# Potential of Bio Diesel in India and Its Usage

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## Abstract

India is the third largest country, which produces high rate of emission and creating environmental and ecological imbalances after China and USA. It is estimated that India's vehicular pollution have gone 15 times than 25 years before, because of uses of large number of vehicles for transport which is increasing every year 1.5 to 2 times of available vehicles. This source alone is contributing to about 70% in respect of the total air pollution. Thus necessity of renewable energy such as: bio-diesel, solar PV cells, solar heater, bio-mass and bio-gas, tidal energy, wind energy are very essential to supplement for the use as the green energy to reduce air pollution as well to check the environmental hazard and ecological balances too.

In this paper, authors focus the available potential of Bio-Diesel in India and its usage as a substitute to make Sustainable Energy and ultimately contributes to the mission of Energy Independence by 2030 as dreamed by our past Hon. President of India, Dr. A.P.J. Abul Kalam who mentioned this aspect in his Speech on eve of 59th Independence Day (14th August 2005). The Projection / scope of availability of un-utilized 60 millions hectre lands, forming of Jatropha Curcas, production / yield 2- tonnes per hectre, its massive utilizations in railways –transport diesel engines, buses, luggage carrier trucks and employment generation apart to fulfill the mission of Energy Independence.

**Keywords:** emission, environment, ecology, renewable energy, biodiesel

### 1.0 INTRODUCTION

It is fact that as civilization is growing, transport becomes essential part of life. The biggest problem is the growing population and depiction of fossil fuel. About 100 years ago, the major source of energy shifted from recent solar to fossil fuel (hydrocarbons). Technology has generally led to a greater use of hydrocarbon fuels, making civilization vulnerable to decreases in supply. The current study made in the year 2015, on the basis of Hubbert Curve an American geologist, Marion King Hubbert [**1**] who had projected Peak-Oil in 1956, predicts that if the hydrocarbon fuel /oil is consumed at the current rates, then by 2020, we will be consuming 80% of the entire available resource. This necessitates the search for alternative of oil as energy source or preserving it by tapping some other alternatives such as Non-conventional energy

like battery operated vehicles, wind mills, photocells etc. and to convert their output into mechanical energy, which may alternatively preserve oil source.

India's vehicular pollution is estimated to have increased fifteen times over the last three decades. This source alone is estimated to contribute about 70 per cent to the total air pollution. With 243.3 million tons of carbon released from the consumption and combustion of fossil fuels in 1999, India ranked third in the world behind the China and U.S. leaving for behind Russia and Japan. India's contribution to world carbon emissions is expected to increase in the coming years due to the rapid pace of urbanization, shift from non-commercial to commercial fuels, increased vehicular usage and continued use of older and more inefficient coal-fired power-plants [**2**].

The worldwide researches are also going on for other alternatives such as use of Hydrogen Fuel Cell (which is presently very costly), use of Bio-Diesel or use of compressed air Vehicle engines which may be made of light material body & cylinders of aluminum body.

Thus it is high time to utilize our best knowledge to choose the alternative resources of conventional fossil fuel, to make sustainable energy source. Biodiesel is one of the renewable fuel obtained from vegetable oils, animal fats, and recycled cooking oils.

## 2.0 NECESSITY OF BIODISEL USE IN INDIA

There are two distinct reasons to go for Biodiesel use are:

2.1. Depletion of Fossil fuel
2.2. Emission

### 2.1 Depletion of Fossil fuel

It is known fact that about 100 years ago our researches had gone towards hydrocarbon energy (i.e. petroleum product) as main energy source and now causing civilization vulnerable by its depletion in supply.

### 2.1.0 Why alternative to fossil fuel is sought?

**2.1.1**"*We do not inherit the Earth from our parents; we borrow it from our children*." Saint Exupery

**2.1.2** *When the wells run dry, We use more oil than we find, and if producers are fixing their figures the end could be closer than thought*, by Adam Porter, The Guardian [2005 May 25]

"*Predicting the end of the age of oil can be a sticky business. The Association for the Study of Peak Oil and Gas (Aspo), a collection of industry figures, politicians and academics, this week held its annual meeting at the Gulbenkian Museum in Lisbon...*"

**2.1.3** *Peaking of World Oil Production: Impacts, Mitigation, & Risk Management*, by Robert L. Hirsch, SAIC, Roger Bezdek, MISI, Robert Wendling, MISI for the National Energy Technology Laboratory of the US Department of Energy [2005 February]

"*The peaking of world oil production presents the U.S. and the world with an unprecedented risk management problem. As peaking is approached, liquid fuel prices and price volatility will increase dramatically, and, without timely mitigation, the economic, social, and political costs will be unprecedented. Viable mitigation options exist on both the supply and demand sides, but to have substantial impact, they must be initiated more than a decade in advance of peaking*."

**2.1.4.***Expert says Saudi oil may have peaked*, by Adam Porter [2005 February 22] :

*"As oil prices remain above $45 a barrel, a major market mover has cast a worrying future prediction. Energy investment banker Matthew Simmons, of Simmons & Co International, has been outspoken in his warnings about peak oil before. His new statement is his strongest yet, 'we may have already passed peak oil*."

**2.1.5**. Full text of landmark document now available: Nuclear Energy and the Fossil Fuels by M. King Hubbert, Chief Consultant (General Geology), Exploration and Production Research Division, Shell Development Company, Publication Number 95, Houston, Texas, June 1956, Presented before the Spring Meeting of the Southern District, American Petroleum Institute, Plaza Hotel, San Antonio, Texas, March 7-8-9, 1956.

**2.1.6** Chinese demand set to push Opec to limit, by Javier Blas and Kevin Morrison in London [2005 February 16] …

*"The Organisation of Petroleum Exporting Countries signalled a significant tightening of oil markets towards the end of this year, warning on Wednesday it would have to pump close to its maximum capacity next winter to meet rising demand from China against the backdrop of slowing Russian production.*"

**2.1.7** U.S. Energy Policy: A Declaration of Interdependence, by David J. O'Reilly Chairman and CEO, ChevronTexaco Corporation [2005 February 15] …

"*Simply put, the era of easy access to energy is over. Impart, this is because we are experiencing the convergence of geological difficulty with geopolitical instability... [W]e are seeing the beginnings of a bidding war for Mideast supplies between East and West*."

[Note: By reading this carefully, one can discover that the head of a major oil company is aware of the impending oil crisis. Editor.]

**2.1.8** New Oil Projects Cannot Meet World Needs This Decade, by Oil Depletion Analysis Centre [2004 November 16] …

*"World oil supplies are all but certain to remain tight through the rest of this decade, unless there is a precipitous drop in demand, according to the results of a study by the London-based Oil Depletion Analysis Centre (ODAC). "The study found that all of the major new oil-recovery projects scheduled to come on stream over the next six years are unlikely to boost supplies enough to meet the world's growing needs.*"

**2.1.9** Over a Barrel, by Paul Roberts in Mother Jones [2004 November]:

*"Experts say we're about to run out of oil. But we're nowhere near having another technology ready to take its place."*

*"The fifth revolution will come when we have spent the stores of coal and oil that have been accumulating in the earth during hundreds of millions of years... It is to be hoped that before then other sources of energy will have been developed... Whether a convenient substitute for the present fuels is found or not, there can be no doubt that there will have to be a great change in ways of life. This change may justly be called a revolution, but it differs from all the preceding ones in that there is no likelihood of its leading to increases of population, but even perhaps to the reverse.*" -Sir Charles Galton Darwin, 1952.

We are consuming oil at an incredible pace. Sooner or later we will run out. It is really only a question of when. The answer is that it will be sooner than the authorities would like us to believe. And they know it! Just consider the following.

*"...by 2010 we will need on the order of an additional fifty million barrels a day. So where is the oil going to come from*?" - Vice President Dick Cheney said in a speech at the London Institute of Petroleum Autumn lunch in 1999 (when he was chairman of Halliburton).

## 2.2 Emission control on use of BIODIESEL

### 2.2.0 Influence of fossil fuel on environment and ecology

It is observed that with increasing pace of civilization, uses of transport have become essential part of life and increasing in geometrical progression. This is leading to very hazardous condition due to high rate of pollution.

**Fig.1:** Jatropha Curcas

**2.2.1 Automobile Emission:** Emissions from an individual car are generally low, relative to the smokestack image many people associate with air pollution. But in numerous cities across the country, the personal automobile is the single greatest polluter, as emissions from millions of vehicles on the road add up.

Driving a private car is probably a typical citizen's most "polluting" daily activity. Gasoline and diesel fuels are mixtures of hydrocarbons, compounds which contain hydrogen and carbon atoms. In a "perfect" engine, oxygen in the air would convert all the hydrogen in the fuel to water and all the carbon in the fuel to carbon dioxide. Nitrogen in the air would remain unaffected. In reality, the combustion process cannot be "perfect," and automotive engines emit several types of pollutions.

**2.2.2 Automobiles & Ozone :** Ozone in the upper atmosphere (the "ozone layer") occurs naturally and protects life on earth by filtering out ultraviolet radiation from the sun. But Ozone at ground level is a noxious pollutant. Ozone is not emitted directly but is formed in the atmosphere through a complex set of chemical reactions involving hydrocarbons, oxides of nitrogen, and sun-light. The rate at which the reactions proceed is related to both temperature and intensity of the sunlight. Because of this, problematic ozone levels occur most frequently on hot summer afternoons. Hydrocarbons and nitrogen oxides come from a great variety of industrial and combustion processes. In typical urban areas, at least half of those pollutants come from cars, buses, trucks, and off-highway mobile sources such as construction vehicles and boats.

**2.2.3 Automobiles and Carbon Monoxide:** Carbon monoxide (CO) is a colorless, odorless, poisonous gas. A product of incomplete burning of hydrocarbon-based fuels, carbon monoxide consists of a carbon atom and an oxygen atom linked together. Carbon Monoxide creates Public Health Problem & enters the bloodstream through the lungs and forms carboxyhemoglobin, a compound that inhibits the blood's capacity to carry oxygen to organs and tissues. Persons with heart disease are especially sensitive to carbon monoxide poisoning and may experience chest pain if they breathe the gas while exercising. Infants, elderly persons, and individuals with respiratory diseases are also particularly sensitive. Carbon monoxide can affect healthy individuals, imparting exercise capacity, visual perception, manual extremity, learning functions, and ability to perform

complex tasks. Carbon monoxide results from incomplete combustion of fuel and is emitted directly from vehicle tailpipes. Incomplete combustion is most likely to occur at low air-to-fuel ratios in the engine. These conditions are common during vehicle starting when air supply is restricted ("choked"), when cars are not tuned properly, and at altitude, where "thin" air effectively reduces the amount of oxygen available for combustion (except in cars that are designed or adjusted to compensate for altitude).

**2.2.4 Wasteful Uses of Fossil fuel**: It is essential to reduce carbon emissivity due to higher rate of utilization of transport and to increase thermodynamic efficiency of energy usage. For this, the ecological tax reform should be advanced, harmonized internationally step by step, and be a part of the WTO treaty. Energy prices should be sufficiently high to punish wasteful behavior while honoring efficient energy use across the board, and especially in the road transport sector.

**2.2.5 Auto Emission Control Act**: Air pollution and cars were first linked in the early 1950's by a California researcher who determined that traffic was to blame for the smoggy skies over Los Angeles. At the time, typical new cars were emitting nearly 13 grams per mile hydrocarbons (HC), 3.6 grams per mile nitrogen oxides (NOx), and 87 grams per mile carbon monoxide (CO).Since then, the Federal Government in 1995, has set standards to bring down levels of these pollutants, and the auto industry has responded by developing new emission control technologies. The current Federal certification standards for exhaust emissions from cars are 0.25 gram per mile HC, 0.4 gram per mile NOx, and 3.4 grams per mile CO. The standard for evaporative HC emissions is 2 grams per test.

## 3.0 WHAT IS BIODIESEL & ITS SIGNIFICANT BENEFITS OF BIODIESEL

Biodiesel is a fuel additive or alternative combustible fuel for diesel engines. It is nontoxic, biodegradable, and virtually free of aromatics and sulfur. This is because its primary components are domestic renewable resources such as vegetable oil and animal fats. Thus, Biodiesel is the mono-alkyl esters of fatty acids that result from animal fats or vegetable oils. In other words, Biodiesel is the end result of the chemical reaction caused by mixing vegetable oil or animal fat with an alcohol such as methanol. Together these ingredients produce a compound recognized as a fatty acid alkyl ester. A catalyst such as sodium is also necessary in order for the Biodiesel to be considered a finished Product, and is added with the new compound to create Biodiesel fuel.

Biodiesel offers many advantages:

- It is renewable.
- It is energy efficient.
- It displaces petroleum derived diesel fuel.
- It can be used in most diesel equipment with no or only minor modifications.
- It can reduce global warming gas emissions.
- It can reduce tailpipe emissions, including air toxics.
- It is nontoxic, biodegradable, and suitable for sensitive environments.

- It is made in the United States from either agricultural or recycled resources.
- It can be easy to use if you follow these guidelines.

Biodiesel can be used in several different ways such as use 1% to 2% biodiesel as a lubricity additive, which could be especially important for ultra low sulfur diesel fuels (ULSD, less than 15 ppm sulfur), which may have poor lubricating properties. It can blend 20% biodiesel with 80% diesel fuel (B20) for use in most applications that use diesel fuel. It can even use it in its pure form (B100) with take proper precautions. The word biodiesel in this report refers to the pure fuel—B100—that meets the specific biodiesel definition and standards approved by ASTM International. A number following the "B" indicates the percentage of biodiesel in a gallon of fuel, where the remainder of the gallon can be No. 1 or No. 2 diesel, kerosene, jet A, JP8, heating oil, or any other distillate fuel. The use of Bio diesel are tested for various parameters and blending of Bio Diesel up to 18-20 % is found most efficient for the running of the vehicle and also pollution limits due to hydrocarbon (HC), Carbon-mono oxide (CO) and nitrogen (NOx) are found well within the emission limits prescribed by EPA in 1995.

**Table-1: ASTM D-6751 standards for biodiesel**

| | |
|---|---|
| Flash point (closed cup) | 130°C min. (150°C average) |
| Water and sediment | 0.050% by vol., max. |
| Kinematic viscosity at 40°C | 1.9-6.0 $mm^2/s$ |
| Rams bottom carbon residue, % mass | 0.10 |
| Sulfated ash | 0.020% by mass, max. |
| Sulfur | 0.05% by mass, max. |
| Copper strip corrosion | No. 3 max |
| Cetane | 47 min. |
| Carbon residue | 0.050% by mass, max. |
| Acid number -- mg KOH/g | 0.80 max. |
| Free glycerin | 0.020 % mass |
| Total glycerine (free glycerine and unconverted glycerides combined) | 0.240% by mass, max. |
| Phosphorus content | 0.001 max. % mass |
| Distillation | 90% @ 360°C |

### 3.1 Environmental Benefits

In 2000, biodiesel became the only alternative fuel in the country to have successfully completed the EPA-required Tier I and Tier II health effects testing under the Clean Air Act. These independent tests conclusively demonstrated biodiesel's significant reduction of virtually all regulated emissions, and showed biodiesel does not pose a threat to human health.

Biodiesel contains no sulfur or aromatics, and use of biodiesel in a conventional diesel engine results in substantial reduction of unburned hydrocarbons, carbon monoxide and particulate matter. A U.S.

Department of Energy study showed that the production and use of biodiesel, compared to petroleum diesel, resulted in a 78.5% reduction in carbon dioxide emissions. Moreover, biodiesel has a positive energy balance. For every unit of energy needed to produce a gallon of biodiesel, 3.24 units of energy are gained [**5**].

### 3.2 Energy Security Benefits

With agricultural commodity prices approaching record lows, and petroleum prices approaching record highs, it is clear that more can be done to utilize domestic surpluses of vegetable oils while enhancing our energy security. Because biodiesel can be manufactured using existing industrial production capacity, and used with conventional equipment, it provides substantial opportunity for immediately addressing our energy security issues.

If the true cost of using foreign oil were imposed on the price of imported fuel, renewable fuels, such as biodiesel, probably would be the most viable option. For instance, in 1996, it was estimated that the military costs of securing foreign oil was $57 billion annually. Foreign tax credits accounted for another estimated $4 billion annually and environmental costs were estimated at $45 per barrel. For every billion dollars spent on foreign oil, America lost 10,000 – 25,000 jobs [**5**].

### 3.3 Economic Benefits

Increased utilization of renewable biofuels results in significant microeconomic benefits to both the urban and rural sectors, and the balance of trade. A study completed in 2001 by the U.S. Department of Agriculture found that an average annual increase of the equivalent of 200 million gallons of soy-based biodiesel demand would boost total crop cash receipts by $5.2 billion cumulatively by 2010, resulting in an average net farm income increase of $300 million per year. The price for a bushel of soybeans would increase by an average of 17 cents annually during the ten-year period.

In addition to being a domestically produced, renewable alternative fuel for diesel engines, biodiesel has positive performance attributes such as increased cetane, high fuel lubricity, and high oxygen content, which may make it a preferred blending stock with future ultra-clean diesel.

### 3.4 Quality Benefits

Biodiesel is registered as a fuel and fuel additive with the EPA and meets clean diesel standards established by the California Air Resources Board (CARB). B100 (100 percent biodiesel) has been designated as an alternative fuel by the U.S. Department of Energy and the U.S. Department of Transportation. Moreover, in December 2001, the American Society of Testing and Materials (ASTM) approved a specification (D6751) for biodiesel fuel. This development was crucial in standardizing fuel quality for biodiesel in the U.S. market.

The National Biodiesel Board, the trade association for the biodiesel industry, has formed the National Biodiesel Accreditation Commission (NBAC) to audit fuel producers and marketers in order to enforce fuel quality standards in the US. NBAC issues a 'Certified Biodiesel Marketer' seal of approval for biodiesel marketers that have met all requirements of fuel accreditation audits. This seal of approval will provide added assurance to customers, as well as engine manufacturers, that the biodiesel marketed by these companies meets the ASTM standards for biodiesel and that the fuel supplier will stand behind its products [**5**].

### 3.5 EP Act Benefits

Effective November 1998, Congress approved the use of biodiesel as an Energy Policy Act (EPAct) compliance strategy. The legislation allows EPAct-covered fleets (federal, state and public utility fleets) to meet their alternative fuel vehicle purchase requirements simply by buying 450 gallons of pure biodiesel and burning it in new or existing diesel vehicles in at least a 20% blend with diesel fuel. The Congressional Budget Office and the U.S. Department of Agriculture have confirmed that the biodiesel option is the least-cost alternative fuel option for meeting the Federal government's EPAct compliance requirements. Because it works with existing diesel engines, biodiesel offers an immediate and seamless way to transition existing diesel vehicles into a cleaner burning fleet [**5**].

## 4.0 SCOPE OF PRODUCTION OF BIODIESEL IN INDIA

India has nearly 60 million hectares of wasteland, of which 30 million hectares are available for energy plantations like "Jatropha". Once grown, the crop has a life of 50 years. Each acre will produce about 2 tonnes of bio-diesel at about Rs. 20 per litre. Biodiesel is carbon neutral and many valuable by-products flow from this agro-industry. Intensive research is needed to burn bio-fuel in internal combustion engines with high efficiency, and this needs to be a urgent R&D programme. India has a potential to produce nearly 60 million tones of bio-fuel annually, thus making a significant and important contribution to the goal of Energy Independence. Indian Railways has already taken a significant step of running two passenger locomotives (Thanjavur to Nagore section) and six trains of diesel multiple units (Tiruchirapalli to Lalgudi, Dindigul and Karur sections) with a 5% blend of bio-fuel sourced from its in-house esterification plants. In addition, they have planted 75 lakh Jatropha saplings in Railway land which is expected to give yields from the current year onwards. This is a pioneering example for many other organisations to follow.

Similarly many States in our country have energy plantations. What is needed is a full economic chain from farming, harvesting, extraction to esterification, blending and marketing. Apart from employment generation, bio- 7 fuel has a significant potential to lead our country towards Energy Independence [**9**].

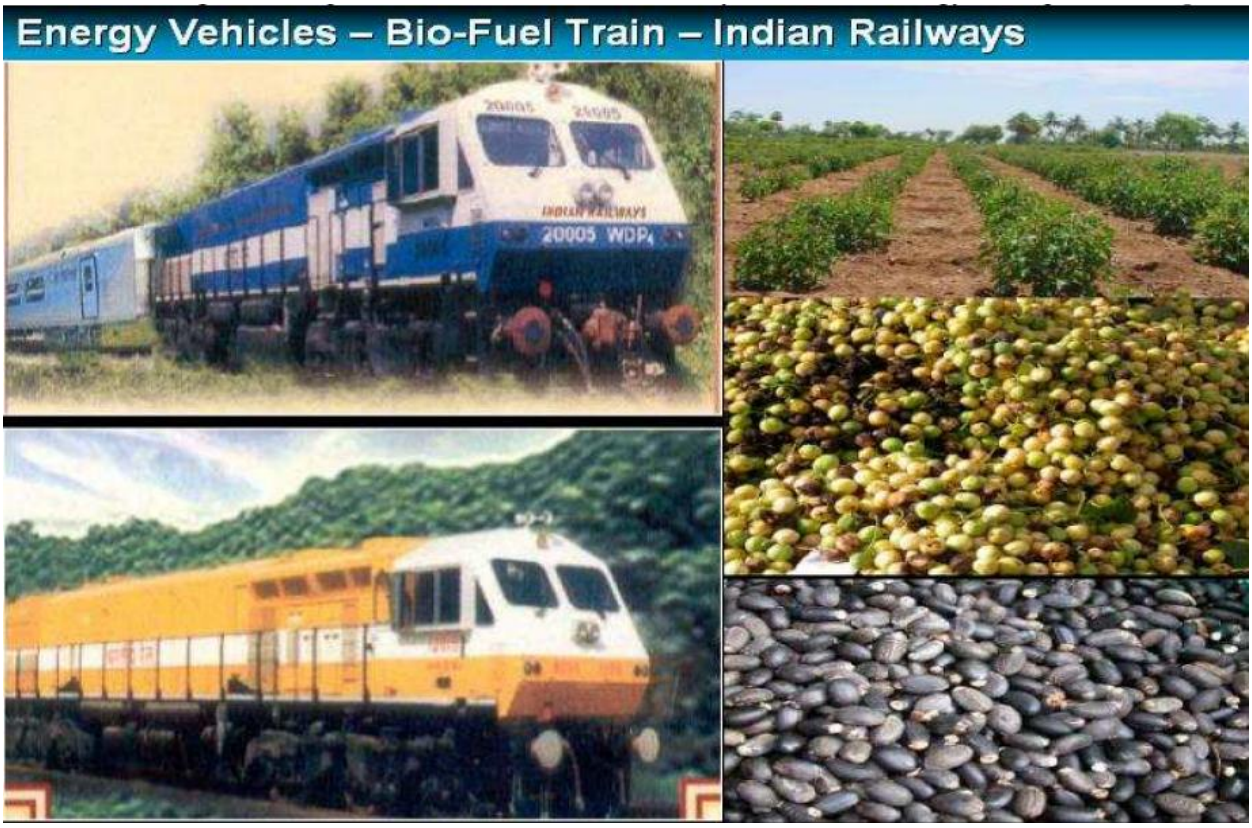


**Fig.2:** Jatropha Farming and Usage in Diesel locomotive

**5.0 CULTIVATION OF JATROPHA & OTHER SEEDS IN INDIA**

Statewide steps to promote Jatropha Curcas and Pomgamia Pinatta.

**5.2 Chhattisgarh:** The government has planted in 2005, 80 million saplings of jatropha, a source of bio-fuel, as the state attempts to tap non-conventional energy sources. It has set a target of cultivating jatropha plantations in one million hectares in 2006, covering 20,000 hectares in the first phase. The government would work with NGOs for starting 350 jatropha nurseries, each spread over a maximum of 500 hectares, in 2005.

**5.3 Andhra Pradesh**: State has taken the lead in Jatropha Plantation. The state government has set up a separate department for bringing into productive use the 728,000 hectare cultivable wasteland available for cultivation of Jatropha plantation for production of bio-diesel. The state government is drawing up a roadmap, which will see the involvement of oil majors like Indian Oil

Corporation (IOC) and Reliance Industries, to make the state the biggest producer of bio-diesel. It is planning to bring between 4 and 5 million acres of land in seven to eight districts of the state under biodiesel plantations and ensure that micro-irrigation is used in a big way in these areas. This will change the ecology of the area.

**5.4 Tamil Nadu:** Underutilised lands could turn into fertile farms and farmers can be assured of a price for their produce. This is a project to produce 100 per cent biodiesel from jatropha. D1-Mohan Bio Oils Limited (a joint venture of Mohan Breweries and Distilleries and U.K. based D1 Oils Plc) plans to bring one lakh hectares under jatropha cultivation in Tamil Nadu. Indian Overseas Bank signed an agreement with Coimbatore based Classic Jatropha Oil (India) Ltd for promoting cultivation of jatropha curcas in Tamil Nadu under contract farming. Classic Jatropha Oil, a subsidiary of Tirupur based major knitwear exporters, has been involved in developing the Jatropha cultivation for a long time. (D1 Oil plc: A UK producer of green fuel, Newcastle-based D1 Oil plc, has 10,000 hectares of the crop planted in India and its target of 267,000 hectares by the end of 2006 is on track.)

**5.5 Uttar-Pradesh**: State is also taking lead in Jatropha plantation in District Basti, Bahraich, Gonda & Barabanki. Formers have started cultivating the Jatropha in big way. Atleast 200 acres land is initially being used for its cultivation. Sofar there is no plant for producing biodiesel from Jatropha seeds.

**5.6 Reliance Industries Ltd to enter Bio-Fuel:** Reliance Industries Ltd (RIL) is planning to enter the bio-fuel segment in a big way. To begin with, the company has earmarked 200 acres of land at Kakinada in Andhra Pradesh to cultivate jatropha, which can yield high quality bio-diesel. The area of cultivation will be increased to many thousands of acres depending on the progress of the project. The project is being implemented by Reliance Life Sciences, a subsidiary of RIL.

**5.7 Several smaller Indian companies are already working towards developing bio-diesel:** Companies like Nandan Bioagro and Labland Biotech have tied up with British oil company D1 Oils to produce jatropha and trade in it. The company will encourage hundreds of farmers to cultivate the crop under an arrangement with the company.

A jatropha seed contains 31 to 37 per cent extractable oil. A jatropha plantation over 100,000 hectares is expected to yield 250,000-300,000 tons of crude jatropha oil per annum. It is estimated that an initial 100,000-hectare jatropha farm will yield revenues of $100 million per annum.

Reliance is also in talks with Maharashtra, Gujarat, Andhra Pradesh and Rajasthan Governments, to get access to land for contract farming.

**5.8 Godrej plans Indian Rupees 5 billion for bio-fuel projects :** Godrej Agrovet Ltd is planning to invest over Indian Rupees 5 billion, for jatropha and palm oil cultivation in the states of Gujarat and

Mizoram. The company would cultivate jatropha or palm oil according to the nature of the waste land in these states.

According to industry sources, Godrej Agrovet would invest Indian Rupees 2.5 billion for bio-fuel plant cultivation along with the palm oil processing and plant cultivation project in Gujarat while it would invest Indian Rupees 2.5 billion for both jatropha and palm oil cultivation in Mizoram.

Godrej would be cultivating both jatropha and palm oil in an area over 10,000 acres in Mizoram as per the fertility of the land. The company is also in the process of setting up mills in Walia (Gujarat) at an estimated cost of $ 10 million.

**5.9 Emami Ltd, one of the leading toiletries outfit in the country**: It is planning to enter into the farming of jatropha, a source of biodiesel. The company might float a joint venture outfit with a leading European company in the field of bio-diesel for the new business. Emami group is now talking to some companies in United States, UK and Austria for technical collaboration for the extraction of oil from jatropha. The project will be first of its kind in the Eastern India. The company will start farming of jatropha in Suri in West Bengal and Balasore in Orissa.

**5.10 Plantation of other seeds:** In India from old days oil from Mahua, Neem, Soybean seeds were extracted and being used for domestic purposes for lighting lamps, heating stoves [7] etc. The potential now be utilized for this by getting the plantation again done which may help in ecological balances and may bee used as renewable energy source.

**6.0 BIODIESEL POLICIY**

**6.1 Price Policy for BioDiesel**: Public sector oil firms have announced a price of Indian Rupees 25 (US$ 0.56) per liter for procuring bio-diesel extracted from non-edible oilseeds for mixing in diesel. The program to sell diesel mixed with non-edible oil extracted from Jatropha Curcas and Pongamia Pinnata, which could cut India's import dependence, but would take 4-5 years to launch on commercial scale. It will take time for adequate quantities of Jatropha Curcas and Pongamia Pinnata to be planted and oil extracted for mixing in diesel.

**6.2 Bio-Diesel Credit Bank**: Petroleum Conservation Research Association (PCRA), www.pcra.org, launched Bio-Diesel Credit Bank. It will co-ordinate activities relating to Carbon Credit.

**Field Trials:** Several Field trials have been performed.

**6.2.1 Indian Oil Corporation**: IOC had placed an order of 450 kiloliters of bio-diesel in 2004, for field trials with the Indian Railways and State Roadways. IOC will be able to supplement 5% of diesel with bio-diesel in three years.

**6.2.2 The first phase of the project**: By Daimler-chrysler India, in 2003-04 saw production of the indigenous biodiesel and completion of road trials on two C-Class Mercedes-Benz cars. The cars,

powered by pure (neat) Biodiesel, traversed the rugged terrain of the country in April-May, 2004, and clocked over 5,900 kilo meters under very hot and humid conditions.

**6.2.3 The Council for Scientific and Industrial Research:** CSIR is now in talks with country's biggest truck and bus maker Tata Motors and Indian Oil to take its biofuel project to the next stage, for testing its vehicles on bio-diesel developed from jatropha plant.

### 6.3 Bio-Fuel Policy in INDIA

**6.3.1 Centre may clear bio-fuel policy by 2006:** The Center is likely to come up with a clear-cut bio-diesel policy by end of 2006. The Energy Policy Committee has submitted its report to the government by November 30, 2005. An in-principle approval is expected to be given by that time, which will be worked into a formal bio-fuel policy later. The report from the committee has made specific proposals which will then be forwarded to the Energy Co-ordination Committee for final acceptance by the government.

**6.3.2 Zero excise duty for bio-fuels on cards**: The government is likely to change the excise duty structure for bio-fuels in the next Budget to make their use attractive. Petroleum ministry officials said the excise duty on biodiesel and ethanol is likely to be made nil and states would be asked to have a favorable sales tax regime.

**6.3.3 Govt. to assist, encourage states in bio-diesel production** : The government will assist states promote Jatropha cultivation for increasing bio-diesel production in the country under the National Rural Employment Guarantee Scheme, the Rajya Sabha was informed on 7 Dec 2005.

**6.3.4 Andhra Pradesh State Government Introduces Draft Industrial Policy:** The Andhra Pradesh government has introduced a draft biodiesel policy to facilitate both investors and farmers to plant oil-bearing trees in 1.5 million acre in the next four years. Also, a risk fund of Indian Rupees 2 Billion is expected to be created, as loan to the state government, to support small and marginal farmers with maximum five acre land holding. There is also a proposal for constituting a biodiesel board, which would be an autonomous board for integrated development of jatropha cultivation and bio-diesel oil in the state. The proposed board, having legal authority, will monitor the tripartite agreement signed between the stake holders, besides assisting, encouraging, and promoting jatropha cultivation, according to the officials involved in preparing the draft policy said. Following the constitution of policy, the government is determined to promote contract farming for buyback of jatropha seeds. The minimum buy-back price will be fixed considering the different variables including the quality and quantity of the produce. A special department called the Rain Shadow Area Department has been created as a special purpose vehicle for planning, coordination, monitoring and implementation of the biodiesel program.

## 7.0 COMMERCIAL PRODUCTION IN INDIA

### 7.1 Two small units are already in production:

**7.1.1 Aatmiya Biofuels Pvt Ltd**, 68,G.I.D.C. Por Ramangamdi Taluka & District Vadodara, Gujarat- 391243, Phone No : 0265 2885009, Mobile No : 09879359010, has commercialized the production of biodiesel in Gujarat on 8th March 2005 and now producing 1000 liters/day. The company is promoted by Mr. Umakant Joshi, umakantjoshi@hotmail.com a Chemical Engineer who did his graduation from M.S.University of Vadodara, then post graduate in Chemical Engineering from Delaware University, USA specialized in Bioenergy.

**7.1.2 Gujarat Oelo Chem Limited (GOCL)**, a Panoli-based firm started on 12th of March 2005, producing bio-diesel from vegetable based feedstock. It released the first commercial consignment of bio-diesel to Indian Oil Corporation (IOC). Head Office : Gujarat Oleo Chem. Ltd., D-315, Crystal Plaza, Oshiwara Link Road, Andheri(W), Mumbai- 400053, Tel : 91-22-2673 3369 / 70 / 71, Fax: 91-22-2634 9195. E-mail: gocl@bom5.vsnl.net.in, Website: www.gujaratoleochem.com. Regd. Off & Works: Plot No. 631-639, GIDC, Panoli, 394 116, Tel : 91-2646-271 730 / 731 / 647, Fax : 91-2646-272195.

**7.2 Production Plans:** Number of companies are planning to set up new units.

**7.2.1 Kochi Refineries Ltd (KRL)** is setting up a pilot plant with a US firm to extract biodiesel from rubber seed oil. An R&D exercise, the company proposed to look at the feasibility of the project and would initially have a pilot plant set up with a daily capacity of 100 liters. The company has initiated studies into the availability of rubber seed oil from neighboring Tamil Nadu, especially from the Nagercoil belt.

**7.2.2 Another Kochi-based company, TeamSustain Ltd**, a division of US-based Dewcon Instruments Inc, is in talks with a US firm for setting up a biodiesel plant in Kochi.

**7.2.3 Pune-based Shirke Biohealthcare Pvt. Lld.**, 11, Navrang Plaza, Tingre Nagar, Vishrantwadi, Airport Road, Pune, India, 411 015. Tel: 91-20-5623 3110, Cell : 91-9422010236, Fax : 91-20-2581 3993, jet_india@rediffmail.com, is setting up a refinery at Hinjewadi, with a capacity to process 5,000 liters biodiesel per day from Jatropha plant. The refinery will also produce 1 MW power with the oil cake, apart from natural gas which will be used to run the power plant.

**7.2.4 Renewable energy company Bhoruka Power Corporation Ltd**, has received a grant of 100,000 dollars from the US government to conduct a detailed feasibility report for a bio-diesel project in State of Karnataka. The study envisages use of Neem or Pongamia non-edible oilseeds for production of bio-diesel as well as power.

**7.2.5 The Southern Online Biotechnologies Limited**, which is setting up a bio-diesel project in Andhra Pradesh, has signed MoU with several government bodies and non-governmental organisations, for procuring raw material like Pongamia Pinnata (Karanja or Kanuga) and Jatropha seed. The oil extracted from this seed is used to produce bio-diesel. The company is setting up the bio-diesel project at an estimated cost of Indian Rupees 150 million at Choutuppal in Andhra

Pradesh, with technology from a German company named Lurgi. The plant capacity is 30 tons per day or 90,000 tons per annum. It would require around 100 tons of seeds per day. The annual requirement of seeds is around 32,000 tons. As the current availability of seeds in the state is less than 4,000 tons, company will use other raw materials like acid oils, distilled fatty acids, animal fatty acids and non-edible vegetable oils like neem, rice bran etc,

**7.2.6 Jain Irrigation System Ltd,** has plans to set up a Indian Rupees 480 million large-scale commercial bio-diesel plant, with a capacity of 150,000 tons per day in Chattisgarh by 2008. R&D work at 3 tons per day biodiesel pilot plant at Jalgaon, built at a cost of Indian Rupees 5 million. This will be followed by another bio-diesel plant with a capacity of 10 tons per day at Jalgaon. The current concern in the biodiesel industry is finding adequate farmland to make sure our industry receives a regular supply of feedstock.

**7.2.7 Nova Bio Fuels Pvt. Ltd**, is setting up a Indian Rupees 200 million, biodiesel plant with a capacity of 30 tons per day in Panipat in 2006. Their plant would also supply glycerine to local pharma companies.

**7.2.8 Naturol Bioenergy Limited** is setting up an integrated biodiesel facility in Andhra Pradesh. The 300 tons per day biodiesel plant will come up in the port town of Kakinada at an estimated cost of Indian Rupees 1.4 billion and would be a 100 per cent export-oriented unit.

**7.2.9 An Indian Rupees 9 million biodiesel plant**, is coming up in Ganapathipalayam village, about 20 km away from Pollachi. KTK German Bio Energies India, is all set to commence commercial production of biofuel from January 2006. The plant will use rubber seeds for extraction biodiesel.

**7.2.10 Biodiesel extracted from Pomgamia Pinatta (Karanj) seeds**, was commercially launched in Pune in January 2006. The fuel has been produced and marketed by Pune-based Mint Biofuels, Though the plant initially had a capacity of 100 litres per day, it was scaled up to 400 litres per day. The company will set up a Indian Rupees 300 million plant at Chiplun, which will have a capacity of producing 5,000 tons of fuel per day. Plans are afoot to increase the capacity of the plant to 1,00,000 tons within a period of four years.

**7.2.11 Vijayawada based Sagar Jatropha Oil Extractions Private Limited** is setting up an Indian Rupees 100 million jatropha oil extraction unit at Gannavaram. The company has also experienced success with contract farming of the jatropha plant in the state. Jatropha oil is mixed with diesel to produce biodiesel.

**7.2.12 British Petroleum on Feb. 2, 2006,** declared that it will fund a $9.4 million project in India to see if biodiesel can be produced from a non-edible oil bearing crop. The project by The Energy and Resources Institute in the southern state of Andhra Pradesh will study the feasibility of producing biodiesel from the crop Jatropha Curcas. The 10-year project will cultivate around 8,000 hectares of wasteland with the crop and install equipment needed for seed crushing,

oil extraction and processing, to produce 9 million liters of biodiesel per year. The project will also include an environmental and social impact assessment. TERI will run the project's daily operations.

**8.0 RISING CRUDE PRICES**

**8.1 The rising crude oil prices** will lead to higher usage of vegetable oils and fats as alternative fuel. Demand for bio-fuels will invariably increase, it is expected that the demand for bio-fuel from vegetable oils and fats will shoot up to 3 million tons a day.

**8.2 Biodiesel will have a pronounced impact** on edible oil prices: Prices of both palm and soy oils will firm up in the coming months, with demand for biodiesel alone grabbing at least six million tons of oils despite the slower growth of the economy.

Crude Palm Oil futures have gone up from 1,300-1,500 ringgit to a new higher range of 1,400 to 1,600. As the period October to February advances, prices will creep towards the upper end of this range. Crude de-gummed soy oil would be in the range of $460-500 per ton free on board, while RBD palm olein will be in the $400-450 band and crude palm oil will be between $370-420 free on board.

Malaysia and Indonesia are the world's largest producers and exporters of palm oil, while Brazil and Argentina are among the top soy oil producers. From mid-2006, the use of soy oil for biodiesel will have a pronounced impact on prices, and the total biodiesel capacity coming on stream by the end of 2006/07 will require 1.6 million tons of soya oil. Edible oil imports by India, the world's leading buyer, in 2005/06 could remain flat at around 5.65 million tons, but imports of soy oil will go up at the expense of palm oil.

**9.0 OPPORTUNITIES TO EMPLOYMENT**

There are new work opportunities in Jatropha cultivation and biodiesel production related sectors, and the industry can be grown in a manner that favors many prosperous independent farmers and farming communities specially Promotion of Women employment[**10-11**].

**10.0 CONCLUSION**

In view of fast depleting fossil fuel reserves and growing energy requirements, it has become inevitable to look into for alternative sources of energy. Biodiesel has immense potential for being used as an alternative fuel for internal combustion engine. The production of Biodiesel can be under taken through various non edible oils through esterification. Following conclusion drawn from present study:-

- Peak oil is turning point for mankind and the 100 year of easy growth may end, if self-sufficiently & sustainability of energy is not maintained on priority. It may end up a better world [**2**].

- India has 60 Million hectors [**9**] un-utilized land and if 50 % of land is used for Jatropha cultivation, major problem will be over. But production of food grains must commensurate with rising population of India, that may likely to reach from 110 to 140 Crores by 2030.
- Jatropha yield would be 2 tonnes per hectors that may produce of 60 Million Tonnes of Biodiesel. It may definitely add to the dream of our Dr. APJ Abdul Kalam, past Hon. PRESIDENT OF INDIA towards ENERGY INDEPENDENCE by 2030[**9**].
- Presently Biodiesel as a renewable energy appears to be a very wise step to go for Plantation of Jatropha, but serious thoughts also to be given to the other Sustainable Energy Resources (such as non-conventional energy source Photocells, Hybrid Electric, Wind mills, use of Compressed Air, Hydrogen cell [**4**], Propane & Ethyl ester-Ethanol Biodiesel [**6**] etc.) in addition to Biodiesel, Biomass, Biogas & Fat from food grain.
- Constraint: Use of Pure Biodiesel as Vehicle fuel is not possible.

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