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Bio fuels Towards a greener and secure energy future (A Review)

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Abstract— Fuels are any materials that store potential energy in forms that can be practicably released and used as heat energy. Fuels are required for a variety of purposes, but are utilized chiefly for Transportation and Power Generation.
Fossil Fuels will soon be exhausted, if we had replenished fuel sources, what direction should we go in? Any hydrocarbon fuel that is produced from organic matter (living or once living material) in a short period of time (days, weeks, or even months) is considered a Biofuel. One such plant is used as Biofuel known as Jatropha, which can be cultivated anywhere along, roads, railway tracks, on border of farm and even an alkaline soil. It occurs mainly at lower altitude (0-500Cm) with average annual temperature above 20°C, and rainfall of 300-1000 mm.
Biodiesel is eco-friendly. It provides alternative to conventional fuel with clean burning. Biodiesel contain no petroleum, but can be blended with conventional diesel fuel which gives comparable energy to conventional fuel.
This fuel can be used in any diesel engine without any modification. Biodiesel is degradable, non toxic and free from sulphur and lead.
Keywords— Biodiesel; Biofuel; Jatropha; Fossil fuel

I. INTRODUCTION

Fuels are any materials that store potential energy in forms that can be practicably released and used as heat energy. Fuels are required for a variety of purposes, but are utilized chiefly for Transportation (Globally, Transportation accounts for 25% of energy demand and nearly 62% of oil consumed.) and Power Generation (The generation of electricity is the single largest use of fuel in the world. More than 60 % of power generated comes from fossil fuels). Fossil Fuels will soon be exhausted but If we had replenish fuel sources, we have direction like Electric cars, Solar power, Wind power and Biofuels [1]. Any hydrocarbon fuel that is produced from organic matter (living or once living material) in a short period of time (days, weeks, or even months) is considered a Biofuel [1,2].

A. Biofuel versus Fossil Fuel

Fossil fuels are not renewable, which means they will run out at some point. As our ability to pump fossil fuels from the ground diminishes, the available supply will decrease, which will inevitably lead to an increase in price. Biofuels can be looked upon as a way of energy security which stands as an alternative of fossil fuels that are limited in availability. Today, the use of biofuels has expanded throughout the globe. Fossil fuels are Nonrenewable (in the sense that once used it is no longer available) and take millions of years to form. The burning of fossil fuels releases carbon dioxide: *the gas that causes global warming*. Mining of Fossil fuels leads to irreversible damage to the adjoining environment; (narrow shafts for oil, caverns for coal) .Mining coal is a very dangerous job to do and it involves deforestation. The Power stations, which make/use coal, need lots of fuel. they regularly get this supply through truck or train, to operate/generate electricity. This means that they also need a large area for the reservation of coal.The using of natural gases causes horrible smells, especially during transportation. Crude oil is very hazardous. It causes environmental pollution.They release a poisonous gas called carbon monoxide, this gas is very toxic for humans and animals [1].

B. Petrol/Diesel Price Rising

Petrol/Diesel price = cost price (procuring + refining + marketing) + tax (central + state)+ Cost price= f(international crude price)

International Crude Price = f(Supply, Demand, Government policies, Financial Institutions, Geopolitics)

International crude price is rising, therefore cost price is rising thus increasing the petrol price [1].

C. Positives of Biofuels

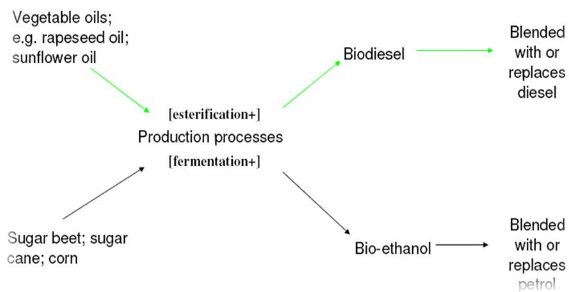
The energy content of biodiesel is about 90% that of petroleum diesel.The energy content of ethanol is about 50% that of gasoline.The energy content of butanol is about 80% that of gasoline. Biofuels burn cleaner than fossil fuels, resulting in fewer emissions of greenhouse gases, particulate emissions, and substances that cause acid rain such as sulfur. Biodiesel is sulfur free and has fewer polycyclic aromatic hydrocarbons, which have been linked to cancer. Additionally, biofuels are biodegradable, so if they do spill, less harm is done compared to when fossil fuels spill [1,2].

II. CLASSIFICATION OF BIOFUELS

Biofuels are often broken into two generations.

1st generation biofuels are also called conventional biofuels. They are made from things like sugar, starch, or vegetable oil. Note that these are all food products. Any biofuel made from a feedstock that can also be consumed as a human food is considered a first generation biofuel [1,2].

2nd generation biofuels are produced from sustainable feedstock. No second generation biofuel is also a food crop, though certain food products can become second generation fuels when they are no longer useful for consumption. Second generation biofuels are often called “advanced biofuels” [1,2].



Feedstock
↓
Transportation
↓
Biorefinery
↓
Processing & Conversion
↓
Distribution
↓
End User

Fig.1.Biofuels life cycle

A. Biodiesel

Biodiesel as an alternative fuel for diesel engine is becoming increasingly important due to diminishing petroleum reserves and environmental consequences of exhaust gases from petroleum fuelled engines. Biodiesel, which is made from renewable sources , consists of the simple alkyl esters of fatty acids [4]. As a future prospective fuel , biodiesel has to compete economically with

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petroleum diesel fuels . One way of reducing biodiesel costs is to use the less expensive feed stock containing fatty characteristic turns attention to Jatropha curcas , which grows in tropical and subtropical climates across the developing world [5].

Oil contents ,physicochemical properties , fatty acid composition and energy values of Jatropha species were investigated to know about the fuel power of the plant [6,7,8,9].

B. Benefits of biodiesel

Biodiesel reduces carbon dioxide exhaust emissions by up to 80% and produces 100% less SOx than petroleum. Biodiesel reduces exhaust smoke (particulates) emissions by up to 75% so the usual black cloud associated with a diesel engine can be eliminated. The smell of the biodiesel exhaust is far more pleasant and it provides significant lubricity improvement over petroleum diesel fuel so engines last longer, with the right additives engine performance can also be enhanced. Biodiesel is much easier to handle and does not cause cracking or redness also it is much less dangerous to put in vehicle fuel tank as its flash point is ± 150°C (300°F) as opposed to petroleum diesel ± 70°C (150°F) [2,6].

III. JATROPHA PLANT

Jatropha can be cultivated anywhere along, roads, railway tracks, on border of farm and even an alkaline soils and in high as well as low rainfall. Jatropha occurs mainly at lower altitude(0-500Cm) with average annual temperature above 20^0C, and rainfall of 300-1000mm.

Jatropha provides the prevention of soil erosion , Soil improvement, Poverty reduction , Renewable energy and Promotion to labours [1].

Fig.2.Jatropha curcus

A. Bio-Diesel Plant

Fig.3.Bio-diesel plant

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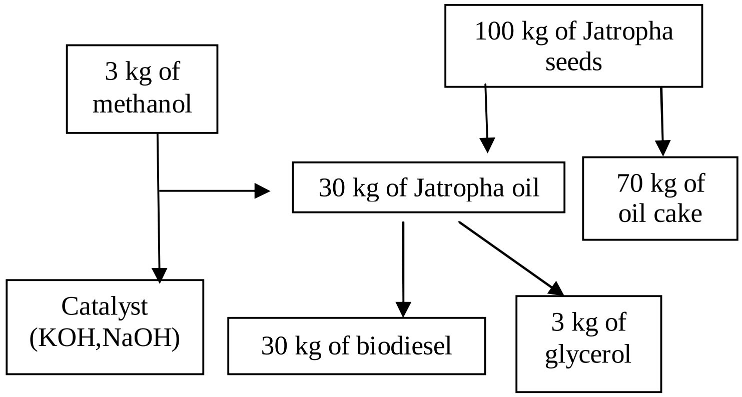

Fig.4. Conversion of Jatropha seeds to biodiesel.

In the process of biodiesel production from crude Jatropha curcas seed oil (CJCO),who have high free fatty acids (15%FFA) .The high FFA level of CJCO can reduced to less than 1% by a two-step pretreatment process. The first step is carried out with 0.60 w/w methanol-to-oil ratio in the presence of 1% w/w H_2SO_4 as an acid catalyst in 1-h reaction at 50 LC. After the reaction, the mixture is allowed to settle for 2 h and the methanol–water mixture separated at the top layer is removed. The second step is transesterified using 0.24 w/w methanol to oil and 1.4% w/w NaOH to oil as alkaline catalyst to produce biodiesel at 65 LC. The final yield for methyl esters of fatty acids is achieved ca. 90% to 95% in 2 h [2].

TABLE I. ECONOMICS OF BIODIESEL FROM JATROPHA

S.N.	Item Or Expenditure	Amount Rs.
1	100 kg seeds which are Rs 5/ kg	500/-
2	Oil extraction and other charges which are Rs 1.50/ kg	150/-
3	Transesterification cost which is Rs 8/ kg oil	240/-
4	Total	890/-

S.N.	Sale	Amount Rs.
1	70 kg oilcake which is Rs 2/kg	140/-
2	Glycerol	60/-
3	Total	200/-

B. Jatropha as a contributor for improvement of local livelihoods

Smallholder farmers would engage in jatropha seed production in order to sell to private biodiesel enterprises that would compete with wholesale supplies of diesel. However, other value chains exist for jatropha biodiesel production in which smallholder farmers might be able to obtain more attractive outcomes. After identifying the different value chain channels based on the scale of production and operating actors involved [3].

C. Alternative value chains and potential impacts on local livelihoods

The value chain consists of four stages: production of feedstock (farming), oil extraction (first processing), transesterification (second processing), marketing to end-users, and distribution of products that connect each stage. The actors in the value chain include local farmers, domestic and international private enterprises, government agencies and national and international end-users, depending on the local context.

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For commercial investors interested in selling biofuel to wholesale or international market outlets, large-scale production is likely to generate greatest profits. For society as a whole, large-scale production will provide greatest benefit in terms of increased access to a renewable source of energy. However, for smallholder farmers in local communities, small-scale production and processing may bring more benefits.

There are two scenarios for introducing jatropha production to local communities . The first scenario is large-scale production where private enterprises take initiatives to produce large amounts of biodiesel and local populations are incorporated into the production process as wage labourers on plantations or contract suppliers of seed. Jatropha can be grown on "marginal" or "waste" land, a claim which must be tested for validity. While there may appear to be a great amount of underused marginal land in developing countries where jatropha could be grown. Land that is not farmed may be considered to be "idle," producing little economic value. However, replacing pastoralism with farming activities could lead to degradation of natural resources.

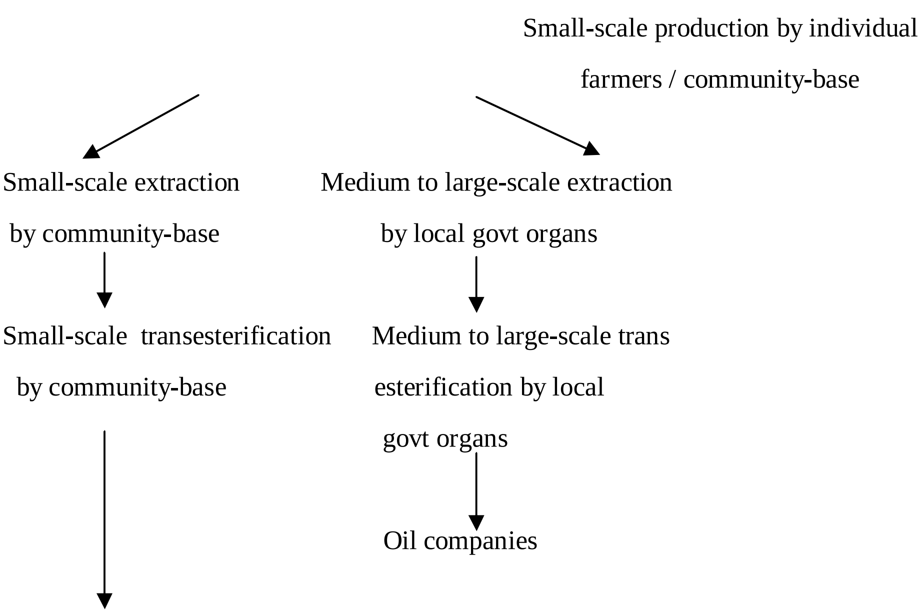
A second scenario is the case of small-scale decentralized biodiesel production. Local populations grow jatropha seeds which are collected through local collection systems, and jatropha biodiesel produced in small oil pressing and processing facilities. Facilities could be operated by community groups, cooperatives or private enterprises. Provided that transesterification is included in the biodiesel production process, the product can be sold in local retail markets as a substitute for imported petroleum-based diesel [3].

D. Potential of jatropha "oil" for the improvement of local livelihood

The opportunity for local populations to maximize benefits from jatropha is to engage not only jatropha production but also in oil extraction. Even if transesterification is not realistic, locally extracted oil can be directly used in diesel engines or as a kerosene substitute for lamps and stoves [13].

Experiments are also under way to use jatropha oil as a substitute for kerosene in lamps and stoves. Jatropha oil is much less expensive than kerosene so its use could contribute to savings for local communities and poor urban households. Jatropha oil might be most competitive with kerosene when produced in rural areas close to the source of seed supply and far from the source of kerosene production.

Currently, the most promising and well developed uses of jatropha are for soap and candle making [14]. Soap production with jatropha oil has been promoted in Mali, Tanzania and Madagascar where it has gained recognition in the market as an anti-septic natural soap. However, the market for jatropha soap may not expand much beyond its current size due to the high price compared to ordinary soaps [15].



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(Domestic market)

Local consumers

& industries (Local market)

Domestic consumers

Large-scale production by domestic & int'l enterprises with local labour or purchase contracts with local farmers

Large-scale extraction

by domestic enterprises

Large-scale extraction

by int'l enterprises

Large-scale transesterification

by domestic enterprises

Large-scale trans

esterification (abroad)

by int'l enterprises

Industries

(Domestic market)

Oil companies

(Int'l market)

Industries

(Int'l market)

Int'l consumers

Fig.5. Scale-based analysis of value chain channels for Jatropha curcas biodiesel

E. Biodiesel : first trial run on train

First successful trial run of a superfast passenger train was conducted on Dec 31, 2009 .The Delhi - Amritsar Shatabdi Express used 5% of biodiesel fuel.The Railway annual fuel bill for Diesel is Rs 3400 crores ,by the addition of 10% mixture with Diesel, The Railway annual fuel bill will reduced to Rs.300-400 crores / annum [1].

F. Indian Initiatives

The National Mission on Biodiesel has been launched by GOI.There are various State Governments who designated special authorities/bodies to manage. The Ministry of Petroleum and Natural Gas notified biodiesel purchase policy and The government Institutes as well as Public and private sectors are working on technology, promotion ,processing and end use of biodiesel [1].

The former President of India, Dr. Abdul Kalam, is one of the strong advocators of Jatropha cultivation for production of bio-diesel. The plantations of *Jatropha curcas* occurred at Rashtrapati Bhawan in 2004. The State Bank of India provided a boost to the cultivation of Jatropha in India by signing a MoU with D1 Mohan, a joint venture of D1 Oils plc, to give loans to the tune of 1.3 billion rupees to local farmers in India [1].

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G. Bioethanol

Brazil stands 1st in terms of Biofuel consumption. According to UNCTAD report, Brazil uses pure ethanol in 20% of their vehicles and a 22 to 26 % ethanol-petrol blend in the rest of their vehicles.CO emission from automobiles decreased from 50g/km in 1980 to 5.8g/km in 1995. The USA and Australia use a 10% ethanol blend. India is 4th largest producer and the government mandated the use of a 5% ethanol blend in petrol sold in nine sugarcane producing states.

IV. BIOGAS

Biogas typically refers to a gas produced by the breakdown of organic matter in the absence of oxygen. It is a renewable energy source, like solar and wind energy. Furthermore, biogas can be produced from regionally available raw materials such as recycled waste. Biogas is produced by anaerobic digestion with anaerobic bacteria of biodegradable materials such as manure, sewage, municipal waste, green waste, plant material, and crops. Biogas comprises primarily of methane (CH_4) and carbon dioxide (CO_2) and may have small amounts of hydrogen sulphide (H_2S), moisture. The gases methane, hydrogen, and carbon monoxide (CO) can be combusted or oxidized with oxygen. This energy release allows biogas to be used as a fuel. Biogas can be used as a fuel in any country for any heating purpose, such as cooking. It can also be used in a gas engine to convert the energy in the gas into electricity and heat [1].

TABLE II Typical composition of biogas

S.N.	Compound	Molecular formula	%
1	Methane	CH_4	50–75
2	Carbon dioxide	CO_2	25–50
3	Nitrogen	N_2	0–10
4	Hydrogen	H_2	0–1
5	Hydrogen sulphide	H_2S	0–3
6	Oxygen	O_2	0–0

A. Biogas benefits

Biogas could potentially help reduce global climate change. Normally, manure that is left to decompose releases two main gases that cause global climate change: Nitrogen dioxide and methane .Nitrogen dioxide (NO_2) warms the atmosphere 310 times more than carbon dioxide and methane 21 times more than carbon dioxide. By converting cow manure into methane biogas via anaerobic digestion, the millions of cows in the United States would be able to produce one hundred billion kilowatt hours of electricity, enough to power millions of homes across the United States [1].

B. Biogas in India

In India, Nepal, Pakistan and Bangladesh biogas produced from the anaerobic digestion of manure in small-scale digestion facilities is called gobar gas; it is estimated that such facilities exist in over two million households in India, fifty thousands in Bangladesh and thousands in Pakistan, particularly North Punjab, due to the thriving population of livestock. The digester is an airtight circular pit made of concrete with a pipe connection. The manure is directed to the pit, usually directly from the cattle shed. The pit is then filled with a required quantity of wastewater. The gas pipe is connected to the kitchen fireplace through control valves. The combustion of this biogas has very little odour or smoke.Owing to simplicity in implementation and use of cheap raw materials in villages, it is one of the most environmentally sound energy sources for rural needs [1].

V. BIOMASS

Biomass is biological material derived from living, or recently living organisms. In the context of biomass for energy this is often used to mean plant based material, but biomass can equally apply to both animal and vegetable derived material.

A. Benefits of using Biomass

Many biomass fuels generate lower levels of such atmospheric pollutants as sulphur dioxide, that contributes to 'acid rain'.The use of biomass fuel provides an economic incentive to manage woodland which improves biodiversity. Biomass residues, arising, co-

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products and waste not used for energy, This will generate CO_2 in any case, and may also produce methane (CH_4), a greenhouse gas 21 times more potent that CO_2 [1].

VI. CURRENT RESEARCH

Research is on going into finding more suitable biofuel crops and improving the oil yields of these crops. Using the current yields, vast amounts of land and fresh water would be needed to produce enough oil to completely replace fossil fuel usage. It would require twice the land area of the US to be devoted to soybean production, or two-thirds to be devoted to rapeseed production, to meet current US heating and transportation needs. Specially bred mustard varieties can produce reasonably high oil yields and are very useful in crop rotation with cereals, and have the added benefit that the meal left over after the oil has been pressed out can act as an effective and biodegradable pesticide. The NFESC, with Santa Barbara-based Biodiesel Industries, is working to develop biofuels technologies for the US navy and military, one of the largest diesel fuel users in the world. A group of Spanish developers working for a company called Ecofasa announced a new biofuel made from trash. The fuel is created from general urban waste which is treated by bacteria to produce fatty acids, which can be used to make biofuels [1].

A. Ethanol biofuels

As the primary source of biofuels in North America, many organizations are conducting research in the area of ethanol production. The National Corn-to-Ethanol Research Center (NCERC) is a research division of Southern Illinois University Edwardsville dedicated solely to ethanol-based biofuel research projects. On the federal level, the USDA conducts a large amount of research regarding ethanol production in the United States. Much of this research is targeted toward the effect of ethanol production on domestic food markets. A division of the U.S. Department of Energy, the National Renewable Energy Laboratory (NREL), has also conducted various ethanol research projects, mainly in the area of cellulosic ethanol [1].

B. Algae biofuels

From 1978 to 1996, the US NREL experimented with using algae as a biofuels source in the "Aquatic Species Program". A self-published article by Michael Briggs, at the UNH Biofuels Group, offers estimates for the realistic replacement of all vehicular fuel with biofuels by using algae that have a natural oil content greater than 50%, which Briggs suggests can be grown on algae ponds at wastewater treatment plants. This oil-rich algae can then be extracted from the system and processed into biofuels, with the dried remainder further reprocessed to create ethanol. The production of algae to harvest oil for biofuels has not yet been undertaken on a commercial scale, but feasibility studies have been conducted to arrive at the above yield estimate.In addition to its projected high yield, alga culture unlike crop-based biofuels does not entail a decrease in food production, since it requires neither farmland nor fresh water. Many companies are pursuing algae bioreactors for various purposes, including scaling up biofuels production to commercial levels. Prof. Rodrigo E. Teixeira from the University of Alabama in Huntsville demonstrated the extraction of biofuels lipids from wet algae using a simple and economical reaction in ionic liquids.Research is going on to use Algae as a source for biodiesel [1].

VII. CONCLUSION

The global rise in the price of petroleum prices and interest in renewable energy sources has resulted in increased interest in all types of biofuels across the developing world. Biofuel is eco-friendly and provides clean burning as an alternative fuel. Biodiesel contain no petroleum, but can be blended with conventional diesel fuel. These fuel can be used in any diesel engine without any modification. Biodiesel is degradable , non toxic and free from sulphur and lead. Biodiesel production from jatropha provides the prospective benefits for Every one, the production of biodiesel with less expensive feedstock for private enterprises, access to alternative clean energy sources for the society as a whole, jatropha as an alternative income source for smallholder farmers, and lastly the national policy perspective on biodiesel as an alternative energy source and on policy equitability among different stakeholders.

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