Jatropha* seeds contains the protein with strong toxicity named Curcin, and is not suitable for feed usage. It can be used for fertilizer or, if its volume is fairly large, steam turbine fuel for power generation. In the project, domestic sale as fertilizer in Madagascar is mainly planned.

4 Procurement of raw materials (*Jatropha* seeds)

It takes 3-5 years to harvest seeds with enough oil content (about 35% of seeds' weight). For earlier operation of BDF plant and earlier supply of BDF, necessary amount of seeds plan to be imported from a foreign country, until the harvested seeds in Madagascar have enough content of oil and necessary all amount of seeds can be procured in Madagascar. The country and region where the seeds of *Jatropha* can be procured in a few years are limited. In the project, import from Myanmar is planned. In Myanmar, plantation of *Jatropha* was begun several years ago and plantation in larger area has been advanced. According to the Ministry of Agriculture and Irrigation, the plantation area of *Jatropha* in Myanmar was already 400,000ha by August, 2006, and 650,000ha by May, 2007. And they scheduled to enlarge it to 1,270,000 ha by the end of 2008, and 2,090,000 ha by the end of 2009.

On the other hand, the plantation candidate sites of *Jatropha* in Madagascar in the project are assumed followings;

- Lowland areas along coast connecting Vatomandry City located in the southwest 150km of Toamashina City with Brickaville City located in the southwest 85km of Toamashina City.

and

- The surrounding area of Lake Alaotra

And the extraction and the verification of the proper plantation land for *Jatropha* were done in both sites.

² FAO : Food and Agriculture Organization

The east coast site has the dilapidation area where tropical forests has been changed to meadow by settlers' deforesting or slash-and-burn farming. Oji paper Co., Ltd is planning AR-CDM project there. Therefore, it is necessary to consider that the proposed project site shall not compete with Oji's AR-CDM project site (project boundary) .

The surroundings of Lake Alaotra in the inland are important as the granary area in Madagascar, while the dilapidation area in it has been expanding due to the soil deterioration caused by deforestation. Therefore, it is necessary to note the land use competition with the farming ground. According to the analytical result, it seemed that Jatropha plantation area required for the project can be secured in the east coast site (Vatomandry City – Toamasina City) and the south part of Lake Alaotra. Especially in the south part of Lake Alaotra, though the close examination including field investigation is necessary, the suitable area for Jatropha plantation seemed to be widely distributed. There is possibility of business development around it.

Figure-2 shows candidate sites' location of Jatropha plantation and BDF plant

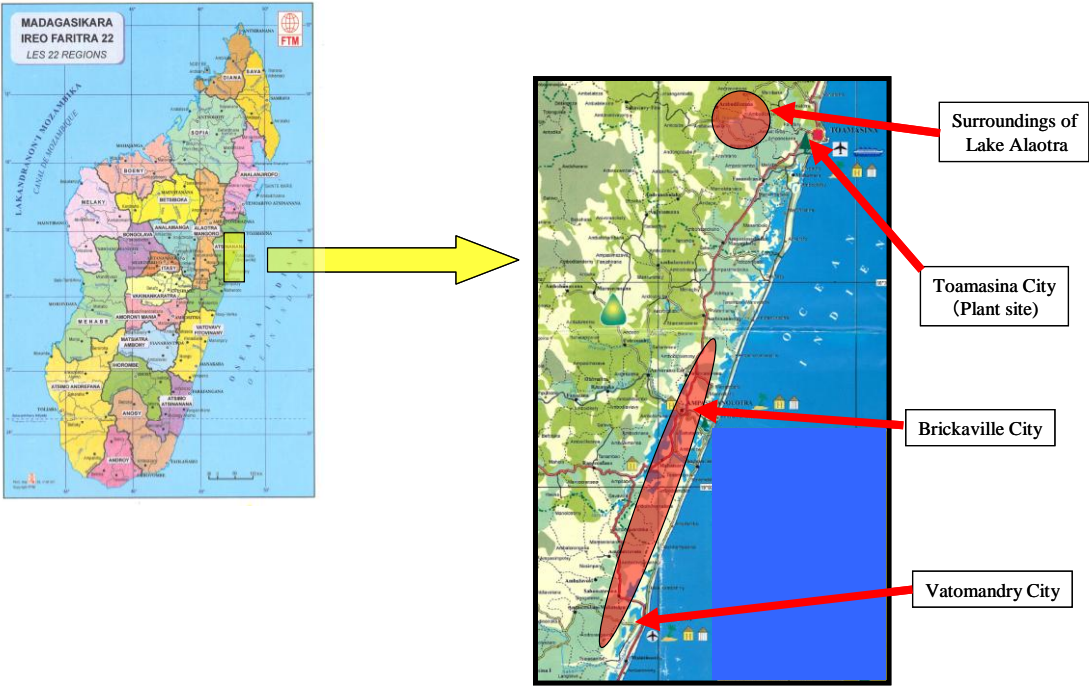


Figure-2 Candidate sites' location of Jatropha plantation and BDF plant

Plantation of *Jatropha* has already started in some countries in Africa and Asia. Since the plantation is easy, general information about its technique is in public. The data and documents about *Jatropha* plantation, which were obtained from BAMEX, the supporting organization for USAID program in Madagascar, have almost the same content as the technical information which has already been in public. In Madagascar, *Jatropha* plantation has just started in 2005, and the information about plantation kind, plantation experience, plantation technique have not been accumulated by the parties concerned. Moreover, the detailed trial calculation data of plantation cost for seedling, plantation, and technique after seedling (maintenance of branches, harvesting of fruits and seeds, fertilizing etc.) was obtained from BAMEX. However, this trial calculation result is only the references, because plantation technique has not been established completely. Therefore, it is necessary for obtaining information about (1) selection of variety, (2) yield of seeds, (3) plantation technique, including selection of the suitable land, to start plantation examination.

5 Procurement of raw materials (Chemicals)

Chemicals necessary for oil squeezing and BDF production are methanol, hydrochloric acid, sodium hydroxide, sodium methylate, activated carbon, phosphoric acid, etc. But methanol is the largest chemical in volume and is used in main chemical react with *Jatropha* oil. Since these necessary chemicals can not be procured in Madagascar, they are imported mainly from South Africa in the project.

6 Analysis as CDM business

6.1 Methodology

The project is CDM project reducing CO₂ emission by utilizing BDF which is produced by the project participants, as electricity generation fuel substitution. Following approved methodology of small-scale CDM project is applicable for the project;

Type: Type (i) – Renewable energy projects

Category: D. – Electricity generation for a system

The BDF plant scheduled to be constructed in Toamasina City. Considered the transportation distance, power plants for sales are selected as follows;

- Diesel power plants belonging to Toamasina interconnected electric system
- Diesel power plants of micro grids in the districts called R2, R4, and R0 (around Toamasina City, south-east district of Madagascar, middle-east district of Madagascar respectively)

The total capacity of the selected diesel power plants is 14.536MW and it meets the requirement of 15MW or less, which is regulated by the above-mentioned small-scale methodology.

6.2 Baseline emissions

The amount of the baseline emissions in the electric power system multiply the annual total amount of electricity generated at power plants (kWh) by the carbon emission factor for the grid. And the amount of the baseline emissions in micro grid multiply the annual electricity generated at respective power plants (kWh) by the respective approximative carbon emission factor of diesel power generating plants. As a result, the amount of the baseline emissions is 25,846 tCO₂e /y.

6.3 Project emissions and Leakage

The following three points were verified about the amount of the project emissions;

(1) Emissions by electricity consumption in project site

In the project, electricity is purchased from an electric grid in Toamasina region, where the BDF plant schedule to be constructed. Since the thermal power plants in Toamasina region are the objects of the project, the amount of their electricity generation is substituted by BDF. Therefore, the carbon emission factor for the grid in Toamasina electric system becomes zero, and the amount of the emissions by electricity consumption in project site become zero.

(2) Emissions by fossil fuel consumption

Since the amount of heavy oil consumption in project site is about 1,800 ton/year (estimate), the emissions by fossil fuel consumption are estimated as 5,629 tCO₂e /y.

(3) Emissions by the increase of transport of fuel to power generation plants

Because it was difficult at this FS stage to check with present transport frequency of fuel about all the object electricity generation plants, prior presumption was not done. When the project is executed, transportation frequency is monitored and the emissions by the increase of transport of fuel are calculated.

Regarding leakage, GHG emissions by fertilizer and land creation are verified. From the above-mentioned 6.2 and 6.3, the total of project emissions are calculated as 16,825 tCO₂e /y.

6.4 Monitoring plan

Monitoring plan of the project shows on Table-2.

Table-2 Monitoring plan

Data/Parameter	Unit	Description	Source of data to be used	Measurement method	Frequency
EGm,y	kWh	Amount of electricity generated at power plant in micro grid using BDF	Flow meter	Mesurement	Continuously
VOLBDF,y	tonne	Amount of BDF input for power generations	Flow meter	Mesurement	Continuously
SFCBDF	kg/kWh	Fuel consumption per unit of electricity generated	Determination in lab	Mesurement	Before crediting period
EGPJ,FF,y	MWh	Amount of electricity consumed from the grid	Electricity meter at BDF plant	Mesurement	Continuously
CEFelec	tCO2/MWh	Emission factor for electricity consumption	JIRAMA's official utility documents	Calculation by the methodology	Before crediting period
Fcons,y	kL or ton	Fuel consumption in plant	Purchase invoices	Keep purchase invoices	Annually
NOvehicles,y	number	Number of additional vehicles for transport compared to baseline	Record of a transportation company	Mesurement	Annually
DTy	km	Average distance travelled for additional BDF transport	Expert estimate based on the record of a transportation company	Calculation	Annually
VFcons	l/km	Vehicle fuel consumption in litres per kilometre	Fuel consumption record of a transportation company	Mesurement	Annually
MSFi,t	tonne	Mass of synthetic fertilizer	Delivery statement	Keep record of quantities purchased and/or used	Annually
MOFi,t	tonne	Mass of organic fertilizer	Delivery statement	Keep record of quantities purchased and/or used	Annually

6.5 Duration of the project activity / Crediting period

Duration of the project activity is assumed 25 years including factory construction period, crediting period is assumed 10 years without extension update.

Since Jatropha requires about 3-5 years to have seeds of enough content of oil, at first, the seeds for squeezing oil are imported in the project. Since, it is difficult to verify that import of Jatropha seeds in the project does not cause the increase of GHG emissions in export country, the substitution of fossil fuel by BDF produced from the imported Jatropha seeds (from the 1st year to the 3rd year of BDF production) is removed from the object of crediting.

7 For the implement of the project

7.1 Economy Analysis

Internal return of return (IRR) under the precondition was shown in Table-3.

Table-3 Internal rate of return (IRR) of the project

Emissions reduction trading value	Internal Rate of Rreturn (IRR)
In case of no value	13.84%
In case of US\$ 5/tCO ₂ e	14.01%
In case of US\$10/tCO ₂ e	14.19%
In case of US\$15/tCO ₂ e	14.36%
In case of US\$20/tCO ₂ e	14.54%
In case of US\$25/tCO ₂ e	14.57%

As shown in Table-3, in case the emission credit is not admitted, the value of IRR is insufficient for investment, considering that price of raw materials and products may fluctuate by exchange rate of local currency (Ariary). In case the emission credit is admitted and its sales price ranges from S\$15/tCO₂e - US\$20/tCO₂e or more, the project enters the category to be examined as an investment project.

7.2 Issues and tasks for project implementation

In the present stage, it is difficult to implement the project immediately, because there are issues and tasks should be overcome or settled. Issues and tasks and their solution are as follows;

(Procurement of raw materials (Jatropha seeds) and Jatropha plantation)

Regarding procurement of Jatropha seeds from Myanmar in the project, since the situation of Jatropha plantation and the details of its plan in Myanmar have not been checked on the site yet, it is required to visit there for checking them and to negotiate about procurement of Jatropha seeds with the government.

Regarding Jatropha plantation in Madagascar, it is necessary to explain enough to some villages the outline of the project, feature of Jatropha, plantation method, fertilizing method, seed-harvesting method, cost, and the merit for villages etc., and to obtain their understanding and consent. Moreover, it is necessary to plant Jatropha systematically with cooperation of plural villages, and a Japanese plantation leader is

indispensable to do the plantation work in Madagascar. First of all, small-scale model business should be started with the dispatch of a Japanese plantation leader for future establishment of plantation technique.

(Sales of products)

From the viewpoint of commercial profitability, the plant scale is assumed as 33,000 tons /year of BDF production capacity in the project. On the other hand, about 26,000 tons/year of BDF are projected to be supplied to 31 electricity generation plants of JIRAMA. Therefore, 7,000tons/year remains. It is considerable to supply it ;

- Electricity generation plants of JIRAMA other than the assumed 31 plants
- Specific transport company
- General diesel-cars

However, it will be necessary to examine whether those should be CDM projects, and whether those are approved as CDM projects by checking with the approval situation of the methodology of biofuel use for transportation.