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Arab Republic of Egypt
Ministry of Trade and Industry

Arab Republic of Egypt
Egyptian Biofuel Industry Development Study

FINAL REPORT

March 2010

Japan International Cooperation Agency (JICA)

Japan Development Institute (JDI)

Arab Republic of Egypt
Ministry of Trade and Industry

EGYPTIAN BIOFUEL INDUSTRY DEVELOPMENT STUDY

- Competitive Commodity from Sun and Wastewater -

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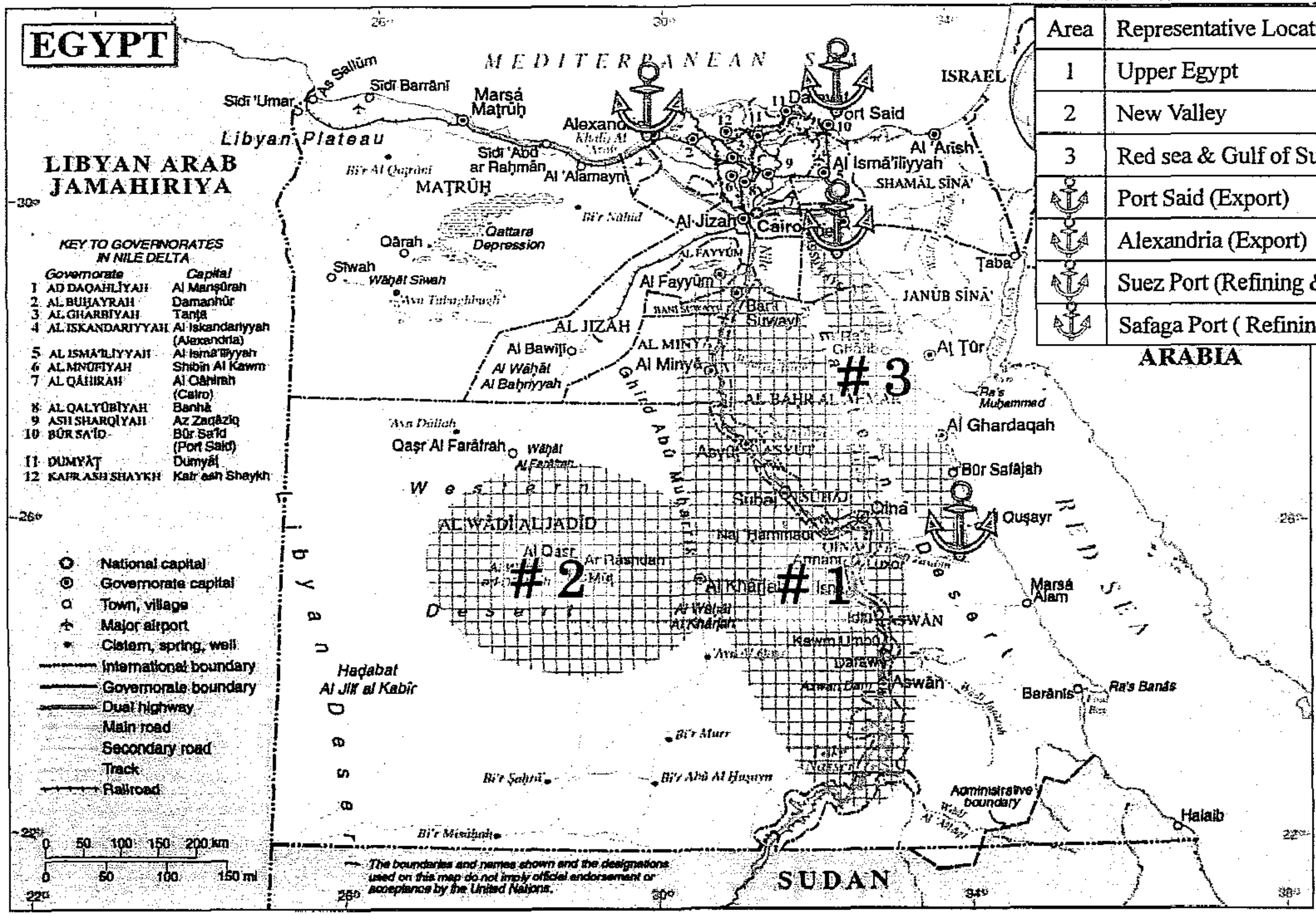
Exchange Rate (As of December, 2009)
USD 1.0 = EGP 5.5



Area	Representative Location
1	Upper Egypt
2	New Valley
3	Red sea & Gulf of Suez coast
(anchor)	Port Said (Export)
(anchor)	Alexandria (Export)
(anchor)	Suez Port (Refining & Export)
(anchor)	Safaga Port (Refining & Export)

Map. 1 Study Area and the Potential Focused Area for Jatropha Biofuel Industry Development

Preface

"Change" is the most symbolic word for the world situation for the recent years. Knowable financial crisis followed by the historical recession might help people shake their conservative mind of "Protecting/Maintaining present condition." The problem was NON SUSTAINABLE economic model that had been far from real world. One of the most symbolic events could be the U.S. president Obama's election in 2008 and his Nobel Prize in 2009. Though there are numbers of criticism against the president's performance, his successful achievement would be "Giving hope for people, change people's mind and let the people participate the change." Hope/willingness is certainly the power of solving problems and achieving goals.

It is also the time for change in Egypt to realize a competitive and environmentally sound industry in the world. Egypt has uniquely proved the practical and effective use of wastewater for valuable commodity production in the non-arable land for a while. As strategic "Water resource management", the wastewater application for energy crop production was a successful practice. However, it has not reached the reliable level of practices for "Alternative energy production." As the global consensus of "No-competition" against food production, *Jatropha curcas L.* has been one of the most popular options of the biofuel feed for the sustainable energy solutions for last 10 years. Public and private sectors have intensively worked on the development of "Economically viable" Jatropha supply chain model and have yet reached such level in the world.

Egypt has been one of pioneers working on Jatropha industry development, but Egypt is the only country applying treated wastewater and proves highest level of seed productivities and no-competition against food production. Many stakeholders, especially public sectors involved in wastewater, agriculture and environment, and international and Egyptian privates have discussed the opportunities of the actual implementation yet reached the reliable solutions for a long time. It is good time for all stakeholders to move forward with practical and reliable strategies rather than continuous talks.

Japan International Cooperation Agency (JICA) has recognized the uniqueness of the Egyptian model and potentiality of the economic benefits, especially for job creation, wastewater management and an alternative energy source for Egypt since 2007. JICA has also supported Egyptian authorities to promote the Jatropha based industry development with a study on biofuel industry development (Appendix A3) with workshop in 2007 and renewable energy seminar in 2008. In addition, JICA has seen the needs for innovations to realize such unique opportunities. With the cooperation of Ministry of Trade and Industry (MTI), Egypt, JICA decided to review the potentiality of the "Egyptian Jatropha Biofuel Industry Development" and consider the potential field of assistance for government of Egypt.

Based on the familiarity of Jatropha business development and contribution for the JICA biofuel study in 2007, JICA appointed Japan Development Institute (JDI) to study the existing condition of Jatropha practices in Egypt and propose the smart strategies for the Jatropha biofuel industry development. JDI dispatched three study missions from August to December 2009 with four experts in this field:

(1) Dr. Shoichi KOBAYASHI, JDI: Team leader and strategic development advisor
(2) Prof./Dr. Takashi TATSUMI, Tokyo Institute of Technology: Biofuel standardization expert
(3) Eng. Hiroshi OTANI, JDI: Biofuel policy expert
(4) Eng. Shinya NAGAOKA: Biofuel committee mobilization & biofuel industry development

Throughout intensive hearing with present and potential stakeholders and field observation, we confirmed the tremendous opportunities and needs for good guidance for Egypt. Under the serious regulation on EU's GHG emission (ref. section 2) and discussion against climate change abatement at Copenhagen (Appendix A6) and aviation sectors serious intention (Appendix A7 and A8), we recognized the "Bio-jet fuel" is the best available option for "Egyptian Biofuel Industry Development" model. In order to realize such goal, there are numbers of key challenges to overcome.

In this report, we provide reality of the existing Jatropha practices and potentiality of Jatropha biofuel industry development in Egypt from chapter I to III and point out the key challenges to overcome and propose potential strategies in chapter IV. We sincerely hope that this study help government of Egypt and JICA make a decision for the next steps toward Egyptian Jatropha biofuel industry development, especially for a detail feasibility study on the nationwide program development with the intergovernmental communication and the immediate need for yield improvement that is the most critical bottleneck for the industry development at this moment.

Lastly, we deeply appreciate Dr. Mohamed Hany Barakat, First Under Secretary, MTI for the full support of the JICA study team and his warm hospitality. We also appreciated Dr. Ahmed Fouad Mandour, Executive Director of FTC, MTI for his practical and precise advices as well as clever management of the round table discussion among stakeholders at the end of JICA study. Engineer Ali Omar. Asal, the director general of Afforestation and Environment, Egyptian Ministry of Agriculture and Land Reclamation, is another most appreciated officer for his generous and extensive support for this study. We also like to express our appreciation for Engineer Mamdouh Ismail Raslan, vice chairman of Holding Company for Water and Wastewater, for his sincere understanding and support for JICA study team. Lastly, we sincerely appreciated Engineer Emad Hassan, a consultant of Supreme Council of Energy, for his keen interests to explore the Jatropha biofuel possibility and invaluable advices to the JICA study team. We also thank other officials and private businesses to support for this study. Without their support, we could not reach the reality of the Egyptian potentialities and provide our strategies.

Sincerely Yours
1st, March 2010

Shoichi Kobayashi,
Chairman, Japan Development Institute

CONTENTS

LIST OF TABLES

LIST OF FIGURES

Abbreviation

ARC	Agricultural Research Center
BDF	Bio Diesel Fuel
COP	Conference of Parties, UNFCCC
EEAA	Egyptian Environmental Affairs Agency
ECHEM	Egyptian Petrochemicals Holding Company
EGAS	Egyptian Natural Gas Holding Company
EOJ	Embassy of Japan
EU	European Union
FAO	Food and Agricultural Organization of the United Nations
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GHG	Greenhouse Gas
HCWW	Holding Company for Water and Wastewater
IATA	International Air Transport Association
IPCC	Intergovernmental Panel on Climate Change
ICAO	International Civil Aviation Organization
IEA	International Energy Agency
Jatropha	Jatropha curcus
JICA	Japan International Cooperation Agency
JDI	Japan Development Institute
JV	Joint Venture
LE	Egyptian Pound
MCA	Ministry of Civil Aviation
MTI	Ministry of Trade and Industry, Egypt
MALR	Ministry of Agriculture and Land Reclamation, Egypt
MALR/AE	Department of Afforestation and Environment, MALR
MHES	Ministry of Higher Education and State Ministry for Scientific Research
MOEE	Ministry of Electricity and Energy
MOF	Ministry of Finance, Egypt
MOH	Ministry of Housing, Utility and Urban Development, Egypt
MOP	Ministry of Petroleum
MOU	Memorandum of Understanding
MSEA	Ministry of State for Environment Affairs
MWRI	Ministry of Water Resource and Irrigation
NRC	Natural Research Center
NWRP	National Water Resources Plan
ODA	Official Development Assistance
O&M	Operation and Maintenance
PPP	Public and Private Partnership
RLC	Robbiki Leather City
SUTSWA	Safe Use of Treated Sewage Water for Afforestation
UNFCCC	United Nations Framework Convention on Climate Change

Executive Summary

I. Egyptian Potentiality for Bio-Jet Fuel

Objective of the Study and Background Information

The principal objectives of the "Egyptian Biofuel Industry Development Study" are to examine the reality of the *Jatropha curcus*, an inedible biofuel feed, cultivation practices irrigated by treated wastewater in Egypt as well as potential development strategies for Egyptian Jatropha biofuel industry development and its potential field of JICA assistant for government of Egypt. JICA has recognized the potentiality of "Biofuel industry development in Egypt. In order to analyze the potentiality of the Jatropha industry development and possible assistance for its realization, JICA appointed JDI to analyze the reality on the ground, realistic potentialities and possible strategies for government of Egypt.

This study covers the following topics with updated information and experts' explanations:

I. Egyptian Potentiality for Bio-Jet Fuel
II. Facts of Jatropha Investment Environment in Egypt
III. Cost Analysis of Egyptian Model
IV. Challenges and Recommendations

Fresh water security has been one of the most important national strategies in Egypt. As a smart strategy to avoid the contamination of the Nile River and provide valuable products from the wastewater resource, three responsible ministries (Ministry of Agriculture and Land Reclamation (MALR), Ministry of Housing, Utilities and Urban Development (MOH), and Egyptian Environmental Affairs Agency (EEAA)) started a joint program known as "Safe Use of Treated Sewage Water for Afforestation (SUTSWA program)." The SUTSWA program successfully promoted the valuable use of wastewater by producing artificial forest for anti-desertification, greening, and wood sales as well as oil crop production such as Jatropha and Jojoba. Sustainable energy security is another serious matter that the government of Egypt has been extensively working on. Now, the government pays keen attention to the "New and renewable energy" and Jatropha has become one of potential candidates for an energy security measure and for effective and sustainable wastewater management measure. As a result of the government's attention on the Jatropha, many stakeholders both public and privates have had a lot of talks but few actual trials have been made on the ground due to the unfamiliarity of the Jatropha business models and numbers of failures in Asia and other African countries.

Call for Sustainable Biofuel Development in the World

Although the food supply was enough level in 2008, expectation in the biofuel investments led the historical hype of the food prices. EU has been seriously considering the restriction of "Edible oil use" for the biofuel production for the responsible action to avoid such unfavorable competition between not only food and energy security but also developing countries and industrialized countries that had been aggressively promoting biofuel as their "Sustainable energy" strategy.

Emergent Demand for Bio-Jet Fuel for the EU's Regulation

As the leading environmentally countries, EU has been aggressively making efforts to reduce green house gasses (GHG) to minimize the advice effects from the climate change. For the responsible actions, EU has strictly put restriction of the GHG emission, known as CAPPING, which regulates a company's maximum GHG emission. In case the company's activities would exceed the allowance/CAPPING, it needs to reduce GHG emission by introducing less GHG emitting technologies or simply purchase the emission allowance under the EU emission trading scheme (EU ETS). EUETS could not include the aviation sectors in the initial (2005-2007). Though EU could not put this restriction by 2011, but aviation sectors were finally agreeable to participate EUs efforts from 2012, at the last period of the second EU ETS period between 2008-2012, known as NAP 2. As the official decision and inclusive of the aviation sectors, EU commission declared the amendment of the 2003/87/EC to include aviation activities in the scheme for GHG emission allowance trading within the Community (DIRECTIVE 2008/101/EC) in November 2008.

DIRECTIVE 2008/101/EC to Include Aviation Activities in the EU GHG Reduction Mechanism

The Directive 2008/101/EC decided, among others, the following provisions:

- In order to avoid distortions of competition and improve environmental effectiveness, emissions from all flights arriving at and departing from EU airport shall be included into the scheme from 2012.
- For the period from 1 January 2012 to 31 December 2012, the total quality of allowance to be allocated to aircraft operators shall be equivalent to 97% of the historical aviation emissions.
- For the period from 1 January 2013 and after, the total quantity of allowances to be allocated to the aircraft operators shall be 95% of the historical aviation emission.
- The Commission shall review the total quantity of allowances to be allocated to aircraft operators. The percentage of allowances to be allocated to aircraft operators may be changeable in the future
- Of the total quantity of allowance allocated to aircraft operators, 15% of allowances shall be auctioned. This percentage may be increased as part of the general review of the Directive.
- If aircraft operators could not meet with the requirements, the excess mission penalty shall be EUR 100 for each tone of carbon dioxide emitted for which aircraft operators has not surrendered allowances.

At this moment, there are only three (3) possible options available to comply with EU regulations. The first option is to improve energy efficiency of aircraft operation. The second option is to use sustainable biofuel. Then, the last option is to purchase certified carbon credits such as EUETS emission reduction unit (ERUs) of EU Emission Trading Scheme or certified emission reduction (CER) of Clean Development Mechanism (CDM) from the market.

COMMISSION REGULATION (EC) No.748/2009 is the official notice of potentially regulated aircraft. operators under the Directive 2008/101/EC from 2012. This list lists only registered companies by the time the registration was finalized so that any commercial operation, even its not listed at this moment, shall be subject to follow the Directive 2008/101/EC. With the discussion with representative of Ministry of Aviation, only EGYPTAIR and EGYPTAIR CARGO have scheduled and non schedule flights for EU at this moment though there are 26 companies listed in the EC No.748/2009.

EU Jet Fuel Market

Unlike stationary power units, transport and agricultural sector heavily depend on oil due to the requirement of movability-high energy density. In the case of aircraft, jet fuel is the only option for practical operations.

Trend and Historical Demand

Based on the historical record of the jet fuel consumption in EU countries, the consumption of the energy has continuously increased as EU's economic growth. Considering the consumed jet fuel in EU (27 countries) in 2007, it has reached 53 million tons/y.

Assumption of Jet Fuel Price in 2020

In case of the successful implementation of Jatropha biofuel supply chain development in Egypt, 2020 is the earliest possibility to commercially produce bio-jet fuel with the professional judgment. Due to the historical crude oil price and jet fuel prices, the future jet fuel price could be calculated by future crude oil price as follow. We assumed the jet fuel price in 2020 from the most recognized future crude oil price by International Energy Agency (IEA) and IATA's historical records. We assumed the expected jet fuel price is US$124/bbl or US$960/t in 2020.

Assumed Future Crude Oil Price and Expected Jet Fuel Price

	2015	2020	2030
World Energy Outlook 2009 crude oil price per barrel			
WEO2009/ Real Basis (2008US$)	87	100	115
WEO2009/ Nominal (US$)	102	131	190
Implied Jet Kerosene Price: 124%* of crude oil price/bbl			
Real Basis (2008US$)/bbl	108	124	143
Nominal (US$)/bbl	126	162	236
Implied Jet Kerosene Price: 124%** of crude oil price/t**			
Real Basis (2008US$)/t	750	860	990
Nominal (US$)/t	900	1,100	1,600

Source: IEA WEO2009, *IATA Economics,** Jet Kerosene (0.8kg/litter), Crude oil (0.9kg/litter)
***1.0 bbl=159litter

Assumption of Bio-Jet Fuel Price and Its Market in EU in 2020

Considering the price of the bio-jet fuel in 2020, we assumed the additional value of the bio-jet fuel. Since the bio-jet fuels is expected reduce lower carbon emissions, we counted the value of the reduced carbon emission. Though it is hardly to generalize the GHG reduction of a bio-jet fuel due to the variety of the production processes and their GHG emissions, we assumed a reasonable CO_2 reduction by the experience of the Japan Air Line's Jatropha bio-jet fuel flight (2 ton-CO2e/t-jetfuel). Additional value of the bio-jet fuel can be defined by the following equation Eq.(1). Considering the expected bio-jet fuel price in 2020, it is calculated by the Eq. (2) .

Additional value of the bio-jet fuel (US$)
= 2 (CO_2/t-jetfuel) x Weight of consumed bio-jet fuel (ton) x Price of CER/ERU (US$ /CO_2e)- Eq.(1)

Bio-jet fuel price-2020 (US$960/t)
= expected jetfuel-2020 (US$860/t) + CO2 premium-2020 (50 US$/t-$CO_2$ x 2 t-CO_2) Eq.(2)

Expected CO_2 Price and Bio Jet Fuel Price in 2020

	2008	2015	2020	2030
Implied Jet Kerosene Price: 124%* of crude oil price				
Real Basis (2008US$/t)		750	**860**	990
Nominal (US$/t)		900	1,100	1,600
Implied CO2 Price and Bio-Jet Fuel Price				
Average CO_2 reduction (t-CO_2/t-fuel)*	2	2	**2**	2
CO2 Price (2008US$/$CO_2$-t)**	20	N/A	**50**	110
Expected CO2 Premium (2008US$/t-fuel)	40	-	**100**	220
Assumed Price of Bio Jet Fuel Price (2008US$/t-bio-jet fuel)	-	-	960	1,210

*Source: * JDI's assumption for expected CO2 reduction,** IEA WEO2009,*

Considering the minimum requirement in EU with the mandate 5% reduction of CO2 (ref. section 2) and the latest available jet fuel demand in EU (Table. 3.2), the expected minimum market will exceed 2.7 million t-bio-jet fuel/y and US$2.6 billion. The basis of such calculation is as follow.

Minimum bio-jet fuel market in EU (2.7 million t-bio-jet fuel/y)

= jet fuel consumption in EU in 2007 (5,3414 t-jet fuel/y)* x 5% Eq.(3)

* due to the same level energy density of bio-jet fuel 1 ton of jet fuel can be replaced by 1 ton of bio-jet fuel

Scale of the Minimum bio-jet fuel market in EU (US$2.6 billion)

=2.7mil t-bio-jet fuel/y (Eq.3) x US$960/t-bio-jet fuel (Eq.2)

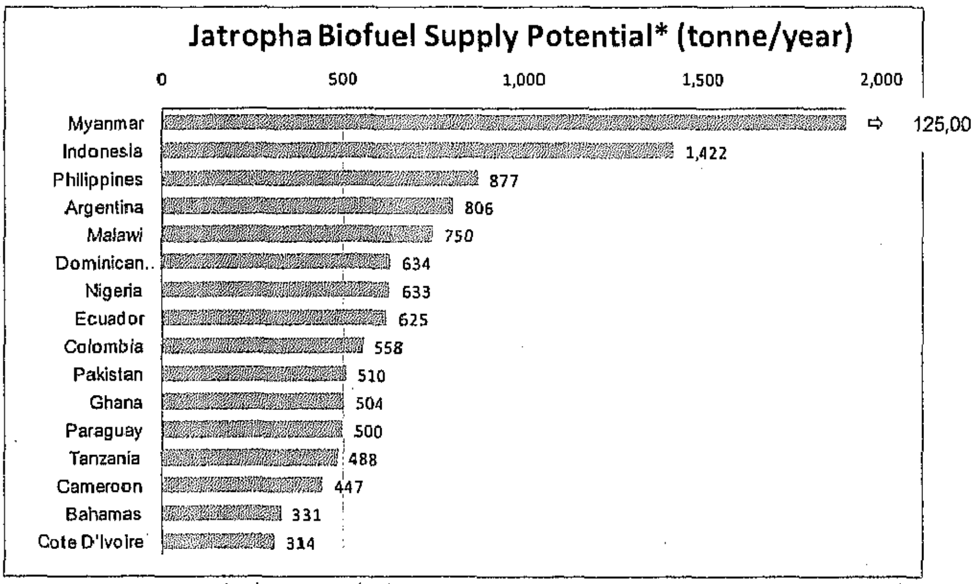
Advantage of Jatropha Biofuel and Its Supply Capacity

As describe in the section1, EU has started the consideration of restricted use of "Edible oil" for biofuel production in case it adversely affects the security of food and affordability of the food for the consumers, especially in developing countries. As one of few alternative options to produce biofuel feeds without competition, Jatropha has numbers of recognized advantages despite its commercializing stage.

Reality of Jatropha Supply Chain and Biofuel Supply Capacity

Jatropha has been seriously considered as a LOW COST biofuel feed in the world, especially in EU to practically and sustainably proceed with their aggressive biofuel policies. As a commercial business operation, Jatropha received serious attentions from the biofuel producers as the alternative biofuel feeds. Due to its "Inedible" characteristics and potentiality to cultivate in non-arable/waste land, it was even more attractive for both biofuel feed buyers and investors into Jatropha plantation businesses. However, mainly due to the immaturity of Jatropha business model, few commercial plantations have actually made profits from their operation.

Considering the "Reality of Jatropha supply chains and biofuel supply capacities", it is hardly to find the realistic situation and capacities due to the privates' investment activities. Based on a global Jatropha database, there are 150 thousand Ha plantations are registered. Expected size of Jatropha plantation in 2012 will be 3,871 thousand Ha. Also, based on the Ministry of Agriculture and Forestry, Myanmar (Burma), the planted area has reached roughly 5 million feddan (2 million Ha) in 2009. With the assumed average yield and oil extraction rate, we assumed the theoretical supply capacity of the Jatropha biofuel from the Jatropha planted area.



* Biofuel Potential (t/y) = Area (ha) x Average Yield** (0.25 t/ha) x OER (25%***),
** Seed yield highly depending on plantation condition and management, typically 0.25t/ha level by historical records, we assumed 0.25t/ha
*** OER depending on oil content of the seeds and oil expeller, typically high OER in commercial operation, we assumed 25%

Source: Jatropha book, JDI(Myanmar and biofuel potentiality calculation)

Theoretical Capacity of Jatropha Biofuel Supply in the World

Theoretically, the world Jatropha biofuel supply capacity would be 134 thousand (t/y) comprised of 125 thousand t/y by Myanmar (93%) and 9.4 thousand by the rest of the world (7%). Although there are tremendous numbers of Jatropha trees in Myanmar, it is not an economically viable price level at the oil extraction factories outside of Myanmar as of December 2009 due to logistic costs and other *transaction difficulties* (JDI).

Potentiality of Egyptian Jatropha Biofuel Supply Capacity

Availability of the treated wastewater is the limitation factor of Jatropha cultivation in Egypt. We assumed the potentiality of the Jatropha plantation from the HCWW's master plan on wastewater treatment by 2017. With presently available wastewater in Upper Egypt and present yield of Luxor level, potential production of the Jatropha biofuel is 135,000 ton/y. With the potentially available wastewater by 2017 (284 million m^3/y) and higher yield with higher OER (25%), the potential production of the biofuel would reach 1,944,000 ton/y, which is 105% of imported diesel fuel and 118% of sum of domestic and international jet kerosene consumption in Egypt 2007.

Availability of Treated Wastewater and Potentiality of Jatropha Biofuel Production in Upper Egypt

		Actual	Design Capacity	Condition
Fayum	1,000 m3/d	NA	68	
Mniya	1,000 m3/d	NA	110	
Asyut	1,000 m3/d	57	472	
Suhaj	1,000 m3/d	76	292	
Quina	1,000 m3/d	158	325	
Luxor	1,000 m3/d	35	56	
New Valley	1,000 m3/d	15	78	
Awswan	1,000 m3/d	106	153	
Total Wastewater in Upper Egypt	million m3	163	567	
Available for Jatropha cultivation	million m3	82	284	50% of Wastewater
Jatropha watering	litter/year	365	365	
Maximum Jatropha Trees	million trees	224	777	
Maximum Jatropha Plantation	feddan	487,500	1,690,000	2.5 feddan/ha
Seed Production-Present Potential	tonne	673,000		1.38 t/feddan
Seed Production-Future Potential	tonne		7,774,000	4.6 t/feddan
Biofuel Production-Present Potential	tonne	135,000		20% of seed weight
Biofuel Production-Present Potential	tonne		1,944,000	25% of seed weight
Oil Sales-Present Potential	Mill USD/y	108		800 US$/t-biofuel
Oil Sales-Future Potential	Mill. USD/y		1,555	800 US$/t-biofuel
Oil Sales-Future Potential	Mill.LE/y		8,553	5.5 LE/US$

Source: HCWW (wastewater capacity), JDI (the rest of the calculation and assumption)

Potentiality of Egyptian Jatropha Business Model

Egypt is the only country applying treated wastewater and has showed potentiality of multi beneficial business model for sustainable economic development. Though the Egyptian model has yet reached economically viable model, its remarkable benefits have been proven by an advanced wastewater management program known as "Safe Use of Treated Sewage Water for Afforestation (SUTSWA)." Summary of the Potentiality of Egyptian Jatropha Business Model are shown in the following tables.

Advantage of Egyptian Jatropha Model

Advantage	Remarks
1. 365 days-availability of SUN	● One of three most important components for "Competitive yields" ● Directly affect the yields
2. Reliable availability of nutrient rich water	● One of three most important components ● Stable wastewater supply from treatment facilities
3. Abundant availability of NON arable land	● One of three most important components ● Over 90% of the Egyptian land kept unused ● *Typically the hardest part of the business model*
4. Competitive access to EU market	● The most profitable market for Egyptian biofuels ● Enabling low cost shipping and enjoying higher profitability
5. Availability of conventional refineries *and skilled engineers*	● Two of the most important factors to produce bio-jet fuels ● Typically limited availability in developed or oil rich countries rather than biofuel feed producing country
6. Availability of Large Scale Non Arable Land	● Typically the most critical bottleneck in industrializing Jatropha bio energy in other countries ● While in Egypt, abundant availability of *considerably large scale non-arable land*
7. Availability of competitive logistics network (road, rail, & waterway)	● Fundamental of the competitive business model ● Basis of the low cost production and high profitability ● Not the case in ecologically/potentially suitable Asia and African country

Potential Benefits on Egyptian Economy

Potential Benefits	Remarks
1. Sustainable energy source from sustainable wastewater and abundant non-arable land	● A renewable energy source for Egyptian energy security measure ● Effective wastewater management for sustainable environmental management ● Profitable use of unused or/and non-arable land
2. Competitive NON-OIL exporting commodity	● Alternative competitive exporting product of Egypt for the future ● Diversification of Egyptian economic model
3. Technical transfer in agribusiness and biofuel industries	● Strategic technology development for maintaining competitiveness in the global market ● One of the key sectors of global needs
4. Creation of skilled and unskilled jobs	● Good opportunity for rapidly glowing young people and unskilled elder persons heavily *depending on governmental subsidies or fupports* ● Effective distribution measure for substantial need creation outside of the Nile delta
5. Sustainable wastewater management	● Effective measure for improper use or illegal dumping in freshwater sources such as the Nile and agricultural drainage ● Potential source for sustainable tariff structure
6. Good FDI & DDI opportunity for PPP projects	● Widely used and practical measure to meet public needs with privates' power ● One of the most popular sectors for investment

Suitability of Upper Egypt Development

Suitable Advantages	Remarks
1. STRONGER sunlight	● Condition for the higher yield
2. HIGHER temperature and warmer in winter	● Favorable for higher yield ● Requirement for annual seed production
3. Availability of wastewater	● Requirement for substantial amount of wastewater treatment and its safety discharge
4. Availability of large scale non arable land	● Economical use for the unused land ● Minimal requirement to arrange the present stakeholders/land owners
5. Availability of LABOR forces	● Need for substantial number of permanent and seasonal labors in plantation

Potentiality of an Advanced Jatropha Center in the World with PPP Scheme

Advantage	Remarks
1. One of the highest productivities of Jatropha seed in the world	● Highest level even with the "Wild" variety ● Faster progress for the high yield breeding program due to the faster growing environment
2. Stable/reliable seed production	● Highly manageable watering condition unlike other "Rain-fed" practices in Asian and Africa ● Relatively stable climate
3. Publics' interests in Upper Egypt development and sustainable energy source development	● Two priority topics of government of Egypt ● Necessary for its sustainable development strategy ● Contribution for other Middle East and African countries' sustainable energy strategies
4. Privates' interests in SUSTAINABLE & INEDIBLE biofuel feed supply chain development	● High demand for dependable centers for Jatropha business development ● Necessary strategies for business sustainability ● Contribution and business opportunity in renewable energy development and GHG reduction and

II. Facts of Jatropha Investment Environment in Egypt

Stakeholders and Present Activities in Jatropha Supply Chain Development

Unlike conventional business sectors, a Jatropha biofuel supply chain involves a wide variety of government authorities and private business sectors. It is essential for Egyptian Jatropha biofuel industry development to smartly arrange a wide variety of authorities' jurisdictions and roles. In order to understand the key authorities' interests and involvement in Jatropha biofuel supply chains, we summarized the key stakeholders' general responsibilities, Jatropha related activities and interests for the further involvement. Following are the summary of the key stakeholders involvement and interests.

Stakeholder	Present Involvement	Field of Interest
Ministry of Petroleum and Egyptian Petrochemicals Holding Company	● Study on Jatropha BDF for alternative fuel supply	● Biofuel production and distribution
Ministry of Agriculture and Land Reclamation	● **The primary body of SUTSWA program for afforestation**	● **Jatropha plantation** ● **Authorities for afforestation activities**
Agricultural Research Center	● Extensive Jatropha study	● Practical contribution for technical improvement
Ministry of Housing, Utility and Urban Development	● **Supervisor of HCWW**	● **Policy lead to assist HCWW's activities**
Holding Company for Water and Wastewater	● The primary body of SUTSWA program for wastewater treatment and supply	● Economical use of treated wastewater ● Afforestation
Ministry of State for Environmental Affairs / Egyptian Environmental Affairs Agency	● **The program coordinator of the SUTSWA program**	● **Promotion of the SUTSWA program and wider application of Jatropha plantation**
Ministry of Trade and Industry	● JICA study	● Jatropha plantation with treated wastewater ● Biofuel standardization ● Guide for the industrial development
Ministry of Civil Aviation	● **None**	● **One of countermeasures to meet EU regulation**
Ministry of Higher Education and State Ministry for Scientific Research and National Research Center	● Cairo-Tsukuba Univ. study	● Scientific contribution for necessary technical improvement ● Total coordination
Ministry of Water Resource and Irrigation	● **None**	● **Water balance for the national water plan 2017**
Important Authorities to be Involved in the Further Stage: Prime Minister's House/ Supreme Council of Energy	● Energy security discussion at SCE	● One of alternative fuel use
International Agencies: USAID	● **Assistance for Luxor pilot project for EEAA**	● **Not clear**
International Agencies: GTZ	● Assistance for HCWW	● Assistance for HCWW's afforestation ● And maybe more
Private's Activities in Jatropha Supply Chain	● **A private's plantation in Suez**	● **Businesses related Jatropha biofuel supply chain**

Potential Use of Jatropha Biofuel in Egypt and Biofuel Standardization

Biofuel Standardization

With present technologies, potentially, four kinds of liquid biofuel can be produced from Jatropha, PPO (Pure Plant Oil), BDF (Bio-Diesel Fuel), HVO (Hydrotreated Vegetable Oil) and Bio-Jet Fuel. PPO can be used either as a feedstock to produce BDF, HVO and Bio-jet Fuel or as a substitute of petroleum derived diesel fuel to run some sorts of old type diesel engines or modified diesel engines. Accordingly, PPO, BDF and HVO can be said as fuels for "Agricultural/Fishery Machines" and "Power Generators" as well as for "Road Vehicles". Bio-Jet Fuel is a fuel for "Aircraft". In order to distribute the Jatropha biofuels as alternative fuel, standardization of the biofuel is required for safety use of end users. Given four types of biofuel standards are either available or under the process of standardization in 2010 based on conventional fossil fuel based standardization. The section 7.1 provides detailed information of fuel property and standardization as well as known issues of applications.

Practical Usage of Jatropha Biofuels

Maturity of the biofuel production technologies varies, but biofuel standardizations secure the safety use of available biofuels for "Conventional" power sources. As long as a biofuel product meets those standards, usage of such fuel does not make significant difference compared to the conventional combustion. Since Jatropha biofuel is not commercially available on the market in any country at this moment, we analyze the most likely applicable use of Jatropha biofuels based on similar property biofuel applications.

Applicable Use	Remarks
Road Vehicles, Locomotives and Ships	● BDF has been widely used. ● Synthetic diesel fuels (HVO, BHD or NERD) will be available with the reduction of refining cost ● PPO is limited application with engine modification
Power Generator	● Either BDF or PPO is more suitable for generator due to slower engines and stable operation
Aircraft	● Synthetic bio-jet fuels has been tested in the limited test environment, but it was proved to be applicable without any modification

III. Cost Analysis of Egyptian Model

In order to analyze the feasibility of the Jatropha business from the financial points, we conducted a cast analysis. The result clearly showed the need for technical improvement. Also technical improvement only may not be able to solve the issues without public support and governmental policies on coordination. Followings are the summary of the cost analysis.

Basic Assumptions for Commercial Scale Plantation in 2020

Item	Value	Remarks
Initial year	2020	With technical improvement and policy development as well as the commercially viable price of crude oil price
Project Life	15 year	Considering internal rate of return (IRR) for 15years
Size of the Plantation	1,000 feddan (400ha)	Due to the MALR's experiences, 1,000 feddan would be the minimum scale of the plantation to cost effectively develop the plantation 1 ha = 2.5 feddan

Item	Value	Remarks
Seed Productivity	**0.92 t/feddan-y (2.3t/ha-y)**	**Present Luxor level, without high yield breading**
Jatropha Trees	460 tree/feddan (1,150 tree/ha)	Luxor practices (3m x 3m)
Oil Recovery Rate (ORR)	**20%**	**Percentage of recoverable/convertable weight of Jatropha oil: presently 20% at Luxor with mechanical oil extraction**
Land Lease	100 LE/feddan-y (US$45/ha-y)	Symbolic price for reference purpose US$1 = 5.5 LE
Treated Wastewater	**2.0 LE/m^3 (US$0.4/ m^3)**	**Assumed HCWW's operation cost (HCWW)**
Cooperate Tax	0%	20y exemption, due to Law No. 8 of Investment Incentives, renewable energy or Upper Egypt development related project shall be applicable
Jatropha vegetable Oil Price in 2020	**3,438 LE/t (US$625/t)**	**Price of biofuel feeds for refinery = Value of extracted vegetable oil price including Jatropha oil + CO_2 premium (see. section 3.2)**
Jatropha Seed Sales	550 LE/t (US$100/t)	80%* of Jatropha vegetable oil price x ORR(20%) * 100 - 80% = 20% profits is typically feasible for oil extraction business
Initial cost of Plantation	**2,780 LE/feddan (US$1,264/t)**	**Estimated cost of existing project including Pump House, Pump and Filter (500 m3 / h to head of 65m , rotation 1500 R/m x 2), Outlet Line from Pump (200mm x 2), Main Outlet Line (500mm x 1), Inlet Line from Balance Pond/Water Treatment Station, Ground Preparation for Plantation, Seedling, Man Power for Plantation Development, Drip Irrigation Piling, Miscellaneous**
O&M cost of Plantation	991 LE/Feddan-y (US$405/ha-y)	Actual cost by MALR including Workers-permanent, Workers-seasonal, Utility-power, Utility - potable water, Transportation for workers, Miscellaneous/Replace

Sensitive Analysis Cases

Option	Condition	Remarks
1. Baseline	Present practices in Luxor and other newer plantations	● Negative cash flow throughout the project
2. High Yield	**Present cost with Increase Seed Productivities with Existing High Yield Breed**	**● Positive cash flow from the project year 5 ● Negative IRR**
3. Higher Yield	Present cost with Further Improved Seed Productivities (New Breed)	● Positive cash flow from the project year 4 ● IRR 13.7%
4. Cost reduction	**Higher Yield condition with Initial and O&M cost reduction**	**● Positive cash flow from the project year 4 ● IRR 16.3%**
5. Land Cost Free	Cost reduction condition with Free Land Lease	● Positive cash flow from the project year 4 ● IRR 18.5% ● Close to the privates' consideration on investment
6. Wastewater Free	**Cost reduction condition with Free Land Lease with Free Wastewater**	**● Positive cash flow from the project year 3**

Option	Condition	Remarks
		● IRR 27.1% ● Possible IRR for the privates' consideration on investment

Summary of the Cost Analysis

The series of cost analyses clearly show the needs for productive improvement and substantial efforts in cost reduction measures. The improvement of seed productivities can be achieved conventional technologies including breading and harvesting as well as advanced scientific measures.

On the other hand, the cost reduction is also necessary challenge to make the Egyptian Jatropha biofuel model feasible. As an energy security measure, it is required to develop extensive scale of Jatropha or other energy crop plantation, but present practices are not financially feasible to extend such scale. High level political wills are also required even with the application of the new breed and lower cost condition.

IV. Challenges and Recommendations

Summary of Recommendations and Recommended Action Plans

Throughout the field observation and discussion with key stakes holders, we reconfirmed the high potentiality of the Egyptian biofuel industry development. However, we also confirmed that it is hardly to realize the commercially viable industry development without technical improvements and strong political wills to achieve such goals. Following are the list of challenges and recommended actions to address.

Summary of Recommendations for Egyptian Biofuel Industry Development

Item	Summary
1. Increase Productivity of Jatropha Seed	● High yield breeding program ● Improvement of cultivation and harvesting technique ● Profitable use of byproducts
2. Cost Reduction of Irrigation System and O&M	● Strategic allocation of Jatropha plantation for existing wastewater plants ● Cost reduction of drip irrigation system for large scale plantation ● Advanced R&D for applied surface irrigation for large scale plantation ● Cost reduction of O&M costs ● Cost effective logistic system development
3. Security of Wastewater Supply	● Ensuring stable wastewater supply ● Economically viable wastewater tariffs for Jatropha plantation developers ● Cost reduction of the wastewater treatment
4. Strategic Allocation of Jatropha Plantation	● Master plan development for nationwide wastewater resources use with new and existing city development

Item	Summary
	● Smart allocation of non arable land and wastewater treatment plant ● Arrangement of land ownership transfer
5. Political Will and PPP Scheme	● Clear vision and policy on biofuel industry development ● Government's leadership to promote favorable environment for FDI ● Coordination of stake holders
6. Environmental Considerations	● Avoidance of ground water contamination ● Ensuring the environmental health
7. No Competition against food production	● Clear policy on no food competition ● Security of no Jatropha production in farmland ● Security of fresh water use for food production

In order to address such matters, we recommend the following action plans.

Recommended Action Plans for Egyptian Biofuel Industry Development

Phase	Actions
1. Urgent Needs: Experimentation & Creation of Investment Climate	● Detailed feasibility study covering the wastewater supply, land and geological database, suitable land allocation for Jatropha plantation and wastewater treatment as well as new city development ● Formulation of a Bio-Energy Policy ● Implementation of high yield breeding program for Jatropha with the support of international experts ● Selection and implementation of large scale pilot plantation project ● Leverage public authorities and preparation of PPP scheme for the full scale Jatropha plantaion development by privates ● Preparation of a "Green energy fund" that encourages the green energy development investments by private sectors
2. Mid-Term Needs: Commencement of Jatropha Plantations	● Implementation of commercial scale polantation ● Installation of oil extraction plants for crude vegetable oil production (PPO) ● Exportation of PPO for EU market ● Preparation of biofuel refinery for bio jet fuel and testing jet fuel for aviation within Egypt
3. Long-Term Needs Completion of Supply Chain Development for Jatropha Bio-Jet Fuel Supply in the Market	● Full production of bio jet fuel ● Export jet biofuel to EU market ● Distribution of bio-jet fuel to Egypt air ● Distribution of synthetic bio diesel for EU or Egyptian market (byproduct of bio-jet fuel)

Recommendation for JICA

Government of Egypt needs technical and institutional improvement for the unique industrial development, which would significantly affect Egyptian sustainable development policy in energy, environment, water resource, economy, and regional development. Although relevant authorizes have been seriously considering the realization of such projects, scattered efforts have yet reached sustainable development models in both wastewater treatment system and Jatropha biofuel supply chain. Despite authorities' serious interests and efforts, it is hardly to achieve a competitive industry development without timely and appropriate support. Though there are varied challenges, assistance for selected key challenges could significantly improve the possibility of the biofuel industry development in Egypt. For the potential assistance for government of Egypt, two (2) short term and three (3) mid to long-term assistance programs are recommended.

SHORT TERM ASISSTANCE

1. Detail Feasibility Study on Egyptian Biofuel Industry Development

Shortly followed by this study, further detail feasibility study is recommended to address the high-level policy makers and key stake stakeholders in the actual stage. Following are the recommended objectives of the study.

- Nationwide study on wastewater and non-arable land availability with geographical and soil mapping survey
- Priority site selection for Jatropha plantation development
- Basic design of the Jatropha plantation for the selected sites
- Feasibility study on nationwide biofuel supply chain development including oil extraction, refining, and logistics
- Detailed examination on policy, regulation, and laws in biofuel industries and to-do list for improvement
- Recommendations for Jatropha industry development roadmap

2. Assistance for Productivity Improvement

Due to the short of productivities, expected annual profits from Jatropha sales will hardly exceed the annual O&M cost without productivity improvement. At this moment, there are some high yield breeds available on the market, it is necessary to adapt Egyptian environment. The cost analysis showed the existing high yield breeds are not even high enough for the Egyptian models. High yield breeding is the basic technique to make the agribusiness feasible and profitable. Though there are highly potential institutions in Egypt, it would be necessary to assist the capability of "Jatropha breeding" and technological transfer of advanced Japanese technologies in breeding.

- High yield breeding program with the support of Japanese advanced breeding technologies
- Technical transfer of the cultivation technology from advanced countries
- Technical transfer of the competitive technologies for byproduct usage

MID-LONG TERM ASISSTANCE

3. Financial and Technical Assistance for the Wastewater Plant Development in Upper Egypt

Financial and technical assistance for development of treated wastewater systems would greatly contribute to the Egyptian biofuel industry development. Once the technical and institutional matters are solved with short-term assistance, a large number of wastewater plant projects are likely to start, in Upper Egypt. In order to realize the biofuel industry development, security of "Low cost" wastewater supply is one of key factors to solved at the actual operation stage.

Considering the need for large investment for such projects, JICA may be provide technical assistance and soft loan for such wastewater treatment development in Upper Egypt. Since high level water treatment is not required for Jatropha cultivation, low cost treatment practices such as a series of oxidization ponds would be suitable for "Low cost wastewater production and supply. Since the oxidization pond treatment has been widely used, especially in Upper Egypt, technical assistance may not be important. However, further cost reduction and cost effective treatment technologies should be carefully assessed and sufficient soft loan shall be provided to contribute to the competitive wastewater treatment and supply.

4. Green Fund for Renewable Energy Development Projects

A financial scheme such as a green fund could greatly help expected renewable energy projects including wind, photovoltaic and solar heat, and biofuel projects in Egypt. Maturity of technologies and scale of the investments vary so that potential scale and timing of the expected investments shall be carefully assessed. As EU countries have been supporting Egypt in renewable energy fields, especially wind and soar, coordination of the donors may be required.

Since HCWW is responsible for wastewater treatment and its supply with other source of funding, the applicability of the green fund would be the Jatropha plantation, oil extraction, and synthetic biofuel refineries by private sectors. In many case in Egypt, public companies dominate an industrial sectors applicable in energy sectors so that applicability of such fund shall include a public and private JV company as well. In order to sustainably manage the fund, the applicability may be extend to energy saving projects as well.

5. Financial Assistance for Egyptian and Japanese JV Companies for Jatropha Biofuels

Furthermore, JICA may be able to provide direct financial assistance for Egyptian and Japanese JV companies for biofuel supply chain development. The JICA finance might be defined as public infrastructure sector or renewable energy sectors with PPP scheme, typically BOT (Built Operate and Transfer) or BOO (Build Operate Own). Though some renewable energy businesses become competitive level compared to the conventional fossil fuel model, majority of renewable energy businesses still require strong support and commitments from public sectors. In other words, such higher risk projects shall be under the JICA finance scheme.

The applicability of the finance can be defined as follow:

- Japanese company's participant ion in biofuel supply chain vestments
- Majority of the companies' components are supplied by Japanese companies
- Companies with advanced technological development, which can be widely applicable for other countries' renewable energy development

CHAPTER I

Egyptian Potentiality for Bio-Jet Fuel

1. Objective of the Study and Background Information
2. Emergent Demand for Bio-Jet Fuel for the EU's Regulation
3. EU Jet Fuel Market
4. Advantage of Jatropha Biofuel and Its Supply Capacity
5. Potentiality of Egyptian Jatropha Business Model

I. Egyptian Potentiality for Bio-Jet Fuel

1. Objective of the Study and Background Information

1.1 Objective of the JICA Study

The principal objectives of the "Egyptian Biofuel Industry Development Study" are to examine the reality of the *Jatropha curcus*, an inedible biofuel feed, cultivation practices irrigated by treated wastewater in Egypt as well as potential development strategies for Egyptian Jatropha biofuel industry development and its potential field of JICA assistant for government of Egypt.

Japan International Cooperation Agency (JICA) has been supporting the Government of Egypt for its economic development. JICA has recognized the potentiality of "Biofuel industry development in Egypt" based on the JICA's initial study[1] in 2007 prepared by Japan Development Institute's (JDI). Due to the continuous interests and serious demand for assistance in Jatropha biofuel industry matter by Egyptian authorities, JICA is seeking for potential fields of assist for need for Government of Egypt. In order to analyze the potentiality of the Jatropha industry development and possible assistance for its realization, JICA appointed JDI to analyze the reality on the ground, realistic potentialities and possible strategies for government of Egypt.

This study report is comprised of four chapters to easily address the reader's interests:

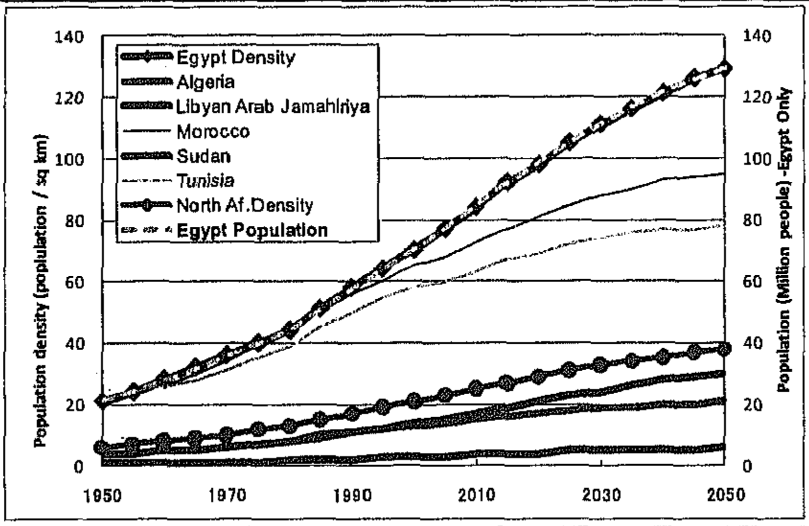
I. Egyptian Potentiality for Bio-Jet Fuel
II. Facts of Jatropha Investment Environment in Egypt
III. Cost Analysis of Egyptian Model
IV. Challenges and Recommendations

1.2 Background of the JICA Study in Egypt

Fresh water security has been one of the most important national strategies in Egypt. As warmly facilitated by stable governance and public supports for living, Egypt has become one of the fastest population growth countries in northern Africa and Middle Ease, the water security has been become more and more serious matters in Egypt (Figure. 1.1). In order to avoid the excessive concentration of population in the Cairo and adjacent Nile delta, the government of Egypt has made extensive efforts to promote the new city development. As the successful distribution of population in Upper Egypt along the

[1] Appendix A3: Summary of Egyptian Biofuel Industry Development Study (JCA2007)

Nile, the inflow of the sewage water or other effluent became the serious issues for downstream cities including Cairo.



Arable Land Availability Country	person/Ha
Egypt	6.9
Algeria	0.9
Libya	0.1
Morocco	1.1
Sudan	1.1
Tunisia	0.5

Source: UN World Population Prospects (2009)

Figure. 1.1 Population Growth and Arable Land Availability

As a smart strategy to avoid the contamination of the Nile River and provide valuable products from the wastewater resource, three responsible ministries (Ministry of Agriculture and Land Reclamation (MALR), Ministry of Housing, Utilities and Urban Development (MOH), and Egyptian Environmental Affairs Agency (EEAA)) started a joint program known as "Safe Use of Treated Sewage Water for Afforestation (SUTSWA program)." The SUTSWA program successfully promoted the valuable use of wastewater by producing artificial forest for anti-desertification, greening, and wood sales. The program has also promoted successful oil crop production such as Jatropha and Jojoba as faster return on investments compared to the woods production.

At the same time as the population growth, the security measure for the energy became another critical issue in Egypt. The government of Egypt has been working on the sustainable strategy for the energy strategies for long time. Now, the government pays keen attention to the "New and renewable energy" and Jatropha has received serious attentions due to its potentialities for a security measure and effective use of the wastewater resource for sustainable development.

As a result of the government's attention on the Jatropha as well as domestic and international investors, many stakeholders both public and privates have talked a lot about the potentialities but few actual trials have been made on the ground due to the unfamiliarity of the Jatropha business models and numbers of failures in Asia and other African countries. As a responsible ministry of a new industrial development and one of primary consumer sectors of energy in Egypt, Ministry of Trade and Industry (MTI) also paid attention to the Jatropha biofuel industry development. With its potentiality and request from MTI, JICA conducted an initial study on Egyptian Jatropha Biofuel Industry Development in 2007. Though the study was well accepted by MTI and other relevant authorities as well as potential investors, few actual actions toward its realization had been made by early 2009.

1.3 Call for Sustainable Biofuel Development in the World

1) Sustainability Issue

The sustainability of biofuels has become a great issue in the recent years when the production of biofues, notably biodiesel fuel (BDF) as well as bio-ethanol, has substantially increased and the conflict between energy vs. food has been a serious social issue.

Generally speaking, the main reasons for encouraging the production and use of biofuels by governments are threefold: mitigation of climate change, enhancement of energy security and development of new industry. Unfortunately, however, not all impacts of producing and use of biofuels could be appreciated as positive. As the world biofuel industry grows, concern over the negative impacts of unsustainable biofuels production and use became evident, specifically with respect to inappropriate use of water, loss of land, reduced food security, deteriorated biodiversity, etc.

Because of this, people have started recognizing the importance of sustainability in producing and use of biofuels. So far, a number of initiatives were led by various different parties. Among others, the initiatives by the Roundtable of Sustainable Biofuels (RSB) and the European Union (EU) are well known. RSB is a party that has taken the worldwide initiatives gathering a wide variety of stakeholders who have concerns on this issue. Its stakeholders are farmers, biofuel producers and suppliers, transport industry, investors, NGOs, governments, inter-governments agencies and experts. RSB partners aim to develop principles and criteria of sustainability for the production and processing of biofuels. Another important party that has also taken the strong initiatives is the European Union (EU). The EU has committed itself to an ambitious set of targets to foster energy and environmental improvements. It aims at reduction of greenhouse gas emission by 20%, a general improvement of energy efficiency by 20% and the target market share of 20%, all to be achieved by the year of 2020. Moreover, the EU has established a target of 10% for the use of renewable energies in transport sector by 2020. Both 20% target for the overall market share of renewable energy sources, as well as the 10% for transport are mandatory targets set out in the Directive 2009/28/EC on the promotion of the use of energy sources from renewable sources, to be achieved through common efforts of Member State of the EU. It is just this Directive that call for sustainable production and use of biofuels in the EU.

2) Sustainability Criteria of RSB (Roundtable for Sustainable Biofuels)

In 2008, the Steering Board of the RSB has issued and disseminated a "Version Zero" catalogue of sustainability principles and criteria for biofuels. The version has been improved since then and the current version of 0.5 follows the same guidelines as the previous one, but the version 0.5 is more accurate than the version zero and includes requirements from all stakeholders. A thoroughly updated document of version 1.0 is expected to be published by 2010. The major items for sustainability criteria taken up by RSB in the current version are briefly described hereunder.

Item	Criteria
1. Greenhouse gas emission	Biofuels shall contribute to climate change mitigation by significantly reducing lifecycle GHG emissions as compared to fissile fuel.
2. Human and labor right	Biofuel production shall not violate human rights or local labor rights, and shall promote decent work and the well-being of workers.
3. Rural and social development	In regions of poverty, biofuel production shall contribute to the social and economic development of local, rural and indigenous people and communities.
4. Food security	Biofuel production shall ensure the right to adequate food and improve food security in food insecure regions.
5. Conservation	Biofuel production shall avoid negative impacts on biodiversity, ecosystem and high conservation value areas.
6. Soil	Biofuel production shall implement practices that seek to maintain soil health and reverse degradation.
7. Water	Biofuel production shall maintain or enhance the quality and quantity of surface and ground water resources and respect prior formal or customary water rights.
8. Air	Air pollution from biofuel production shall be minimized along the supply chain
9. Use of technology, inputs and management of waste	The use of technologies in biofuel production shall seek to maximize the production efficiency and social and environmental performance and minimize the risk of damages to the environment and people.
10. Land rights	Biofuel production shall respect land rights and land use rights.

3) Sustainability Criteria of EU Directive 2009/28/EC

DIRECTIVE 2009/28/EC of 23 April 2009 states that irrespective of whether the raw materials of biofuels were cultivated inside or outside of the EU territory, energy from biofuels shall be taken into account for if they fulfill the sustainable criteria set out in this Directive. The major sustainability items described in the current Directive are briefly described hereunder.

Item	Criteria
1.Greenhouse gas emission The greenhouse gas emission saving from the use of biofuels shall be at least 35%. As of 2017, however, it shall be increased to at least 50% and from 2018 and on it shall be at least 60%. For the calculation of greenhouse gas impact the Directive proposes default values for a selected number of production pathways, where these could be established on the basis of results from scientific work, or requires the calculation of actual values in accordance with the prescribed methodology.	
2. Land with high biodiversity Biofuels shall not be made from raw material obtained from land with high biodiversity value, namely land that had one of the following statuses; primary forest and other wooded land, areas designated by law or the relevant competent authority for nature protection purposes or for the protection of rare, threatened ecosystems or species recognized by international agreements, highly bio diverse land and so on.	
3. Land with high carbon sink . Biofuels shall not be made from raw materials obtained from land with high carbon sink,namely land that had one of the following statuses; wetland, namely land that is covered with or saturated by water permanently or for a significant part of the year. Continuously forested areas, namely land spanning more than one hectare with trees higher than five meters and a anopy cover of more than 30%. Land spanning more than one hectare with trees higher than five meters and a canopy cover of between 10% and 30%.	
4. Peatland Biofuels shall not be made from raw material from land that was peatland in January 2008, unless evidences are provided that the cultivation and harvesting of that raw material does not involve drainage of previously undrained soil.	
5. International agreement The EU shall endeavour to conclude bilateral or multilateral agreements with third countries containing provisions on sustainability criteria that correspond to those of this Directive. Where the EU has concluded that agreements containing provisions relating to matters covered by the sustainable criteria the EU Commission may decide that agreements demonstrate that biofuels produced from raw materials cultivated in those countries comply with the sustainability criteria of the EU.	

2. Emergent Demand for Bio-Jet Fuel for the EU's Regulation

2.1 DIRECTIVE 2008/101/EC to Include Aviation Activities in the EU GHG Reduction Mechanism

In its communication of 27 September 2005 to EU council, European Parliament and the relevant EU Committees, the EU Commission outlined a strategy of the inclusion of aviation in the EU's emission trade scheme for reducing the climate impact of aviation. Then, in its resolution of 4 July 2006, the European Parliament concluded that from an economic and environmental point of view, the inclusion of the aviation would be the best way to address the climate impact of aviation, if it is appropriately designed.

As a result of the series of investigation, EU Directive 2008/101/EC of the Parliament and of the Council of 19 November 2008 declared to include the aviation in the EU Emission Trade Scheme to mitigate the greenhouse gas emission from aircraft.

The Directive 2008/101/EC decided, among others, the following provisions:

- ✓ In order to avoid distortions of competition and improve environmental effectiveness, emissions from all flights arriving at and departing from EU airport shall be included into the scheme from 2012.
- ✓ For the period from 1 January 2012 to 31 December 2012, the total quality of allowance to be allocated to aircraft operators shall be equivalent to 97% of the historical aviation emissions.
- ✓ For the period from 1 January 2013 and after, the total quantity of allowances to be allocated to the aircraft operators shall be 95% of the historical aviation emission.
- ✓ The Commission shall review the total quantity of allowances to be allocated to aircraft operators. The percentage of allowances to be allocated to aircraft operators may be changeable in the future
- ✓ Of the total quantity of allowance allocated to aircraft operators, 15% of allowances shall be auctioned. This percentage may be increased as part of the general review of the Directive.
- ✓ If aircraft operators could not meet with the requirements, the excess mission penalty shall be EUR 100 for each tone of carbon dioxide emitted for which aircraft operators has not surrendered allowances.

This legislation of EU was accepted by the world aircraft operators as very serious, because it will, without doubt, add a carbon cost to aviation industry, requiring airlines to pay their carbon emission from 2012. At this moment, there only three (3) possible options are available to avoid paying additional cost for carbon emission. The first option is to improve energy efficiency of aircraft operation by using more energy efficient jet turbines and/or reducing the weight of aircraft by using much lighter materials. The second option is to use sustainable biofuel as a substitute of kerosene jet fuel. Naturally, aviation industry has been enthusiastically perusing the both options, but many people believe that sustainable biofuel would definitely be the ultimate solution to the aviation industry to reduce GHG emission from aircrafts. Then, the last option is to purchase the equal amount of necessary GHG reduction by certified carbon credit such as emission reduction unit (ERUs) of EU Emission Trading Scheme or certified emission reduction (CER) of Clean Development Mechanism (CDM) from the market.

2.2 COMMISSION REGULATION (EC) No748/2009 on the List of Aircraft Operators

COMMISSION REGULATION (EC) No.748/2009 of 5th August 2009 is the official notice of potentially regulated aircraft operators under the Directive 2008/101/EC from 2012. This list lists only registered companies by the time the registration was finalized so that any commercial operation, even its not listed at this moment, shall be subject to follow the Directive 2008/101/EC. Followings are the list of registered companies registered in Egypt. However, with the discussion with representative of Ministry of Aviation, only 9)EGYPTAIR and 10)EGYPTAIR CARGO have scheduled and non schedule flights for EU at this moment so that there might be only two companies need to comply with the EU regulation from 2012. The regulation is subject to be applied any commercial flight, so any operator is required to meet the regulation level in case of EU flights.

1)AIR CAIRO, 2)AIR MEMPHIS, 3)ALKAN AIR, 4)AMC AVIATION, 5)ARTOC AIR, 6)CAIRO AVIATION, 7)CLEOPATRA GROUP, 8)EGYPT JET AVIATION, 9)EGYPTAIR, 10)EGYPTAIR CARGO, 11)EUROMEDITERRANEAN, 12)EXECUTIVE WINGS HE, 13)FAST LINK EGYPT, 14)GHALAYINI, 15)KATAMEYAHEIGHTS, 16)KORAL BLUE AIRLINES, 17)LOTUS AIR, 18)MIL EGYPT (3), 19)NATIONAL AVIATION 2, 20)ORASCOM, 21)S EGYPT, 22)SMART AVIATION HE, 23)STC BERMUDA LTD., 24)SUN AIR (EGYPT), 25)SUNRISE (ALSHOROOK), 26)TRAVCO AIR

3. EU Jet Fuel Market

3.1 Trend and Historical Demand

EU's energy and non-energy consumption by sectors are shown in Figure. 3.1. Unlike stationary power units, transport and agricultural sector heavily depend on oil (yellow area in Figure. 3.1) based energy form. Due to the requirement of movability, high density form of energy is required. Considering the energy/volume and energy/weight density including the relevant storage and safety gears, fuels are the highest forms of the energy density. As a result, transport sectors depend on the fuel from of energy. In the case of aircraft, jet fuel is the only option for practical operations.

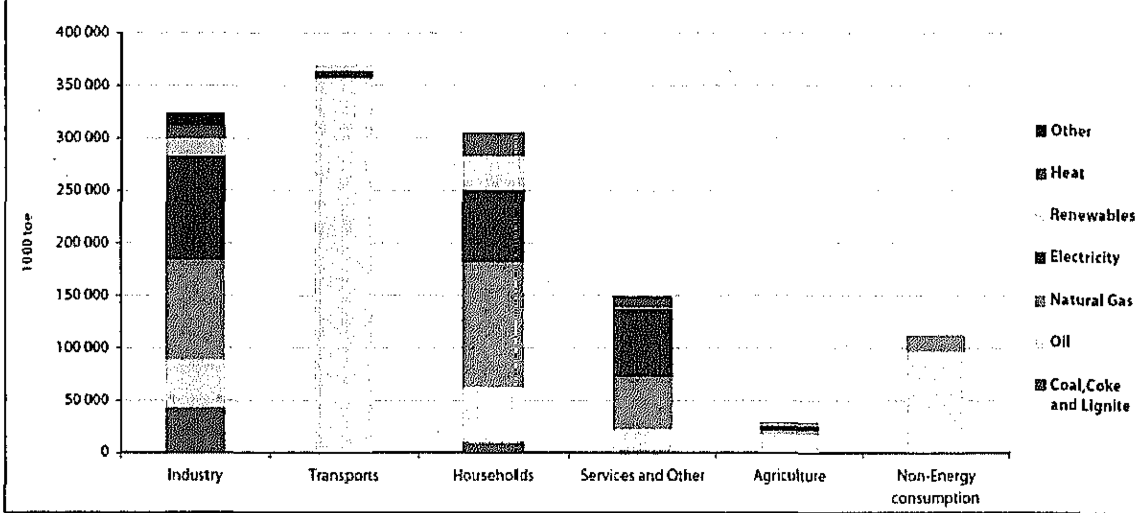
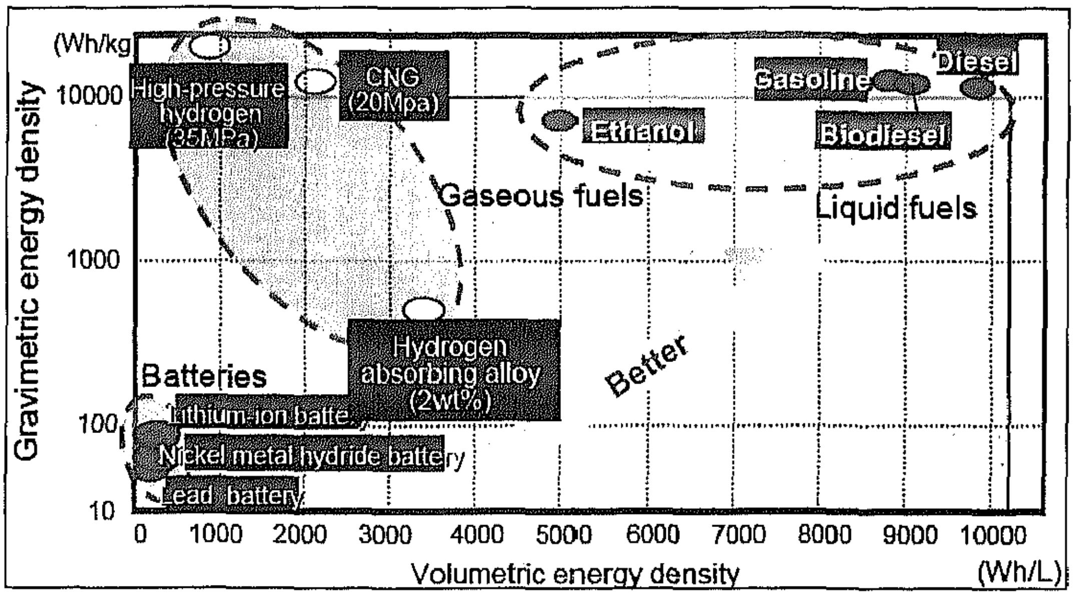


Figure 3.1.6: EU-27: Final energy and non-energy consumption by fuel and end-use sector, 2006

Source: EUROSTAT

Figure. 3.1 Energy Consumption in EU 2006



Source: TOYOTA (NEDO Biofuel Conference 2007)

Figure. 3.2 Energy Density for Different Forms

The share of the fuel consumption by energy basis is shown in Table.3.1. Though the absolute amount of the consumption is still very high, the share of the road has been decreasing due to the shorter cycle of the replacement with higher energy efficiency engines and availabilities of alternative energy source such as electric or fuel and electric hybrid. On the other hand, Aviation sector has gradually increased its share.

Table. 3.1 Trend of the Road and Aviation Share (1991-2006)

Share of Transport Fuel (EU-27)				
	1991	1996	2001	2006
Road	85%	85%	84%	83%
Aviation	11%	12%	13%	14%

Source: EUROSTAT

Trend of the jet fuel consumption in EU countries is shown in Table.3.2 (oil equivalent). As economic growth in the region, the consumption of the energy has continuously increased. Since the energy densities of crude oils and jet fuels are close, the number could considered in jet fuel ton. Considering the consumed jet fuel in EU (27 countries) in 2007, it has reached 53 million tons/y.

Table. 3.2 Trend of the Energy Consumption of Transport Sector in EU (1996-2007)

Energy consumption of transport, by mode; Final energy consumption - Air transport (1,000toe)												
	1996	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**
European Union (27 countries)	35,672	37,538	40,875	43,489	45,529	44,447	43,726	45,100	47,464	49,869	51,856	53,414
United Kingdom	**8,298**	**8,674**	**9,526**	**10,253**	**11,156**	**10,962**	**10,855**	**11,102**	**11,965**	**12,853**	**12,992**	**12,972**
Germany (including ex-GDR from	6,120	6,423	6,633	7,012	7,362	7,021	6,991	7,157	7,731	8,320	8,743	9,061
France	**5,023**	**5,154**	**6,072**	**6,475**	**6,710**	**6,639**	**6,530**	**6,512**	**6,256**	**6,314**	**7,075**	**7,266**
Spain	3,386	3,649	3,974	4,208	4,497	4,538	4,308	4,517	5,006	5,334	5,579	5,870
Italy	**2,624**	**2,720**	**3,173**	**3,564**	**3,497**	**3,405**	**3,196**	**3,721**	**3,707**	**3,877**	**3,981**	**4,228**
Netherlands	2,772	3,003	3,266	3,393	3,348	3,254	3,399	3,338	3,563	3,673	3,703	3,728
Turkey	**1,242**	**1,483**	**1,562**	**1,182**	**1,261**	**1,241**	**1,632**	**1,740**	**1,861**	**2,010**	**1,770**	**2,176**
Switzerland	1,356	1,404	1,464	1.558	1,625	1,561	1,417	1,275	1,203	1,218	1,277	1,362
Greece	**1,230**	**1,187**	**1,201**	**1,284**	**1,325**	**1,191**	**1,154**	**1,162**	**1,208**	**1,181**	**1,295**	**1,312**
Ireland	362	434	449	530	614	737	783	765	727	840	870	1,022
Belgium	**1,072**	**1,342**	**1,591**	**1,554**	**1,524**	**1,154**	**1,251**	**1,546**	**1,427**	**1,283**	**1,179**	**1,016**
Portugal	626	604	650	744	793	758	744	782	842	884	924	1,002

Source: EUROSTAT

3.2 Assumption of Jet Fuel Price in 2020

In case of the successful implementation of Jatropha biofuel supply chain development in Egypt, 2020 is the earliest possibility to commercially produce bio-jet fuel based on the present situation with the JICA study team's professional judgment. Due to the historical crude oil price and jet fuel prices, the future jet fuel price could be calculated by future crude oil price.

However, it is not easy to assume the price of future oil price, especially after the historical hype of oil price in July 2008 and drastic drop till December 2008 due to the financial crisis. Most of the international media have reported the end of the recession caused by the financial crisis in 2008 and strong recovery of energy price (Figure. 3.3). However, many media also reported there are still some unknown critical issues in U.S. commercial real estate sectors, which may also lead the banks' bankruptcy.

Since it is necessary to estimate the market value of the jet fuel for the cost analysis of this report (Chapter III), we assumed the jet fuel price in 2020 from the most recognized future oil price by International Energy Agency (IEA). Especially, IEA's annual energy trend report - world energy outlook (WEO) is one of the most recognized analyses in the market. Due to the sharp fluctuation for last 18 months, WEO2009 has also revised the long term oil price trend from WEO2008 (Table. 3.3). Therefore, the JICA study team referred the best available information at the time of reporting.

Table. 3.3 Comparison Between Crude Oil Price of WEO 2008 and 2009

	2015	2020	2030
World Energy Outlook 2009 crude oil price per barrel			
WEO2009/ Real Basis (2008US$)	87	100	115
WEO2009/ Nominal (US$)	102	131	190
World Energy Outlook 2008 crude oil price per barrel			
WEO2008/ Real Basis (2007US$)		110	122
WEO2008/ Nominal (US$)		148	206

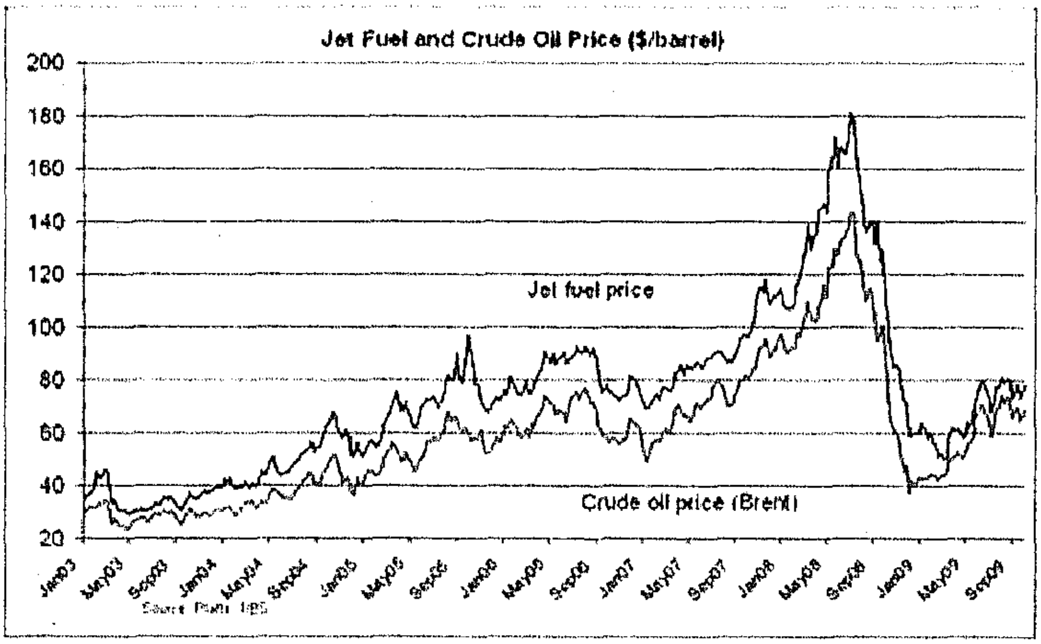
Source: IEA WEO2009

Based on International Air Transport Association (IATA)'s economic data, average price of jet fuel price per barrel is 124% of crude oil price per barrel. Since the relative density of crude oil (roughly 0.9) and that of jet fuel (roughly 0.8) are different, the average price of jet fuel per metric ton is roughly 140% of crude oil price per metric ton (Table.3.4, Figure. 3.3).

Table. 3.4 Price Difference between Crude Oil and Jet Kerosene

	2015	2020	2030
Implied Jet Kerosene Price: 124%* of crude oil price			
Real Basis (2008US$)/bbl	108	124	143
Nominal (US$)	126	162	236
Implied Jet Kerosene Price: 124% of crude oil price*** **			
Real Basis (2008US$)/t	750	860	990
Nominal (US$)/t	900	1,100	1,600

Source: IEA WEO2009, *IATA Economics,** Jet Kerosene (0.8kg/litter), Crude oil (0.9kg/litter)
***1.0 bbl=159litter



Source: IATA Web Site>Economics>Jet Fuel Price Development

Figure. 3.3 Trend of Crude Oil and Jet Fuel Price

Therefore, we assumed the expected jet fuel price in 2020 is US$124/bbl or US$960/t. This assumed price is solely used throughout this study.

3.3 Assumption of Bio-Jet Fuel Price and Its Market in EU in 2020

Considering the price of the bio-jet fuel in 2020, we assumed the additional value of the bio-jet fuel. Since the bio-jet fuels are considered as low carbon emission fuel, the usage of such fuels are able to create additional value of GHG reduction. Actual amount of GHG reduction fully depends on the source of bio-jet fuel. Since the production of the biofuels including the production of feeds, transportation, and procession is likely to consume conventional fossil fuel so that the portion of the fossil based GHG emission shall be considered. Thus it is hardly to generalize the GHG reduction of the bio-jet fuel use. However, due to the recent bio-jet fuel test flight containing Jatropha bio-jet fuel by Japan Air Line, the reduction of the CO_2 emission could be 2 ton-CO_2e/t-jetfuel. In short, one ton of bio-jet fuel could reduce two (2) tons of CO_2 reduction. Since the value of the one ton of CO_2 has been defined by CER and ERU markets, additional value of the bio-jet fuel can be defined by the following simple equation.

Additional value of the bio-jet fuel (US$)

= 2 (CO_2/t-jetfuel) x Weight of consumed bio-jet fuel (ton) x Price of CER/ERU (US$ /CO_2e)- Eq.(1)

Considering Egyptian business model, 2020 would be the earliest production. Expected bio-jet fuel price in 2020 is calculated by the following formula:

Bio-jet fuel price-2020 (US$960/t)
= expected jetfuel-2020 (US$860/t) + CO2 premium-2020 (50 US$/t-$CO_2$ x 2 t-CO_2) Eq.(2)

Table. 3.5 Expected CO_2 Price and Bio Jet Fuel Price in 2020

	2008	2015	2020	2030
Implied Jet Kerosene Price: 124%* of crude oil price				
Real Basis (2008US$/t)		750	860	990
Nominal (US$/t)		900	1,100	1,600
Implied CO2 Price and Bio-Jet Fuel Price				
Average CO_2 reduction (t-CO_2/t-fuel)*	2	2	2	2
CO2 Price (2008US$/$CO_2$-t)**	20	N/A	50	110
Expected CO2 Premium (2008US$/t-fuel)	40	-	100	220
Assumed Price of Bio Jet Fuel Price (2008US$/t-bio-jet fuel)	-	-	960	1,210

Source: * JDI's assumption for expected CO2 reduction,** IEA WEO2009,

Considering the bio-jet fuel market, it would be obviously "Seller's market" due to the limited supply capacity and EU's mandate regulation to reduce the CO_2 described in section 2 as well as aviation sectors' serious intentions of further CO_2 reduction. Attachment 7 and 8 show the official statements of ICAO and IATA's intentions to contribute to the CO_2 reduction globally including any domestic and international commercial flights for the response to the UNFCCC COP/15 Accord. As a result, it will be strong "Seller's market" as long as the pricing of the bio-jet fuel is affordable level for the commercial operators. *Since aviation sectors are not able to afford such environmental costs by themselves only, such goals will* be achieved with the cost share of the service providers and passengers. It totally depends how much "Final consumer-passenger" can afford to pay for the environmental cost of CO_2.

As shown in Table 3.2, the consumption of the jet fuel is likely to increase continuously even after the global scale recession. As mentioned, the demand of the bio-jet fuel is likely to exceed the supply capacity so that the scale of the bio-jet fuel market would be defined by how much "Affordable priced" bio-jet fuel can be delivered at the market. Due to the working progress stages to develop supply capacity of such affordable priced bio-jet fuels, it is hardly defined such supply capacity at this moment. Considering the minimum requirement in EU with the mandate 5% reduction of CO_2 (ref. section 2) and the latest available jet fuel demand in EU (Table. 3.2), the expected minimum market will exceed 2.7 million t-bio-jet fuel/y and US$2.6 billion. The basis of such calculation is as follow.

Minimum bio-jet fuel market in EU (2.7 million t-bio-jet fuel/y)

= jet fuel consumption in EU in 2007 (5,3414 t-jet fuel/y)* x 5% Eq.(3)

* due to the same level energy density of bio-jet fuel 1 ton of jet fuel can be replaced by 1 ton of bio-jet fuel

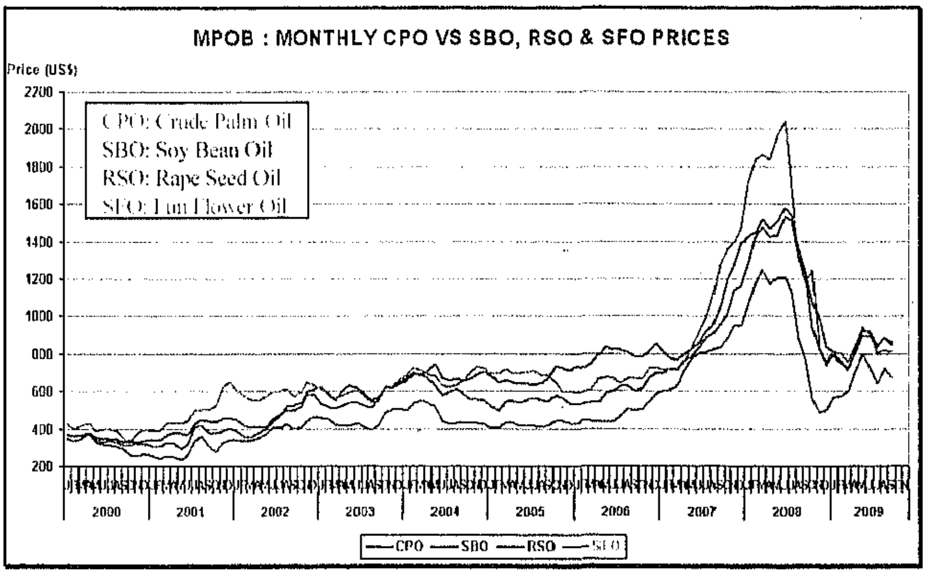
Scale of the Minimum bio-jet fuel market in EU (US$2.6 billion)

=2.7mil t-bio-jet fuel/y (Eq.3) x US$960/t-bio-jet fuel (Eq.2)

4. Advantage of Jatropha Biofuel and Its Supply Capacity

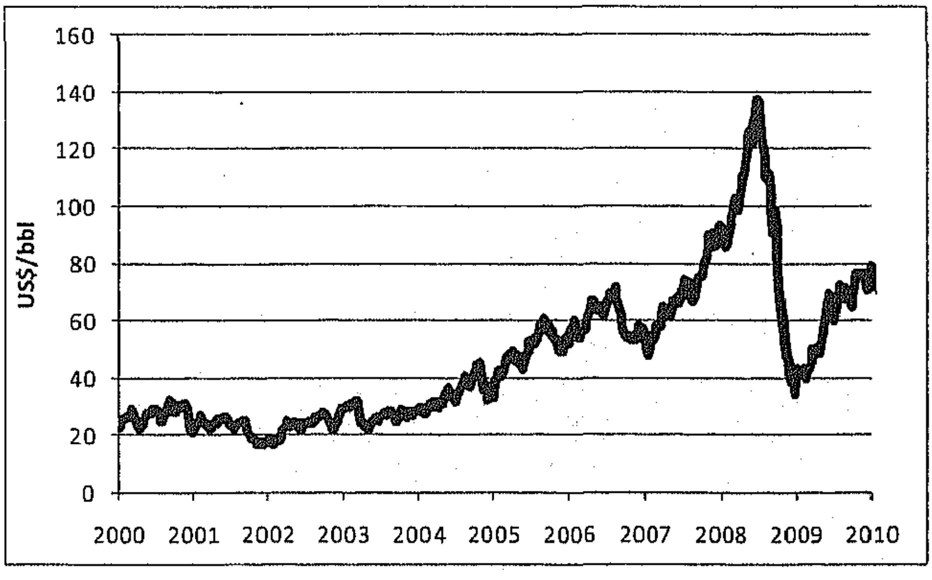
4.1 Advantage of Jatropha Biofuel

Though the supply capacity of the vegetable oils for food and biofuel feed were sufficient enough to meets the actual demand, the excessive interests in "Greener and lower risk" investments led the historical high rise of the vegetable oil prices along with the crude oil prices (Figure. 4.1 and 4.2).



Source: Malaysia Palm Oil Board

Figure. 4.1 Price Trend of Vegetable Oils



Source: The Energy Information Administration, U.S. Department of Energy

Figure. 4.2 World Crude Oil Spot Price Weighted by Exporting Volume

For the responsibility of the food price hype in 2008 including daily foods and edible oils, EU has been seriously considering the restriction of "Edible oil use" for the biofuel production (ref. section 1.3). Table. 4.1 shows the general description and present/potential issues on conventional biofuel feeds and Jatropha.

Table. 4.1 Quick Comparison of Conventional and Potential Biofuel Feed

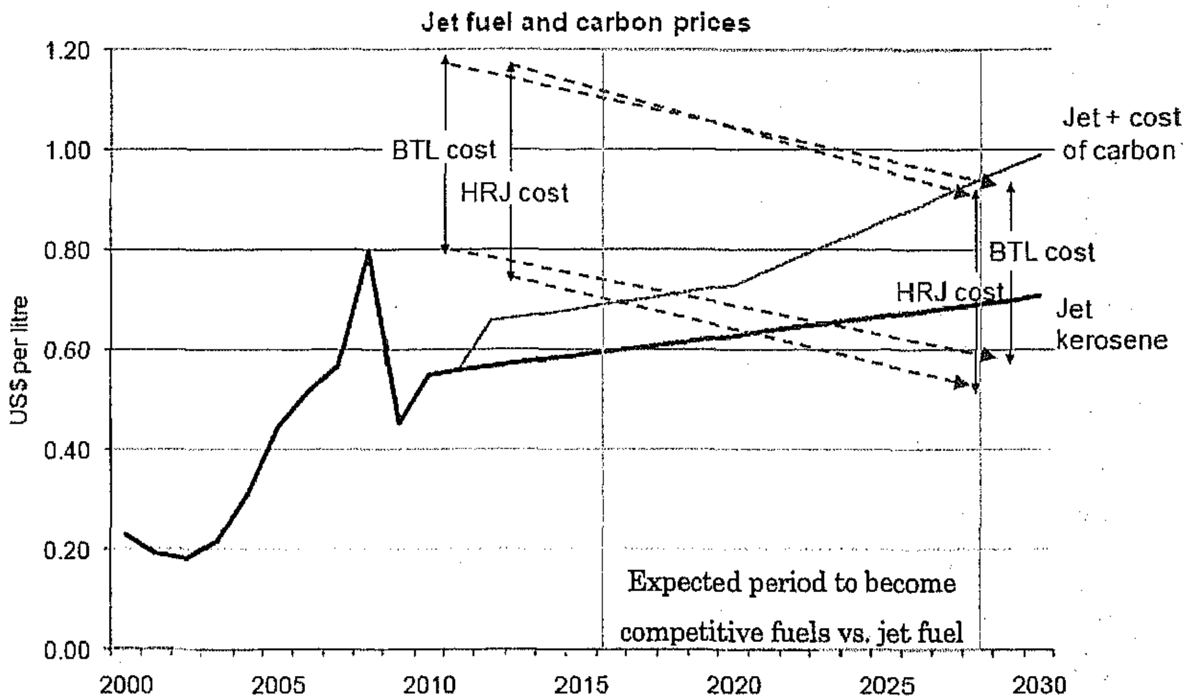
Type	Remarks
Jatropha	**General:** Cultivatable in hot, dry climate, Future BDF feed in some SE Asian countries, Similar to rapeseed oil and suitable for lower temperature usage and the EU standard BDF feed, No/little tax without governmental subsidies **Issue:** Not commercial stage at this moment, Need technical improvement for commercialization, Unsuitable for lower temperature, Unrealistic pricing due to excessive demand for inedible biofuel feed
Rapeseed	**General:** Cultivatable in arable land in mild climate, Fully commercialized commodity, Market oil price 20-30% higher than Palm Oil, common BDF feed in EU, Suitable for lower temperature **Issue:** Potential competition against food supply, Reduction of governmental subsidies in EU for feed cultivation and fuel taxation
Soybean	**General:** Cultivatable in arable land in mild climate, Fully commercialized commodity, Market oil price 20-30% higher than Palm Oil, common BDF feed in US & Brazil, Suitable for lower temperature, No/little fuel tax with governmental subsidies **Issue:** Potential competition against food supply
Palm oil	**General:** Only cultivatable in tropical wet climate, Fully commercialized commodity, Largest supply capacity of vegetable oil, Commonly the bench mark of the biofuel feed price, Market oil price 600-800 USD/t, Future BDF feed in Malaysia, Thailand, Indonesia, Philippines, and other Asia and African countries **Issue:** Destruction of tropical forest, Limited applicability due to the extensive need for water and sun

The summary of the three airlines' bio-jet testing flights powered by Boeing and other technical providers is shown in table 4.2. Probably due to the availability of the biofuels, Jatropha or Camelina (the second crop of wheat producing edible oil in the U.S.) were the primary source of bio-jet fuels at the testing flights. For the consideration of sustainable fuel supply and no-competition against food production, Boeting focused on Jatropha, Camelina, and Algae biofuel. Though Camelina oil is edible, it is considered as the candidate because it is not conventional/common commodity for the consumption at this moment. Also, is was the one of few candidates applicable in the U.S. environment. Considering the "Commercial" use of the identified biofuel feeds, it is still far from the "Affordable priced alternative fuel" due to the on-going process of technical improvement for the cost reduction (Figure. 4.3). Latest information of the mentioned three candidates are summarized in Table 4.3. Based on the applicability and practicality in Egypt, Jatropha would be the ideal option for Egypt. Algae might be another possible option, but it is still far from the commercial level compared to other options.

Table. 4.2 Bio-SPK Test Flight Summary

Airline	Air New Zealand	Continental Airlines	Japan Airlines
Aircraft	Boeing 747-400	Boeing 737-800	Boeing 747-300
Engine	Rolls-Royce/ RB211-524G	CFM International/ CFM56-7B	Pratt & Whitney/ JT9D-7R4G2
Plant Feedstock	50% jatropha	47.5% jatropha, 2.5% algae	42% camelina, 8% jatropha/algae
Fuel Provider for Test Flight	UOP	UOP	Nikki Universal/UOP
Flight date	Dec 30, 2008	Jan 7, 2009	Jan 30, 2009
Flight Test Profile	Climb to FL 350, Mach 0.84 accels & decels, engine windmill restarts, starter-assisted engine relights, simulated missed approach, suction feed test	Climb to FL390, Mach 0.78, accels & decels, engine windmill restarts, starterassisted engine relights, simulated missed approach, suction feed test	Climb to FL390, Mach 0.80, accels & decels, engine windmill restart, suction feed test. Was the only hydro-mechanical engine used for this series of flight tests.

Source: Evaluation of Bio-Derived Synthetic Paraffinic Kerosene (Bio-SPK) by Boeing

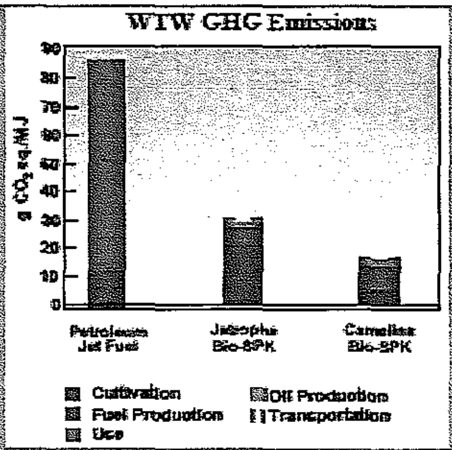


Source: Alternative Fuels Foreword 2009 , IATA

Figure. 4.3 Aviation biofuel supply costs and the cost of using jet kerosene

Table. 4.3 Quick Comparison of Potential Bio-Jet Fuel Feeds

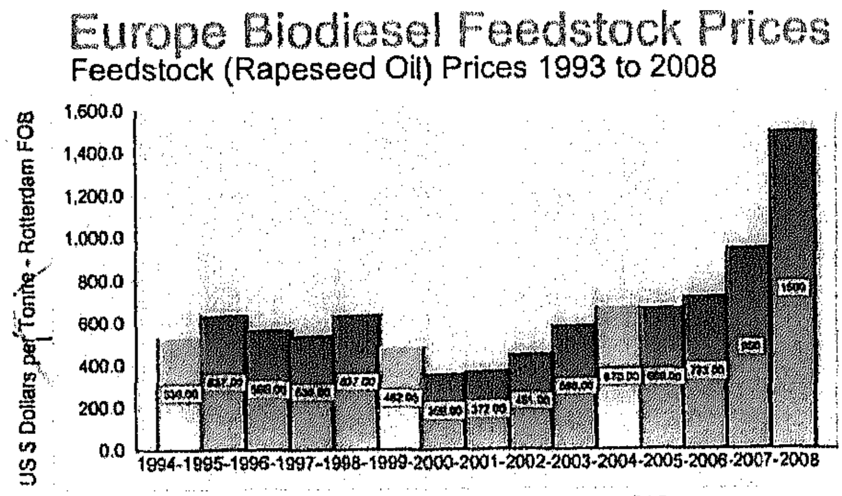
Factors	Jatropha	Camelina	Algae
Cultivation	Non-arable land	Arable land/ 2nd crop	Closed/controlled* water tank/containers *separated from natural environment
Leading Country	SE Asian countries and India	U.S.	U.S.
Required inputs for commercial production	Water/wastewater, fertilizer, warmer climate, stronger sunlight, large scale plantation	Water, fertilizer, primary crop production, mechanical farming, large scale farming	Water (fresh/sea), CO_2, fertilizer, large scale water tanks/containers
Advantage	• Inedible oil • Applicable on non-arable or non-conventional farmland • High quality oil as fuel • High oil content	• Easily commercialized by using primary crop land and mechanical tools • High quality oil as fuel	• Best efficiency to convert CO_2 into biomass/oil before refining • Reportedly lowest energy inputs to produce and collect biomass/oil before refining
Disadvantage	• Needs for technical improvement in economics of the seed production	• Arable land use • Potential competition against food production in land use and water use • Edible oil	• Limited application for CO_2 source, typically coal/oil fired boilers such as power station, cement, steal production • Extensive need for water management facilities, typically costly • Needs for technical improvement to economically dehydration • Needs for significant energy source for dehydration

Factors	Jatropha	Camelina	Algae
CO_2 reduction	 Source: Boeing	• Well to Wheel (WTW), a life cycle analysis of the CO_2 emission for the energy usage, shows the Camelina has advantage in cultivation. • CO_2 emission in cultivation includes the emission of biomass collection so that higher yield of biomass feeds makes big difference. • There are no comprehensive data available for Jatropha due to no commercial supply so that this information should considered as reference purposes. • Bothe Jatropha and Camelina have big advantages to reduce CO_2	• Reportedly, the best GHG reduction against Jatropha and Camelina, but there is no reasonable lifecycle assessment known as WTW approach. • Collection and management of CO_2 require significant energy inputs • Dehydration of algae also requires significant energy inputs** **cf. bio ethanol from corn requires significant heat energy typically burning oil or coal, which makes corn-ethanol similar CO_2 emission as conventional fuels. On the other hand, sugar cane is effective due to the byproduct/bagasse can be use as heat energy.
Fuel Supply for the Boeing Flight test	• Over 45,000 liters of jatropha (jatropha curcas) • Feedstock for the biofuel flight and engine tests was provided by Terasol, Inc. and was sourced from India, Tanzania and Thailand.	• Approximately 19,000 liters of camelina seed oil was sourced from Sustainable Oils, LLC, which was grown in Montana and Washington states, in the US. • It is grown in rotation with non-irrigated wheat when those fields would otherwise lie fallow and uses the same infrastructure used for planting and harvesting making camelina economical and sustainable.	• The algal strain used was identified as being exclusively Haematococcus. • Approximately 4000 liters of raw algal material was sourced from Sapphire Energy, who received the algae starting material from Cyanotech Corporation, located in Kailua-Kona, Hawaii. • This resulted in approximately 1100 liters of raw oil that was then processed for use in the biofuel flights and engine tests.

Source: Source: Evaluation of Bio-Derived Synthetic Paraffinic Kerosene (Bio-SPK) by Boeing, Alternative Fuels Foreword 2009 , IATA, and some comments by JDI experts

4.2 Reality of Jatropha Supply Chain and Biofuel Supply Capacity

Jatropha has been seriously considered as a LOW COST biofuel feed in the world, especially in EU to practically and sustainably proceed with their aggressive biofuel policies. Due to the growing demand for biodiesel led by advanced biofuel policies in many countries especially EU, favorable governmental subsidies and expectations for the profitable business models, price of the biofuel feed stocks increased continuously (Figure.4.4). Since the prices of the biofuel feedstocks are as identical or similar as commodity (food) prices, there have been serious criticism against biofuel production. Certainly, there were some unbalance between fast growing demand in biofuel feeds and gradually developed supply capacity in short period of time. Once the balance meets, expected effects for agricultural sectors are significantly positive for the long term (FAO agricultural outlook 2008).



Source: Biodiesel 2020: A Global Market Survey. 2nd Edition. FAS

For 12+ years, rapeseed oil prices FOB in Rotterdam averaged $615 USD/mt. The1999-2008 trend demonstrates long term, sustained price increases.

Figure. 4.4 EU Biodiesel Feedstock Prices

As a commercial business operation, Jatropha received serious attentions from the biofuel producers. Due to its "Inedible" characteristics and potentiality to cultivate in non-arable/waste land, it was even more attractive for both biofuel feed buyers and investors into Jatropha plantation businesses. As a result of excessive expectation on Jatropha plantation businesses, there have been numbers of unrealistic announcements of massive scale plantation development since early 2000s. However, mainly due to the immaturity of Jatropha business model and low productivities, few commercial plantations have actually made profits from their operation.

Considering the "Reality of Jatropha supply chains and biofuel supply capacities", it is hardly to find the realistic situation and their capacities due to unfavorable performance of privates' investments. Though the expectation is still high, many investors and businesses have left the Jatropha plantation businesses due to the no feasible experiences. As a result, there are still exaggerated announcement of the Jatropha plantation businesses to attract potential investors, most of such information are not reliable.

After the years of trial and errors, there are some serious voluntary Jatropha communities including public authorities and research centers as well as private businesses making efforts in Jatropha business development. One of such community, "Jatropha book", has been developing a global Jatropha database for the better understanding of Jatropha businesses (http://www.jatrophabook.com/home.asp). The database is created based on the voluntary basis from the participants so that it does not cover all activities in the world. However, most of the major projects seem to be covered. Due to the participants voluntary information, not all information are reliable so that such information shall be considered as reference purpose even its well organized community.

Based on the Jatropha book as of December 2009, there are 150 thousand Ha plantations are registered. Expected size of Jatropha plantation in 2012 will be 3,871 thousand Ha. As historical practices show, the "Expected Jatropha plan" is hardly achievable and far from reality. Though Myanmar (Burma) is not included in the Jatropha book, it is known to the largest Jatropha planted county in the world. Based on a GAIN Report[2] on Biofuel Status in Myanmar by U.S. Department of Agriculture (USDA) Foreign Agricultural Service, there were 1,680 thousand feddan (772,000Ha) Jatropha planted area in 2007(Table. 4.4). Based on the Ministry of Agriculture and Forestry, Myanmar, the planted area have reached roughly 5 million feddan (2 million Ha) in 2009 (Table. 4.4). The GAIN report also reported the seed yields of Myanmar practices though the number is more than 50–100% higher than JDI's observation in Myanmar (Table 4.5).

Table. 4.4 Three-Year Plan of Jatropha for Myanmar (Burma) 2006-2008 and Actual in May 2007

State/Division	2005	2006	2007	2008	2009*	Plan Total
Total:1,000Feddan/ (1,000Ha)	16 (6.4)	2,046 (818)	2,688 (1,075)	3,382 (1,353)		8,117 (3,247)
Actual Total: 1,000Fed./(1,000Ha)			1,680/ (672)		5,000* (2,000*)	
Plantation			715/ (286)		-	
***Fencing/* community forest**			965/ (386)		-	

* Ministry of Agriculture and Forestry, Myanmar confirmed by JDI in 2009
Source: USDA GAIN Report Bio-Fuels Update – Burma (2007)

[2] GAIN Report Bio-Fuels Update -Burma, USDA Foreign Agriculture Thailand Office 2007, <www.usdathailand.org/upload/Burma_Market/BM7015Biofuel.doc