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FEASIBILITY OF BIODIESEL FROM JATROPHA IN THE CONTEXT OF NEPAL

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ABSTRACT:

Nepal has no petroleum resources and imports all required petroleum products. Fluctuating prices, reliability of supply and political issues all make this an undesirable energy source. It is best for Nepal to actively pursue developing and promoting alternative domestic energy sources like bio-fuels from Jatropha. Rather than importing petroleum products from other countries, national development would be much more sustainable and stable if local resources are put to use to some extent. The bio-fuel domestic production model also aides in local capacity development and employment along with providing numerous other environmental benefits. In order to ensure success, bio-fuels must be properly managed through all stages of cultivation, production, promotion, and commercialization. Currently there is a lack of data defining the best practices for these stages. Numerous other countries, such as India, Brazil and the USA have shown that bio-fuels can be used as an effective alternative to fossil fuels. An in-depth study on the promotion of appropriate technology, identification of problems and exploration of stakeholder's ideas will help to promote bio-fuels for Nepal in the same ways as it has been worked for other nations. Feasibility of biodiesel depends on its capability to compete with imported petroleum products, so financial and economic indicators will help to promote biodiesel from Jatropha as a potential alternative energy in the Nepalese context.

KEY WORDS: Jatropha, Biodiesel, Cost.

1. INTRODUCTION:

Nepal is one of the energy rich countries especially in terms of renewable energy resources like hydro power, solar energy, and biomass energy including bio-gas and liquid bio-fuels. But most of these resources still remain untapped. There are no proven fossil fuel deposits available in the country and we are fully dependent on the imported petroleum products. About 40% of foreign currency reserves are required to import fossil fuels every year [MOF, 2007]. High Speed Diesel (HSD) is imported in large amount compared to other petroleum products and its import is increasing year by year with an average increase of 17276 kL/year. A study from 1980s shows that some 286 species of oil-bearing indigenous varieties of plants (edible and non edible) were found in Nepal out of which non edible varieties can be proven suitable for the production of biodiesel [Singh et. al., 1991]. Biodiesel is the only alternative fuel that can be used directly in any existing unmodified diesel engines. Among the various vegetable oil sources, non-edible oils are suitable for biodiesel production. Among the non-edible oil sources, Jatropha curcas is identified as potential biodiesel source and comparing with other sources, which has added advantages such as pleasant smell, or odorless and can easily mix with diesel fuel, rapid growth, higher seed productivity, suitable for tropical and subtropical regions of the world (Corner, 1979). Jatropha has similar properties to diesel fuel and its oil blending up to 40 to 50 per cent with diesel fuel could be used in engine without modifications (Pramanik, 2003) (Pramanik, 2003) .

2. WORLD TRENDS:

Jatropha oil as biodiesel has been implemented in many countries like India, Brazil, USA, etc. There are many crops that can be used for producing biodiesel, but the choice normally depends on local availability, affordability and government incentives. For example, rapeseed oil is preferred in Western Europe, while the United States favors refined soybean oil as a feedstock. Although Brazil is the world's second-largest producer of soybean, its government is fostering a castor oil–based biodiesel industry (Regmi, 2010).

The big palm oil producing countries in Southeast Asia are Malaysia and Indonesia are currently focusing on palm kernel and palm seed oil. Both India and China have large Jatropha (physic nut) plantations under development. In addition, China is investigating recycled cooking oil as an option. The most important feedstocks by 2010 are expected to be soybean, rapeseed and palm oil, in descending order. Nevertheless, Jatropha and cottonseed oils will show the highest growth rates (Regmi, 2010).

In terms of the market size, the biodiesel industry reached 3,524 million liters in 2005, with Western Europe having the largest share of the market. Although it is still the largest producer, market fragmentation has decreased Western Europe's monopoly in the biodiesel market. Its share which represented 95% of the market in 2000 had been reduced to approximately 80% by 2005 (Regmi, 2010). This is accounted by new players, such as Asia, entering into the market.

In April 2003, the committee on development of biofuel presented a report with recommendations to replace 20% of India's diesel consumption. This has brought numerous institutions, private investors and farmers to prepare and start with work on a major Jatropha Program. Several states in India have distributed plants free of charge to small farmers, encouraging private investment in Jatropha plantations and setting up biodiesel processing plants. The Indian Railways have started to use Jatropha oil blended with diesel to power its diesel engines with great success (Prusty, 2007).

3. JATROPHA POTENTIAL IN NEPAL:

Jatropha curcas which can be easily cultivated in degraded lands, semiarid lands, waste lands, and marginal lands, is now widely gaining its popularity all over the world as a source of biofuel. Biofuel Programme of GoN is also specifically focused in Jatropha. Jatropha (local name- 'Sajiwan' or 'Kadam') is a drought-resistant perennial shrub growing well in marginal/poor soil. Jatropha is found up to 1400 meters of altitude. It is reported from 64 districts of Nepal (AEPC, 2010).

Climatic conditions are favorable for Jatropha Curcas L. trees in around 30% of the country, so there is immense opportunity to enhance natural resources. Resource enhancement can promote economic enterprise in rural areas in cultivation, seed collection and processing as well as improvements in agricultural productivity, environmental protection and the quality and stability of marginal land (Boswell, 2003). Therefore, there is possibility to cultivate Jatropha plants in these districts.

Table 1 Land status in Nepal

S.N.	Area of utilization	%	Area, ha
1.	Agriculture	20.1	29,64,400
2.	Secured forest	19.7	29,05,400
3.	Other forest	18.4	27,13,700
4.	Not use in shrub and agriculture	11.4	16,81,300
5.	Parti/khark	11.9	17,55,000
6.	Other (Ice, rock, river etc.)	18.5	27,28,400
Total		100	1,47,48,400
Marginally used land from (From 3-6)		13.7	20,20,530

(CBS, 2011)

In the above Table 2, marginally used land from 3-6 is 2,020,530 ha which can be used for Jatropha cultivation.

4. METHODS FOR COLLECTION AND STORAGE OF SEEDS:

After collection the fruits are transported in open bags to the processing site where they are dried in shade until all the fruits have opened and seeds exposed. When the seeds are dry they are separated from the fruits and cleaned.

The seeds should be dried to low moisture content (5-7%) and stored in air-tight container. At room temperature the seeds can retain high viability for at least one year.

5. PRODUCTION OF JATROPHA OIL:

The yield of Jatropha oil in seeds varies on types of species, climatic conditions, quality of the soil, irrigation, periodic trimming, crop density and use of pesticides. The Jatropha oil can be extracted by mechanical expelling method and solvent extraction method. In Mechanical expelling method, oil yield from seed is low but it is cheaper than solvent extraction method thus it is feasible in low scale oil extraction. However, solvent extraction method is feasible for mass scale oil extraction. 'At present J. curcas L. has a great role as a resource for green fuel because its kernels contain oil that can be a substitute for diesel. In the oil extraction process, the fruits must be dehulled, the nut shells must be shelled, and the kernels must be dried and then oil has to be extracted (Sirisomboon et al., 2007)

Institute of Engineering, Center for Energy Studies with support of Alternative Energy Promotion Center collected Jatropha seeds from various locations and oil is extracted by using mechanical extraction method at Himalayan Agro-enterprises and Research Centre Pvt. Ltd., Ramnagar, Chitwan. The locations, its elevation and oil content are given in Table 3.

Table 2 Oil extraction from Jatropha seeds

Location	Elevation (m)	Oil content (% by wt)
Tanahun	700	19.30
Rupandehi	400	22.75
Makawanpur	700	27.9
Palpa	800-1000	28.46
Panchthar	600-1000	21.42

Research team found that the seeds collected from Palpa content maximum oil. The reason behind this was the seeds were properly dried and fresh although it was grown in higher altitude.

Due to mixing of old seeds and sand, oil content in the seeds from Rupandehi was low even though its elevation is low.

Although seeds from Tanahun and Makwanpur were collected from same elevation, oil yield was lower in Tanahun's seeds because seeds were collected from existing wild plant and lack of fertilizer whereas the seeds were collected in Makawanpur from the plants fenced around the cultivated land.

Seeds from Panchthar were from fencing plant around the grass land due to which seeds from low fertilizer land and oil content was relatively low.

Primary and secondary data has been used to determine the cost of Jatropha oil. It depends on cost of electricity, labor, seed, fuelwood, revenue from pressed cake. During determining cost of Jatropha oil, cost of electricity, labor, seed and wood are Rs. 8/unit, Rs. 200 per day, Rs. 15 to 35/kg and Rs. 5 per kg respectively.

For the expelling rate of 1kg seeds per minute, the electricity consumption from the electric motor was 0.07 unit and wood consumption for steam generation was 0.101 kg. Using density of Jatropha oil 920 kg/m^3 cost of Jatropha oil for different oil content and seeds cost without and with considering revenue from pressed cake are shown in Figures 1 and 2 respectively.

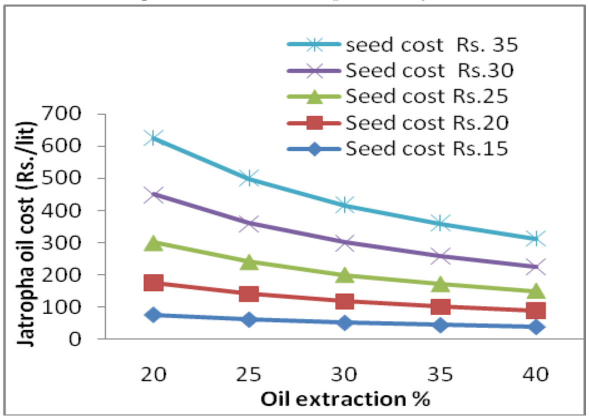

Figure 1 Cost of Jatropha oil excluding revenue from byoroduct

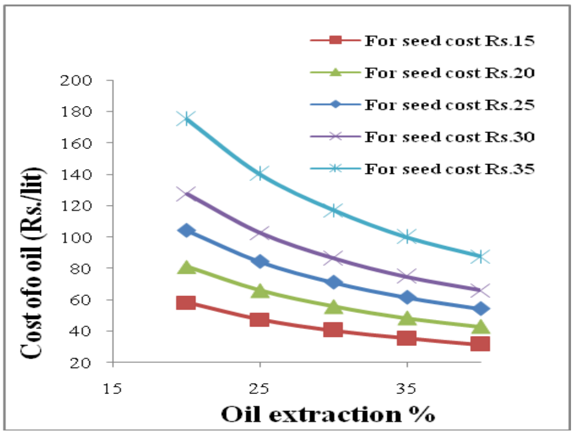

Figure 2. Cost of Jatropha oil including revenue from byoroduct

6. BIODIESEL PRODUCTION:

The biodiesel is produced from raw Jatropha oil by transesterification process. In transesterification process alcohol is mixed with Jatropha oil in the presence of a catalyst (Potassium or sodium hydroxide. It is separated from heavier glycerol in methyl ester phase by using gravity separation method. Methanol is widely used because of its low cost as well as physical and chemical advantages. The components and its proportion for chemical reaction are given below.

100 kg of oil + 20 kg of methanol =100 kg of biodiesel + 10 kg of glycerol + 10 kg of methanol

The required quantity of catalyst is 1-2% of the alcohol quantity (S. Traore et al., 2015).

According to above proportion, to convert one kg Jatropha oil into biofiesel, 0.1 unit electricity will be consumed. Current market prices of methanol, potassium hydroxide, electricity and operator expenses are Rs. 97/lit, Rs. 305 /kg, Rs. 8/kWh and Rs. 200/day respectively. Using above price, the cost of biodiesel production is Rs. 23.84/ kg without considering revenue from glycerol but its cost reduces to Rs. 19.87/kg with considering revenue of glycerol (Rs. 65/kg). Using density of biodiesel 870kg/m^3 cost of biodiesel for different oil content and seeds cost without and with considering revenue from pressed cake and glycerol are shown in Figure 3 and Figure 4 respectively.

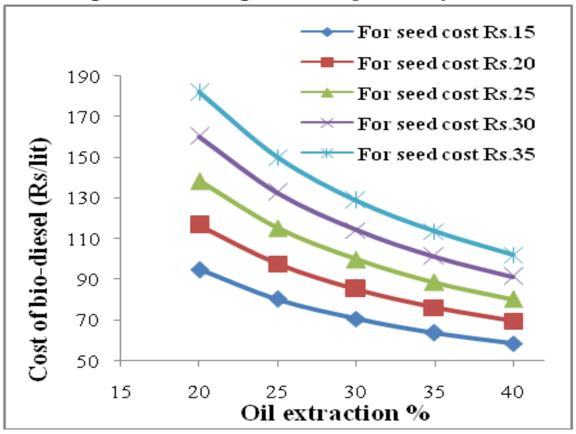

Figure 2 Cost of biodiesel excluding revenue of byproduct

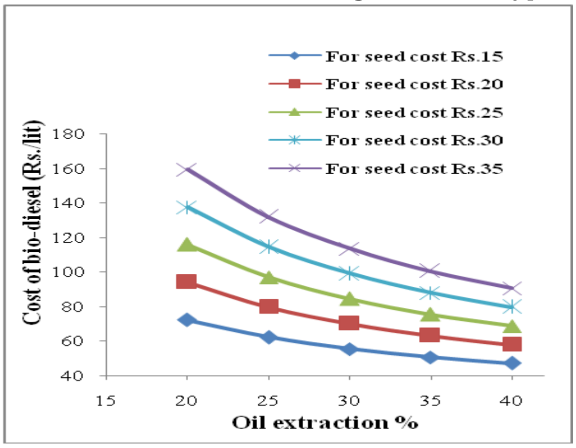

Figure 3 Cost of Biodiesel including revenue from byproduct

7. CONCLUSIONS:

The organized plantation and systematic collection of Jatropha can allow biodiesel as potential substitute to petroleum diesel which can reduce the import burden of petroleum substantially. This will help to solve energy security to some extent.

Jatropha oil will create job for rural community and will increase their living standard.

Problems are arising due to lack of proper technology of cultivation, channelized market mechanism, institution development and policy.

Biodiesel at lower seed cost and higher oil content can only compete with imported diesel. On the other hand, increasing price trend of imported petroleum indicates biodiesel may be potential source as a substitute of diesel in the coming future.

Government policy is urgent for the promotion of Jatropha.

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