SIXTH FRAMEWORK PROGRAMME

FP6-2004-INCO-DEV-3

PRIORITY A.2.3.: Managing Arid and Semi-arid Ecosystems

First Periodic Activity Report (01.01.2007 – 31.12.2007) January 2008

ANNEX 4-4: Report on Best Practices, Successes and Failures in India

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COMPETE

Competence Platform on Energy Crop and Agroforestry Systems for Arid and Semi-arid Ecosystems - Africa

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Report (Draft) on Best Practices, Successes and Failures in India

Competence Platform on Energy Crop and Agroforestry Systems for Arid and Semir-Arid Ecosystems – Africa (COMPETE)

Work Package 4: South-South and North South Cooperation

Winrock International India

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Executive Summary

The Indian Biofuels Program began during World War II when Ethanol was blended with petrol (gasoline) to meet the shortages during the war. However, the program was abandoned thereafter. India is one of the largest producers of sugarcane, which is the main feedstock for sugar and ethanol. In India, ethanol is mainly produced from molasses, which is the by-product of sugar. The present ethanol blending program began when blending of 5% Ethanol with petrol was made mandatory in 9 States and 4 Union Territories from January 1, 2003. In the finance budget for the year 2003-04, excise duty exemption to the extent of Rs. 0.30 per litre of ethanol was announced which was not extended beyond February 29, 2004. The program was, however, abandoned in second quarter of 2004 as the oil and ethanol industry did not arrive at an agreeable price for ethanol. The program was restarted in a phase-wise manner in the third quarter of 2005. For a 5 per cent blend with gasoline, the demand for ethanol in India is 500 million litres (year 2006-07). Similarly, for a 10 per cent blend, 1200 million litres of ethanol is required (year 2006-07).

The Ministry of Petroleum and Natural Gas in September 2006 made 5 per cent ethanol blending with gasoline mandatory from November 1 2006. This program was envisaged to cover the entire country except states of Jammu and Kashmir, north-eastern states, Lakshadweep and Andaman and Nicobar Islands. Oil Marketing Companies (OMC) have issued tenders and have finalized deals with ethanol suppliers in Uttar Pradesh, Tamil Nadu, Bihar, Jharkhand, Goa, Karnataka, and some parts of Andhra Pradesh and Maharashtra. Tenders have not been finalised for Haryana, Punjab, Himachal Pradesh, Rajasthan, Orissa, Gujarat, Madhya Pradesh and Chhattisgarh. These states have been imposing several licensing and procedural requirements, levying a plethora of taxes and restricting inter-State movement of industrial alcohol. In the States where the programme has been finalised, the OMCs are procuring at an ex-distillery price of Rs 21.50 a litre. The end price of the ethanol blended petrol is not expected to exceed the current cost of petrol, failing which the oil companies would be forced to incur the entire input cost.

Technology in the form of azeotropic distillation and molecular sieve are available. A number of fuel Ethanol plants have been financed by Banks and FIs as there are more than 80 plants in the country with a production capacity of 1,300 million litres per year. Banks have also received proposals from sugar mills for setting up Greenfield Ethanol projects. Some large sugar manufacturers are going in for a spree of setting up large number of sugar mill complexes with ethanol and cogeneration units particularly in the state of Uttar Pradesh. Research and Development is being undertaken by various Agricultural Research Institutes to improve the yield of sugarcane. Research is also being carried out on other feedstock such as sweet sorghum, cassava, sugar beet etc.

The environmental benefits by using ethanol blended gasoline are well known. As ethanol is derived from renewable sources of energy, it maintains the 'carbon cycle' of nature, assists in reducing the 'greenhouse effect' and slowing down adverse effects of climate change. Ethanol is produced from renewable sources, which employs solar energy and prevents depletion of limited and precious resources like fossil fuels. The feedstock for ethanol production includes various crops like

sugarcane, sugarbeet, wheat, rice etc. These substrates are readily available within our country and need not be imported from outside, thus saving valuable foreign exchange and enhance the energy security of the nation. Apart from this, there is a tremendous potential for employment generation in the rural areas of India.

Biodiesel

Biodiesel is a clean burning alternate fuel, produced from renewable resources like virgin or used vegetable oils, both edible and non-edible or from animal fat. It can be used in compression-ignition (diesel) engines with little or no modifications. Biodiesel is simple to use, biodegradable, non-toxic, and essentially free of sulfur and aromatics. It can be stored just like petroleum diesel fuel and hence does not require a separate infrastructure. Its higher cetane number improves the ignition quality even when blended in petroleum diesel.

India is a net importer of edible vegetable oils and it may not be possible to set aside farmland for bio-crops due to the pressure of producing food grains. However, a very vast land area in India is classified as below marginal/degraded/waste land. These wastelands are presently not under regular farming. Considering this, the cultivation of crops for production of non-edible vegetable oil could be taken up to serve two major objectives. Firstly, with proper selection of low nutrition demanding oil-bearing species, the wasteland can be brought under plantation. Secondly, such activity will lead rejuvenation of the wasteland by upgrading the soil quality.

India has an advantage of being a tropical and sub-tropical country where several species capable of giving oil-bearing seeds are known to grow. Jatropha curcas (Ratanjot, Wild Castor, Jangli Erandi) and Pongamia pinnata (Karanj, Honge) are two such trees, which can thrive on any type of soil, need minimum input and management, and have low moisture demand. The propagation of these is much easier and Jatropha curcas starts giving reasonable yields of seeds after the third year of plantation. Both these seeds have high oil content (25-40%) and the yield is adequate to justify its use for biodiesel production. It is estimated that even if 10% of the total wasteland is brought under cultivation of these species, India can produce about 4-5 million MT of biodiesel per annum, which is about 10% of our current diesel demand.

The Government of India has made Ministry of Rural Development the nodal ministry for undertaking Biodiesel demonstration project by planting Jatropha curcas on 400,000 ha of wastelands, which was initiated by the Planning Commission through a Report on Development of Biofuels. Although the Report of the Planning Commission was submitted in July 2003, the first hesitant steps were taken in 2006 with the release of approximately $11 million for this $300 million project. For a 5 per cent blend with diesel 2.6 million tonnes of biodiesel is required (year 2006-07). Similarly, for a 20 per cent blend, 13.38 million tonnes of biodiesel is required (year 2011-12).

In October 2005, the Ministry of Petroleum and Natural Gas announced a bio-diesel purchase policy, which came into effect from January 1, 2006. The policy prescribes that public sector oil companies (IOC, BPCL and HPCL) shall purchase bio-diesel of prescribed BIS specification from registered

authorized suppliers through 20 purchase centres at a uniform price of approximately Rs. 25 (US$ 0.55) per litre (this price has been revised to Rs. 26.50 per litre). The purchase price would be reviewed by the oil companies every six months with due consideration to market conditions.

Several states have taken the lead to promote plantation of tree-borne oil bearing plants. Chhattisgarh is one of the leading states that have taken several initiatives to promote biofuel plantations. The state launched the Chhattisgarh Biofuel Development Authority (CBDA) as the nodal agency to deal with issues related to promotion of biodiesel. The state has set itself an ambitious target of planting jatropha curcas on one million hectares of land. Uttarakhand launched the Uttaranchal Biofuel Board (UBB) as the nodal agency to deal with issues related to promotion of biodiesel. UBB has set itself a target to grow jatropha in 2 lac hectares by the year 2012. UBB has already achieved plantation in almost 1 lac hectare by November 2006. This has been covered in 9 districts of Uttarakhand including 654 Van Panchayats. Uttaranchal has set itself an ambitious plan to produce 100 million litres of biodiesel per annum. Similarly, other states such as Karnataka, Andhra Pradesh, Tamil Nadu, Gujarat, Haryana among other states have launched biodiesel programs in their respective states.

A few large scale biodiesel production facilities are being set-up in India. Entrepreneurs and the corporate sector are investing in these production facilities. A few of them are Nova Biofuels (30 tons per day), Natural Bioenergy Limited (300 tons per day), Southern Online Bio-Technologies Ltd. (300 tons per day). Apart from these initiatives Kochi Refineries Ltd., KTK German Bio Energies India, and British Petroleum are setting up biodiesel units. The European biodiesel technology suppliers are supplying technology for all these companies.

1.0 Introduction

With a population of about 1.1 billion (2006), India is the second most populous country in the world. The Indian economy has been experiencing a robust growth since eighties that accelerated during the nineties and gaining further momentum in the first decade of twenty first century with expectation of sustained growth of over 8%. Approximately 65% of the Indian population lives in rural areas, which depends on agriculture and allied activities. It is estimated that India consumes about 3% of world's energy and is the sixth largest energy consumer in the world. India has a fairly low per capita consumption of primary energy of 520 kg of Oil Equivalent (KgOE) (2003) as against the world average of 1,688 KgOE and the US energy consumption of 7,835 KgOE. India has large indigenous coal reserves and is the third largest coal-producing country in the world that contributes to more than half of its total energy requirements. However, India is not endowed with large crude oil sources. Although approximately 30% of India's energy needs are met by oil, approximately 70% of that oil is imported. Renewable Energy contributes just over 5% of country's energy needs.

Indian Economy has been experiencing robust growth since early nineties. This has resulted in a tremendous growth in the vehicular sector. This can be observed in the Table 1 and Figure 1 below.

Table 1: ***Growth of Various Transport Vehicles in India***

	1970-71	1980-81	1990-91	2001-2002
Two-wheelers	575893	2530441	14199858	41478136
Three-wheelers	36765	142073	617365	1881085
Cars	539475	900221	2266506	5717456
Taxis	60446	100845	243748	684490
Jeeps	82584	120475	443734	1168868
Buses	93907	153909	331096	552899
Trucks	343000	554000	1355953	2088918

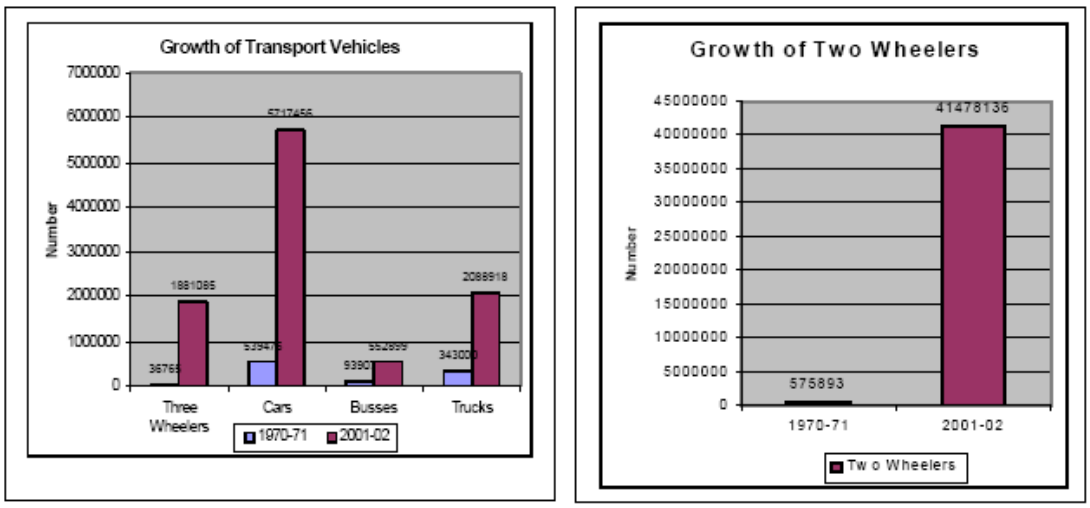
Source: Center for Monitoring Indian Economy Pvt. Ltd. (CMIE)

With the economy expanding rapidly, the number of vehicles is growing at an exponential rate. In the last 30 years the two-wheeler population has grown by about 75 times while that of cars and trucks has grown by more than 10 times and 7 times respectively. This in turn, together with agriculture and industrial requirement, is leading to accelerated increase in the consumption of petroleum products and is reflected in the doubling of consumption of crude oil from 57.75 million tonnes in 1991 to 116 million tonnes in 2005 as can be seen in **Figure 2**. The net import of crude oil to India was approximately 83 million tonnes valued at about $40 billion. It has been estimated by the Planning Commission that the diesel consumption will raise from 39.8 million tonnes 2001-02 to 66.90 million tonnes in 2011-12 while the consumption of petrol will rise from 7.07 million tonnes to 12.85 million tonnes in the same period.

Biofuels can play central role in reducing the adverse effects of economic instability, greenhouse gases (GHGs), and helps in enhancing rural employment and development. Biofuels also reduce vehicular pollution and, in many cases, improve the engine performance and are compatible with existing vehicular fuels and therefore do not require significant investment in development of

new infrastructure as is the case in fuels such as hydrogen. Biofuels thus will play an important role in achieving the goal of sustainable development. Bio-ethanol, straight vegetable oil (SVO), and bio-diesel are the important biofuels in case of India.

Figure 1: ***Growth of Transport Vehicle and Two wheelers***



Source: Draft of Integrated Energy Policy

1.1 Bio-ethanol

The Alcohol industry in India has been in existence for more than a century. This industry received a major fillip during World War II when a number of distilleries were set up to produce 'power alcohol', now referred to as Ethanol, as there was a shortage of petrol. After World War II, the requirement of Ethanol/Power Alcohol dropped drastically because petrol became readily available at very low prices. Most of the units having ethanol producing capacity converted to producing alcohol for the potable and industrial sector. In the late seventies (1979-80) because of the 'oil shock', trials were undertaken in India once again to use ethanol-blended petrol in automobiles. The trials were successful but the program but the pilot projects could not be taken up because of the erroneous conclusion of the technical report that the availability of alcohol was limited. An opportunity was therefore lost in introducing Ethanol on a limited scale in some parts of the country where adequate quantity of Ethanol was available.

In early 1990s highly successful trials of blending ethanol with petrol and utilizing them to fuel automobiles was undertaken in Delhi. However, it was in April 2001 that the first pilot project to blend 5% ethanol in petrol was taken up in Miraj, Manmad (both in the state of Maharashtra) and Bareilly (Uttar Pradesh). The total sale of petrol in these depots was about 13,400 KL per month, which translates into a consumption of 6.7 lac litres of ethanol per month.

Because of the success of the pilot projects, the government issued in gazette notification on September 13, 2002 its decision to make blending of 5% ethanol in petrol mandatory in 9 sugar producing states and 4 union territories from January 1, 2003.

1.1.1 Installed Capacity of Bio-ethanol Production

India is one of the largest producers of sugarcane, which is the main feedstock for sugar and ethanol. In India, Ethanol is mainly produced from molasses, which is the by-product of sugar. There are around 325 distilleries operating in the country with an installed capacity of alcohol (hydrous) of more than 3,500 million litres per year. The installed capacity and production is concentrated in two sugarcane growing states - Uttar Pradesh (UP) and Maharashtra while Tamil Nadu, Andhra Pradesh, Gujarat, Punjab, and Haryana are the other major states. The actual use of alcohol was very limited in the potable, alcohol based chemicals and other uses and the capacity utilization was about 45%. There were hardly any plants producing bio-ethanol and their capacity utilization was also low. The use of ethanol for blending with petrol has resulted in better utilization of capacity of distillery units.

As stated earlier a very limited installed capacity of ethanol production existed in the country prior to the announcement of the Government of India regarding its decision to blend 5% ethanol in petrol because of the very limited applications of this product in other industries. Three ethanol plants that were set up after the Second World War continue to operate in the state of UP with a capacity of 19.2 million litres per year. The above plants are of small capacity, fairly old, and used out-dated Azeotropic distillation technology with Benzene as the third component. These units have been supplying most of the ethanol required for the three pilot projects launched in 2001.

After the launch of the pilot projects and thereafter the mandatory blending notification, there was tremendous interest in the Indian alcohol industry as well as new entrepreneurs to set up ethanol dehydration facilities in the 9 States and particularly in Uttar Pradesh and Maharashtra. As a result, a large number of plants have been set up in these States with maximum capacity being set up in UP and Maharashtra. It has been reported that more than 100 bio-ethanol plants have been set up in India with an installed production capacity of 1,500 million litres.

1.1.2 Demand Projections for Bio-ethanol

The demand for petrol and diesel is shown in **Table 6 and 7** respectively**.** The maximum consumption of petrol is in Maharashtra followed by States of Gujarat, Delhi, Andhra Pradesh, Karnataka and Punjab. The diesel consumption also closely follows this pattern. The Petrol consumption is expected to increase to 10.07 million tonnes in 2005-06 to 12.9 million tonnes in 2010-11. In the same period, the diesel consumption is expected to increase from 52.3 million tonnes to 66.9 million tonnes.

The existing bio-ethanol production capacity is more than 3 times the current requirement of 500 million liters if 5% blend is introduced in the whole country. This is projected to increase at a rate of 7%. With the introduction of mandatory ethanol program, the consumption in the year 2003-04 was 292 million litres as against projected demand of 375 million liters. However, there was a setback in 2004-05 as no blending took place because of higher ethanol prices due to shortages of feedstock and non-renewal of excise duty incentives to the oil companies.

1.1.3 Potential of Bio-ethanol Production

The production potential of Ethanol has been estimated as 10 million tonnes of oil equivalent (MTOE) as per the Draft of Integrated Energy Policy of the Government of India. It has been estimated that 1.2 million hectares of intensive cultivation will be necessary to achieve this target. However, more land can be used if India can improve productivity of agriculture on its 60 million hectares of irrigated land. The projections of the Planning Commission pertaining to the availability of ethanol are conservative as can be seen in the Table B6.1 below:

Table B6.1: ***Ethanol demand and supply for blending with gasoline***

Year	Gasoline demand	Ethanol demand	Molasses production	Ethanol Production			Utilization of Ethanol		
				Molasses	Cane	Total	Potable	Industry	Balance
	MMT	Th KL	MMT	Th KL	Th KL	Th KL	Th KL	Th KL	Th KL
2001-02	7.07	416.14	8.77	1775	0	1775	648	600	527
2006-07	10.07	592.72	11.36	2300	1485	3785	765	711	2309
2011-12	12.85	756.35	11.36	2300	1485	3785	887	844	2054
2016-17	16.4	965.30	11.36	2300	1485	3785	1028	1003	1754

Notes:
1. Area under sugarcane cultivation is expected to increase from 4.36 mha in 2001-02 to 4.96 in 2006-07 which would add additional cane production of around 50 MMT.
2. About 30% of cane goes for making gur and khandsari. If there is no additional increase in khandsari demand, sugar and molasses production would increase.
3. The present distiller capacity is for 2900 Th kL of ethanol and looks to be sufficient for 5% blend till 12 th plan
4. A growth of 3% in potable use and a 3.5% in chemical and other use has been assumed.

The Draft Policy on Biofuels has set a target of 5% biofuels use in petrol and diesel by 2012. It further envisages a medium-term indicative target of 10% by 2017 and 20% in the long-term, beyond 2017.

1.2 Biodiesel

India has an advantage of being a tropical and sub-tropical country where several species capable of giving oil-bearing seeds are known to grow. Jatropha curcas (Ratanjot, Wild Castor, Jangli Erandi) and Pongamia pinnata (Karanj, Honge) are two such trees, which can thrive on any type of soil, need minimum input and management, and have low moisture demand. The propagation of these is much easier and Jatropha curcas starts giving reasonable yields of seeds after the third year of plantation. Both these seeds have high oil content (25-40%) and the yield is adequate to justify its use for biodiesel production. It is estimated that even if 10% of the total wasteland is brought under cultivation of these species, India can produce about 4-5 million MT of biodiesel per annum, which is about 10% of our current diesel demand.

The Ministry of Rural Development is the nodal Ministry for implementing Biodiesel activities in India. A demonstration project was initiated by the Planning Commission by planting Jatropha curcas on 400,000 Ha of wastelands. Although the Report of the Planning Commission was submitted in July 2003, the first hesitant steps are being taken in early 2006.
Under the guidance of Ministry of Petroleum and Natural Gas (MPNG), Indian Oil Corporation R&D

centre has undertaken laboratory trials of Biodiesel. The Indian Oil Corporation (IOC) and Hindustan Petroleum Corporation Ltd. (HPCL) have experimented with various mix of biodiesel with diesel in State Transport buses in Haryana, Gujarat and Mumbai. Indian Oil has also signed a Memorandum of Understanding (MoU) with Indian Railways for plantation of Jatropha curcas on some railway land for demonstration purposes. In October 2005, the MPNG has announced a bio-diesel purchase policy, which came into effect from January 1, 2006. The policy prescribes that public sector oil companies (IOC, BPCL and HPCL) shall purchase bio-diesel of prescribed BIS specification from registered authorized suppliers through 20 purchase centres at a uniform price of approximately Rs. 25 (US$ 0.55) per litre. The purchase price would be reviewed by the oil companies every six months with due consideration to market conditions.

The Indian Railways are the largest users of diesel (about two million MTPA) and also own large areas of land, presently without organized plantation. It is estimated that the Railways can produce enough biodiesel to replace about 5 to 10% of diesel required for their use. Indian Railways and IOC are working together to develop biodiesel for captive use. Railways are also operating trains using a blend of biodiesel and diesel.

Fuel-grade biodiesel must be produced as per strict specifications prescribed in the country. In EU the Biodiesel must meet the EN 14214 specifications while in USA ASTM D6751 have to be met in order to ensure proper performance of the fuel in engines. In India, fuel-grade biodiesel standards prescribed by Bureau of Indian Standards (BIS) must be complied with.

1.2.1 Biodiesel Scenario in India

The present production capacity of Biodiesel is constrained by the production of Feedstocks. Feedstock is constrained by the fact that since the price of vegetable oil has to be low, only the non-edible variety can be used and that has to be planted mainly on wastelands and degraded lands both in forest and non-forest areas. However, there is availability of adequate degraded and wasteland land as estimated by the Ministry of Rural Development. As per the latest estimates of the Ministry of Rural Development (2005), there is approximately 55 million Hectares of Wasteland in the Country. Out of this, it has estimated that about 33 million hectares may be suitable for plantation of TBOs such as Jatropha. In Addition, the Planning Commission has estimated that large tracts of land will be available such as boundary plantation, along the railway tracks & roads, Canals, ponds, and rural households:

Table 2: ***Estimation of lands for Jatropha curcas plantation (National Mission on Biofules)***

Area in Million Hectare

Land Type	Area	Potential for Jatropha plantation
Under stocked forests	31.0	3.0
Protective hedge around agricultural fields	142.0	3.0
Agro-forestry		2.0
Fallow Lands	24.0	2.4
Land related programmes of Ministry of Rural Development		2.0
Public lands -railway tracks, roads, canals etc.		1.0
TOTAL	197.0	13.4

NOVOD Board has made projections for Jatropha plantation for the next 3 years as in Table 3. The above projections for 2006-07 by NOVOD appear to be optimistic but not unachievable. However, the plantation of Jatropha curcas for the year 2008-09 appears to be highly optimistic with projection of 3.1 million hectare. The increase in plantation area is unlikely to take place unless very attractive policies and incentives are in place and the prices of crude oil rise further.

Table B6.3: ***State Wise Plantation of Jatropha curcas***

Sr. No.	Name of State	Plantation upto 2005-06 (in ha.)	Plantation upto 2006-07 (in ha.)	Plantation upto 2008-09 (in ha.)
1.	A.P.	17500	35000	200000
2.	Chhattisgarh	47000	80000	500000
3.	Gujarat	8000	50000	400000
4.	Karnataka	2000	10000	50000
5.	M.P.	1700	50000	100000
6.	Maharashtra	5000	25000	500000
7.	Mizoram	2000	25000	100000
8.	T.N.	5000	25000	500000
9.	Uttranchal	9220	50000	200000
10.	M.O.E. & Forest	-	40000	160000
11.	Railways	3000	25000	47000
12.	Other ministries	10000	50000	200000
	Total	127420	560000	3117000

The projections of Planning Commission for Biodiesel is shown in **Table B6.4**.

Table B6.4: ***Diesel &Biodiesel demand, area required under jatropha for different blending rates***

Year	Diesel Demand MMT	Bio-Diesel @ 5% MMT	Area for 5% Mha	Bio-Diesel @ 10% MMT	Area for 10% Mha	Bio-Diesel @20% MMT	Area for 20% Mha
2001-02	39.81	1.99	N.A.	3.98	N.A.	7.96	N.A
2006-07	52.33	2.62	2.19	5.23	4.38	10.47	8.76
2011-12	66.90	3.35	2.79	6.69	5.58	13.38	11.19

The integrated energy Policy of India has estimated that the potential for plantation for Biodiesel is 20 million Ha and that will result in production of Biodiesel equivalent to 20 Million Tonnes of oil equivalent. This is possible as adequate land resources are available. As against this the Planning Commission has estimated in its report that 13.38 million tonnes of Biodiesel can be produced by 2011-12. The target set by the proposed (Draft) National Policy on Biofuels is 5% Biodiesel blending by 2011-12 ie. 3.35 million tonnes, 10% by 2017, and 20% beyond 2017.

2.0 Policy issues - Biofuels

The biofuel policy is being drafted by the Ministry of Non-conventional Energy Sources. Consultations within the government are being undertaken to finalize the policy. The Salient features of the first draft are as follows:

"The National Biofuel Policy is proposed to contribute to energy security of the country through sustainable production, conversion and applications of biofuels. The policy would be for the duration of **ten-year** time horizon subject to periodic review. This vision statement on biofuels – 'biodiesel, bioethanol and other biofuels **for at least 20% of renewable biofuels** in the petroleum sector especially in the area of middle distillates and to reduce imports of oil by means of displacing imported crude oil or refined oil products by domestically produced biofuels thereby saving foreign exchange and promoting energy security.'"

"This Policy aims at promoting the use of biofuels or other renewable fuels to replace diesel or petrol for transport and other applications with a view to contributing to objectives such as meeting climate change commitments, environmentally friendly security of supply and promoting renewable energy sources. The policy considers the overall climate and environmental balance of various types of biofuels and other renewable fuels."

The Draft policy has suggested following Strategy of the Biofuels Program:

"Biofuels would be able to grow rapidly in the future only if continuous policy support and direction is provided. Various strategies have to be followed for accelerating the pace of biofuel market development in the country. Major strategies as proposed in this policy are as follows:

- Stimulating demand for biofuel by issuing biofuels directive, setting national targets, ensuring sustainable production, conversion and applications.

- Promoting R&D extensively for advanced technologies including second generation biofuels and establishing bio refineries.
- Provision of Tax incentives:
  - Partial or full exemption of central excise duties on all biofuels.
  - Energy Taxation Directives and
  - Incentives for biofuel production, conversion and applications in stationary, portable and transport applications.
- Capturing environmental benefits
  - Setting minimum environmental standards for feedstock production.
  - Providing fuel quality directives
- Targeting applications of biofuels for stationary and portable applications for generation of distributed power, energisation of pump sets, liquid fuel stoves etc., especially for rural areas.
- Active involvement of central and states governments and their agencies in the production, extraction, processing and distribution of biofuels for commercialization.
- Expanding feedstock supplies that combine centralized with decentralized production and applications
- Promoting of public and private partnership.
- Special focus on decentralized market driven approach which takes into account local and regional variations, biodiversities and requirements.
- Setting up of large scale HRD programmes in the central and states including education, awareness, training and capacity building."

It has laid down the following targets:

"The Policy would ensure that a minimum proportion of biofuels is placed in their markets, and, to that effect, shall set national indicative targets. The aim of the policy is to project short term -5% by 2012, medium term-10% by 2017 and long term-20% beyond 2017, demands and plan for the substitution through various forms of biofuels. The National Biofuel Development Board (NBDB) would bring out directives on the following issues:

- Year wise targets for total biofuels quantity required and possible supply
- Year wise target for Tree Borne Oilseeds (TBO) plantations for the next 15 years
- Year wise target for Biofuels (biodiesel) use as a liquid fuel for next 15 years
- Fiscal incentives – including the various tax incentives and rebates at the Central and State level

The policy deals with the following additional elements:

- Proposed Fiscal and Financial Incentives
- Fiscal incentives including taxes
- Financial incentives for biofuels processing and its applications
- Financial incentives for research design and development
- Financial incentives for plantation

- Identification of land and land transfer policy
- Biofuel Purchase Policies
- Refinancing Agencies
- Research, Design and Development (RD&D)
- Use of By-Products
- Legislation for Enabling Use of biofuels
- Demonstration Projects
- Capacity Building
- Evaluation and progress reporting/Monitoring
- National Biofuel Development Board
- National Biofuel Fund

Some of the most important aspects of the policy are:

- Proposed Fiscal and Financial Incentives
- Fiscal incentives including taxes
- Financial incentives for biofuels processing and its applications
- Financial incentives for research design and development
- Financial incentives for plantation
- Identification of land and land transfer policy
- Legislation for Enabling Use of biofuels

It proposes "legislation for enabling use of Biofuels." This envisages the following:

"The Policy promulgation will be followed by an appropriate legislation in the next five years. Legislation to use of Straight Vegetable Oil (SVO), bioethanol, biodiesel and other forms of biofuels would be issued. The legislation will include the following:

- Mandatory obligation of the oil companies to purchase biofuels – bioethanol, biodiesel and other biofuels conforming to the prescribed specifications offered to them and blends it with diesel initially to the extent of 5% and progressively up to 20%, depending on the availability at the depot. The mandatory obligation provision would be in-force only after ensuring sustainable production of biofuels, which is expected to take place in the next five years.
- Engine / equipment manufacturers are required to provide warranties on usage of SVOs / Bioethanol / Bio-diesel / other biofuels and modify the engines / equipments if so required Freedom of the citizen and entities to use Straight Vegetable Oil (SVO), bioethanol or biodiesel in any blend with diesel as fuel in engines that run small industry, agricultural machinery and for power generation in stationary and portable purposes apart from using in transport in rural areas once successfully demonstrated after suitable modifications in the technology.
- Freedom to process vegetable oils, fats etc into biodiesel and use it locally.

However, the above policy is not the final version and therefore may not be comprehensive and many other important aspects may be included through a process consultation. Keeping in view that about 80% of fuel consumed in India is diesel; the Ministry has sponsored R&D studies on

blending ethanol with diesel to be undertaken by IOC (R&D). Trials with 5% blend were carried out after successful development of a coupler for blending of Ethanol with Diesel. However, due to some shortcomings of this blend the implementation of the Ethanol diesel blending has been held up. Also in view of the shortage of Ethanol for 5% blend of petrol in 2004 and 2005 the program has been kept in abeyance. Moreover, Biodiesel has been considered to be a better fuel than Ethanol for blending with Diesel.

The Draft of the Auto fuel Policy of August 2002 also states that "The Development of technologies for producing ethanol and biofuels from different renewable sources can play a major role in commercialisation of biofuels vehicles in the country, which should be encouraged by providing R&D and other support through suitable fiscal incentives".

The Ministry of Petroleum and Natural Gas (MoP&NG) is also promoting the use of Biofuels and on May 15, 2005 the Government of India made the following announcement:

"Promoting Alternative Fuels for Energy Security: Steps were taken to encourage/streamline supply and use of bio-fuels for blending with petrol and diesel. Resources like ethanol, bio-diesel and hydrogen hold a significant potential to supplement efforts to reduce import dependence for hydrocarbons. Implementation of the Ethanol-blended petrol (EBP) programme envisaging 5 per cent blending of ethanol in petrol in notified sugar producing States and adjoining areas was suffering due to inadequate availability of ethanol at reasonable prices. In order to enable smooth implementation of the programme, the Government decided that the Oil Marketing Companies (OMCs) will supply 5per cent EBP in notified areas if the indigenous price of ethanol offered for the programme is comparable to that offered by the indigenous ethanol industry for alternative uses and is also comparable at a particular location to the import parity price of petrol subject to adequate supply of ethanol. The oil marketing companies have accordingly invited tenders for procuring ethanol and the bids are now under evaluation. It is expected that there will be no further roadblocks for smooth implementation of the programme. The **Government** has also mooted a proposal for MoU with Indian Sugar Mills Association (ISMA) for ensuring long term availability of ethanol for EBP programme.

Biodiesel is another area which is receiving the attention of the Government, as this fuel can provide sustainable livelihood to marginalised rural farmers and the landless who can plant/collect Jatropha curcas from the oil of which primarily biodiesel can be made. The Ministry of Petroleum & Natural Gas has committed to lend blending and marketing support for large scale use of Biodiesel when such Biodiesel becomes available through the proposed National Mission on Biodiesel which envisage large scale Jatropha curcas plantation and for which the Ministry of Rural Development has been made the nodal Ministry. The OMCs in cooperation with the State Government are experimenting with running Biodiesel blended diesel buses in Gujarat, Haryana and Maharashtra." (PIB May 15, 2005)

2.1 Policy issues – Bio-ethanol

The Ministry of Petroleum and Natural Gas (MoP&NG) supported pilot scale trials of 5% ethanol petrol blends at three locations/districts. The trials at the Miraj began in April 2001 and in Manmad and Bareilly in June 2001. These pilot plant projects proved to be successful. On December 10, 2001 the Government of India decision to blend 5% ethanol with petrol in phases was announced. The government said that R&D studies would be undertaken to blend ethanol with diesel. It was proposed that Sugar Development Act would be amended in order to provide financial assistance for production of ethanol.

An Inter Ministerial Task Force (IMTF) was formed in order to promote the use of ethanol. The members of this Task force included the Minister of Petroleum and Natural Gas, Minister of Agriculture, Minister of Food, Consumer Affairs & Public Distribution, and Minister of State for Rural Development. Also representatives of Governments of Uttar Pradesh and Maharashtra were invitees to the meetings of this Task Force.

On March 20, 2002, a committee headed by Dr. SJ Chopra, appointed by the Government of India, has concluded that blending of ethanol is a better option than use of other oxygenates such as ETBE, MTBE, etc. This committee also reiterated that the Government had already taken the decision to introduce ethanol in a phased manner. It also stated that the quantity of ethanol required for blending with petrol on an All-India basis would be about 500 million litres.

On February 28, 2002, the government proposed a surcharge of Rs 6.00 per litre on petrol while the surcharge on petrol doped with 5% ethanol would be Rs 5.25 per litre. This was subsequently modified and the incentive for blending of 5% Ethanol in petrol was reduced from Rs. 0.75 per litre of blended gasoline to Rs 0.30 per litre.

A Memorandum of Understanding (MoU) was signed in 2002 by the Ministry of Petroleum and Natural Gas, India and Ministry of Development, Industry and Foreign Trade, Brazil. The MoU provides for sharing of technology and consultancy on optimal blending ratios for best performance, engine and fuel system modifications, comparability of fuel system components, and development of stabilizers for use in ethanol diesel blend. This was very important MOU as Brazil has extensive experience of three decades in operating ethanol program successfully.

Sugar Development Act: The Government in March 2002 has amended Sugar Development Act, 1982 so that production of ethanol and co-generation of power from bagasse would get financial assistance from the Sugar Development Fund. The objects wive was to give impetus to encourage efforts in increasing the use of ethanol for blending and for an efficient use of the entire quantity of molasses currently produced. The increased returns to the units concerned would naturally flow back to the agriculturists. With stable and assured payments, the farmers would gain in the process.

The Government also announced an outline of a road map for Ethanol blending without any deadline or schedule that proposed a program to be undertaken in three stages. During the first

phase, nine sugar producing States and four Union Territories were to be covered followed by the rest of the country in the second phase. The third stage would involve increasing the 5% ethanol-petrol blend to 10%.

Mandatory Notifications: The Ministry of Petroleum and Natural Gas, Government of India, notified on September 13, 2002 that the sale of 5% ethanol-blended (doped) petrol (gasohol) would be made mandatory in 9 States and 4 Union Territories from January 1, 2003. With this announcement, the renewable fuel program based on ethanol was ushered into the country and India joined a select group of nations who promote this oxygenate/fuel that is environment friendly, derived from renewable source of energy and assists sustainable development. The nine States and four Union Territories are: Andhra Pradesh, Goa, Gujarat, Haryana, Karnataka, Maharashtra, Punjab, Tamil Nadu, and Uttar Pradesh. The four Union Territories are: Daman and Diu, Dadra and Nagar Haveli, Pondicherry, and Chandigarh

The Planning Commission of Government of India in its Report on Biofuels in 2003 has suggested that by 2011-12 a target of 10% Ethanol blending should be targeted for which is equivalent to about 1.4 billion litres.

The program however, did not take off the way it was anticipated mainly due to a mismatch between the price offered by the oil companies to purchase ethanol and the one offered by the sugar industry. There were other institutional mechanisms that were not in place for a smooth launch for the ethanol program. Actual introduction of blends took place in the following sequence in 2003:

- Uttar Pradesh – January to February
- Maharashtra & Goa – March
- Karnataka – April
- Andhra Pradesh – July
- Haryana & Punjab – July/August
- Tamil Nadu – Oct (partially)

As can be seen from above, the initial hurdles were overcome in stages and technical feasibility of nation wide program has been established in the year 2003-04 and substantial blending did take place. However, the program suffered a setback in 2004-05 and blending came to a halt due to draught and fall of sugar production, mainly in the Western and Southern states, leading to higher molasses and Ethanol prices. The oil companies stopped lifting Ethanol as the Ethanol manufacturers refused to supply Ethanol at the price of Rs 17.50 per litre fixed in 2003-04. The MoP&NG subsequently amended the notification on October 27, 2004 and made it conditional on availability, import parity price and competitive market prices prevailing in the country.

Keeping in view that about 80% fuel consumed in India is diesel; the Ministry has sponsored R&D studies on blending ethanol with diesel to be undertaken by IOC (R&D). Trials with 5% blend were carried out after successful development of a coupler for blending of ethanol with diesel. However,

due to some shortcomings of this blend the implementation of the Ethanol diesel blending has been held up. In view of the shortage of Ethanol for 5% blend in petrol in 2004 and 2005, the program has been kept in abeyance. Moreover, biodiesel has been considered to be a better fuel than Ethanol for blending with Diesel.

The rules and regulations for obtaining permission for two typical states are given below: -

Existing fiscal and taxation policies for the fuel ethanol sector: The Central Government had imposed an excise duty of Rs. 500 per tonne on molasses used for alcohol production. This has been raised to Rs. 750 per tonne. In addition there is a Central Excise Duty of 16% with an education cess of 2% on the Excise duty on ethanol/industrial alcohol. There is also a Central Sales Tax of 4% against 'C' form for interstate sale of alcohol.

The State Governments impose various taxes on ethanol/ industrial alcohol. Thus, for example in the state of Uttar Pradesh, an Administrative charge of Rs 110 per tonne is imposed on molasses. In addition, a local (state) sales tax of 2.5% is imposed within the state on molasses. For sale of denatured alcohol within the state a fee of Rs 0.15 and an additional fee of Rs. 0.15 per litre is charged as licence fee and denaturant fee respectively. A purchase tax of Rs 0.80 per litre is also imposed on ethanol (denatured alcohol) within the state of Uttar Pradesh.

Interest subsidy scheme - As per our discussions with MNES, it offered an interest subsidy of 3% on IREDA loans for Ethanol made from non-molasses sources. However, there were no takers to this subsidy.

2.2 Policies - Biodiesel

Since Biodiesel concept is relatively new in India, no major policy initiatives have been taken in India except first tentative baby steps. As stated earlier the Planning Commission released a "Report of the Committee on Development of Biofuel" in 2003. This report recommended a very ambitious program for development of Biodiesel in the country. It envisaged that in the first phase a demonstration program would be taken up for undertaking plantation of Jatropha curcas on 400,000 hectares of land, mainly on degraded/wasteland and fallow lands. In the second stage it recommended that a target of 5% of blend of Biodiesel in Diesel by 2006-07 involving a production of 2.6 million tonnes with Jatropha plantation on 2.2 million hectares. It further projected that a blend of 20% would be achieved by 2011-12 that would require 13.38 million hectares of Biodiesel to be blended with diesel. However, the progress has been slower than expected and these targets are unlikely to be achieved as large-scale plantation of TBOs has not started.

Biodiesel Purchase Policy: One of the significant initiatives is the announcement of Biodiesel Purchase policy by the Ministry of Petroleum and Natural gas on Oct 9, 2005. This policy states that, "One of the critical elements for achieving the objective of energy security is the development of alternative sources of energy including Biofuels".

It states that "The Ministry of Petroleum and Natural Gas is already implementing a five percent ethanol-blended program, which is designed **to support agriculture and rural sector."** The Biodiesel Purchase Policy lists the advantages of Biodiesel including its being 'environmental friendly', having almost no sulphur or aromatics and contains about 10% oxygen. It is safer and diesel blended with Biodiesel would result in reduction of Hydrocarbons, carbon monoxide, and particulate matter. It recognizes that "the cost of feedstock is the most important constituent in the economics of Biodiesel Production." It gives the rational for choice of non-edible purchase of Biodiesel from any registered producer of Biodiesel.

It envisages purchase of biodiesel conforming to Bureau of Indian Standards at Rs 25 per litre from January 1, 2006 at any of the 20 designated purchase centre of oil companies. It also states that prices would be revised every six months. The policy envisages that Biodiesel manufacturers would register with the State level coordinators of the oil companies. The registration would be valid for a period of one year. It also stipulated that the product should meet the specifications and would be tested for six critical parameters that are: Density, Viscosity, Flash Point, Water Content, Copper Corrosion, and Acid Value.

The minimum quantity to be supplied per consignment would be at least 10 KL. It states that priority would be given to producers using non-edible oils and supporting the farmers. However, the practical experience has shown that due to high prices of feedstock, there has been no purchase of Biodiesel at these centres. The Biodiesel manufacturers are now awaiting announcement of new prices, which was due on July 1, 2006. The location of only 20 centres in a large country like India is a barrier. The registration every year is another barrier. As long as a supplier is supplying regularly as per contract the need for registration year does not appear necessary.

Some state governments have announced policy measures. For example, both Uttranchal and Chattisgarh have set up Biofuel and Biodiesel Boards. They have notified a purchase policy for procurement of oilseeds and announced a minimum support price. They have also undertaken large scale plantation. Some governments have announced policies for lease of wasteland in Madhya Pradesh, Chattisgarh and Rajasthan. The Andhra Pradesh Government has also prepared a draft Biofuel policy. The policy issues, both at Central and State level, which will promote Biodiesel program are almost identical.

3.0 Barriers and challenges

3.1 Bio-ethanol

As stated earlier, the Government of India had announced a policy to blend ethanol with petrol. However, the program did not commence as smoothly as was expected on January 1, 2003 for a number of reasons as stated below:

- Adequate ethanol production capacity had not been established to supply Ethanol to the oil Companies, as the time period of three and half months was insufficient. However, a

substantial capacity was being set up in most of the sugar producing states to meet the demand.

- The Oil Companies also did not have adequate facilities for testing, storage and blending at the various oil depots (warehouses).
- Prolonged price negations between the Ethanol Companies and Oil Companies were another factor. Ultimately, a uniform price of Rs 17.50 per litre ex-factory was agreed upon but ethanol producers in many states resisted.
- A major barrier that was encountered was the absence of long-term policy and frequent changes in the policy. For example, the Government had announced an excise duty benefit of Rs 0.30 per litre for blending 5% Ethanol in Petrol, which benefited the oil companies. However, the excise duty incentive was later withdrawn and the rising prices of feedstock (molasses) and Ethanol, because of lower production of sugarcane due to adverse weather conditions, resulted in complete stoppage of the entire program from the financial year 2004-05 as the oil companies were not prepared to pay a higher price for ethanol.

- Mandatory notification of Sept. 2002 for blends of Ethanol is concerned the Government also decided to modify it. The new notification of October 2004 added major conditions to the mandatory clause. These conditions include "if the price of sourcing indigenous ethanol for supply of ethanol blended petrol is comparable to the price of indigenous ethanol for alternative uses, and the delivery price of ethanol at the location is comparable to the import parity price of petrol at that location and the indigenous ethanol industry is able to maintain the availability of ethanol for ethanol-blended petrol program at such prices". The State of Uttaranchal was added to the list of states and it mandatory provision was applicable to most districts of Andhra Pradesh, except Chittor and Nellore districts, and 9 districts of Tamil Nadu.

There are a number of other major issues/barriers related to the successful implementation of this program, which involve all the stakeholders. Some of the major barriers, which may hinder streamlined implementation of this program, are listed below:

3.1.1 Central & State Government

- There is a lack of comprehensive Policy on Biofuels and lack of incentives. No Ministry/Institutional body/nodal Agency has been assigned or set up by Government to coordinate the efforts of Ethanol sector, which has representation from all stakeholders in order to frame pro-ethanol policies and address major issues. The Ministry of Petroleum and Natural Gas plays the role in facilitating purchase of Ethanol but not in promotion of the same through comprehensive policies.
- Undue controls and restrictions of the State Government in the production, sale, movement and distribution of ethanol. There are restrictions even on setting up of new plants and to upgrade and/or expand existing plants. Currently, the new alcohol manufacturers need to obtain a license from the State Excise Authority. This leads to a major barrier for the entry of new players. There should not be any permission required from State Government in this regard.

- Control on interstate movement of ethanol by the State Governments is another major barrier, which needs to be removed.
- High tax, charges, levies, fee including import and export pass fee on interstate movement of ethanol needs to be removed.
- Moreover in a number of the states, for every tanker-load supply of ethanol to the oil companies, the alcohol manufacturers need to get permissions from the State Excise Office, which is a cumbersome procedure. There should not be any need for such permissions once the Ethanol has been denatured, and therefore this process needs to be discontinued. Even if such a procedure needs to be continued, the permit needs to be made available by the Officer In-charge posted by the State Government at the distillery.
- The procedures for loan approvals, disbursement of funds from Sugar Development Fund for setting up Greenfield distilleries/ethanol plants need to be made simpler and faster. Currently, the Ethanol industry has to wait for a longer time to get funds to upgrade their plants.
- Presently, there are no incentives available from the Government for the production and supply of Fuel Ethanol. Incentives for this sector need to be given on lines similar to other renewable sources of energy. The incentives in the form of capital subsidy, soft loans, and excise and custom duty concessions are required.
- At present, there is a restriction on the use of various substrates including sugar cane and grains for manufacture of ethanol. These restrictions need to be removed to enable ethanol manufacturers to use the most appropriate, economical and readily available substrate.
- The state laws, rules and regulations are out-dated and need to be totally revised and simplified.
- Renewable energy technologies are given tax incentives world over and India should not lag behind in implementing the same as the usage of renewable energy technologies provides energy security to the nation.
- The Government has announced a policy to blend 5% ethanol with petrol with the intention to cover the whole country in Phase two, subsequently increase ethanol petrol to 10% and introduce 5% ethanol diesel blends. However, it has not specified any milestones or issued a roadmap on the implementation of the entire program, which is very important for its success. Unless a time bound program for the coming years is announced there will be lack of clarity and uncertainties, which will lower the level of commitment in all the stakeholders. Therefore, timely large-scale investment and adequate capacity building cannot be expected to take place in absence of coherent biofuels friendly policy and removal of restrictive regulations and controls by the States.

3.1.2 Feedstock

The Central Government fixes a minimum statutory price for sugar cane and other crops and the State Governments in turn fix their own price – State Advised Prices. The unrealistic statutory price may be a barrier to other feedstock like cane juice and other substrates. As the cost of production varies from state to state, the cost of ethanol would also vary. It is desirable to have a uniform policy and tax structure across the country on this issue. There is doubt whether sugarcane is

permitted to be used as a feedstock for Ethanol as stringent monitoring is done by the Cane Commissioner's office in each state. The clarity on this issue is lacking.

In view of this the industry relies on one feedstock i.e. molasses. In the foreseeable future molasses may not be able support a blend of more than 5% to 7.5%. The industry should diversify its feedstocks and use if required for potable purposes other feedstocks such as sweet sorghum, sugar beet, grain, tubers etc.

3.1.3 Oil Companies and Dealers

Adequate storage capacity for Ethanol is not available at many depots of oil companies that undertake blending. This is a barrier to stream lined operations and the oil companies and the dealers need to build up their blending capacities.

Delay in making payment against supply has been reported to be another issue that hinders streamlined blending of Ethanol in many depots of oil companies Prompt payments by the oil companies to the ethanol producers are necessary.

3.1.4 Automobile Manufacturers

While the oil companies have no objection to blending 10% Ethanol as is the practice in many countries such as USA, the automobile industry has been raising issues on material compatibility in using a 10% blend of Ethanol. The Society of Indian Automobile Manufacturers (SIAM) should take up such issues concerning auto manufacturers and assist in resolving them. The SIAM felt that the ingress of water into the storage tanks could cause drivability problems. SIAM also had a concern that corrosion could also arise due to improper handling, storage and dispensing of ethanol at the distillers' end as well as the oil manufacturers' end.

Another issue that is being raised is the reduction of caloric value, and thereby fuel economy, if a 10% ethanol blended petrol is used. However, the global experience shows that the reduction is marginal i.e. 0% to 3%.

3.1.5 Ethanol Manufacturers

- The Government made 5% ethanol blended petrol mandatory from January 1, 2003. However, adequate capacity, both for Ethanol production (dehydration of alcohol) and for testing, storage and blending of Ethanol at the oil depot, did not exist on that date. This was a major barrier and new plants had to be set up and other sources for producing ethanol had to be developed. An additional 30 to 40 ethanol facilities were to be set up in three and half months (by January 1, 2003) with a minimum production capacity of 350 to 400 million liters, which was not possible. This was a major temporary barrier, as the government had not given adequate notice to develop these facilities.
- Another barrier, which the producers have run into is the availability of feedstock. Currently, the industry is dependant on only one substrate i.e. molasses. The availability of molasses is dependent on sugar production, which is erratic. This is a barrier and there is a need to start examining the potential of other substrates like sugar cane juice, sugar beet, sweet sorghum,

corn, inedible and damaged grain, bagasse, biomass, agricultural and forest residue etc to meet the entire demand of the country.

- The existing alcohol plants (distilleries) are of relatively small capacities and the technology is also of a lower level. These plants need to be upgraded to meet the ethanol requirement in the country in a cost effective manner.
- The sugar content of the existing sugarcane is low and the yield per hectare of sugarcane is also less. This is a barrier and needs to be addressed.
- Another important barrier is that the Ethanol industry does not have adequate R&D facilities. They need to set up R&D units to improve the yield and the quality of ethanol produced from conventional feedstock.

3.1.6 Standards and Certification

Currently the Bureau of Indian Standards (BIS) permits only a 5% ethanol blend with petrol as per IS 2796:2000. Thus, there is a barrier for use of 10% ethanol blend at present. Based on the successful trials conducted by Indian Oil Corporation (IOC) and the favourable report submitted by them, the Standard for Petrol (Motor Spirit) needs to be amended to a permit use of 10% blend with petrol. BIS does not specify any guidelines for using an ethanol blend with diesel. Tests are being carried out for ethanol diesel blends and these have met with partial success. BIS standards for ethanol diesel blends will be introduced only if the standards are suitably amended. However, there is no hurry to introduce relevant standard as there is a shortage of Ethanol in the country and Biodiesel is perceived to be more compatible with diesel than Ethanol.

3.1.7 Research and Development

Currently there are no links between R&D organizations and the industry. This link should be encouraged to facilitate the promotion of ethanol. Adequate R&D facilities for undertaking research in biomass to ethanol, developing new technology and improving the yields are not available. Moreover, funds for these have not been allocated. Denaturant is added to ethanol so that it cannot be used for drinking purposes. Cheaper denaturants need to be developed and approved by the government.

3.1.8 Banks/Financial Institutions (FIs) Biofuels

- Many Bank and financial institutions (FIs) are not fully informed about various aspects of technology plantation of feedstock and Biofuels manufacture, particularly Biodiesel. This is a barrier and needs to be addressed by way of capacity building exercises of training adequate manpower, if required
- Since the technology for ethanol projects is relatively new, Banks/FIs may not be conversant with various aspects of technology and viability of Biofuels projects.
- Another barrier is that the Banks/FIs may not be fully aware of the government policies and procedures relating to supply/usage of Biofuels. The Banks may also not be aware of the benefits, available from the government to the industry to produce Biofuels. However, as a large number of plants have been established the Banks are now better equipped to deal with Ethanol related issues.

3.1.9 Environmental Issues

The effluent from production of Ethanol from molasses has high COD and BOD as it is rich in organic matter. This effluent even after treatment does not, generally, prescribe to norms of Pollution Control Board leads to pollution. The Board has prescribed that all alcohol manufacturing units will have zero discharge. The use of Bio-composting of sugar press mud with effluent has been successfully undertaken to achieve this norm. However, the adequate availability of press mud and other biomass is often a constraint. Thus this has become a major barrier in setting up large sized distilleries. Brazil produces most of its Ethanol from sugar cane, which produces effluent with lower BOD and COD loads. It undertakes ferti-irrigation with this effluent in the sugar cane and other crops. The Indian norms for ferti-irrigation are very stringent and require bringing down the BOD to very low levels, which is very costly, and therefore is not being widely practiced.

3.2 Biodiesel

The barriers to Biodiesel Program are similar to Ethanol program. Most of the barriers listed in the above section on Ethanol are also applicable not only to Biodiesel but also generally to all Biofuels. However, there are some issues that are applicable only to Biodiesel that have been enumerated and examined in detail in this section.

As per the Biodiesel Purchase Policy, blending of Biodiesel with diesel was to commence from January 1, 2006. Based on this policy it would appear that there would be a rush to produce and supply Biodiesel to the Oil Companies. However, as per information available no blending of Biodiesel has taken place in the last 6 months as no Biodiesel was supplied to 20 purchase centres that were made available for procuring Biodiesel produced. It is obvious that there are important critical barriers that are preventing widespread use of Biodiesel in the transport & other sectors. The key barriers are availability of Feedstock, absence of policy, Pricing, lack of Financial Incentives, This section gives details of each one these barriers.

3.2.1 Central and State Governments – Policy and Regulation

Biodiesel faces similar issues relating to barriers as Ethanol. However, the Biodiesel sector is not as highly controlled and regulated as Ethanol. Thus the movement and use of Biodiesel would be considerably easier than Ethanol.

3.2.2 Central Government

Lack of Vision and Long-Term Policy: As stated earlier, the Government of India has not enunciated a vision that has broad consensus of the legislature so that necessary political will be created to enable Biofuels Program to continue whichever political party comes to power. It has also not formulated a long-term policy that has general approval of all major parties so that all concerned stakeholders can enter this area with a measure of confidence.

The Government has not undertaken any major program to incentivize growers/farmers/entrepreneur to undertake plantation of Jatropha curcas and other TBOs. This is required as it takes 3 to 10 years for such plants to give commercially viable yields of seeds.

It is necessary to mandate the use of Biodiesel in petro diesel as a blend, subject to availability at the depot. Once mandate is announced the Oil Companies will buy at prices, which are determined by market forces and not based on unrealistic announcements of Ministry of Petroleum. As the plantation size increases, feedstock availability and efficiency of the industry will increase. This along with competition will result in lower prices of Biofuels in general and Biodiesel in particular. Uncertainty or unfriendly Biofuels Policy will not attract entrepreneurs to invest and financial institutes to finance this sector.

As the cost of production of Biodiesel is substantially higher than the price offered by the oil companies as per the Central government's Biodiesel Purchase Policy, it is one of the most important barriers that has to be overcome. For this the Government needs to announce certain tax incentives and, if required, subsidies for making Biodiesel more attractive.

The government has not defined 'Biodiesel' or 'Biofuel' in a category that will attract minimum taxes and duties or will exempt duties for a period of 7 to 10 years. In fact there is confusion on this account.

3.2.3 State Governments

Many State Governments are encouraging Biodiesel Program, Initiatives have been taken by a few State Governments to announce Biofuel Policy of their States. Theses States include Andhra Pradesh, Chhattisgarh and Uttranchal Pradesh. Some of the States such as Chhattisgarh and Uttranchal have formed **Chhattisgarh Biofuels Development Authority** and **Uttranchal Biodiesel Development Board** respectively. Other States have not taken any such measures. Many States have not given any incentives to the Biodiesel program such as exemption or lower VAT, land allotment, incentives for taking up of TBO plantation, lease of wasteland on lease for plantation of TBOs. Some states are contemplating introducing new policies on lease.

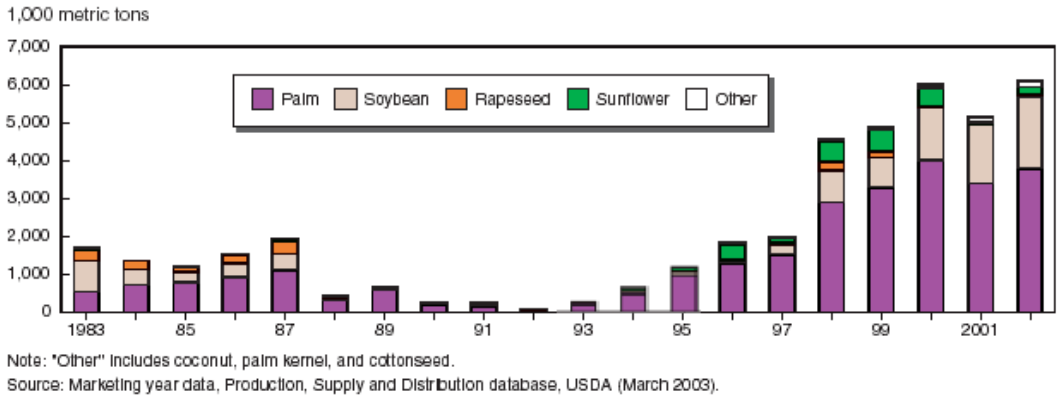
The main barriers at the state government level are:

- Lack of Nodal Minority or Agency dealing with Biodiesel in most states
- The Sales Tax/Value Added Tax has not been defined in many states and producers are not certain in many states are not sure what tax rates will be applicable.
- Transfer of land on lease to growers/farmers/entrepreneurs for undertaking plantation is another barrier that needs to be addressed immediately.
- Assurance that minimum price would be available for the feedstock (seeds) is another barrier that needs to be addressed to instil confidence in the grower.
- Making available quality planting material at a reasonable rate is another barrier in which the government can play the role of a facilitator.
- The lack of standardized agricultural practices for growing of TBOs is another barrier that the grower is facing. The Agriculture and Forest Department can also play an important role in contributing to this by using its organizations such as Agricultural Centres for dissiminating this information and providing knowledge inputs to the growers.

3.2.4 Feedstock

Availability and price of Feedstock (vegetable oil) for Biodiesel is the most important barrier. In this context, it must be noted that India is not self sufficient in edible oils and is a large net importer of edible oil. In fact, the imports of edible oil have grown significantly in the period 1993 to 2001. Subsequently there has been a flattening of imports as can be seen in the **Figure B2.1** & **B2.2**, which also shows the composition.

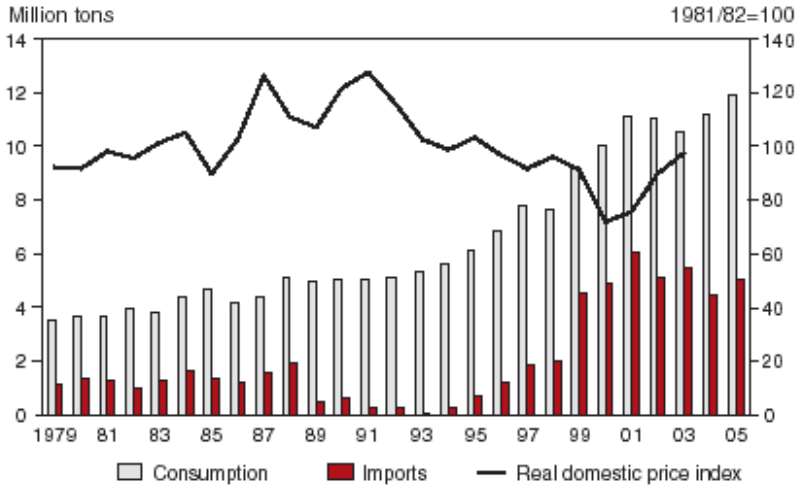
Figure B2.1: ***Composition of India's edible oil imports***



Note: "Other" includes coconut, palm kernel, and cottonseed.
Source: Marketing year data, Production, Supply and Distribution database, USDA (March 2003).

The market wholesale prices of edible oils are also high as compared to International prices, as import duty is very high and as demand is outstripping the indigenous supply. The Government also has kept the minimum support prices for oil seeds high as it wants the farmers to undertake its plantation and thereby increase indigenous availability of edible oil.

Figure B2.2: ***Edible oil consumption, imports, and prices, India***

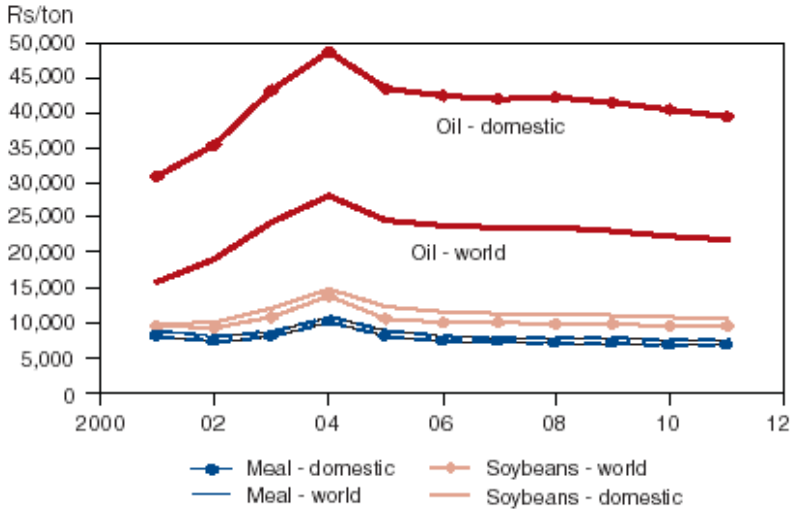


Source: USDA Production, Supply, and Distribution database; Economic Survey, Government of India.

The Indian yields of oil seeds are low as compared to international. Domestic market prices are higher despite the fact that Indian per capita income is considerably lower than developed

countries. The average prices of oil seeds and oil are significantly higher as has been illustrated in the case of soybeans and its oil in the **Figure B2.3** below:

Figure B2.3: ***Reference scenario price trends for a soybeans and products, India***



Source: ERS, India oilseed sector model.

It can therefore be concluded that use of any edible oil for producing of Biodiesel is not an economically feasible solution and therefore is a major barrier. The availability of used or waste vegetable is also limited as supply chain is not established and most of food processing takes place in the unorganized sector.

In view of the barrier of price and availability there are two options available to overcome it:

- Import low priced edible or non-edible oil e.g. Crude Palm Oil or Palm Fatty Acid Distillate at concessional duties.
- Use non-edible oil both imported and indigenous for Biodiesel production.

The import of edible oil such as Crude Palm Oil for producing Biodiesel is not viable as it attracts very high total import duty of almost 90%. The only option for overcoming this barrier is to reduce the import duties of such oils. However, there is resistance in GOI to permit the import of edible oil for production of Biodiesel at concessional import duty as there is apprehension that this oil will be misused for sale as edible oil in the domestic market as the profit margin would be substantially higher in this case.

Unfortunately the availability of non-edible oils is also limited although it has a good potential (Annexure III-1). Most of the non-edible oils are based on Tree Borne Oil Seeds (TBOs). The TBOs in India are mostly located in forest area and are scattered and therefore accessibility is a problem. This problem is further complicated by the fact that many of these oilseeds are available only in rainy season when accessibility is more difficult and the oilseeds tend to get spoilt before they can be harvested, normally after monsoons. This is a major barrier that needs to be overcome. Thus, although the potential is reasonably high but the actual collection is low.

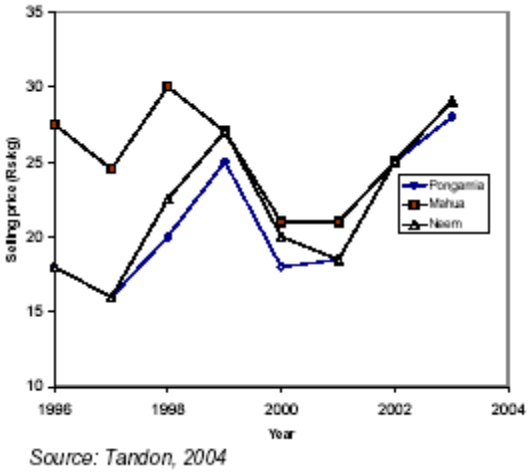
The low availability of non-edible oilseeds and oil has had an adverse effect on the price in the past few years. Particularly recently when the demand of non-edible seed and oil has increased tremendously due to various stakeholders eyeing the potential demand due to 'hype' built up by the future demand of Biodiesel, which will use essentially non-edible oils. The seeds of Jatropha curcas, for example, are available at anywhere between Rs 10 to Rs 50 per kg in the wholesale market. Most of the Jatropha seed is currently being used for growing planting material and is commanding a high price even though the quality of these seeds as planting material is suspect. The cost of various non-edible oils seed is shown below **Figure B2.4** and **Table B2.1.**

Table B2.1: ***Price levels of Pondamia oil seeds at various stages of trading***

Year 2002-2003	(In Rs/100 kg)	
	Minimum	Maximum
Village markets	300	400
Primary wholesale markets	400	500
Wholesale markets	500	700
Regulated markets	600	900
Export markets	600	900
Import markets	600	800
Source: Raju K.V. 2003 (on-going study in Kolar district of Karnataka)		

Source: GTZ Report

Figure B2.4: ***Selling price of oil derived from main TBOs***



Source: International Biofuels Conference –Winrock International India

This barrier is sought to be surmounted by undertaking large-scale plantation TBOs in the country on large tracts of wasteland in the country and making available feedstocks at reasonable rates.

3.2.5 High Cost of Biofuels (Biodiesel) Compared to 'Petrobased' Products

The cost of Biodiesel is at present significantly higher as compared to petro-based diesel. The price of Biodiesel is reported to be Rs 40 to Rs 110 per litre as against the present retail price of diesel of Rs 33 per litre (Delhi). Since large-scale plantation is taking place in the country the price of Jatropha based Biodiesel was reported to be even higher at Rs 80 to Rs 110 per litre.

Against this, the purchase price announced by the GOI, as a part of purchase policy, was Rs 25 per litre landed at the purchase point/depot of the oil company. It is reported that no Biodiesel was sold to oil companies at this price in the period of January 1,2006 to June 30, 2006. A price revision was to be considered after this period, which has not been done till date. As stated earlier, the high prices are due to high non-edible oil seed prices such as Jatropha, Pongamia etc. Since feedstock constitutes more than 70% of the cost of production of Biodiesel, the product price can become lower only if the feedstock prices fall.

It must also be noted that non-edible oil has competitive demand such as soaps, detergents, cosmetics etc. that can buy this oil at a higher price than Biodiesel.

In this context the price of Biofuels, especially Biodiesel, is influenced significantly by the price of by-product(s). Thus the lower anticipated prices of glycerine would leave producers of Biodiesel with smaller margins to cut prices. If the price of Glycerine falls from Rs 50 to Rs 25 per Kg, the net realization of the Biodiesel producer will reduce by about Rs 2.50 per litre.

One option of keeping the cost down is to use the SVO as a fuel for stationary Engines. Small Engines can be used in villages to either electrify the village or to run various power-related commercial and agriculture activities including pumping of water for irrigation, village flour mill, welding facility, oil extraction facility etc. The avoidance of transesterification may lead to lower costs in terms of avoidance of transportation, processing and taxes.

3.2.6 Plantation

3.2.6.1 Maturation period of TBOs: Unlike most edible oil crops such as soy bean, rape seed, sunflower etc., the maturation period of most non-edible oil seeds bearing trees/plants is very long- normally 5 to 10 years. This is a major barrier for promotion of Biodiesel and SVOs as it involves barriers in terms of sustenance without a ready source of income, uncertainty and risk for the Biodiesel producer as he cannot set up his production unit immediately. The poor growers / farmer for whom the plantation is supposed to be the panacea for livelihood, this problem is particularly grave as the plantation involves costs and then waiting for a period of 4 to 5 years without significant income. This barrier can be overcome if package of practices for intercropping are developed so that farmer can earn regular income from these crops while the Jatropha matures.

3.2.6.2 Availability of Quality Planting Material: Quality Seed for propagation is not available in quantities required at present. Plantation is taking place with planting material, which is not of definitive quality. Ready access to reliable quality of planting material (seed or sapling) at reasonable price to the grower has not been assured through out the country. Reliable planting

material will make grower confident about the yields. At present seeds of questionable quality are being procured for plantation by growers at price as high as Rs.100 to 200 per Kg.

3.2.6.3 Status of TBOs Agro-technology & Formulation of Agricultural Practices: As the climatic and soil conditions vary widely in India it is necessary to prepare a package of practices for various agro-climatic regions of the country. The knowledge about optimum package of practices is lacking for most TBOs and particularly for Jatropha curcas. Since TBOs are long maturation crops, it requires a fairly long time to finalize package of practices. The plant spacing also will vary. In addition, management of plantation including plant protection against diseases and pests has not been fully developed for each region. In this context, R&D is taking place in a large number of centres in various locations in India.

3.2.6.4 Yield of TBOs including *Jatropha curcas*: Definitive data of yield in various parts of the country is not available. It has been assumed that on an average in un-irrigated conditions 4 tons of seed will be produced per hectare of plantation and it will yield 1.250 tons of oil and 2.75 tons of oil cake. These production levels may not be achieved. The yield would have definite effect on the viability of the program.
It is expected that farmers in their own holdings that have low productivity, fallow lands and on their field boundaries will take to plantation of Jatropha curcas.

3.2.6.5 Price variation in Price of Seed: Most states have not announced minimum prices of seed that will encourage farmers to take up plantation that will give commercial yield in 3 to 6 years. If the prices of seed fall or the farmer is not able to sell seed he may remove the plantation.

3.2.7 Oil Companies and Dealers

The experience of Ethanol blending and barriers thereof will be relevant to Biodiesel also. The issues are almost the same. One issue that is unique is the Government's decision to select only 20 purchase centres for purchase of Biodiesel in the country. Therefore, the Oil Companies have developed very limited infrastructure for blending. The purchase centres should be set up at oil depots nearest to Biodiesel producers so that cost of transportation can be minimum. Thus this may be a barrier to blending of Biodiesel. Adequate infrastructure for blending needs to developed at all depots nearest to the Biodiesel plants being set up in order to reduce transport costs and thereby reduce the blending costs of Biodiesel. In order to cover the cost of setting up this infrastructure, no incentive has been provided to the Oil companies.

The personnel responsible for purchase and blending of Oil Companies have had the tendency of not being too enthusiastic about blending as it may be involve additional tasks such as testing of Biodiesel, blending, account keeping etc. It is important that these personnel are aware of the long-term advantages of Biodiesel and remain motivated. This has been accomplished to some extent because of wide publicity given by media and the unique role being played by the President of India in promotion of Biodiesel

The Oil companies need to interact with reputed producers and set up adequate blending and testing facilities so that delays in purchase can be avoided once the Biodiesel facility starts producing commercially. The Oil companies need to assure supply of anti-oxidants and flow improvers and other chemicals for blending so that the diesel user faces no operational problems.

3.2.8 Automobile Manufacturers

The experience of Ethanol blending and barriers thereof will be relevant to Biodiesel also as the issues are very similar. The Engine and Automobile manufacturing companies need to warranty all types of engines for use up to 20% blend and need to make minor modification in rubber and other parts. In the past Automobile Companies have been hesitant to promote Biofuels. Some of them have been resisting 10% Ethanol. They have not announced openly that they would warrantee vehicles that use up to 10% Biodiesel- blended diesel. SIAM has an important role to play in coordinating the efforts of the oil companies.

3.2.9 Biodiesel Manufacturers

One of the major barriers of high cost of production in the infancy stage of biofuels/biodiesel program is the small unviable plant size, which does not lead to economies of scale. In order to achieve this, availability of feedstock has to be ensured and would require both consumption and production volumes to grow substantially.

Smaller plant size leads to higher cost of production and this in turn becomes a barrier, as Biodiesel cannot compete with diesel. This barrier can only be overcome if the import of vegetable oil, and Fatty acid distillates is permitted at very low import duties in the initial few years. However, the prices of imported oils can also increase significantly as there is a large demand of such oils by a large number of countries. Therefore, the risk of increase of price of imported oil is a barrier both for the producer as well as for the Financial Institutions and Banks.

The Biodiesel manufacturers in India that are producing requisite quality of Biodiesel in sufficient quantities are limited. This is primarily due to the fact that feedstock is not available at present. However, some producers are setting up units that are based on imported oils and at least one of them has opted for 100% export oriented unit.

3.2.10 Standards and Certification

The Biodiesel Standards as per BIS have been formulated (IS15607:2005). However, these standards generally follow the EU Standards for Biodiesel and are very stringent. Testing facilities for assessing all the specifications as per these standards is not widely available. Therefore this standard may become a barrier as the producer may not be able to control all the parameters of quality as laid down in the specifications. In addition, only 5% Biodiesel is permitted to be blended in diesel as per the BIS Standards.

3.2.11 Banks/Financial Institutions (FIs) Biofuels

The experience of Ethanol blending and barriers thereof will be relevant to Biodiesel also. The issues are almost the same. However, one major potential barrier that can be created by bank is

lack of willingness to give moratorium period of up to 5 years or more for plantation of TBOs. This is important as large-scale plantation in the organized sector can only take place if funds are available from the financial institutions on reasonable and practical conditions. NABARD is already aware of these issues as they are similar to those in the horticulture sector.

3.2.12 Large number of stakeholders & lack of coordination agency and coordination

One of the major barriers in promotion of Biodiesel is that a large number of stake holders are involved. Within the Central Government there are many ministries and organizations that are dealing with various aspects of this program. However, the nodal ministry for taking up this program has not been named although the nodal ministry for the Demonstration Project has been named as Ministry of Rural Development. Other concerned ministries need to accept and cooperate with the designated ministry. The State Governments need to take interest in the program in a sustained manner and designate a nodal ministry or a high-powered body for this program. There may be a probability that the desired degree of cooperation from the concerned ministries / departments or States may not be forth coming and therefore, high level Inter Ministerial Taskforce may need to be created to overcome this barrier.

3.2.13 Fluctuations in the price of Crude oil

The international price of crude oil may fall down sharply, even if on a short-term basis, and the oil companies may not purchase bio-diesel for blending. Even if the crude prices do not fall, the economic price of biodiesel may be higher than the HSD especially at the initial infancy stage of this industry and the oil companies may be reluctant to buy biodiesel. The blending of biodiesel needs to be made mandatory which at present it is not. The oil companies have not been directed through administrative measures and also through a law that they will purchase all biodiesel offered to them and blend them with diesel irrespective of crude oil prices.

3.2.14 Competing Demand of SVO

There may be competing demand for non-edible oil commercial uses such as soap making, cosmetics, straight vegetable oil as a fuel, biodiesel or even as seed etc. If the price of oil for competing product is higher, as is the case with soaps, cosmetics etc., then it may not be commercially viable to produce Biodiesel. At present the demand of seed as planting material is so high that SVO is totally unviable as a feedstock for producing biodiesel in most parts of the country.

3.2.15 Establishment of Linkages

At present the market mechanism for Biodiesel is weak as hardly any linkages exists between the grower, oil extractor, biodiesel producer or biodiesel user. Unless the grower is certain that his seed will sell he will be hesitant to take up plantation. Linkages have to be established at the earliest.

Availability of oil seed is the basic requirement for which funds are being made available. The assumption is that once the required area has been covered with plantation, the existing units for oil expression / extraction would be able to utilize the seed produced and provide oil to the processing units. Likewise the assumption is that the transesterfication units will come up in the

catchment area of the plantations. Both these assumptions have a probability of going wrong, especially because no direct financial incentives in the form of subsidies are envisaged.

3.2.16 Availability of Wasteland

Although India has about 55 million Ha of waste land and about 33 million Ha appears to be fit for cultivation, the actual availability after taking into consideration the minimum rainfall of 600mm, present land use and other prerequisite conditions will be lower. The ownership of land is also not clear. There has to be clear cut guidelines so that grower of Jatropha has access to land, tenancy rights and right to sell produce (Oil seeds etc.). In forest land also which constitute nearly half of the total actual land fit for cultivation the above-mentioned issues need to be sorted out so that the land is actually made available for cultivation. Another issue that may be a barrier is the competing use of the degraded lands for grazing, subsistence crops and for Biomass for fuel.

3.2.17 Long Gestation and Terms of Land Lease

Since the maturation of TBOs takes a minimum of 4 to 5 years it is imperative that in case land is being given on lease the lease amount should be reasonable/affordable and that the lease payment for the first 5 years be paid in instalments in the subsequent years. This is a major barrier for marginal grower/farmer. Land lease conditions needs to be practical and attractive. The adverse effect of long gestation period can be overcome by developing intercropping for various regions of the country. The intercropping is not a proven concept with TBOs.

3.2.18 Large-Scale Plantation

In case small areas of plantations are covered, it is not possible to extract the oil or transesterifiy the oil to make Biodiesel commercially viable. Thus large-scale plantation should take place in areas suitable for growing of TBOs in order to avoid high cost of transportation. This requires coordinated action of growers of one area where adequate land is available which will require motivation of growers. Thus one minimum reasonable sized Biodiesel plant of 50,000 Tonnes per annum capacity would require Jatropha plantation of about 40,000 to 50,000 Ha. This may not be possible initially.

3.2.19 Assurance of Minimum Procurement Price to Growers by State Governments

Since most of the growers involved in cultivation of TBOs such as Jatropha curcas are likely to be from poorer strata, it is important that the State Governments announce a minimum price of seed to ensure that the farmer is not exploited and that in case of glut in prices of oil seeds he is able to sell to the Government.

3.2.20 Research and Development

Since the cost of Biodiesel is high as the cost of feedstock and processing is high, it is essential to overcome these constraints. For this, aggressive R&D has to be carried out. It is essential that new high yielding varieties of TBOs be developed in order to make Biodiesel competitive. At the same time, the production should be sustainable in terms of productivity, soil, water quality and ecology. Besides, more efficient processes need to be invented or improved including those involved in the utilization of by-products such as Glycerine, oil seed cake etc. In addition, R&D on

new generation of Biofuels that will lower the cost and minimize adverse environmental impact, need to be taken up. Unfortunately, the country is allocating meagre funds for this purpose, which is a major barrier.

4.0 Regulatory and Institutional Aspects

The Regulatory and Institutional Issues are important because they can either facilitate in removing barriers or can become barriers themselves. All regulations and rules should be devised in a way so that they encourage and promote Biofuels rather than becomes a major hindrance. It has been reported that following legislation will be applicable to Biofuels:

- The Standards of Weight and Measures Act 1976
- The Bureau of Indian Standards Act 1986
- The Essential Commodity Act 1955
- Prevention of Black-marketing of Supplies of Essential Commodities Act 1980
- The Prevention of Food Adulteration Act of 1954
- The Motor Spirit and High speed Diesel Order 1998
- The Environmental Protection Act 1986
- Motor Vehicles Act 1981
- The Manufacture, Storage and Import of Hazardous Chemical Rules 1989 & 2000
- The Central Excise Act 1944
- The Central Excise Tariff Act 1985

In addition Rules and regulations to the above Acts will also be applicable.

4.1 Definition of Biofuels

The term biofuels needs to be suitably defined and categorized so that there is clarity as far as structure of various taxes, duties and levies is concerned. This definition should be such that it can derive benefits that are applicable to Renewable Energy or to other desirable technologies and products. It has to be classified in a suitable manner for purposes of excise duty/Sales Tax/VAT etc. The term Ethanol/Absolute Alcohol has already been defined and excise duty has been fixed by the Central Government & Sales Tax and other duties also prescribed by the State Governments.

The definition and categorization has to be undertaken under section S19 of the Weights and Measures Act of 1976 to establish standards of weights and measures for trading of the item. As stated earlier, the term Ethanol and absolute alcohol is defined but the term biodiesel has not been defined.

4.2 Specifications & Quality Standards for Biofuels

Biofuels produced and used in India would be required to confirm to the Bureau of Indian Standards (B1S) which is applicable as per The Bureau of Indian Standards Act 1986. The use of Ethanol as per Bureau of Indian Standards has been permitted in petrol as per IS 2796:2000 (Annexure IV-1a). This standard permits the use of 5% Ethanol in Petrol as an oxygenate. Thus the blending of Ethanol is restricted to 5% only. The specifications for the quality of Ethanol is Specified as per IS 15464:2004 (Annexure IV-1b).

Standards for Biodiesel have been formulated by B1S and approved as per IS 15607:2005 (Annexure IV-2) and restricts the blend percentage to 5% in diesel. The Diesel specifications are as per IS 1460:2004 (Annexure IV-3). However, since the feedstock availability is limited and the production of Biodiesel is a constraint this limit of 5% would not be a major hurdle. However, the BIS specifications for Biodiesel are quite stringent and would require sophisticated facilities to undertake testing as per these specifications. However, facilities to test all parameters at one centre are not readily available at many places in the country.

4.3 Environmental Standards

The Environmental Protection Act 1986 and Air (Protection & Control of Pollution) Act 1981 prescribes the standards for Ambient Air Quality, Fuel Standards and Emissions from engines. These Standards are being made increasingly stringent and generally follow the standards set by European Union.

4.4 National Ambient Air Quality Standards (NAAQS)

The health of a country is influenced by the pollution of environment. In this context Air Quality Standards have been set up. These are particularly relevant to the urban areas where vehicular pollution often leads to non-attainment of such standards. It may be pointed that Biofuels generally promote attainment of NAAQS. There is a concern that Biofuels raise the NOx emissions but a holistic view needs to be taken as it lowers other major pollutants.

4.5 Fuel Quality & Emissions from Engines (for Vehicles and Stationary & Other Applications)

Minimum Standards for fuel quality have been prescribed so that such fuels do not cause pollution due to evaporative emissions as well as from the emissions after combustion in the engine. As far as fuels are concerned, the regulations have been tightened with introduction of Bharat I,II & III standards, which are similar to Euro Standards. It is has been observed that the introduction of stricter fuel and engine emission norms in metro cities like Delhi has resulted in improvement of air quality.

However, there are one or two parameters, which have negative impact on the environment. In Ethanol the parameter of major concern is Ried Vapour Pressure. Ethanol Petrol blends increase the Ried Vapour Pressure of the blends if used in small quantities. This adverse impact has to be evaluated with its other environment beneficial properties such as reduction of HC, CO, PAH etc.

This issue needs to be evaluated utilizing a holistic quantitative methodology to determine whether overall effect is positive or negative.

EPA defines “Volatility is the property of a liquid fuel that defines its evaporation characteristics. RVP is an abbreviation for "Reid vapor pressure," a common measure of gasoline volatility, as well as a generic term for gasoline volatility. EPA regulates the vapor pressure of all gasoline during the summer months (June 1 to September 15 at retail stations).” “Depending on the state and month, gasoline RVP may not exceed 9.0 psi or 7.8 psi. See EPA Guide to Federal and State RVP Standards. EPA provides a 1.0 psi RVP allowance for gasoline containing ethanol at 9 to 10 volume percent.”

Another negative effect of biofuels is that it increases the NOx emissions of Engine. The increase is minimal if the 2 to 10% Biodiesel or Ethanol is used in the blend. In this case too the overall effect has to be evaluated in order to reach a conclusion of environment benefit. Generally, in most countries Ethanol is treated as an oxygenate that has been considered to have a positive impact on the environment including its effect on ozone formation and smog.

4.6 Modification of Engines

The Motor Vehicle Act of 1988 regulates the modification of engine of a vehicle for use for any other type of fuel. The use of up to 20% of Biodiesel or Ethanol will not require any modification in engine and it may be relatively simple to confirm to the relevant sections of this Act. However, the Motor Vehicle Rules 115 of the Central Motor Vehicles Rule, 1989 may require to be suitably modified to operate vehicles on fuels such as Ethanol and Biodiesel.

4.7 Misuse of Seeds and Oils of Non-edible seeds

Since many of the seeds and Oil being used to produce biodiesel are toxic it is important that the seeds should not be consumed. Since the price of such non-edible oils are likely to be significantly lower than edible oil seeds it is important that unscrupulous elements are kept in check so that they do not start blending such oils with edible oils and cause major hazard. In order to do so Prevention of Food Adulteration Act has to be strictly enforced. In addition, public awareness needs to be created through out the country regarding the hazards of using non-edible seeds and oils for edible purposes.

As far as adulteration of Ethanol with potable alcohol is concerned, the country has a fairly good record of preventing the consumption of such alcohol for potable purposes. This has been achieved by addition of denaturant to the dehydrated alcohol. This step is undertaken by State Excise Authorities to prevent loss of revenue to the state Government from the misuse of Ethanol, as potable alcohol attracts very high level of taxes while the taxes are low on Ethanol used for blending with petrol. Thus it is not because Ethanol, without denaturant, cannot be used for potable purposes but because the State Governments do not want to lose revenue that measures such as adding of denaturants are taken.

4.8 Production, Storage, Transportation and Safety of Biofuels and their Feedstocks

Due to the toxic nature of non-edible oils they may attract provisions of the Manufacture, Storage and imports of Hazardous Chemicals Rules 1989 and 2000. Essential Commodities Act & Motor Spirit & High Speed Diesel (Regulation of Supply & Distribution and Prevention of Malpractices) Order 1998: In order to blend biofuels in petro fuels the above act is applicable. However, it is needs to be clarified that whether individual organizations such as railways, state transport companies/corporations, fleet owners and all types of organizations can blend Biofuels in higher proportions than those specified by Standards.

5. Financing issues

5.1 Financial Instutions & Banks - Bio-ethanol

Discussions with some major Public Sector banks have revealed that they have financed a large number of sugar mills and distilleries in the past and continue to do so. The distilleries financed are those, which are generally engaged in the manufacture of Rectified Spirit, Extra Neutral Alcohol, Industrial Alcohol and Potable alcohol – country liquor, Indian made foreign liquor, etc. Majority of Ethanol projects have been set up by sugar mills because they want to diversify and improve their profitability and use molasses for value added products rather than selling it. Many of these sugar mills already have a captive attached distillery. Thus the additional investment required by such units for setting up alcohol dehydration units to produce Ethanol is relatively small (in most cases less than $1 million for a 30,000 litres per day of Ethanol production). Many of these mills have used their own investments to set Ethanol Plants. A number of fuel Ethanol plants have been financed by Banks and FIs as there are more than 80 plants in the country with a production capacity of 1,300 million litres per year. Banks have also received proposals from sugar mills for setting up Greenfield Ethanol project. Some large sugar manufacturers are going in for a spree of setting up large number of sugar mill complexes with Ethanol and cogeneration units particularly in the state of Uttar Pradesh. These units have collected substantial funds from World Bank, Initial Public Offer (IPOs), Bonds etc.

5.2 Financial Instutions & Banks - Biodiesel

Only a few Biodiesel plants are being financed as the economic/commercial viability of such projects is still in doubt. This is primarily due to:

- High cost and limited availability of feedstock, which constitutes most important component of cost of production.
- Low price of Biodiesel announced by the Government in its Biodiesel Purchase Policy.
- Lack of Policy of biofuels especially biodiesel especially non-enforcement of any mandatory provisions or incentives in order to make biodiesel competitive in its early stage.
- Lack of experience in financing such Projects.
- Risk associated with new technologies and products.

However, NABARD has given consent to re-finance Banks to promote plantation of Biofuels by growers/farmers/entrepreneurs. A number of Banks have also come forward to give loans to undertake Tree Borne Oil Seeds (TBOs) plantation, which may be re-financed by NABARD. NOVOD Board has also introduced a scheme for financing of TBO plantation which involves providing subsidy for such projects.

The Government of India in the Demonstration Project also has envisaged a substantial portion of subsidy for undertaking plantation on 400,000 Ha, possibly under the National Rural Employment Guarantee Act (NREGA) that is focuses on the poor of the country and by means of additional subsidy by the Centre.

5.3 Availability of Finance & Role of Banks / Financial Institutions

Since it takes minimum of 4 to 5 years for the plantation to mature and start giving saleable quantities of seeds, the moratorium period for payment of interest and loan amount should be at least 5 years. Banks are normally not giving loans with such a long moratorium period. It is necessary for the financial institutions such as NABARD and banks to modify their terms for this Program. Since the oil seeds price has to be low in order for Biodiesel to compete with diesel, the interest rates have to be low so as not to put additional financial burden on the grower. The Government of India has to come out with a policy to support low rate of interest. The Banks are also hesitant to provide micro-finance to the farmers especially marginal or poor as they are not sure of the recovery of funds. A mechanism does not exist to give due comfort to the Banks, which needs to be evolved at the earliest. In this context it must be mentioned that farmers are hesitant to take loan as many of them are in distress due to bank loans taken previously, which they are not able to payback.

5.4 General Terms & Conditions for Biofuels

Amount of loan: Amount of loan sanctioned is need-based depending on project requirement and its debt servicing capacity. Loan is sanctioned only after ensuring viability of projects. Generally term loans with a debt service ratio between 1:1 to 2:1 are made available by Bankers/FIs.

Interest Rate: Interest rates of banks vary depending on Prime Lending Rate (PLR)/Prime Term Lending Rate (PTLR) a spread to cover the costs and risks of the banks. For term loans and working capital loans, interest rates may vary based on the banks internal rating of the borrowers, which is linked to compliance of certain financial/operational parameters, conduct of the account, compliance of terms/conditions of sanctions etc. For term loans of new units, higher interest rate is generally stipulated. However, lower interest rate can be stipulated for term loans and working capital loans, respectively at the level of banks' Head Office.

Margins: Margins i.e. promoters contribution varies from 25% to 40%. Power to relax the margin depending upon merits of individual case maximum by 5% to 15% is permitted at various levels of sanctioning authorities.

Repayment Period: Working capital loan facilities are renewed annually, while term loans are repayable in a period of 3-7 years depending upon the units' profitability and repayment capacity. For Horticulture or TBO plantation the Banks may modify the moratorium period as the commercial yields may start only in 3 to 7 years. For term loans sanctioned to new biofuels production units, a moratorium period of 1-2 years is also permitted depending upon merits of individual case.

Securities: The working capital loans are backed by primary securities of raw materials, stock-in-process, finished goods, stores/spares etc, while term loans are backed by block assets like – land/building, plant/machinery, furniture/fixtures etc which are financed by a bank. In terms of banks' general policy guidelines, the additional securities in the form of collaterals are not to be insisted upon. However, in practice, it is observed that the bankers are demanding collateral securities in addition to primary in the form of immovable properties, guarantees from the persons of financial standing/corporate guarantees, tangible securities like Government/Postal securities, insurance policies, banks' fixed deposits etc to mitigate credit risk. As regards quantum of collateral securities asked for by the bankers to secure the loans depend upon the risk related to the loan and there is no hard and fast rule to determine the quantum of the collaterals.

5.5 Viability and Success Rate

The viability of any project depends on a large number of factors. The importance and criticality can differ depending on factors such as:

- Location
- Landed price of raw material
- Yield and quality of product
- Consumption and price of utilities
- Net selling price and period of contract
- Overheads and marketing & selling expenses
- Volume of sale of product and by products etc.

The government taxes, duties can also be important factors sometimes. For example, a sudden increase in these without a corresponding escalation clause in agreement with the oil companies can cause problems. Another factor, which is of utmost importance, is the provision for arrangement of working capital. In case, price and availability of raw material varies significantly and the selling price of product does not vary accordingly during the year, it is essential to ensure that adequate quantity of raw material is purchased at lowest price. In case of Biofuels, the price of product is likely to remain fixed for a fairly long time, say a period of 6 to 12-month as dictated by the Oil Companies but the price of feedstock may vary significantly during the year. If feedstock is to be procured from outside then it is very important that it is bought in maximum required quantities when the price is minimum – e.g. for north India the best time for procurement of molasses is normally in the months of February to April. Since molasses can form around 60% to 75% of the cost of production, it is important to procure the same at the lowest price in order not only to improve viability but also to remain competitive. Adequate working capital funds are also required to ensure that production is not interrupted in case the payment after supply of product

(Ethanol) is not received on time or even if there is a substantial delay. For Biodiesel the same conditions are applicable and therefore buying adequate quantities of seeds or oil when prices are low(est) is of prime importance for viability of such projects.

A preliminary and indicative cost of production cost analysis undertaken by WII suggests that it appears that even if the cost of captive molasses net of taxes and transportation is considered same, the cost of production of distillery cum ethanol plant attached to a sugar mill with captive molasses is likely to be significantly lower than stand alone distillery. This is because of the high taxes and transportation costs that have to be borne by stand alone distillery. Thus in such a situation, only a very inefficient attached distillery may not be able to compete with a stand alone distillery in particular region or area or location. The same logic applies to Biodiesel unit also. An integrated large unit with its own expelling and extraction and transesterfication facilities is likely to be more viable commercially than a non-integrated unit.

5.6 Risk Factors

For any project, if the weaknesses of the business outweigh the strengths, with respect to its short and long term viability, the risk factors increase significantly as far as a Financial Institutions (FIs) involved in lending is concerned.

It is important for a financial institution to be aware on an ongoing basis of the business environment and trends in that particular business. It is essential for the concerned FI to foresee and predict, well in advance, potential risks as they develop over a period of time.

A number of important qualitative risk factors have been identified for the Biofuels sector including ethanol and Biodiesel business, $which include:

- A sudden and significant increase in price of raw material is a major risk factor.
- The fall in price of product(s) because of intense competition in case of over capacity may also increase the risk factor.
- Producing product of unacceptable quality or achieve lower yields or efficiencies or unacceptable quality.
- Inability to receive orders because of quoting higher prices in the tender may totally or substantially reduce the sale of Biofuels and thus the fall in turnover may lead to the project working below break-even point.
- Inefficient operation of plant due to a number of factors including purchasing poor quality of feedstock may lead to losses is another risk factor.
- The interrupted supply of utilities of poor quality at high rates is another major factor.
- Non-availability of infrastructure including transportation, communication, health and education facilities, breakdown of law and order etc. may be another factor.
- Obsolescence of technology or selection of wrong technology can render the project unviable.
- Pollution problems - especially related to treatment of distillery effluent and use of benzene and/or other toxic third components in dehydration of alcohol - may lead to complete closing

down of Biofuels unit by the pollution board. This is another risk factor that has to be addressed.

- Any change of Government policy regarding making of Biofuels mandatory, feedstock (such as seed or sugar cane) pricing, restriction on movement of molasses or alcohol/ethanol may result in project becoming non viable.
- Any increase of duties, taxes, transportation costs, reduction in subsidies or tax incentives may have an adverse impact on the viability of the project and therefore constitutes a risk factor.

However, the Financial Institution may after undertaking risk analysis decide to promote the Project. At the present stage of development of Biofuels it is important that both State and Central governments give due comfort to the FIs so that their concern regarding risk perception and analysis is substantially addressed especially in case of Biodiesel and other emerging liquid Biofuels.

6.0 Technological issues

6.1 Feedstocks

6.1.1 Bio-ethanol

Alcohol can be manufactured from a large number of raw materials, which fall into three main categories:

- Sugar based
- Starch based
- Cellulose based

Sugar Based

In this category the main crops are sugar cane (sugar cane juice & molasses), sugar beet (beet juice and molasses), and sweet sorghum. Molasses, waste by-product of sugar industry, is the only feedstock used in India for fuel Ethanol production.

Currently molasses is the only feedstock being used to produce ethanol. In India, more than 300 distilleries produce alcohol/ethanol of different grades. Thus the technology is fully established. However, up-gradation of technology is required and economies of scale have to be utilized by setting up larger units. It is important that new varieties are developed that give high yields and use lower inputs including water for irrigation.

- **Starch Based**

  Grains: This category includes all types of grain including wheat, rice, corn (maize), barley, malt, sorghum, millet etc.
  Tubers: This category includes tubers of various species such as potatoes, cassava (tapioca) etc.

In many parts of the country grain & malt, and to some extent, sorghum (grain) and cassava (tapioca) has been used particularly to manufacture alcohol for potable purposes. There appears to be universal perception that grain/starch-based alcohol is better for potable purposes and therefore normally commands a higher market price than that made from molasses. Except for damaged/rotten grain, the cost of production of ethanol manufactured using gain is generally higher than that from molasses. There have been press reports, which state that government is contemplating shifting the potable sector to grain and using molasses for industrial and fuel purposes.

- **Cellulose Based**

This category includes agro-waste, agro- residues, bagasse, rice husk, straw, groundnut shells, wood chips, sawdust, organic municipal waste etc. This substrate is still being tried out on pilot plant scale as the cost of production from this source works out to be more expensive than from normal sources. The cost of raw material is the lowest but the cost of processing and finance costs are exorbitant.

In India, traditionally molasses from sugar mills has been used as a substrate for manufacture of alcohol. Before Ethanol blending with petrol started in 2003, there was more than adequate molasses available to meet the requirements of the industry to manufacture alcohol as well as other uses. However, with the possibility of ethanol being blended with petrol resulted in potential demand of molasses going up significantly, there is a new awareness to examine the manufacture of ethanol from other feedstock including sugarcane juice. A serious scrutiny is also being done with respect to cultivation of tropical sugar beet and sweet sorghum.

6.1.2 Biodiesel

There is a limited availability of feedstock such as Jatropha curcas and Pongamia Pinnata (Karanj) and seeds of other TBOs. Also the collection of such seeds is not been undertaken efficiently. There is a need to undertake research to improve varieties so that high yielding varieties and optimum agricultural practices are developed for each Agro-climatic zone. Organized and documented knowledge in this sector is very limited. Therefore, capacity building and making available quality planting material are important.

Thus the most important issue relating to Biodiesel in India is the need to urgently take up R&D to determine the most appropriate feedstocks.

6.2 Technologies for Biofuel Production

6.2.1 Bio-Ethanol

The technology for commercial manufacture of alcohol (rectified spirit) and thereafter ethanol from various feedstocks, except biomass, is available in the country. The level of indigenous technology especially for production of alcohol from molasses as a feedstock is fairly high. However, the level of technology from sugar beet especially for efficient extraction of juice may have to be imported.

The Indian alcohol industry is more than a century old and, therefore, the technology for rectified spirit from molasses is well established. However, newer innovations in this technology such as 'continuous fermentation technology' and 'pressure vacuum distillation technology' have developed over the past decade or so. These have been successfully incorporated in a number of plants. The technology and plants for producing alcohol are being supplied by Indian Companies not only in India but also all over the world. Praj Industries is supplying alcohol plants based on continuous fermentation and pressure vacuum distillation technology and setting up fuel Ethanol plants using molecular sieve alcohol dehydration technology based on license from US company. The Swedish Company Alfa Laval is also using its India subsidiary to sell technology and plants to various countries from India.

Most of the alcohol produced in the country is based on molasses as a raw material, which is waste bye-product of the sugar industry. In years of average rainfall, the sugarcane production is normal leading to adequate availability of sugar and hence molasses. In such years the quantity of molasses has been adequate to meet the requirements of the country for various uses including Ethanol (5%), potable and industrial use. In fact molasses had been regularly exported before Ethanol Program was introduced, as there was excess. However, small quantity of rectified spirit has been made from malt and grains such as wheat, rice, sorghum and cassava. This alcohol has largely been used for potable purposes. With the recent trend in improvement of quality, the use of grain based alcohol for potable purposes is increasing steadily. Thus technology for production of alcohol based on various feedstocks is well established.

Molasses is commercially the most popular raw material because its cost of production works out to be the lowest in years of normal production and availability. The processing cost is also the lowest for this raw material as the number of steps involved in it's processing is the minimum and the utility consumption is also the lowest. Other feedstocks that are being actively considered for Fuel Ethanol are sugarcane juice, sweet sorghum, sugar beet and inedible grain. The cost of producing ethanol from these would depend on the cost of feedstocks/substrates. It may also be reiterated that sugarcane is one of the most efficient energy crops. In addition, cost of production of Ethanol based on damaged grain is likely to be low, in case it is available at throwaway prices and in adequate quantity. In some special cases and at specific locations sweet sorghum, cassava, beet etc. may also be viable but the probability of this is remote.

Manufacture of Ethanol based on Biomass as a feedstock is not yet a commercially proven technology and its capital costs as well as processing costs are higher while the feedstock costs are much lower. The overall cost of production from this feedstock, however, is likely to be higher as per estimates made by an expert group at Indian Institute of Technology, Delhi.

Therefore, cost of production should be arrived at after examining the past and future long-term scenario with respect to availability and prices of feedstock proposed to be used for each location specifically and no general rule can be framed for selection of feedstock for the entire country.

The technology for manufacture of ethanol by dehydration of Alcohol involves special processing of alcohol/rectified spirit. There are three commercial routes for dehydration of Ethanol from rectified spirit/ alcohol/crude alcohol. These are as follows:

- Azeotropic distillation Technology
- Molecular Sieve Technology
- Membrane Technology

- ***Azeotropic Distillation Technology***

This is the oldest technology and was used during World War II to produce Ethanol in India. Thus the technology for ethanol production from rectified spirit using Azeotropic distillation is well established in India, as a number of plants exist in the country based on this technology. This technology involves a distillation system employing benzene as the third component.

The initial capital cost (project cost) for this technology is lower than the molecular sieve technology but the cost of production is higher because of higher energy consumption and higher consumption of benzene or other similar third component such as cyclohexane. It is essential to mention here that the third component may cause air pollution as well as water pollution especially since components such as benzene are known to be highly carcinogenic.

- ***Molecular Sieve Technology***

This is the most commercially popular, financially viable and environment-friendly technology, which has emerged, in the late 1980s. This is a clean technology in which molecular sieves remove the water and dehydrated alcohol/ethanol is obtained. The details of this technology are given in Annexure II-1. The dehydration process using this technology can be carried out either in liquid phase or vapour phase. For very small plants and for removing less water content liquid phase technology is adequate. However, for larger plants where ethanol is being used for blending with petrol, the globally preferred technology is based on vapour phase dehydration of ethanol.

In this technology, although, the capital cost is higher than Azeotropic distillation, the cost of production is lower. Another major advantage is that it does not cause any pollution especially water pollution, as is the case with Azeotropic distillation technology. In fact almost all the new plants set up in India use this technology rather than Azeotropic distillation technology.

- ***Membrane technology***

Membrane Technology is an emerging technology, not widely used commercially, which employs a membrane that allows smaller molecules to pass through while the larger ones cannot pass through. In this process, the membrane acts as a filter to remove remaining water from the mixture of alcohol and water. At present the capital cost of this technology is high. However, if the cost comes down this technology has the potential to overtake the Molecular sieve technology in the future. A commercial plant using this technology has been set up in India.

6.2.2 Biodiesel

(a) Extraction of SVO

The extraction of vegetable oil (SVO) consists of pretreatment of seeds, if required, such as steaming followed by crushing the seeds in various types of presses such as:

- Hand operated mechanical presses
- Hand operated hydraulic presses
- Animal operated grinding mills cum presses
- Electric powered grinding mills cum presses
- Electrically powered oil expellers
- Solvent extraction plants

While the first three processes mentioned above are generally inefficient and can only be used when the requirement of SVO is very limited, the last is the most efficient but are viable only if substantially large production is envisaged.

Small-decentralized expellers typically have throughputs ranging from 30 to 50 kg/hr to 1000 kg/hr. In these expellers the oil is normally extracted by cold pressing, the maximum oil that can removed from the oil seeds by this process is about 90% of the total and balance of the oil is retained by the oil cake. For these type of expellers the reduction in oil output is partly offset by an enhanced cake value particularly if the oil is edible oil as it is sold as a protein rich animal feed.

In many developing countries where the seed production is highly decentralized and the quantity of oil seeds to be crushed is relatively small such units with low capital investment may be a viable option. In case the need arises, these extraction units can eventually become an ancillary to the larger solvent plants as suppliers of raw materials i.e. crushed cake. In the solvent extraction process a solvent is used to extract oil efficiently, usually, attaining an extraction efficiency of about 98%.

After oil has been expelled the minimum treatment it needs to undergo is the process of filtration. The filtration is typically carried out using filter presses. The expelled SVO is pumped at sufficient pressure to a filter press or a number of filter presses. In the filter press the suspended solid impurities are removed by the filter cloth. A filter aid may be used to facilitate the filtration of oil.

In case the oil has a high acid content, another processing step that may be required to be carried out is to neutralize the oil with an alkali such as sodium hydroxide (caustic lye). The soap formed in the reaction can be removed either by washing and settling or by continuous centrifuges.

In case the gum content of the oil is high it may have to be de-gummed using various technologies including acid, enzyme etc. There are a number of processes for undertaking transesterification of vegetable oil including:

- Alkaline Process
- Acid Process
- Catalyst free supercritical Process

(b) Biodiesel

The most popular commercial process followed at present is the alkaline process. In case the plant size is small it may be advisable to produce batch wise, which is easier to operate and is less automated but has higher manpower requirement. For larger plants continuous production is recommended in which continuous reaction takes place, producing Biodiesel.

The process of production of biodiesel involves reaction of vegetable oil with methanol or ethanol employing a catalyst such as sodium or potassium hydroxide. In this process the reaction that takes place is called transesterification, which results in formation of biodiesel and glycerol (glycerin). The methanol present in the glycerin phase is removed by distillation and glycerin concentrated by removal of water. The biodiesel is separated from the glycerin of higher density by settling or centrifuging. The glycerin in crude form can be processed and distilled to make various grades of glycerin that can be sold to various consumers. A water wash may be given to biodiesel to remove impurities from it including methanol, catalyst and any remaining free glycerin. It is then distilled to remove the methanol and also to remove the water and final traces of glycerin.

Although it is possible to manufacture biodiesel at a very small scale including at home it is not recommended because Methanol, a normally non-renewable petrochemical, used is highly toxic and has an adverse effect on human health. The biodiesel produced at such a small scale may not recover methanol from either the biodiesel or the glycerin. Any ingestion through contamination of water stream or even by inhalation may have adverse impact on health. Methanol, like Ethanol, is classified as a highly inflammable chemical under various laws and special procedure has to be followed in handling, transport, storage and use. On the other hand ethanol, a renewable biofuel, is not toxic but the transesterification reaction with it is slower, the properties of biodiesel produced from it are slightly different.

7.0 Supply & Distribution

Effective supply chain and its efficient management is a pre-requisite for successful and sustainable Biofuel program. It is therefore, necessary that issues relating to supply and distribution be adequately addressed. Regular supply of biofuels ethanol and biodiesel is vital to avoid erratic blending, variations in fuel quality and distortions in the market. Therefore, it is important to collect data on sources of supply (molasses and other raw material for ethanol and tree-borne oil seeds such as Jatropha curcas for biodiesel) and alternative uses of biofuels in the country. Marketing and distribution issues are also very important for large-scale use of biofuels in the transport sector. In this case, the groups of stakeholders involve ethanol producers, biodiesel producers, and oil marketing companies and the retailers.

Ethanol

➲ Storage at the Ethanol Producing Plant

At the distillery, ethanol after production has to be initially stored in a 'day storage tank'. In this tank the production for one whole day is stored so that it can be transferred to the main ethanol storage tank after the quality has been checked, the quantity measured and it has been verified by the excise authorities and approval obtained. The number of days of storage capacity in the day storage tanks can be 2 or 3 in order to take into account the holidays on which excise department and senior plant officers may not be available. Thereafter, subject to approval, the ethanol is pumped for storage in the main ethanol storage tanks. A minimum storage capacity of about one month of production should be created at the Biofuel manufacture's and oil company departments so as to take into account any delays in lifting due to tendering by the oil companies, transportation bottlenecks etc. Denaturant has to be added before the ethanol is stored in the denatured ethanol storage tank in the ethanol plant.

Ethanol mixes with water readily and the dehydrated ethanol will convert into hydrated alcohol. Thus following adequate precautions need to be taken including steps to ensure that dehydrated ethanol or its blend with petrol does not come into contact with water at any stage:

- In the process of transfer from manufacturing to storage, addition of denaturant, storage at the distillery, transportation in tankers to the oil depots.
- Storage at the storage tank of oil depot, blending with petrol, transfer of blended gasoline (gasohol) in tankers to the petrol pumps.
- Storage at storage tank of the petrol pump, dispensing at the petrol pump and in the fuel tank of the vehicle.
- All tanks need to be fully covered so that there is no ingress of water from rain or any other source. Before starting initial filling of any storage tank, all pipes, pumps, dispensers, and storage systems need to be cleaned and water/ moisture removed. Indeed, the complete system in the supply chain needs to be moisture and water free to prevent phase separation.

- The depot has to install metering facility to measure the quantity of ethanol being received. It also needs to install testing facility to check the quality of ethanol being supplied as per international standards.
- Silica gel traps may also be installed at supply locations and retail outlets (petrol pumps). Indian Oil Corporation has recommended that for storage of ethanol silica gel traps should be provided in order to remove atmospheric moisture in ethanol.

➲ Storage, storability, handling and transportation of ethanol and its blends

Storage of Ethanol poses no major problems. However, long-term storage may lead to increase in moisture (water) content in Ethanol and may also result in some evaporation losses. Also, since Ethanol readily mixes with water, precautions have to be taken that all tanks, pipe lines and other equipment handling ethanol are proper cleaned and water removed. In the storage dehydrating agents such as silica gel can be used to prevent uptake of moisture from the atmosphere by Ethanol. In addition, the fuel tanks of vehicles in which the blend is being used need to be also cleaned and water totally eliminated. Another important issue is lowering of RVP of blend. This may need waiver of the norms or use of gasoline with lower RVP so as to attain the norms.

It is necessary to follow all precautions for ethanol and its blends related to avoiding fire hazards and other safety measures involved in handling and storage of petrol.

Ethanol is more biodegradable than petroleum based diesel and spills of ethanol are safer and less harmful when compared to petrol. However, all precautions and preventive measures taken in case of petrol should be followed for Ethanol and its blends to avoid spills or leakage and containment of spills.

Transportation of Ethanol does not require any special precautions, except to ensure that the container is cleaned and does not contain water and is able to prevent ingress of water. It can be transported by tankers with necessary safety features and warnings on the tanker similar to that of petrol. An additional issue that may need attention is the use of anti- corrosive or other additives to be added to the blend. Another important issue is the distribution method of the ethanol-gasoline mixture. Basically the idea is to find the most optimum possible way and means of handling ethanol in the transport sector.

➲ Blending of Ethanol

Ethanol blends readily with petrol in any proportion and splash blending of Ethanol is considered adequate to achieve homogenous blend.

Biodiesel

➲ Blending, Storage & Distribution Issues

It has been reported that Free Fatty Acid content as well as viscosity of biodiesel has a tendency to increase on prolonged storage. Since bio-diesel is biodegradable it has been estimated that it can be stored for a period of six to twelve months. The use of some anti-oxidant additives may also be required for relatively long-term storage of Biodiesel.

It is recommended that bio-diesel be stored in clean, dry and approved tanks. Although the flash point of bio-diesel is high compared to fossil diesel it should be treated in the same way as other petroleum products. It is, therefore, necessary to follow all precautions for biodiesel and its blends related to avoiding fire hazards and other safety measure involved in handling and storage of fossil diesel. Bio-diesel can be stored for relatively long periods in closed tanks. Biodiesel blended B20 fuel can be stored in tanks, above ground depending on the pour point of the blend and ambient minimum temperatures. There is a possibility of using additives to improve its flow characteristics in case of low temperature storage and pumping Bio-diesel and its blends. Biocides (which kills microbes) may also be used, if and when necessary, for prevention of microbial attack on the Biodiesel in fuel tanks.

It is to be noted that Biodiesel is more biodegradable than petroleum based diesel. Large Biodiesel spills may be harmful to some extent but they are safer and less harmful when compared to fossil diesel. However, all precautions and preventive measures taken in case of fossil diesel should be followed for Biodiesel and its blends to avoid spills or leakage and containment of spills.

Transportation of Biodiesel does not require any special precautions and can be transported by tankers with necessary safety features and warnings on the tanker, as is the case with petro-diesel.

➲ Blending of biodiesel

Biodiesel blends readily with petroleum diesel in any proportion. For blending of biodiesel with fossil diesel simple static mixers may be used or even pouring the two together in a tank (splash blending) would be adequate. Proper flow/volume measuring instruments will have to be installed. Requisite additives, if required, may also be added during this process. The blending operation requires the same precautions as in storage and handling of petroleum diesel. However, the petroleum companies may install adequate testing facilities to test the quality of biodiesel, if necessary. Blending of Biofuels/Bio-diesel with fossil diesel can be undertaken at the petroleum refinery, storage depot/terminals or at the retail dispensing stations. However, in order to control the quality and the blend percentage, it may be advisable that it is done at the oil depot/warehouse under the supervision of the petroleum companies. For using Biodiesel in colder climate it may be necessary to add flow improvers.

8.0 Environmental Impact

National Ambient Air Quality Standards (NAAQS): It may be pointed that Biofuels generally promote attainment of NAAQS. There is a concern that Biofuels raise the NO2 emissions but a holistic view needs to be taken as it lowers other major pollutants.

There is an increasing concern about the air pollution levels in the Indian cities. Fifty-three metro and large cities have been identified as 'non-attainment cities, which have not achieved NAAQS'. However, SO2 is below standard in most of the metro cities and showing a decreasing trend while the NOx, is above standard in a few cities. SPM/RSPM is above standard in most cities while CO is below standards in most cities. The dominant sources of air pollution in these cities have been identified as vehicles, industries, generating sets, biomass burning. However, it needs to be mentioned that while SO2 levels are below norms in most cities, NOx is above the norm in some cities and showing an increasing trend in some others. SPM and RSPM is above standards in most metros.

The trials undertaken by IOC (R&D), Indian Railways and other organizations have shown that there is considerable reduction of all types of pollutants including Carbon Monoxide (10 to 50%), Sulfur dioxide (100%), soot emissions (25 to 60%), Hydrocarbons (10 to 50%) particularly PAHs, However, there is a slight increase or decrease in NOx depending on age of the vehicle and the tuning of engine (See Annexure VIII – 1, 2 & 3).

In this context, Biofuels have an important role to play in reducing air pollution as vehicular traffic id the major contributor to pollution in the cities.

Fuel Quality and Emissions from Engines (for Vehicles and Stationary & other Applications): Minimum Standards for fuel quality have been prescribed so that such fuels do not cause pollution due to evaporative emissions as well as from the emissions after combustion in engine. As far as fuels are concerned the regulations have been tightened with introduction of Bharat I,II & III standards. The introduction of stricter fuel and engine emission norms in metro cities like Delhi has resulted in improvement of air quality.

Ethanol blended gasoline is not only a clean fuel but also an octane booster and an oxygenate. Fuel ethanol reduces the emission of carbon monoxide and hydrocarbons by assisting in complete combustion. It replaces octane boosters like tetraethyl lead, which leads to poisonous lead-fumes polluting the atmosphere. It is also a replacement for other oxygenates like MTBE (methyl tertiary butyl ether) – which contaminates the ground water resources. It is also free of sulfur and aromatics like benzene that are toxic and harmful to health.

When ethanol is added in the range of 5 to 10% in order to improve it's combustion characteristics and reduce air pollution it is utilized as an oxygenate, which has an 'in-built' oxygen in its composition which assists in complete combustion in engines. This reduces emissions of carbon

monoxide and hydrocarbons in the exhaust gases of vehicles, by taking combustion to completion. It is necessary and advisable to reduce emissions of carbon monoxide and hydrocarbons because they are toxic to human beings. Completion of combustion also reduces emission of particulate carbon matter, which could cause respiratory disorders. Another important function of oxygenates such as ethanol is as an octane enhancer and an anti-knocking agent. These compounds improve the octane number of petrol, thus improving the engine performance of vehicles. However, in order for the engine to perform properly and reduced emissions Ethanol blended petrol must meet the specifications of denatured fuel ethanol for blending with gasoline, for use as automotive spark-ignition engine fuel, which has been prescribed.

It is to be noted that there are one or two parameters, which have negative impact on the environment. In Ethanol the parameter of major concern is Ried Vapour Pressure. Ethanol Petrol blends increase the Ried Vapour Pressure of the blend at lower concentrations. This adverse impact has to be evaluated with its other environment beneficial properties such as reduction of HC, CO, PAH etc. This issue needs to be evaluated utilizing a holistic quantitative methodology to determine whether overall effect is positive or negative. EPA defines “Volatility is the property of a liquid fuel that defines its evaporation characteristics. RVP is an abbreviation for "Reid vapor pressure," a common measure of gasoline volatility, as well as a generic term for gasoline volatility. EPA regulates the vapor pressure of all gasoline during the summer months (June 1 to September 15 at retail stations).” “Depending on the state and month, gasoline RVP may not exceed 9.0 psi or 7.8 psi. See EPA Guide to Federal and State RVP Standards. EPA provides a 1.0 psi RVP allowance for gasoline containing ethanol at 9 to 10 volume percent.”

Another parameter with slightly adverse effect is the increase of NOx in some cases. However, the overall positive effect of lower CO, HC, SPM, and CO2 has to be considered while assessing Ethanol and indeed all Biofuels.

The effluent from production of Ethanol from molasses has high COD and BOD as it is rich in organic matter. This effluent even after treatment does not, generally, prescribe to norms of Pollution Control Board leads to pollution. The Board has prescribed that all alcohol manufacturing units will have zero discharge. The use of Bio-composting of sugar press mud with effluent has been successfully undertaken to achieve this norm. However, the adequate availability of press mud and other biomass is often a constraint. Thus this has become a major barrier in setting up large sized distilleries. Brazil produces most of its Ethanol from sugar cane, which produces effluent with lower BOD and COD loads. It undertakes ferti-irrigation with this effluent in the sugar cane and other crops. The Indian norms for ferti-irrigation are very stringent and require bringing down the BOD to very low levels, which is very costly, and therefore is not being widely practiced.

Biodiesel

Biodiesel is a clean burning alternate fuel, produced from renewable resources like virgin or used vegetable oils, both edible and non-edible or from animal fat. It can be used in compression-ignition (diesel) engines with little or no modifications. Biodiesel is simple to use, biodegradable, non-toxic, and essentially free of sulfur and aromatics. It can be stored just like petroleum diesel

fuel and hence does not require a separate infrastructure. Its higher cetane number improves the ignition quality even when blended in petroleum diesel. All diesel fuel injection equipments rely on diesel fuel as a lubricant to some extent. When sulphur is reduced in diesel to improve emissions, the lubricity of diesel decreases. Low lubricity fuel may cause high wear, scarring and fuel pump failure. The lubricity of diesel is especially poor when the sulphur level is below 500 PPM. It has been observed that addition of biodiesel in small amounts (1-2%) can restore the lubricity to low sulphur diesel and protect engine components. While ultra low sulfur diesel has low lubricity, even 2% Biodiesel, with its high lubricity, eliminates the need to add additives that enhance lubricity. As stated earlier NOx may be slightly higher but this is offset by other positive effects of Biodiesel on the environment.

As far as plantation of Jatropha curcas is concerned one major issue id Monoculture Vs Mixed Plantation. For a large-scale program to succeed vast amount of degraded forestland available needs to be utilized for Jatropha curcas and other suitable TBOs. Fifty percent of Jatropha curcas plantation in the Demonstration Project is to be on forestland. There is a opinion within the forest departments that large-scale cultivation will lead to mono-culture, which is not desirable for forest land and Jatropha plantation mixed with other species should only be promoted. There is another radical opinion that is being propagated it is not a forest species and should not be encouraged in the forests. This may become a barrier if some adverse decision is taken on this issue in future.

Another negative effect of biofuels is that it increases the NOx emissions of Engine (See Annexure). The increase is minimal if the 2 to 10% Biodiesel or Ethanol is used in the blended. In this case too the overall effect has to be evaluated in order to reach a conclusion of environment benefit. Generally, in most countries Biofuels are treated as oxygenates that have been considered to have overall positive impact on the environment.

9.0 Socio-economic Benefits

It has been estimated that at the beginning of this millennium, 260 million people were poor and India was a home to 22% of the world's poor. Most of the poor live in rural areas and poverty is a cause of social unrest. Therefore, employment is one of the most important challenges faced by India that will lead to reduction of poverty.

Biofuels have many benefits for a developing economy like India, which are well documented, including the following:

- Provides employment especially rural
- Leads to development of economy especially rural
- It leads to energy security
- It reduces air pollution thereby reducing healthcare costs
- It stabilizes the economy by reducing vulnerability because of high value of imports of crude oil and petroleum products

- It mitigates the adverse impact of climate change by reduction of Green House Gases (GHGs)
- Being compatible with existing transportation fuels such as diesel and petrol, it eliminates the cost of developing alternate infrastructure as is the case with CNG and hydrogen

Ethanol

Ethanol is made from molasses, which is a by-product of sugar manufacture from sugarcane. With demand from Ethanol for blending with petrol growing, the viability of sugar industry in India is increasing. In the past, due fluctuating production and prices of sugar, the overall health of sugar industry has been poor. With sugar mills setting up Ethanol plants and cogeneration facilities, this is leading to improved financial health of the industry. This in turns enables the mills to pay promptly a better price of sugarcane to the farmers. In the past, many of the sugar mills were not able to pay the farmers for long periods of time and Government had to intervene. The prompt payment at higher prices of sugarcane has improved the financial situation of the farmers significantly. The sugar mills are also expanding their plants and setting up new ones. This is leading to increase in direct and indirect employment in the sugar mills and also larger cultivation of a cash crop leading to better socio-economic conditions of farmers. It is to be noted that sugarcane is one of the most remunerative cash crops.

It has been estimated that sugarcane farming supports million of farmers and their families. This in turn leads to rural development and employment.

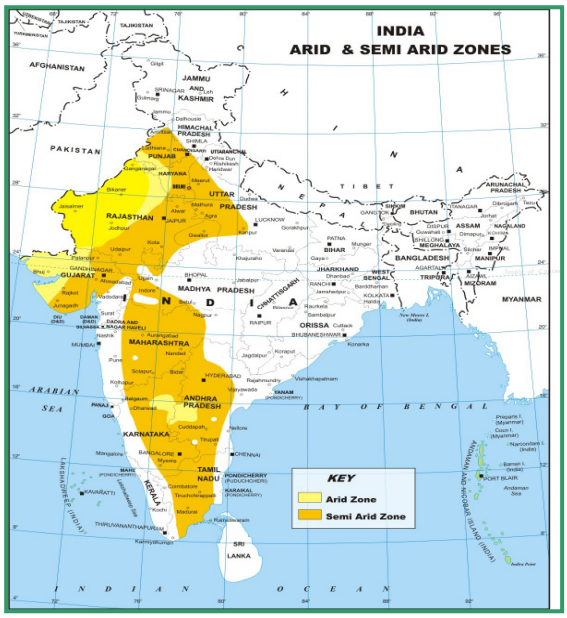
Biodiesel

The Planning Commission Report on biofuels has estimated that plantation of Jatropha curcas will result in 311 person days of employment per hectare that is one year of rural employment. This estimate has been backed by other estimates. Thus taking up of 10 million hectare of plantation will result in about 10 million person years of employment. In addition, it has been estimated that maintenance of the plantation will require a minimum of between 60 to 90 person days of employment per year per hectare. Thus there is a huge potential for regular employment on a long-term basis. Thus the annual employment potential for 10 million ha works out to be about 3 million person years per year.

10.0. India Case Study

India has a tremendous potential as a producer of biofuels. Out of the 130 million ha of wasteland 40 million ha is suited for cultivation. The Government of India has set up the National Mission on Biodiesel which has brought 0.128 million ha under Jatropha plantation up to the year 2005-06. Thereby, the target of 0.56 million ha has not been achieved. Even the states which have a high proportion of wastelands (i.e. Madhya Pradesh, Chattisgarh, Rajasthan and Gujarat) have not been able to realize the potential. The time lag of three years, uncertain market and buying back mechanisms amongst others have been the major the causes of slow progress.

The India case study was undertaken to provide learning experiences to the COMPETE platform for sub Saharan African countries. The India case study focused on Arid and Semi Arid India (see Map below).



Map showing arid and semi-arid areas in India

Some of the states in India within arid and semi arid India have covered certain milestones. The state of Andhra Pradesh with support from the Government of Andhra Pradesh has introduced plantations of Jatropha and Pongamia. The Department of Forests, Government of Andhra Pradesh, the International Crop for Research in Arid and Semi Arid Tropics (ICRISAT) and the Central Arid Research Institute (CRIDA), Hyderabad, has been actively involved in Pongamia plantations in Joint Forest Management (JFM) areas, research in Jatropha and Sweet Sorghum and plantations in Ananthapuram, Mahboob nagar and Nalgonda districts, respectively. While ICRISAT's research on Sweet Sorghum as agricultural crop for biodiesel production is integrated in the biofuel policy of India, Pongamia plantations in JFM areas by the Forest Department comply with the Forest Conservation Act of 1947.

The following characteristics serve as justifications for Jatropha plantations. Pongamia pinnata is native to the Western Ghats and is mainly found along the banks of streams and rivers or near the sea on beaches and tidal forests. It also grows in dry places far in the interior and up to an elevation of 1000 m. It is often grown to line avenues all over India. Being a non exotic species, it has not been very difficult for the state governments in Andhra Pradesh and Tamil Nadu to promote Pongamia plantations in Joint Forest Management Areas in degraded forests.

Reasons for encouraging Pongamia plantations

1. In India there are well-established collection and marketing networks for non-edible oils, going back to the Vedic days, for use as fuel for lighting lamps. Presently there is an extended use of these in soaps, lubricants etc. with prices controlled by the Mumbai Market.

2. Pongamia pinnata is a natural wild tree in India.

3. At commonly used densities of more than 100 trees per hectare, many trees yield 10-15 tonnes of seeds per hectare on maturing. Since 15 to 20 year old trees use soil to more than 10 m depth (unlike agricultural crops which use only 150 mm of top soil), both the survivability during dry periods and annual output per hectare are better than what could be obtained from many agricultural crops.

4. Pongamia normally starts yielding after 3 to 4 years. Even though the output of a young sapling is only a fraction of that of a mature tree, since the number of saplings planted per unit area is high, the yield per hectar is still comparable to what can be obtained from a mature plantation. As the plants grow, the weak ones are thinned out providing supply of green leaves for composting (green manure), thin sticks for fending, fuel for cooking and for power generation through gasification.

5. Villages have a tradition of growing a fence of trees on the boundaries of their dry lands. Remnants of such fences can be seen today. These serve as wind brakers and therefore, help to conserve the moisture obtained by the crops from rainfall and irrigation. They also provide green leaves, fuel and useful outputs like seeds and fruits. Paucity of financial resources within the rural community have led to the cutting down of these trees and selling them as firewood. Encouraging farmers to revive this cultural practice of live fencing could lead to a fair population of trees per household.

6. Most tree based oil seeds yield about 25 percent oil and 70 percent cake considering 5 percent losses in the process of oil extraction using expellers. This technology is well established in India. The cake has multiple uses but if it becomes available in large quantities, it is probably best used in industrial fermenters to produce biogas (methane) with the produced sludge used as fertilizer. This use can also be extended on a small scale to the villages for local use.

7. Unlike Europe and North America which are pursuing Canola (Rape seed), an agricultural crop, to produce biodiesel, India should pursue greening rural areas with oil seed bearing trees as low input and low cost option. However, in terms of investing value into a local resource it amounts to bringing liquidity to an enormously large dormant asset. Further, every 10 million hectare equivalent of tree cover could give 25 million tones of diesel substitute and another 70 million tones of cake annually, which can be used to substitute Indian coal. About 30 million hectare can completely replace the current use of fossil fuels, both liquid and solid.

8. Pongamia plantations could help sequestering carbon and reducing CO2 emissions to benefit the global environment.

Chattisgarh, a state in central India targeted a programme on Jatropha plantation in 1 million hectares by 2012. The Chattisgarh Biofuel Development Authority (CBDA) was set up in 2005 to ensure steady progress. However, the progress is limited in terms of geographical area covered by the plantations due to clear cut guidelines from the Ministry of Environment and Forests, Government of India. The state government has undertaken special steps to link farmers with Biofuel Programme to use field boundaries as well as barren land belonging to farmers. Government organizations are encouraged to use Government wasteland on lease for taking up Integrated Biofuel Projects. This policy initiative includes supply of Jatropha saplings to farmers, support prices and land allotment policy to investors. The Indian Oil Corporation (IOC) has signed a Memorandum of Understanding (MOU) with the state government and is in the process of forming a joint venture company with Chattisgarh State Renewable Energy Development Agency (CREDA). This Joint Venture will plant Jatropha on around 7000 ha of land available along railway tracks and it will produce Jatropha seeds for processing 8000 kl of biodiesel every year.

Rajasthan represents Arid India. No authentic data is available on revenue records reagarding area under biofuel trees like Mahua (Madhuca latifolia), Jatropha and Pongamia but it is estimated that 13 -15,000 ha of land is under Jatropha in the form of fence and wasteland plantations. The Biofuels Authority of Rajasthan prepared a roadmap for the development of biofuel plantations, setting up of oil extraction and transesterification plants and marketing biofuels in the state. The authority has estimated that out of 56,000,000 ha of land, 21,000,000 ha have immediate potential for Jatropha plantations. The Government of India and the Directorate of Agriculture, Government of Rajasthan in collaboration with Maharana Pratap University of Agriculture and Technology, Udapaur initiated survey, identification, development of elite lines and development of agrotechnology for Jatropha cultivation.

In the South Indian State of Karnataka Biodiesel activities have emerged as a major program during the past 5-6 years from trial productions to industrial productions or usage by the diesel vehicle industry. The combined experiences of the University of Agricultural Sciences, Bangalore and Dhardwad, Department of Agriculture Government of Karnataka, SUTRA, SAMAGRA VIKAS have developed proven strategies for augmenting the availability of the resources for oil production. A model has been initiated in Doddabalarpur Taluk for the production and marketing of biofuels in milk cooperatives and the University of Agricultural Sciences Bangalore has initiated work to establish the biofuel park at Hassan. The state is exploring the possibility of using species other than Jatropha and Pongamia such as Neem (Azadirachta indica), Paradaise tree (Simarouba glauca) and Mahua (Madhuca latifolia) as a resource base. In Karnataka, a state level Biodiversity Board has already been constituted.

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