Biofuels : Jatropha a potential source

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The use of biological systems for the fulfillment of human needs perhaps started way back in 6000 B.C. when Sumerians and Babylonians fermented a kind of beer. Though it started with fermentation, the biological processes kept undergoing many changes over the centuries and started getting themselves registered in human mind. The non judicious use of terrestrial fuels like coal and petroleum used by humans since time immemorial is causing their continuous depletion from the natural ecosystem. Alternative energy sources are under harvest, which include solar, wind, geothermal and many more. For the need of future race a great amount of biological mass is required to be buried under earth for continuous harvesting of fuel from lithosphere. For maintaining ecofriendly environment and for continuous replenishment for the forthcoming generations, the development of biofuels is one of the most significant biotechnological development.

Bio-fuels : Biofuels are any liquid, solid or gaseous fuels that are produced from organic matter. They include bio diesel, bioethanol, a product of bioethanol i.e. ethyl tertiary butyl ether, bio gas, bio methanol and bio oil. The extensive range of organic materials used for biofuel production includes starch and sugary plants such as corn, wheat or sugar cane; oily plants such as rape seed, soya beans or jatropha; vegetable oils and animal fats; wood and straw; algae and organic waste and others. Biofuels are commonly referred to as first generation (bioethanol and biodiesel), or second generation which cover a variety of technologies. The rising concern over climate change in the last decade has generated interest in biofuels as a possible means of:

- Reduction in carbon dioxide emission.
- Employment opportunities.
- Contribution to overall energy security.
- Improvement in air quality in congested areas.

Biofuels are not a recent invention and have a long history in the motor industry, stretching right back to the development of the internal combustion engines of the 1800s. Rudolf Diesel designed his compression engine to run on peanut oil, while Nicolaus Otto's pioneering spark-ignition engine was developed to run on ethanol.

The two most common first generation biofuels are bioethanol from starch or sugar crops and biodiesel from oil-rich plants. As these fuels are primarily derived from crops which may also be used as food for animals and humans, these type of fuels have been thought to be diverting food away from the human food chain to the engines. With biofuels, depending on method of production, the overall green house gas emission savings are positive and in some cases zero carbon production is possible as carbon emitted during the burning of biofuels is compensated by the carbon absorbed by the plants as they grow. The impact on biodiversity may be negative, however, in many cases the cultivation of biofuels may enhance biodiversity, especially if underutilized agricultural land is used for production. Biofuels will only negatively impact food markets if they compete for land with the agricultural sector.

Second generation biofuels are biofuels generated from technologies and are still under trial. It is these sustainable biofuels that may provide serve as a source for the future generations. Some of the new technologies focus on increasing yields from plant-derived fuels.

Alternative to diesel : oil can be extracted from a variety of plants and oil seeds. under Indian conditions only such plant sources can be considered for bio diesel production, which are not edible in appreciable quantity and which can be grown on large scale on wastelands. Moreover, some plants and seeds in India have tremendous medicinal value, considering these plants for bio diesel production may not be viable and wise option. It is significant to point out that, the non-edible vegetable oil of *Jatropha curcas* / Castor has the requisite potential of providing a promising and commercially viable alternative to diesel oil since it has desirable physicochemical and performance characteristics comparable to diesel. Cars can be run with *Jatropha curcas* oil without any change in design.

Jatropha is a drought-resistant, non-edible, perennial plant that can be grown on marginal land with limited water and nutrition. Optimum growing conditions are found in areas with temperatures of 20^0C to 30^0C with no frost, and where the soils are free-draining sands and loams and also there should be no risk of waterlogging. The plant is propagated from seeds. A fully grown plant can attain a height of 3-4 metres and may become taller. However, for better harvesting purposes, height is kept around 2 metres. The advantage of this plant is that it controls erosion.

Moreover, it is suitable for intercropping, especially during the first two to five years before it starts to yield fruit. Yield estimates vary considerably, depending on the site and the growth conditions. The seed yield could be 1-2.5 tonnes/ha/year for degraded land and low amounts of input. Fertile soils and high inputs may produce 2-5 tonnes per ha per year. The seeds contain 55-60% oil that can be converted into biodiesel by trans esterification. From a sustainability point of view, it has been estimated that high protein seed cake can be produced which can be potentially used as animal and fish feeds and, also as organic fertilizer, particularly in remote areas. The leaf, bark and seed extracts of the plants have various other industrial and pharmaceutical uses. As it is inedible, it does not compete directly with food production. Jatropha is toxic, and people in the tropical and sub-tropical areas have grown it for a long time to protect their fields against wild animals. Other traditional applications are as fertilizer (fruits and leaves), soap (seed oil) and medicine (leaves and latex) as well as for erosion control. Jatropha biodiesel is extracted from the seed oil. The husks and cake can be used as fertilizer or briquetted for heat and power generation. Fatty acids can be used to produce soap. By-products from the trans esterification process are potassium fertilizer and glycerine. The seed shells can also be separated out ('decortication') for heat and power production and to obtain meal.

Biodiesel yield from Jatropha averages 340-795 litre/ha on barren land and 795-2840 litre/ha in normal soils. The fact that it is possible to store and transport the fruit before processing makes it suitable for small-scale production. The oil subtraction is rather uncomplicated with low technological requirements. The subsequent processing to biodiesel, however, requires a higher degree of know-how and technical equipment, so a combined approach, integrating small-scale farmers and technological expertise, is customary. Apart from the income opportunities and the positive impacts such an arrangement might have on rural growth, another advantage is the possibility of local use of the oil, reducing fuel expenses and increasing public health. However, economic profitability of biofuels will require intensive crop management. While drought-resistant, Jatropha will only produce fruit if it receives sufficient light, nutrients and water. Jatropha cultivated on poor land required double the amount of energy (mainly fertilizers and irrigation) to yield the same amount as when cultivated on fertile soil. For attaining high yields, fertilizer and irrigation requirement is more for efficient biodiesel production on marginal land.

Advantages of bio-diesel:

- 100% reduction in carbon dioxide emissions
- 100% reduction in sulphur dioxide
- 40-50% reduction in soot emission
- 10-50% reduction in carbon monoxide emission
- 5-10% reduction in nitrous oxide emission depending on the type of engine
- 10-50% reduction in hydrocarbon emission
- 97% reduction in phenanthrene
- 71% reduction in benzapyrene
- 13% reduction in aldehydes and aromatic compounds

Some other advantages of bio-diesel area :

- It is safe to handle because it is biodegradable and non toxic
- It is safe to transport as it has high ignition temperature of about 148.88C
- It has same fuel mileage as of diesel fuels
- It has pleasant aroma
- It is more lubricating than petrodiesel fuel.

Because of high price of petroleum products and rapid depletion of their underground reserves, tree borne oilseed species, Jatropha in particular find itself in advantageous situation. The vast expanse of degraded barren land in India has to be brought under vegetation for future common good. It will lead to the opportunity to earn carbon credits through clean development mechanism while creating rural employment and a non conventional energy system. Considering the prevailing favourable situation, the biodiesel programme based on jatropha and other tree borne oilseeds should be encouraged. Government programmes should reach at implementation level. Jatropha can succeed if it is promoted through a systematic programme.

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