

The Scope of Production and Usage of Biofuels in Nepal

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Abstract

Developing countries are facing the problem of energy shortage. With growing demand and increasing prices of imported petroleum products, they are being compelled to shift towards development and uses of bio-fuels as supplementary energy sources. A major concern; however is that tracking down of energy security through increased biofuels development could intensify food insecurity in many developing countries. The impact would be greater on poorer countries, if edible food grains get converted into bio-fuels. Thus, proper attention should be given to promote non-edible feedstocks such as Jatropha and others at uncultivable waste lands.

Nepal is entirely dependent on imported fossil fuels. The current price of imported petroleum product is quite high comparing the current economic status. Short supply and frequent price rise of petroleum products i.e. petrol, diesel and cooking gas is leading to dissatisfaction. Moreover, transportation and distribution of petroleum products to remote and hilly areas impose additional cost on top of the already expensive petroleum products. Consumption share of diesel, kerosene, petrol, and aviation fuel were 67.1 %, 6.1%, 17.7% and 9.1% respectively during the year 2009/10. Import and consumption of petroleum products increased by 31.3 % during the year 2010/11, that impose annual cash payment to outsider from the country equivalent to US\$ 900 million.

Currently, Government of Nepal, development partners and private sectors are showing interest on production and utilization of domestic bio-fuels. Domestic production of bio-fuels could help to some extent relieve this situation. However, considering the limited availability of arable lands and rapid population growth, available productive agricultural land cannot be diverted to the production of bio-fuels. Thus, large-scale production of crop-based bioethanol is not an option for Nepal. Lands normally not suitable for major food crops production could be helpful for non-edible feedstocks such as Jatropha, if produced commercially. However, the concept of biofuels is still new for Nepal. Cultivation of Jatropha in mass scale will need subsequently support for sustainable production. It will definitely help to address the problem of energy scarcity as well as to reduce the external dependency of fossil fuels in the country. Moreover, it also contributes to some extent to boost-up the economy of the country by reducing the existing

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trends of imported petroleum products. Currently the plantation of Jatropha is at pilot phase. Approximately 12,000 hectares of uncultivated land has been used for Jatropha plantation in various parts of Nepal. Moreover, there is urgent need to bring the riverside flood prone lands, flood damaged lands and deforested public land for the intensive cultivation of Jatropha cultivation.

The climatic condition such as weather, annual precipitation, altitudes and soil characteristics for Jatropha cultivation are favorable in Nepal. However, further studies are needed to understand the issues related to development of Jatropha based biofuels in Nepal.

Government's strategy for energy plans, programs and implementation are almost entirely dependent to external financial resources. The Government policy is not attracting private sector to invest in commercial production of bio-energy by using non-edible feedstocks. Development partners may have interest in the development of bio-fuels which can contribute to boost up the economy of rural people and ultimately contribute to ensure the food security as well as to meet growing energy demand. Moreover, there is an urgent need of conceptual understanding among the stakeholders for policy reformulation to build-up the collaboration on irrigated agriculture, food security, and bio-energy development in Nepal.

Background

Energy is key input to the physical development. Per capita energy consumption is often considered as an indicator of economic status and well being of the people, society and country. Nepal's per capita energy consumption at 15Giga Jules is one of the lowest in the world. Also, almost 90 percent of the energy is consumed in the residential sector, which indicates that the consumption of energy in the production and commercial sector is meagerly low. Access to sustainable form of energy is pre-requisite to social and economic transformation in the rural areas and to improve the quality of life of the people. This paper looks into the possibility of production and use of biofuels and their use as sustainable and alternative source of energy. Considering Nepal's agro-climatic diversity, wide ranging plants known for biofuel production have been identified for promotion in different agro-climatic zones. While production of biofuel is expected to enhance decentralize energy access and energy security at the local level and providing sustainable means of fuel for wide ranging rural and urban applications, this will also lessen the ever increasing burden on the import of petroleum fuels. Since the production of biofuel will essentially be concentrated to the rural areas, this will create positive impetus for enhancement of rural economy through increased employment and creation of alternative economic opportunities.

Developing countries are continuing the uphill battle for economic growth and poverty reduction. At the same time, their struggle are also relating to serious energy crises and consistently increasing petroleum price. These countries are also expected to face higher

consequences of climate change despite the fact their share in the consumption of petroleum fuel and emission rates of greenhouse gases is much lower.

In Nepal, the new initiative of biofuel production concentrates on production of biodiesel as an alternative to petroleum fuel based on oil seed crops. *Jatropha Curcas L.*, popularly called Jatropha has been identified as promising species for production of oil that can be used as substitute for diesel upon some processing. Jatropha is receiving increased attention due to its specific characteristics of being drought resistant and ability to grow on marginal lands. This plant found widely in semi-domesticated form in tropical and subtropical areas of the country but its exploitation has not been made to commercial scale. The key advantages associated to promotion of Jatropha is that it is easy to establish, grow quickly and requires little care and grow even in poor soils except waterlogged areas. Seeds of the Jatropha are crushed to extract oil which can be processed to prepare fuel that can be used to power a diesel engine.

Considering predominantly agrarian economy of the country and large tract of marginal lands, promotion of Jatropha fits into the agro-climatic environment. Combining the cultivation of Jatropha with the environmental considerations, the scope of biofuel production becomes still broader. In addition, considering Nepal's ever increasing petroleum budget and huge amount of foreign currency going towards import of petroleum fuels, promotion of area under biofuel plants create added potential.

The Government of Nepal started Biofuel Program, called Jaibik Indhan Karyakram beginning the fiscal year 2009/10 with the allocation of \$ 0.625 million. In the program Jatropha was selected as potential plant for the production of oil for biodiesel processing. In fiscal year 2010/2011, \$0.028 million was allocated to the program in the production, processing and promotional activities. National Bio-fuel Program in which special focus has been given for the promotion of *Jatropha Curcas* by implementing various activities such as training and capacity building establishment of Jatropha nursery and germplasm garden, installation of transesterification units and development of promotional materials. The program is supported by Alternative Energy Promotion Centre (AEPC), the government agency entrusted with the responsibility of promotion of appropriate alternative energy technology in the country. A number of entrepreneurs have made investment in the production processing Jatropha based biodiesel production by the emphases of the government and economic opportunities in the production and processing of biodiesel,

It has been found that a number of demonstrations on Jatropha cultivation and use of extracts have been made in different parts of the country, which are successful to some extent, for increasing awareness on the potentiality of Jatropha as an Alternate Source of Renewable fuel. Some of the companies established at present include Everest Bio-Diesel, High Himalayan Agro Nepal and Crystal Bio-Energy Nepal which also invested in establishing commercial scale farms for Jatropha cultivation.

Objective

Within the established opportunity and potential for production of biodiesel in the country stated above, this study was undertaken with three-fold objectives:

- (a) Analyzing the scope of biofuels in developing country
- (b) Assessing the consumption and trend of modern energy options, and
- (c) Suggesting the policy measures for biofuel promotion in the country.

Methodology

In the framework of the study objectives, this study involved analysis of secondary data from different sources and other pertinent information. The key focus of the study has been on identifying the areas of the policy reforms to create supporting environment for the promotion of biofuel in the country.

Discussions

General Scenario of Land Use

The distribution of land use in the country is shown in Table- 1. The area under forest is 5.828 million hectares followed by arable land which covers 4.121 million hectares. Arable land further can be divided into cultivated land areas (edible crops production) and potential but not cultivated land which covers 3.091 million hectares and 1.03 million hectares respectively. Similarly, land area covers pasture, wetland and other land are 1.766 million hectares, 0.383 million hectares and 2.62 million hectares respectively.

Table 1: Occupied land area pattern

Particulars	Million hectares
Cultivated land Areas (Edible crops)	3.091
Possible arable land (Non cultivated land)	1.03
Arable Land Areas (Subtotal)	4.121
Forest land Areas	5.828
Pastureland Areas	1.766
Wetland	0.383
Others	2.62
Total land area	14.718

*Data source: Agriculture Information and communication Centre, Agriculture Diary 2012

The landlocked country Nepal is categorized in three ecological regions: High Mountain and Himalayas, Mountains and low hills and Plain areas of Terai Region (Figure 1). Terai region has good potential for year round crop production wherever irrigation facility is available. Therefore, Terai is considered the food basket of the country. Similarly, mountain region is suitable for

livestock farming where large pasturelands can be seen. Compared to Terai large part of the landscape in the hills and mountains has relatively lower potential for crop cultivation due to one or more limitations relating to topography, soil fertility and soil moisture deficiency. These marginal areas that is not suitable for year round crop cultivation can be put to cultivation of Jatropha and other plants for biodiesel production.

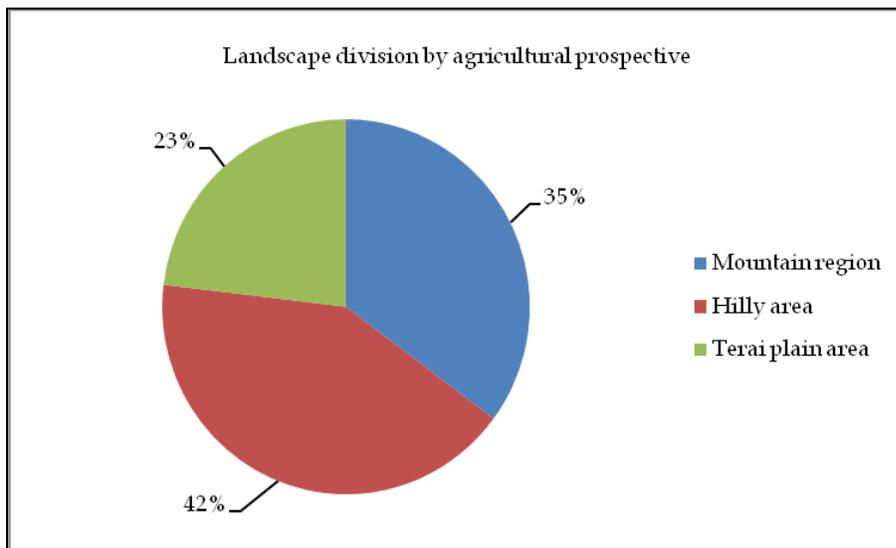


Figure 1: Landscape division by ecological and agricultural prospective

Policy Related to Biofuel Programs in Nepal

The goals of Rural Energy Policy- are as follows;

- To reduce dependency on traditional energy and conserve environment by increasing access to clean and cost effective energy in the rural areas.
- To increase employment and productivity through the development of rural energy resources.
- To increase the living standards of the rural population by integrating rural energy with social and economic activities.

Existing Institutional Set-up:

- **At Central Level** – Alternative Energy Promotion Centre (AEPC) is carrying out activities related to formulation of rural energy policy and programs, studies and research, subsidy disbursement, technical assistance, selection of companies, organization installing rural energy systems, donor co-ordination, monitoring and evaluation. There is a separate national biofuel program wing to promote biofuels all over the country.
- **Rural Energy Central Co-ordination Committee** – Government of Nepal has also constituted a Rural Energy Central Coordination Committee under Chairmanship of member of NPC responsible for energy. Executive Director of AEPC is the member secretary of this committee. The formation and mandates of the committee is as per rule.

- **Central Rural Energy Fund**– Central Rural Energy Fund (CREF) under AEPC receives fund from Government of Nepal and from other donor communities used towards promotion of appropriate alternative energy technology and resources in the country.
- **At District Level**– District Energy and Environment Section (DEES) has been established in each DDC office. District Energy Fund and Village Energy Fund are also established to promote and expand rural energy at district and village level.

Nepal is a Potential Country for Jatropha Production

Development of commercial bio-fuel has a great potential in Nepal. This can reduce dependency on imported petroleum products. Many species of Jatropha found in Nepal have sufficient fatty acid content to convert them into bio-diesel. Although it has been found that Jatropha can be grown on barren and waste lands where production of other crops is not possible but for the better yield following factors are important which are suitable in Nepal:

- **Climate:** Terai and Siwalik range has tropical and subtropical climate which is favorable for the growth and development of Jatropha.
- **Rainfall:** Although Jatropha is drought resistant plant, it requires at least 1200 mm annual rainfall for better yield. Average annual rainfall in Nepal is 1500 mm to 2500 mm which will be good for good production of Jatropha seeds.
- **Elevation of land:** Most of the lands in Terai regions are extended between 60 m to 1000 m altitude. This altitude is favorable for Jatropha cultivation.
- **Availability of technical manpower and farm labor:** There is large pool of technical personnel trained in agriculture, forestry and natural resources management who can be effectively engaged in the promotional programs relating to biofuels. There are sufficient labors who can be effectively engaged in the production and processing activities. This will help increasing employment opportunities at the local level.
- **Market:** Nepal imports the entire needs of petroleum. Considering established potential of biodiesel as alternative to petroleum fuel, there will be huge established market for bio-diesel within the country.

The controversy and the future of biofuels program

Around the globe biofuels have created a stir. The prices of maize and wheat have increased at an alarming rate as they are being used to extract ethanol, the alcohol used for motor fuel. The cars are guzzling away the food that we eat, making us more vulnerable to hunger. The rich people are able to purchase the ethanol but the poor are facing the high rise in their prices. Jatropha cultivation has provided a solution to this war for food between cars and people which also in a way contestation between developed and developing world.

There is an immense potential for commercial production of biofuels in Nepal. Around 30% of the area in the country, which essentially include marginal lands potentially unsuitable for cultivation of food crops but favorable for the cultivation of Jatropha. Apart from Jatropha, there are many other non-edible oilseeds that can be cultivated on the wastelands, for production of biodiesel. It is anticipated that even 10% of the areas that is favorable for cultivation of Jatropha could produce enough biodiesel to substitute fossil diesel use in the country substantially.

While production and promotion of Jatropha looks acceptable option for energy self-reliance, there are associated controversies stemming from viability and likely consequences to food security and environment on longer terms. There are also controversies relating to possibilities of long-term storage of biodiesel and its blends. The controversy relating to consequences of Jatropha cultivation on food security emerges essentially from the experience from the developed world where commercial viability and incentive attracted commercial growers to put large tract of agricultural land to production of biofuels and also use food crops for production of biodiesel. The possibility of long term storage of biodiesel and its blends needs further research.

Consumption trends of commercial energy options

In Nepal, more than 90% of the energy supply originates from traditional sources, such as wood, agricultural residue and animal wastes. Less than one third of the population has access to electricity and in the rural areas. The commercial sources of energy such as petroleum, coal and electricity are used mainly for industrial, transport and domestic sectors with negligible use in the agricultural sector. This is because agriculture in Nepal is still highly labor intensive with little mechanization. Collection of firewood has been the main cause of deforestation. Air pollution is a serious concern in urban areas due essentially to vehicular pollution. The transport sector is the largest contributor to total emissions of pollutants in urban areas followed by emissions from the households, industries and commercial sectors.

Nepal is dependent on imported petroleum fuel from India. The consumption trend of fossil petroleum fuel in the country for past two years is shown in Table-2 shows sharp increase in the import and sale of all kinds of fossil fuels.

Table 2: Supply and distribution (Import and sales)

Import of Petroleum Products [in KL except LPG]								
SN	Fiscal Year	MS	HSD	SKO	ATF	LDO	FO	LPG in MT
1	2010/2011	188082	652764	43399	99990	228	1434	159286
2	2009/2010	162902	608065	52714	82824	240	2612	141171
Sales of Petroleum Products [in KL except LPG]								
SN	Fiscal Year	MS	HSD	SKO	ATF	LDO	FO	LPG in MT
1	2010/2011	187641	655128	49495	101314	227	1415	159286
2	2009/2010	162275	612505	55788	82631	238	2589	141171

Source: www.nepaloil.com.np

The price rise on the petroleum fuel has been another area of concern in Nepal and in other developing countries. Government of Nepal has been providing subsidies to Nepal Oil Corporation to maintain the price of petroleum fuels in the country. Under deregulation policy, the government has come up with price adjustment mechanism based on the changes in the price of the fuel in the international market. Despite this adjustment, the subsidies on the essentially fuel for household level uses, such as kerosene and LPG has been continuing which is estimated to render average monthly loss of US\$ 19.5 million.

Cost and Returns from Jatropha Cultivation

An estimated costs and returns from the Jatropha cultivation in Nepal is very difficult to analyze considering that commercial production of Jatropha and large scale use of biodiesel is yet to be tested. However, the cost and returns from Jatropha cultivation is expected to result at different stages of cultivation, harvest, processing and marketing. There will also be streams of non-tangible costs and benefits of Jatropha cultivation emerging from primary, secondary and tertiary chains of production, processing and marketing of Jatropha.

Jatropha is highly resistant to drought, thrives in arid areas, and requires as little as thirty liters of water a month during the non-rainy season. Animals do not eat this plant and thus is safe from them. The plant produces oil-bearing seeds within six months of planting and can last over thirty years without replacement when managed properly. Cultivation of plants around field boundaries boosts crop yields by pre-empting browsing livestock; root systems and leaf-shed improve soil stability and quality. Its seeds contain thirty per cent or more oil, which can be easily expelled and extracted. By-product residues would then be available to boost crop yields and at the same time reduce the consumption of costly and imported chemical alternatives.

Leaving aside the uncertainties in the costs and benefits of Jatropha cultivation for biodiesel production in the country, the expected outputs from Jatropha cultivation in the present context are expected to be as under:

- Cultivation of Jatropha will help lessening energy crisis in Nepal, at least in the rural areas, which will also lessen to some extent the expenditure towards petroleum import.
- Promotion of Jatropha cultivation will definitely attract increased investment in biofuel production and processing in future creating opportunities for employment and income diversification in the rural areas.
- Environment protection and biodiversity conservation, especially in the watershed areas that are degraded due to continued natural and anthropogenic forces.

At the national level, promotion of biofuels will create opportunities for new industries and technology, additional employment and commercial activities. Environmental benefits resulting from the promotion of Jatropha and other biofuel plants will have long and enduring impacts in the correction and restoration of degraded watersheds in terms of improvement in soil fertility;

increase in water yield and in arresting the process of erosion and land degradation. Utilization of plant oil to meet the energy demand in the rural areas would help conserving the forest area in the country. *Jatropha* has natural potential for use as bio-fence; hence cultivation of *Jatropha* around the field boundaries would protect the valuable crops from browsing livestock and improve the micro-climate for crop production.

Continued efforts are however required building awareness of the people, entrepreneurs and others stakeholders on benefits of production of biofuels. The biofuel projects underway in the country, which rely on private-sector participation, need to be supported so that these create demonstration effect for replication and proliferation. Some of the barriers relating to promotion of biofuels in the country are identified in Table-3 which is social, economic, technical and institutional in nature. Addressing these barriers would mean increasing incentive for the people and entrepreneurs to invest in production, processing and commercial activities relating to biofuels.

Table 3: Barriers in the Promotion of Biofuels in Nepal

Barrier Type	Reasons
Institutional	Institutional capacity limitation (Research & Development) demonstration & implementation
Market	Lack of marketing systems, limited access to markets infrastructures and services
Awareness Information	Lack of awareness and access to information on biofuels
Financial	Inadequate financing arrangements for production, processing and marketing of biodiesel
Economic	Unfavorable cost, poverty and imbalances in prices
Technical	Lack of access to technology and inadequate maintenance facility
Capacity	Lack of skilled human resource and training facilities
Social	No grass root participation at the local people
Environment	No proper valuation of environmental benefits
Policy	Lack of proper co-ordination in between public and market regulatory mechanism

Recommendations on Policy Measures

Nepal has yet to formulate biofuel policy however government has initiated biofuel program which has created impetus for biofuel promotion in the country. The efforts of the government have succeeded attracting involvement of small number of producers and entrepreneurs in *Jatropha* cultivation in different parts of the country. There are strong needs to create environment that would create multiplier effect in the promotion of *Jatropha* and other biofuels.

Some of the policy interventions suggested based on the findings of this study in promotion of *Jatropha* are as stated hereunder:

1. Formulation of a Biofuels Board

- To coordinate policies amongst different government agencies
- Promote public debate instead of closed-door policy formulation
- Evaluate and approve large-scale production proposals under public private partnership model

2. Pro- Food Security Approach

- Transfer/convert marginal and wasteland for growing energy crops keeping aside the prime agricultural land for diversified food crop production
- Support of local level government entities (VDCs, DDCs) in updating land use information and regulating land use for production of *Jatropha*

A Community Based Biofuel Production

- Involving small holders and landless farmers in cooperative farming
- Mobilizing the local level government entities in the monitoring process
- Identifying endemic non-edible oil crops in biofuel promotion program

3. Private Investments

- Encourage private sector to invest in the production and processing of *Jatropha* and other biofuels through credit facility and tax rebate for shared risk.
- Evaluate and approve the projects through Biofuel Board

4. Investing in Research and Development

- Partner with universities, research institutions at home and abroad to improve upon the processes and technology available for the production and processing of biofuels.

Concluding Remarks

Biofuel feedstocks i.e. *Jatropha spp.* cultivation in Nepal is a new concept; however it can be made an integrated approach to create income and supply of bio-diesel production for the development. At the same time, producing more bio-fuels will reduce existing energy expenditures and allow developing countries to put more of their resources into health, education and other basic needs services.

For the full potential development of bio-fuels, without creating new development stress, the promotion of bio-fuels production needs to be carefully planned and implemented in a sustainable manner.

The promotion and dissemination *Jatropha* cultivation in wastelands/marginal, abandoned land along the river side enhance to produce the bio diesel feedstocks and that support poverty

reduction and provides opportunity for the rural development through upliftment of pro-poor/ultra poor in rural areas. We are heavily dependent on the fossil fuel; the fluctuation in fuel price is one of the greatest problems to Nepalese economy. Considering aspects like climate change, fossil fuel reserve depletion, fuel politics for economic enhancement, Nepal needs to enter into the age of bio-fuel. Reduced dependency on imported fuel simultaneously means saving foreign exchange, overcoming loses, creating opportunities for employment and rural development and last but not the least reducing carbon emission. Clean, available fuel impacts positively on health and drudgery and ultimately economic productivity. The cultivation of Jetropha supports the conservation of degraded lands and use of the abandon landslide areas. Tradionally local variety of Jetropha has been utilized as a bio-fencing along the boarder of the private land and the forests.

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