Possibility of Commercial Jatropha Farming to Reduce the Rural Poverty and Fuel Dependency in Nepal

A Thesis
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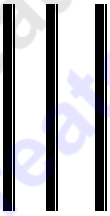

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ABSTRACT

In Nepal more than 80 percent of the total population lives in rural areas. The demand and consumption pattern of energy requirements is increasing day by day. Unemployment, poverty and helplessness are the common features of rural life in Nepal. Energy must be made available to the rural people is urgent in order to meet the pace of modern development and if situation has to be changed. To reduce the misery of the rural people and raise their minimum living standards, supply of modern facilities is very essential.

Energy is essential for development and per capita energy consumption is often seen as an indicator of economic status and well being. Nepal's per capita energy consumption at 0.3 ToE (15GJ) is one of the lowest in the world and more than 90 percent of this energy is consumed in the residential sector, indicating the low use of energy for economic development related activities. In Nepal, various activities related to bio-fuels are to be implemented to enhance rural development there. The demonstration and dissemination of various types of technologies are urgent in order to achieve the goal of rural development.

There is no doubt the fossil fuel reserve is depleting day by day and it is necessary to think about the alternative fuel. Nepal is heavily dependent on the fossil fuel; the fluctuation in 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. Jatropha is a valuable multi-purpose crop to alleviate soil degradation, desertification and deforestation, which can be used for bio-energy to replace petro-diesel, for soap production and climatic protection, and hence deserves specific attention. It can as well help to increase income from plantations and agro-industries. Landless and marginalized people can be made potential beneficiaries of employment opportunities.

This study is an attempt to find out the possibility of Jatropha in Nepal is viable and can produce bio-fuels in future which help to reduce rural poverty and enhance rural development through employment and income generation. This task is to identify the status, prospects, problems and possibility for the application of bio-fuel to reduce rural poverty, technology transfer and local level understanding about bio-fuels especially Jatropha at Lamjung district. Considering several factors Jatropha cultivation in rural areas of Nepal is strongly recommended.

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ACRONYMS/ABBREVIATIONS

AEPC	Alternative Energy Promotion Center
ATF	Air Traffic Fuel
CBOs	Community Based Organizations
CBS	Center Bureau of Statistics
CDR	Center Development Region
CES	Center for Energy Studies
CO_2	Carbon Dioxide
CRT/N	Center for Rural Energy Nepal
DDC	District Development Committee
Ed.	Edited
EDR	Eastern Development Region
ESAP	Energy Sector Assistance Program
FEI	Future Energy International
FFA	Free Fatty Acid
FGDs	Focus Group Discussions
GJ	Gega Joule
GoN	Government of Nepal
HHs	Households
HSD	High Speed Diesel
IDS	Institute of Development Studies
ITDG	Intermediate Technology Development Group
J Oil	Jatropha Oil
Kg	Kilogram
LDC	Least Developed Countries
MDGs	Millennium Development Goals
MS	Motor Spirit
MWDR	Mid Western Development Region
NaOH	Sodium Hydroxide
NOC	Nepal Oil Corporation
NPC	Nepal Planning Commission

PAF	Poverty Alleviation Fund
RE	Renewable Energy
RECAST	Research Centre for Applied Science and Technology
RETs	Renewable Energy Technologies
REDP	Rural Energy Development Programme
SN	Serial Number
TU	Tribhuvan University
UNDP	United Nation Development Program
UNEP	United Nation Environment Program
VDC	Village Development Committee
W	Watt
WDR	Western Development Region
WECS	Water and Energy Commission Secretariat

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CHAPTER-ONE

1. INTRODUCTION

1.1 Background:

Renewable Energy Technologies (RETs) assume to act as a prime engine in meeting the energy requirement of majority of rural households of Nepal. RET is not only technically feasible and reliable but it is also environment friendly. The current interest in renewable energy (RE) has emerged from the fact that conventional energy sources like imported petroleum products are not environment friendly. It can be said that, promotion of RE is an essential to all economic and social development in many rural areas of Nepal. In Nepal more than 80 percent of the total population lives in rural areas. The demand and consumption pattern of energy requirements is increasing day by day. Unemployment, poverty and helplessness are the common features of rural life in Nepal. Energy must be made available to the rural people is urgent in order to meet the pace of modern development and if situation has to be changed. To reduce the misery of the rural people and raise their minimum living standards, supply of modern facilities is very essential.

Nepal, the state of economic development, is the highest traditional fuel consuming countries in Asia because of its high dependency on traditional biomass fuels, mostly firewood and limited extent of charcoal and residues of crops and animals (Bhattarai, 2003).

Nepal's present day energy consumption is still dominated by the conventional sources of fuel wood, agricultural crop residue and dried cow dung. The level of energy consumption determines the development status of any nation. The use of fuel wood as a residential energy source has serious detrimental impacts on Nepal's forests, with deforestation resulting in subsequent soil erosion, loss of arable land and landslides.

The major tasks of the rural women in Nepal are collection of firewood, cooking and taking care of their children. Because of depleted forest, rural Nepalese women need several hours of walk to collect fire-wood and thus are vulnerable due to increased physical drudgery. In addition, spending hours for cooking in hazardous conditions in inefficient stoves result rise to eye infections and other respiratory problems (WINROCK, 2004).

The total energy consumed in Nepal, it is estimated that about 75.79 percent comes from fuel wood; about 5.74 percent comes from animal waste; about 9.24 percent comes from petroleum; about 3.75 percent agriculture residue; about 3.53 percent comes from coal, 1.47 percent comes from electricity while only about 0.48 percent comes from renewable energy sources.

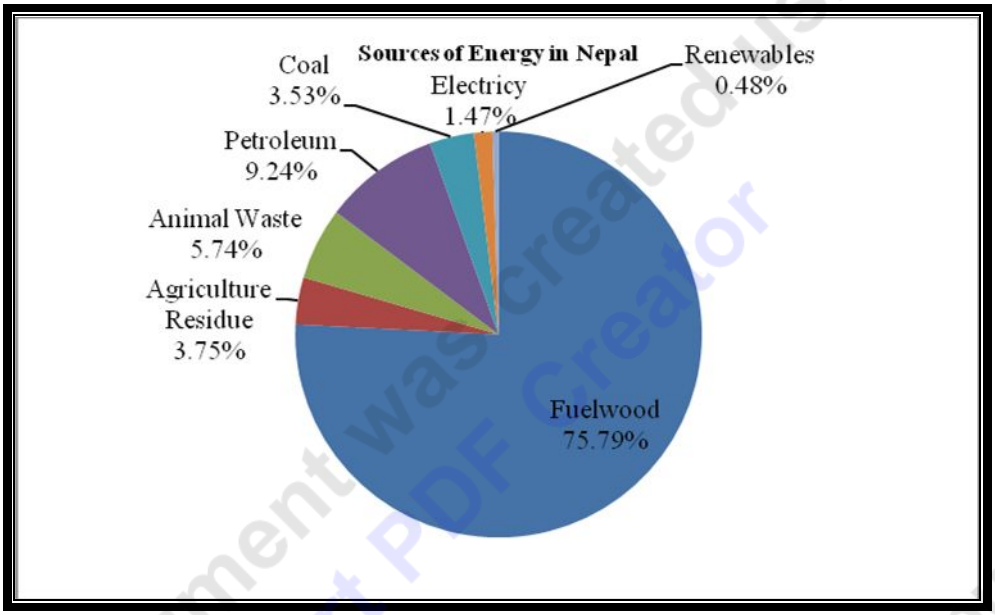

Figure: 1. 1 Sources of Energy in Nepal ***(Source: Economic Survey 2006-07)***

Government of Nepal (GoN) established Alternative Energy promotion Centre (AEPC) in 1996 under the Ministry of Environment, Science and Technology with an objective of dissemination and promotion of renewable energy technologies to improve living standard of rural people and to protect the environment and to develop commercially viable alternative energy industries in the country as well. AEPC is implementing various programmes and projects in partnership with other government bodies, NGOs, private sector and external development partners for the promotion of renewable/alternative energy throughout the country.

Energy is essential for development and per capita energy consumption is often seen as an indicator of economic status and well being. Nepal's per capita energy consumption at 0.3 ToE (15GJ) is one of the lowest in the world and more than 90 percent of this energy is consumed in the residential sector, indicating the low use of energy for economic development related activities[1]. In Nepal, various activities related to bio-fuels are to be implemented to enhance rural

[1] Source: Alternative Energy Promotion Center

development there. The demonstration and dissemination of various types of technologies are urgent in order to achieve the goal of rural development. This task is to identify the status, prospects, problems and possibility for the application of bio-fuel to reduce rural poverty, technology transfer and local level understanding about bio-fuels especially *Jatropha* at Lamjung district.

In Nepal, poverty levels, the fraction of people with an income below USD 1 per day, are in general above 40%. Economic development depends to a large extent on the abilities of the LDCs to put in place a physical, financial and organizational infrastructure, including energy infrastructure. While provision of basic services such as clean water and sanitation seems to be improving in many LDCs, access to modern forms of energy such as electricity remains extremely low (Risø, 2008). Eradicating poverty and providing energy is crucial for achieving the Millennium Development Goals (MDG's). Although there is no specific Millennium Development Goal (MDG) for energy, it is widely accepted that access to energy is essential to the achievement of all the MDG's (Risø, 2008; Modi, V., S. McDade, 2005:17-32). Without access to modern energy services, the poor people in the developing countries are deprived of many potential income-generating opportunities (UN-DESA, 2007).

With regard to the climate change problem, the LDC's like Nepal in South Asia has contributed very little to global greenhouse gas (GHG) emissions (EIA, 2004:73), Hence the concerns for mitigation are not as high on their policy agenda, as the need for energy. The overriding issue is thus how to provide increased energy for development. In the cases where it is possible also to integrate the concerns of climate change and emissions, for instance by replacing high-carbon fuels with low-carbon alternatives such as bio-fuels, this would create more long termed energy pathways, as long as these solutions are economically, environmentally and socially advantageous.

1.2 Problem area:

Developing countries are continuing the uphill battle for economic growth and poverty reduction. At the same time, they also have to struggle with global climate changes threatening exactly these countries the most. Many of the most vulnerable developing countries are increasingly concerned about how to adapt to climate change (DIIS, 2009). However, climate change policies rarely consider potential synergies with sustainable development (URC, 2006).

Furthermore, these policies push aside any considerations and debate on how developing countries can contribute to a more carbon neutral world and on how low carbon technologies can contribute to overall development in these countries (DIIS, 2009).

Thus, for LDC's, the challenge is how to address economic development and poverty alleviation while at the same time engaging in climate change adaptation and low carbon development efforts. The options for combining low carbon development with direct poverty alleviation need to be better understood (DIIS, 2009). Bio-fuels production may represent an opportunity for the Southern Asian region to increase energy supply security, their macroeconomics and to decentralize energy access. This could give a boost to rural economies by opening markets for agricultural surpluses, job creation, and increased health status etc. There are already some experiences with bio-fuels production in Southern Asia. In South Asian countries, the new initiatives tend to concentrate on biodiesel production based on oil seed crops. Jatropha curcas L. *(Jatropha*) is among the most promising species. *Jatropha* is receiving increased attention due to its specific characteristics of being drought resistant and able to grow on marginal lands. Oil-based bio-fuels from *Jatropha* (Jatropha oil) can be used in old diesel engines, and if applied in diesel generators it could potentially support rural energy production.

The oil is also useful in cooking stoves or in oil lamps or for soap production. Thus, to realize the full potential development benefits of bio-fuels, without creating new development stress, the promotion for bio-fuels production needs to be carefully planned and implemented in a sustainable manner if at all possible.

A bio-fuels project in Lamjung district — has been chosen as an example for this thesis to analyze how the farmers are impacted from bio-fuels production and utilization. The project involves 10 rural families who have planted *Jatropha*. The farmers are in a process of drawing up a contract with the investment company for the production of *Jatropha*. Few are very optimistic about the potential of the project as well as the local benefits and development it could bring. Thus, in order to achieve a holistic view on the potential development benefits or impact on poor people of producing and utilization of *Jatropha*, it is essential to consider a wide range of elements affecting the livelihood of poor people. The livelihood term relates to the range of assets out of which people value their way of living. It is a holistic way of looking at possible impacts Jatropha activities on the everyday life for small-scale farmers.

Barriers:

i. Technology:

Bio-fuels production from *Jatropha* is a new concept in Nepal. Due to various reasons, the technology has not been well developed. The reasons such as lack of Knowledge on wider use of liquid bio-fuels from public to policy levels, lack of knowledge of efficient technologies, lack of knowledge on applications, low levels of availability and promotion of bio-fuels compatible technology etc are playing vital role in its development.

ii. Economic:

Economically its commercial viability unproved and biodiesel production is not viable without by products. Liquid bio-fuels are not socially accepted as potential replacement for imported petroleum products in Nepal, the reason behind this is lack of public awareness on energy and economic potential of liquid bio-fuels. The technology associated with petroleum fuels widely disseminated and available which creates risk bearing capacity low.

Nepal depends heavily on traditional energy sources with its major repercussions reflected on forest depletion, health hazards, drudgery and loss of agriculture productivity. It has no known deposits of fossil fuel. Except for electricity, the country depends solely on imports for the supply of all commercial energy products spending almost one fourth of the total export earnings. The state is reportedly incurring a monthly loss of Rs. 20 million for the supply of petroleum fuel. Due to this it has to face with frequent disruption in fuel supply, in turn adversely affecting the economy as a whole. With the petroleum energy, the country is simultaneously importing pollution as well. Nepal is known to possess a number of indigenous resources that can provide alternate energy options. Among the local resources, Jatropha curcas has been identified as a potential oilseed bearing plant for generating biodiesel. Bio-fuels are carbon neutral and therefore they are source of clean energy and are environment friendly. For a developing country like Nepal growing energy crops like Jatropha entails a lot more than substituting imported fuel. It offers enormous opportunities for rural development if it is worth making investment. Making economic assessment of Jatropha farming is therefore a prerequisite

as it provides a basis to decide the viability of exploring the potential of Jatropha curcas for the production of feedstock for bio-fuel[2].

The majority of rural settlements in Lamjung are mainly dependent on traditional biomass. Promotion of Bio-fuel is very new concept and thus efforts undertaken are insufficient. The task is to identify the status, prospects, problems and possibility for the promotion of bio-fuel and its key role for the rural development process by up-liftment of rural pro-poor/women groups.

This study has been marked as an initiation not only for to find out the possibility of economic improvement of rural farmers through *Jatropha* farming on wastelands but it is also for the replacement of the petroleum products like kerosene, diesel and petrol by the bio-fuels like from *Jatropha*, ethanol and other relevant renewable energy. Lamjung district has been selected as the study area.

The study is mainly concerned toward the role of bio-fuels especially *Jatropha* to reduce rural poverty and how it is helpful to enhance rural development in Nepal. Exploration of possibility of bio-fuel sources at Lamjung district has been the other aspect of the study. The study also includes the information regarding socio-cultural aspects towards bio-fuels at Lamjung.

1.3 Objectives:

The main objective of the study is to determine the possibility, access and an awareness level of rural community about bio-fuels especially *Jatropha* at Lamjung district. The overall objective this task is to establish a baseline in bio-fuels and its key role in poverty reduction process.

The specific objectives of this study are as follows;

- To analyze the trend of energy consumption and the level of rural poverty at Lamjung.
- To analyze the prospects and problems for the promotion of bio-fuels/Jatropha in Nepal.
- To analyze the economic/environmental benefits and role of bio-fuels/Jatropha farming in gender sensitization.

[2] Nawa Raj Dhakal, Senior Training Officer (AEPC); Government Policy and Programme on Bio-fuel in Nepal, Report, 2008

- Identify and recommend appropriate methods for the promotion of possible bio-fuels like Jatropha with respect to different socio-cultural settings, climatic conditions, geography and available resource types.

1.4 Significance of the study:

Nepal has diverse physical features, socio-cultural practices however rich in natural resources. Majority of rural people used locally available biomass to fulfill basic energy requirement in their households. Study with regard to Lamjung district, will help to establish a baseline for the need of bio-fuels in rural development. The energy consumption pattern and usable energy produced from biomass sources database in Lamjung district will help to design/plan for the investment and promotion of RETs in rural areas. This task also intends to find out socio-cultural and religious beliefs, economic and institutional issues related to introducing biomass based RETs in Lamjung district.

The issues, problems, constraints and recommendations of this study will help to determine the conceptual framework to assist baseline information about bio-fuels. Without clean environment in the kitchen and reduction of women drudgery in rural areas, there is no chance to achieve modern pace of development. The significant importance of this research is to understand present status/application of bio-fuels at Lamjung and possibility to develop and disseminate in near future. The study also will be more helpful to identify the level of understanding of local people about prospects and problems in the promotion of bio-fuels at Lamjung district.

1.5 Limitations of the study:

There are several limitations in the study. One of the most is time. Three months time is in fact very short time for collecting data and analyzing the result. Therefore, it needs more periods to expose the real context of the rural users. Rural social structure is so much complex to understand in a short period. Secondly, the biodiversity is a natural resource. Its extraction does not also occur frequently, and the activities related to the resource mobilization and conservation work run in continuous pattern. The cases are from few VDCs of Lamjung district, so this study may not include all aspects of benefit sharing and socio-economic and bio-fuels conditions in Nepal. The study mainly emphasizes the relationship between rural development and availability of energy for poverty reduction. Some very little part of the data related to the environmental

benefits and provisional resources will be collected; such as biomass potentials have been surveyed.

Likewise, another limitation is a validity issue. Qualitative research itself always questions on validity and generalization. Though it has a particular character of depth understanding during study, it does not represent the nationwide representation. It may make more logical inference than statistical inference. Due to limited budget, questionnaires will send to organizations located outside district headquarter Beshishahar. However, information were collected through interviews, survey questionnaires and informal discussions as much information as possible through various techniques.

1.6 Structure of the Report

The first chapter is given an introduction and overview of the study. It is followed by the literature review in second chapter, methodological and analytical framework in third chapter, which describes the techniques and tools used to carry out the research study. The general introduction of the case study areas is provided in the fourth chapter. The subsequent chapter five provided the outcomes of the analysis, covering quantitative information of about Jatropha (bio-fuels). The six chapter followed by findings whereas seven chapter includes the conclusion and recommendations. Finally, last chapter followed by annexure parts including questionnaire and photographs.

CHAPTER-TWO

2. LITERATURE REVIEW

To conduct this research study various documents were reviewed before topic selection. Such type of research study with respect to the possibility of bio-fuels promotion at Lamjung was urgent due to lack of any research study there. During the time period of this research, various studies have been conducted with reference to bio-fuels promotion in Nepal.

The study was initiated with the literature review of published documents. Periodic plans of Lamjung district, district profiles, reports, legislation, policies as well as related online internet documents were reviewed. Similarly related documents available at Alternative Energy Promotion Center (AEPC), Rural Energy Development Program (REDP), Energy Support Assistance Program (ESAP), Centre for Self Help Development (CSD-Nepal), Centre for Rural Technology (CRT/N), National Planning Commission (NPC), Water and Energy Commission Secretariats (WECS), Central Bureau of Statistics (CBS), Internet available documents were also reviewed thoroughly.

Bio-fuel is defined as solid, liquid or gaseous fuel derived from relatively recently dead biological material and is distinguished from fossil fuels, which are derived from long dead biological material. Theoretically, bio-fuels can be produced from any (biological) carbon source; although, the most common sources are photosynthetic plants. Various plants and plant-derived materials are used for bio-fuel manufacturing. Globally, bio-fuels are most commonly used to power vehicles, heating homes, and cooking stoves. There are two common strategies of producing bio-fuels. The first is to grow crops high in sugar or starch, and then ferment to produce ethanol. The second is to grow plants that contain high amounts of vegetable oil, such as oil palm, soybean, algae, or Jatropha. Vegetable oil from oil seeds of various plants or waste/crude vegetable oil can be used for manufacture of biodiesel.

One of the most challenging issues being faced by the developing countries in the twenty-first century, having about their 70% of population staying in rural areas, is how to simultaneously attain energy security, economic growth, poverty mitigation and environmental protection for all citizens. These concerns have lead to research for bio-fuel to overcome the above said problems. In Nepal it is not possible for all to get absorbed in government/private services, it will be a wise

step to go for self-employment whatever may the situation/limitation be. Also bio-fuel industries appear to be better substitutes than fossil fuel and can eliminate the problem to a great extent. However the main concern with bio-fuel is its high costing therefore selection of total quality rural based bio-fuel system is to find ways and means to solve the related problems.

Jatropha (Local name- 'Sajiwan' or 'Kadam') is a drought-resistant perennial, growing well in marginal/poor soil. It is easy to establish, grows relatively quickly and lives, producing seeds for 50 years. It produces seeds with an average oil content of 37%. The oil can be combusted as fuel without being refined or can be converted into biodiesel. It burns with clear smoke-free flame, tested successfully as fuel for simple diesel engine. The by-products are press cake a good organic fertilizer, oil contains also insecticide. Jatropha plantation can be done by generative propagation (direct seeding) or vegetative propagation (cutting).

As the environmental problems are in rise due to the use of fossil fuels and the depletion of the fossil fuels is leading to energy crisis, prospect of using Jatropha as an alternative resource is ever growing. Agriculture is a major source of economy for Nepal and the cultivation of bio-fuel plants is easily accepted business. Combining this with the environmental considerations, the scope of bio-fuels becomes even broader. In addition, Nepal is expending a huge amount of foreign currency in the import of petroleum fuels. So, the massive promotion and large scale use of bio-fuels is the urgent need of the country. In this backdrop, GoN has announced Biofuel Programme[3] (*Jaibik Indhan Karyakram*) from fiscal year 2065/66 for the promotion of bio-fuels, particularly Jatropha, in the country.

The major causes of popularity of bio-fuels in Nepal are for the substitution of imported petroleum products like kerosene, diesel and petrol, improvement in health, time saving, easy to farm Jatropha, savings of money and others income generating activities. The provision of government policy to promote bio-fuels has also played important role. Till now programs implemented for the promotion of bio-fuels are limited only to Jatropha.

Some serious friends abroad participate in local adventure and contribute to materialize local initiatives. Pretty annoyed by the tall claims being made by the government that some miracles

[3] Source: www.aepc.gov.np

will follow soon, thing stands ever deteriorated, instead of awaiting miracles to happen, the local sharp brains thus tightened up their belts and jumped into an exercise which if, per chance, come to existence will in all likelihood save billions of foreign exchange and the foreign currency thus saved could well be utilized in procuring some essential commodities that the Nation needed for its development programs.

Fossil Fuel Dependency in Nepal:

There has been an unprecedented growth rate of privately owned small and large motor vehicles as well as an unmonitored influx of mini-vans and buses used for mass transit during the last five years in Nepal, which have steadily accelerated the country's demand for petrol and diesel. Nepal Oil Corporation (NOC) has also been consistently unable to clear their dues with the IOC, largely because of their monthly losses which run up to millions. Demand of fossil fuel, primarily Motor Spirit (MS), High Speed Diesel (HSD) and Air Traffic Fuel (ATF) have been found in the increasing trend since 1993/94 (NOC, 2007/08) at the national level. Still, the prices of petrol has increased more than 30% in the last four years alone, and prices of diesel and kerosene too have steadily risen during these periods. Even though there has been reduction of fossil fuel at the international market, prices in Nepal were not adjusted accordingly, where NOC claimed to do so as for mitigating the previous losses that it has made. When we look over the sales of petroleum products at the regional level it can be found that the Eastern Development Region (EDR) and Western Development Region (WDR) come after the Central Development Region (CDR) for the highest fuel consuming regions. Diesel has been found the highest amongst the other fuel in quantity in all the development regions. More than 150 (‘000 kL) per annum of diesel in different time series has been found consumed in the CDR, while EDR and WDR consumption pattern ranges greater than 50 to 70 (‘000 kL) per year in different time series as shown in the figure. Likewise, consumption of kerosene is also high accordingly and in the similar pattern in different regions. Motor Spirit has been also found highly consumed in CDR, followed by EDR, WDR, MWDR and FWDR in different time series[4].

Currently, rural households with access to irrigation pumps must depend on scarce and expensive diesel fuel. However, many poor households cannot afford to rent irrigation pumps at the going

[4] Source: Nepal Oil Corporation 2008

rate of $2 per hour, and have to depend on rain water for irrigation. Locally produced Jatropha oil is expected to be significantly cheaper than diesel fuel for powering irrigation pumps. Therefore, the project is expected to increase access to irrigation, and enhance agricultural production and rural incomes.

The project has started in communities where Jatropha plants are already growing in the wild or used as hedgerows. Local community groups and coordinating committees are organizing the Jatropha seed collection and managing the operation of high efficiency oil expellers. The oil will not be processed into biodiesel, but will be used directly in pumps modified to run effectively on pure plant oil.

The Center for Integrated Rural Community Development Nepal (CIRCOD-Nepal) is the local NGO implementing this project within the Siraha district. Two government entities, the Poverty Alleviation Fund (PAF), which implements the National Poverty Alleviation Program, and the Alternative Energy Promotion Center (AEPC), are coordinating partners. Winrock International is providing overall management and monitoring for the project – showing local communities how to produce and use Jatropha oil as fuel for irrigation pumps, as well as providing advisory and technical support, coordinating stakeholder activities, and facilitating technology financing.

The impacts of using Jatropha oil in place of diesel fuel for irrigation pumps will be documented by the project. This will include collection of data and analysis of impacts on the rural economy, irrigation coverage, agricultural production, environment, health, drudgery, women, and so on. Efforts will be made to highlight impacts of the project on achievement of the Millennium Development Goals and local poverty reduction. The resulting documentation will be presented to the policy makers for reference and future planning.

Agro fuels are being promoted as one of the main alternatives to the limited and dwindling fossil fuel reserves, and industrialized countries have encouraged the expansion of agro fuel production by mandating ambitious renewable fuel targets that far exceed their own agricultural capacities. Agro fuels are projected to provide 5.75% of Europe's transport fuel by 2010, and 10 percent by 2020, while the United States is aiming for 35 billion gallons a year. To achieve these targets, Europe would need to plant 70% of its farmland to agro fuel crops and the U.S.A. would have to process their entire corn and soy harvest for fuel. This is unrealistic and would disrupt these

nation's food supply systems. The industrialized world is therefore looking to the global South to meet their agro fuel needs, with very little consideration and understanding of the impacts, and unproven climate benefits. Southern governments appear eager to oblige, based on loose promises of development opportunities. Indonesia and Malaysia are aggressively expanding oil palm plantations in an attempt to supply up to 20 percent of the EU biodiesel requirements. In Brazil, fuel crops already take-up an area the size of the Netherlands, Belgium, Luxembourg and Great Britain combined in order to supply mainly local demand, but with the increased global demand the government is now planning a five-fold increase in land usage for agro-fuels. Their goal is to replace 10 % of the world's fossil fuel derived gasoline with agro-fuels by 2025[5].

The subsistence farmers visited don't have much information about Jatropha: they know that the plant produces oil to make biodiesel, that they can sell it, and that its seeds must not be eaten because they are toxic. Therefore, they are very vulnerable to the extensive marketing campaign around Jatropha and this has generated interest from subsistence farmers for using it as cash crop. In general, the leaning to grow cash crops is more dominant in the central and northern region of the country where rainfall is higher and high value cash crops such as tobacco, sugar cane and cotton can be cultivated. However, even in these regions the weak links to markets limit community investments in high value cash crops. The other forms of cash crops are chosen primarily because of the ease of storage, as this allows communities to wait until prices are good and/or wait out oscillating transient sales opportunities (e.g. sales to trucks that pass through communities to collect various products at various times). Jatropha has been marketed as both a high value cash crop and one that stores well.

This creates two types of concerns when dealing with Jatropha. In cases where communities are close to industrial buyers, one concern is that it will follow a similar path to that of farmers who have shifted to sugarcane production to supply a neighboring plantation. The subsistence farmer obtains seeds and chemicals on loan and this is usually deducted from the price when the harvest is sold, but lack of experience with these new crops combined with the climate risks that regularly occur lead to lower yields than expected and the subsistence farmer falls into a growing cycle of debt. The other concern is that the false information about Jatropha ease of storage will

[5] Source: Win-rock International, Nepal, Report 2008

attract subsistence farmers who are not close to markets, which would cause subsistence farmers to lose large amounts of time and resources on a crop that has no possibility of providing for them.

Incessant global demand, exhaustion due to over- exploitation and ever rising prices of fossil fuel have triggered an urgent search for a substitute fuels that are ecologically and economically viable. The energy experts from the national and international arenas have come up with the idea 'Green Energy the Next Revolution', by planting *Jatropha* (Sajiban or Kadam) and carrying out industrial activities related to the extraction of bio-diesel from Jatropha seeds. Recently, these experts have launched 'Mass Jatropha Development Programme', with the theme, 'A hope to alternative clean energy solution in Nepal'. According to them, over 500 thousands hectares of unused land in Nepal could be used for *Jatropha* cultivation that can produce bio-diesel and reduce dependency on imported petroleum products. There were over 50 plants in Nepal that bears seeds and could produce oils. But Jatropha has a capacity of high oil extraction as compared to other seeds, they said. Similarly, the cultivation of Jatropha as a source of alternative energy has several benefits in an economy based mainly on agriculture. "It can solve the unemployment crisis considerably and also ensures the optimal usage of arable land," they said.

Dr. Khem Raj Bhattarai, an energy expert, claimed that Nepal was the only country that was lagging behind to tap the value of *Jatropha*. He said that this cultivation could make Nepal independent in energy and help reduce trade deficit. He pointed out that the Jatropha oil was superior to others oils as it had a short gestation period, easy handling, high oil extraction and superior quality of bio-diesel. He, however, said that the lack of awareness, land use policy and plantation, research and study, reluctance of investors and availability of low population of these species in nature was the challenges that Nepal had to negotiate while promoting this product.

Prof. Dr. Jagannath Shrestha said that the fuel produced from Jatropha produces less carbon emission compared to other fossil fuels. According to him, if one-liter diesel was burnt, it produces 3.5-kg carbon dioxide but Jatropha had half of it.

Shyam Mohan Shrestha, chairman of the Future Energy International (FEI), said that FEI had an experienced partner company hailing from the Republic of Korea. He said that FEI and the

Korean partner company would venture for the establishment of pan-oplie natural resources that would contribute to the economy of the country and also help reduce environment degradation. He said that FEI had planned to invest, attract investors and technical support through its worldwide connections in order to make this industry a success story in the country. He pointed out that the production of Jatropha bio-fuel solves the unemployment crisis considerably and also ensures the optimal usage of arable land[6].

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. Its seeds contain thirty per cent or more oil, which can be easily expelled and extracted.

Besides reducing the consumption of fossil diesel and resultant savings on their import, the use of bio-diesel confers various advantages that include significant reduction of the various pollutants in the burnt exhaust fumes produced by traditional fuels.

Energy is the key input for technological, social and economic development of a nation. The energy supply and demand characteristics have a great role to play in order to attain sustainable development in the country. Thus, meeting Nepal's current energy demand would help foster higher economic growth. Energy demand increases not only due to the increase in population but also due to the people's access to new utilities in the market. As the rate of globalization has a quick impact in technology development, the most affected sector due to growth and globalization is the energy sector and Nepal can not be its exception. Despite endowed with huge natural resources, Nepal has not been able to tap its vast energy resources for the benefit of the country.

In Nepal, with an increase in population, agricultural and industrial activities, the demand of energy is also increasing. According to recent report of the Asian Development Bank (ADB), the demand for power in Nepal has increased steadily with an annual average growth rate of 8.5 % over the past decade, and is estimated to grow at least by 7.5% annually until 2020. However, the

[6] Source: Report on Bio-fuels by Future Energy International, Nepal 2008

current energy generation trend shows that meeting this anticipated energy demand is likely impossible. It is reported that approximately 10% of the total energy demand in Nepal is met at present by imported petroleum products at a cost of over 40% of Nepalese total merchandise export. Despite great potential for hydropower development, power sector development has been constrained due to lack of visionary leadership, inefficient bureaucracy, insurgency, and most profoundly the corrupt mentality of the political stakeholders[7].

Overview of potential products and uses:

In India, pounded leaves are applied near horses' eyes to repel flies. Nuts can be strung on grass and burned like candlenuts. The oil has been used for illumination, making candles and soap, adulterating olive oil, and making Turkey red oil. Mexicans grow the shrub as a host for the lac insect that secretes resin used as a dye and to make shellac. Ashes of the burned root are sometimes used as a salt substitute. Jatropha has been found to have strong molluscicidal activity and the latex to be strongly inhibitory to watermelon mosaic virus. It is also listed as a homicide and pesticide. Jatropha is considered as a poor quality fuel wood since the soft wood burns too rapidly. In Africa, Jatropha is widely planted as a "living fence" and hedgerows to protect food crops from damage by livestock and as a windbreak to prevent soil erosion moisture depletion. In Madagascar, Jatropha is used as a support plant for Vanilla. The bark is reported to yield tannin in commercially useable quantities. In a startling 1982 study, several oil-energy species with the potential to grow in Malagasy (Madagascar) were compared, and Oil palm was considered energetically more promising than Jatropha; nevertheless, around 10,000 ha have been planted to Jatropha (although the citation did not specify whether the plantings were *J. curcas* or *J. mahafalensis,* ed.). Other studies conclude that using the oil to make soap is more profitable than using it as biodiesel; however, this was before the recent rise in fuel costs.

Medicinal:

Although toxic, Jatropha is known as the physic or purging nut for its use as purgative/laxative, and is widely known as a source of medicinal for treatment of a variety of ailments. A range of healing properties have been ascribed to leaf preparations for both topical application and ingestion. Duke provides a most extensive list of its various uses in folk medicine.

[7] Source: www.jatrophabiodiesel.org

Human consumption:

Jatropha can be toxic when consumed; however, a non-toxic variety of Jatropha is reported to exist in Mexico and Central America, said not to contain toxic Phorbol esters. This variety is used for human consumption after roasting the seeds/nuts, and "the young leaves may be safely eaten, steamed or stewed." They are favored for cooking with goat meat, said to counteract the peculiar smell. As such, it is suggested by some that "This non-toxic variety of Jatropha could be a potential source of oil for human consumption, and the seed cake can be a good protein source for humans as well as for livestock." This non-toxic variety has not been studied as well as the toxic varieties; therefore, its properties and yields are relative unknown and "claims" unproven. The IPGRI study reports that the seeds are edible, once the embryo has been removed (no indication of which variety, ed.).

Jatropha Oil:

It is unclear how much genetics play in the amount of oil contained in Jatropha seed and kernels; nevertheless, estimates of the oil content in seeds range from 35-40% oil and the kernels 55-60% (www.jartropha.org). However, the amount of actual oil produced from seeds and kernels is contingent upon the method of extraction, with hand presses extruding only about 20% and more sophisticated a much higher quantity. The by-product of oil extraction from the seeds and kernels is called seed cake, and when oil is extracted as a cottage industry the resulting cake is said to still contain approximately 11% oil. The more sophisticated and efficient method of extraction produces seed-cake with much lower oil content.

The clear oil expressed from the seed has been used for illumination and lubricating, and more recently has been suggested for energetic purposes as a substitute for diesel. One source reports that one ton of nuts yield an estimated 70 kg refined petroleum, 40 kg "gasoil leger" (light fuel oil), 40 kg regular fuel oil, 34 kg dry tar/pitch/rosin, 270 kg coke-like char, and 200 kg ammoniac water, natural gas, creosote, etc.

Oil for lighting and cooking:

Jatropha nuts can be strung on grass and burned like candlenuts, and the oil to make candles. Although many researchers have described Jatropha as a potential domestic fuel for cooking and

lighting, with properties similar to kerosene, it cannot be used directly in conventional kerosene stoves or lamps. High ignition temperatures and viscosity (75.7 10^{-6} m2/s) as compared to kerosene (50-55 C, and 2.2 10^{-6}m2/s respectively) mean that Jatropha oil will not burn as well, and would clog up all the tubes and nozzles in a conventional stove or lamp. Approaches to circumventing these problems are being tried. A low intensity lamp with a wick has been developed. The oil lamp requires a very short wick so that the flame is very close to the oil surface. At Hohenheim University in Germany, a group is developing a special stove to solve the problems, but neither the lamp nor the stove is readily available. So far, models require kerosene both to start the stove and to clean it just before it is turned off[8].

Biodiesel:

The market that excites the most interest is that for biodiesel. However, there are several points of view that differ considerably regarding Jatropha's suitability as a substitute for petroleum products. Right now these views yield less in actual sales than in prospects. How quickly these prospects will develop depends on the observer's point of view. Jatropha oil has long been seen as a possible substitute for fuel oil for diesel engines. This is the product where interest is highest and most research is being conducted.

Unrefined Jatropha oil can only be used in certain types of diesel engines, such as Lister-type engines; but even then they require modifications, and are high-maintenance. The Lister type engine is commonly used in developing countries to run small-scale flourmills or electric generators. These engines also have to be located in warm climates because the viscosity of Jatropha oil is too high at low temperatures. However, any diesel engine, with no modification other than the replacing of natural rubber with synthetic rubber hoses (which late model engines do not have anyway), can run on Jatropha fuel once the oil has gone through a process called trans-esterification.

According to the IPGRI publication, the trans-esterification is process is normally carried out in centralized plants since the small-scale economy of trans-esterification has not been determined. During the process, methanol, a highly flammable and toxic chemical, has to be used, and this requires explosion-proof equipment that might not be available in developing countries. The

[8] Source; www.jatropha.org

WSU study contradicts the IPGR statement by claiming that the process is simple to carry out by just mixing the oil with methanol and caustic soda and leaving it to stand; nevertheless, the chemicals are toxic and highly flammable, and the processing dangerous. Regardless, this could be dangerous. Glycerin settles to the bottom of the tank, leaving the methyl ester, or biodiesel, at the top. This warrants further investigation in order to determine which statement is true. Perhaps both statements are true, and the former process is for more commercial-scale operations, and the latter is an "appropriate technology" developed for small-scale, cottage-industry producers.

Biodiesel is reported to be environmentally superior to petroleum diesel, for Jatropha biodiesel emits about two-thirds less in unburned hydrocarbons and almost half as much carbon monoxide and particulate matter as conventional diesel. It contains no sulfur and so emits none. From the point of view of global warming, it is neutral in its net addition to greenhouse gasses because the carbon dioxide released in combustion was sequestered when growing the crop (this claim is questionable, since CO_2 released would soon equate the CO_2 sequestered by the plants after a relative short time, ed.). The WSU study optimistically concludes that while many vegetable oils are used to manufacture biodiesel, a given amount of land will produce much more oil from Jatropha than from the common alternatives (soybeans, cotton seed, rapeseed, sunflower, groundnuts).

The glycerin by-product of the trans-esterification process can be used to make a high quality soap, or it can be refined and sold at a range of prices, depending on its purity, to be used in an immense range of products, including cosmetics, toothpaste, embalming fluids, pipe joint cement, cough medicine, and tobacco (as a moistening agent).

Soap production:

The glycerin that is a by-product of biodiesel can be used to make soap, and soap can be produced from Jatropha oil itself. It will produce a soft, durable soap, and the rather simple soap making process is well adapted to household or small-scale industrial activity.

Jatropha oil is used mainly in the manufacture of high quality soap. Soap making takes place on a cottage industry scale and is a boon to the people concerned, offering a chance to earn an income in economic environments where there are few such opportunities. The benefits accrue to the oil pressers and soap makers as well as to the farmers who provide the seed. The fact that the

seed has a value is an added encouragement to the use of Jatropha shrubs as live hedges that already yield benefits in the form of livestock control and soil erosion reduction. However in other developing countries, other oils or tallow may be more plentiful and cheaper than Jatropha oil; therefore, planting Jatropha for oil as a raw material and creating cottage industries to make soap may not be economically feasible.

According to the IPGI report, research carried out by the Tata Oil Mills Co., Ltd. in Bombay, India, has shown that with a mixture of 75% hydrogenated Jatropha oil, 15% refined and bleached Jatropha oil, and 10% coconut oil, a soap can be produced with lathering values equivalent to regular toilet soap. As can be seen in the table below, pressing of 12 kg of seeds yields 3 liters of oil that is then transformed into soap. The soap making technology is very simple, and is a real village technology with the only investment is a hand-operated press for $150 US (this figure seems unusually high, ed.). The soap can be made in plastic bowls or buckets, and the pieces cut with ordinary knifes.

As the table shows, the processing of 12 kg of seeds gives 28 pieces of soap of 170 g each, which is 4,760 kg. This takes 5 hours of work (estimated). The total input is added to $3.04 US. The soap can be sold for $4.20 US, and the resulting 9 kg of press cake is well appreciated as organic fertilizer and can be sold for $0.27 US; a total revenue of $4.47 US. Reduced by the input of $3.04 US, the net profit of processing 12 kg of Jatropha seeds is $1.43 US, which is about $0.28 US per hour. Even if the estimated time for processing is doubled, the net profit is about $0.15 US per hour that is more than the average wage for workers[9].

Skin care and cosmetics:

The seed oil can be applied to treat eczema and skin diseases and to soothe rheumatic pain (Heller 1996). The 36% linoleic acid (C18:2) content in Jatropha kernel oil is of possible interest for skincare.

Pesticides:

The oil and aqueous extract from oil has potential as an insecticide. For instance, it has been used in the control of insect pests of cotton including cotton bollworm, and on pests of pulses,

[9] Source: IPGI Report, (www.google.com)

potato and corn. Methanol extracts of Jatropha seed (which contains biodegradable toxins) are being tested in Germany for control of bilharzia-carrying water snails. And the pesticidal action of the seed oil is also the subject of research of International Crops Research Institute for the Semi-Arid Tropics, (ICRISAT) in India.

Other uses:

Jatropha oil is also used to **s**often leather and lubricate machinery (e.g. chain saws).

Seed-cake:

Seed-cake or press-cake is a by-product of oil extraction. Jatropha seed-cake contains curcin, a highly toxic protein similar to ricin in Castor, making it unsuitable for animal feed. However, it does have potential as a fertilizer, discussed in the next section below on markets. If available in large quantities, it can also be used as a fuel for steam turbines to generate electricity. When processed as a cottage industry, the seed cake still contains approximately 11% oil, has 58-60 % crude protein (53-55 % true protein content), and the level of essential amino acids except lysine is higher than the FAO reference protein. Nevertheless, without extensive processing, the seed cake is poisonous to animals, and untreated, is only good as a source of organic fertilizer.

The production of oil from Jatropha seed inevitably results in a by-product of press-cake with a high percentage of protein -- 58 to 64%. One source suggests that it would be an excellent animal feed; however, it is toxic. Pentagon Chemicals in Zimbabwe succeeded in largely detoxifying the press-cake through a combination of heat treatment and solvent extraction, but apparently it was not an economically viable option for commercial production. There are, after all, other kinds of press-cake derived in processing other tree and plant oils that do not need detoxification. Press-cake derived from the non-toxic varieties of *J. curcas* from Mexico and Central America may not be toxic, but the literature reviewed did not show evidence of this. Non-toxic varieties are not grown in southern Africa.

According to the WSU study, trials with Jatropha seed-cake have concluded that its properties compare favorably with those of other organic fertilizers with regard to nitrogen, phosphorus and potassium. However, there are issues needing to be addressed with respect to storage, the formation of organic acids, the slow degradation of lignin (shells) and the possible need for

treatment with pesticides that might result from lack of microbial degradation. The improper storage of the seed cake might also result in the production of toxic aflatoxins.

Charcoal:

In simple charcoal manufacture, 70 to 80 percent of the wood's energy is wasted and lost with yields of 30 percent in an industrial processes and 15-20 percent in a less sophisticated process in developing countries where charcoal is still one of the few simple fuel options. Jatropha wood is a very light wood and is not popular as a fuel wood source because it burns too rapidly. Four samples of *Jatropha curcas* wood were measured at USDA's Forest Products Laboratory and their densities were 0.35, 0.33, 0.37 and 0.22. The scientist concluded that Jatropha wood would not be of much value for either firewood or charcoal.

Some have suggested converting press cake into charcoal, but press cake is much more valuable to use as a fertilizer to ameliorate the impoverished soils in the developing countries with organic matter and nutrient contained within in order to increase crop production. However if the seed hulls were chopped and pressed, it could be used as a fuel for cottage industry use. The extraction oil from Jatropha seeds/nuts is of much higher economic value of Jatropha than converting the wood to charcoal. An exception is if a large area of land was colonized by a variety of Jatropha that had very low yields of nuts/oil and there is a desire to clear the area and replant it with a variety that produced much higher yields of nuts that contain more oil.

Yields and Economics:

Jatropha is being heralded as a tree crop for biodiesel production and increasing incomes of small farmers on marginal lands; however, when you plant crops on marginal lands/soils, you can expect to get marginal yields. Plants mine nutrients from the soil, and to maintain yields, these nutrients need to be replaced. This often means applying chemical fertilizers that even if available, are not affordable to many small farmers. When doing realistic planning on the "real" economics of a Jatropha project, one must also calculate that fact that optimal seed yield of Jatropha won't be obtainable for several years. Furthermore, marginal farmers most often have access to only a minimal amount to land for food crop production; therefore, what will they have to eat until a sound market for Jatropha oil is developed?

The jury is still out on the actual seed and oil yields one can count on from Jatropha plantings. IPGRI concludes that "The low yields revealed in several projects may have been caused by the fact that un-adapted provenances had been used. If investigation of its genetic diversity and its yield potential had been covered by adequate scientific research, this problem could have been overcome."

In the literature reviewed, it could not be determined if adequate research on germ-plasm improvement is taking place to optimize the per plant yield of nuts and oil content. Since Jatropha clones are readily propagated through cuttings, germ-plasm improvement to optimize yields should be easier than with many other plants/trees. One must be very careful in selecting a good source of Jatropha germ-plasm for projects since there is little truth in advertising, and presently the best profitability is in selling seed, cuttings or seedlings produced from plants that are probably not genetically improved and may vary widely in yield. Cloning creates cytoplasmic uniformity in plants making them more susceptible to disease and insect infestation.

Both male and female Jatropha trees are reported; therefore, logically, one might assume that they might produce different yields, but yield differences were not noted.). [ECHO Editor: I suspect that what is meant is that some plants are female and others are bisexual, as is the case with many commercial papaya varieties. Otherwise it is hard to see how the male-only plant would bear fruit.] In an Australian-funded project, the Nicaraguan plant material -- a male sterile plant – was observed to have produced more fruits than the hermaphrodite types. And according to the **IPGRI** document, male sterile plants will facilitate breeding efforts for higher seed production. Also, it is probable the non-toxic varieties yield less than the toxic varieties (both in tonnage of nuts and percentage of oil

Furthermore from the literature it is extremely difficult to determine what actual per hectare yield of nuts one can rely upon when growing Jatropha. Most figures cited were projections that often are inflated and over optimistic in order to procure funding for projects. Also, the estimated oil content of the nuts cited in the literature varies considerably, which adds to the difficulty of calculating the profitability of growing Jatropha. Furthermore, optimizing oil extraction from the seeds requires expensive machinery. One can find on page 36 of the IPGRI study a list of yields cited by a number of sources.

Rather than being based on sound economic planning, many undertakings of Jatropha plantings seem to be based on subsidized project development and the speculative selling of Certified Emission Reductions for potential carbon sequestration trading payments. The cited value of carbon sequestration by Jatropha is questionable, since even if it is closely-spaced the wood is not very dense (densities 0.35 to 0.22, see above Charcoal).

In the literature, the reports of yields vary greatly and are confusing. This can be attributed to one or a combination of the following factors including: yields are sometimes given in terms of fruits, seeds, nuts, or kernels; confusing terminology used in making yield estimates, e.g., some are made in tons (t) while others are in metric tons (MT); variance in germ-plasm; unstipulated spacing between plants; no specific data on soils (ranging from marginal to fertile, and if fertilizer was applied); no information on rainfall and other climatic conditions, and if irrigation is being used

Reports on yields include that from plantations (mostly projected yields), but it is not mentioned if they were established by vegetative propagation or by direct seeding, on fertile or marginal soils, and if the plantations were irrigated or not. When irrigated, Jatropha trees are said to produce seeds throughout the entire year. Often, there is no mention of the age of the trees/shrubs, nor is the variety/cultivar given. Jatropha trees are said to begin producing a measurable amount of nuts at 18 months, but are not expected to reach maturity and optimal yields until after 6 years.

The IPGRI report gives a conversion factor of 30 kg of fruits yielding approximately 18 kg of seed. One might assume that the fruit to seed ratio may be higher in areas of higher rainfall. In one reference, IPGRI estimates that a yield of at least 2-3t (not MT) of seeds/ha can be achieved in semi-arid areas; however, in another citation, IPGRI reports that in Hisar, Bangalore, India, a "quite high seed yield" (1,733 kg/ha or 1.733 MT) was observed in one cultivar. IPGRI confuses the issue by reporting the yield in tons and not MT (this could have been an editing mistake, ed.), while giving the area in hectares.

Gaydou, et. al. (cited by Duke) gives a seed yield approaching 6–8 MT/ha with approximately 37% oil, and such yields could produce the equivalent of 2,100–2,800 liters fuel oil/ha. According to Gaydou, there are approximately 10,000 ha of Jatropha in Madagascar, each ha

producing about 2,400 liters of oil for a total potential production of 24,000,000 liters. One reference reports that *J. mahafalensis* (not *Jatropha curcas*) as the species found in Madagascar, nevertheless, it is predicted to have equal energetic promise. Nevertheless, there has been a request from Madagascar for information on converting *Jatropha* wood to charcoal; therefore, one might assume that the Jatropha plantings may not be profitable and producing as much oil as predicted.

Status of Poverty:

Poverty is a complex phenomenon. It has different meaning to different people depending on the perspective. What constitutes poverty depends very much on who defines it. The view of the politicians, development practitioners, researchers and the 'poor' may diverge substantially. Along with the shift in the development paradigm, there has also been evolution in the concept of poverty. The first attempt at measuring poverty in Nepal was in 1977 when the National Planning Commission conducted a comprehensive survey to determine the status of 'Employment, Income Distribution and Consumption Patterns' (NPC, 1978). It measured poverty in terms of inadequate income to supply minimum caloric requirements. This narrow income based poverty measure has its merit since income represents the capacity of households to access necessities of life. In the absence of other appropriate measures it does serve as a partial proxy of well-being. The concept of poverty has evolved substantially during the decade of the nineteen-nineties and it is now accepted internationally that poverty entails much more than income poverty (see Sen, 1992 and 2000; UNDP, 1997). The following definition given in the Human Development Report 1997 is perhaps the most inclusive.

"From a human development perspective, poverty means the denial of choices and opportunities for a tolerable life. It is in the deprivation of the lives people lead that poverty manifests itself. Poverty can mean more than a lack of what is necessary for material well-being. It can also mean the denial of opportunities and choices most basic to human development – to lead a long, healthy, creative life and to enjoy a decent standard of living, freedom, dignity, self-esteem and the respect of others" (UNDP, 1997)

The following perception of a Nepali poor illustrates the meaning from a different perspective.

"Being nimcharo (poor) is unable to do anything to change the existing situation of deprivation. It is the situation of living without adequate food and cloth even when working to death. It is to live .Obviously; many of the elements that constitute poverty cannot be measured. And no definition can incorporate the implication of being poor which not only makes life miserable for the current generation but also tends to replicate the situation for the next generation. Reflecting these concerns, poverty is now being measured in Nepal in terms of its various dimensions – mainly income, health, and education. But income measure still predominates and comes in the forefront in any poverty discourse.

Nepal has made some progress in human development over the years. There have been improvements in education, health and other social services, particularly in the last decade. However, the level of human development in Nepal remains among the lowest in the world. This stems basically from narrow based economic growth, inequity and inequality in the distribution of opportunities and resources, and social exclusion. Development outcomes have been inequitable as reflected in gender, caste, ethnic and geographic disparities. Poverty has remained intractable and employment opportunities have become scarce. People's needs have remained unfulfilled, institutions have become extremely weak, and policies have not been pro-poor. A large section of the people continues to remain outside mainstream development. The outbreak of armed violence has exacerbated these problems and the country has moved into deeper crisis unprecedented in the history of modern Nepal.

Past efforts have remained largely unsuccessful in attaining equitable and inclusive development because they have been exclusionary. The governance system has remained non-functional, compounding the failures at the institutional and implementation level. The country is yet to attain success to promote equity and equality, participation and ownership, transparency and accountability, and the efficient use of public resources, all of which are essential to promote good governance. There is a strong association between strong and effective democratic governance and empowerment, and the concerns of the poor can be addressed through empowerment that provides equal opportunities to all, regardless of sex, caste, creed or religion, and ensures equitable access to and control over resources and decision-making processes at different levels.

Empowerment is the process of transforming existing power relations and of gaining greater control over the sources of power, especially by disadvantaged groups and communities. Empowerment builds people's capacity to gain understanding and control personal, social, economic and political forces to act individually as well as collectively to make choices about the way they want to be and do things in their best interest to improve their life situation. This definition captures the spirit of human development, which is defined as 'creating an environment in which people can develop their full potential and lead productive, creative lives in accord with their needs and interests to be able to participate in the life of the community[10].'

Empowerment is one of the four pillars of human development, which effectively addresses the other three – equity, productivity and sustainability. It is an effective tool for reducing poverty and promoting human development as it creates the necessary conditions that enable the poor to take advantage of poverty reducing opportunities by strengthening their socio-cultural, economic and political capabilities.

Institutional failure can be attributed mainly to the inadequacy of proper legal, regulatory and administrative frameworks and lack of accountability at all levels of government. The orthodox parliamentary practices adopted in Nepal after 1990 overlooked the exclusionary social structure of our society. No urgency was felt to formulate inclusive economic and social policies or constitutional reform. Deep rooted social cleavages in terms of caste, ethnicity, gender, regional, cultural, linguistic and religious forms of discrimination continued to persist. As a result, continued socio-political marginalization of the deprived sections perpetuated at a time when political awareness among the disadvantaged was increasing. Such diverging trends gradually started fuelling social contradictions in the existing discriminatory society. The top down development paradigm overwhelmed with narrow based growth policies widened income inequalities and sharpened distributional conflict. Rising unemployment and poverty created frustration among the youth and deprived classes. Political instability characterized by inner-party struggle, split of political parties and hung parliaments was inimical to address the rising social contradictions, as more time was spent on consolidating position within the party and balancing power.

[10] Human Development Report 2007, UNDP

Unfulfilled commitments together with problems in inter-party and intra-party co-ordination further weakened the democratic system. Without political reconciliation to strengthen the democratic system and ensure peace or the formulation of an elected government at the central and local levels, it will be difficult to enhance the capacity of the state to implement pro-poor policies and programs and to make institutions work for the poor people. Thus, without effective plan, policy and programs underdeveloped country will unable to shift in new technology. Nepal is rich in biodiversity and natural resources but is famous as a poor nation. To address poverty and reduce dependency of imported petroleum products, there is an urgent need of proper utilization of natural resources.

The Sustainable Livelihood (SL) concept is central to the debate about rural development, poverty reduction, environmental management and energy requirements (Scoones, 1998). It is an attempt to go beyond the traditional definitions and approaches to poverty eradication, as these focuses primarily on certain aspects of poverty, such as low income, or does not consider other vital aspects of poverty such as vulnerability and social exclusion. Even though economic growth may be essential for poverty reduction it all depends on the capabilities of the poor to take advantage of expanding economic opportunities. Hence, poverty is not just a question of low income, but also lack of knowledge; lack of social services; vulnerability; energy crisis etc (Scoones, 1998).

Therefore more attention should be paid to the various factors and processes, which either hinder or improve poor people's ability to make a sustainable living. According to the 1992 United Nations Conference on Environment and Development (UNCED), Sustainable Livelihood can serve as an integrating factor that allows policies to address development, sustainable resource management, and poverty eradication simultaneously (UNDP, 1997). Thus, the Sustainable Livelihood concept offers the prospects of a more reasoned and holistic approach to poverty eradication (Krantz, 2001). The term SL relates to a broader debate about the relationship between poverty and environment. Subsequently there is often little clarity about the exact definition of Sustainable Livelihood. Ian Scoones, Institute for Development Studies (IDS) at Sussex University, proposes the following definition, which is a modified version of the original definition elaborated by Chambers and Conway (Chambers *et.al.*, 1992):

"A livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks, maintain or enhance its capabilities and assets, while not undermining the natural resource base" (Scoones, 1998).

Four different assets can be identified as basis for Sustainable Livelihood (after Scoones, 1998):

- Natural assets – natural resources (soil and water), environmental conditions of land use.
- Economic assets – income generation, costs, employment and investments.
- Human assets – health, skills, know-how and training.
- Social assets – participation and equity.

In such a way both poverty and energy issues are interrelated subjects to address the basic needs of underdeveloped countries.

Bio-fuel in Policy & Plan Documents in Nepal:

Rural Energy Policy, 2006

Three Years' Interim Plan, 2007/08-2009/10

Rural Energy Policy, 2006

Overall Goal and Objectives

- To contribute to rural poverty reduction and environmental conservation by ensuring access to clean, reliable and appropriate energy in the rural areas (Clause 2)

Objectives

- To reduce dependency on traditional energy and conserve environment by increasing access to clean and cost effective energy in the rural areas (Clause 2.1)
- To increase employment and productivity through the development of rural energy resources (Clause 2.1)
- To increase the living standards of the rural population by integrating rural energy with social and economic activities (Clause 2.1)

Rural Energy Policy, 2006

Major Policies…Emphasis on-

- Development of the environmental friendly, suitable and affordable RE technologies (Clause 3.1 & 3.5)
- Decentralization (institutional setup from central to local level) and Capacity development of local bodies (Clause 3.2 & 9);
- Rural Energy Fund at central & local level (Clause 3.3)
- Community management through social mobilisation (Clause 3.10)
- Private sector participation (Clause 3.11)
- Credit mobilization from financial institutions (Clause 3.12)

Source: Nawa raj Dhakal, Senior Training Officer (AEPC); Government Policy and Programme on Bio-fuel in Nepal, Report, 2008.

Rural Energy Policy, 2006

Working Strategies…

- Activities related to awareness creation for the use of bio-fuel, ... will be conducted by encouraging the use of local skill and resource (Clause 4.3.4)
- Technology for bio-fuel, ... will be developed and disseminated by identifying suitable location (Clause 4.3.2)
- Development and promotion of bio-fuel, ... will be encouraged (Clause 5.8)
- Research and development and dissemination will be emphasized on non-edible vegetable oils that can be used as energy (Clause 10.5)

Three Years' Interim Plan, 2007/08-2009/10

Policy & Working policies (Ch. 35; Environmental Management- Clause 7)

- Carbon trade will be promoted to achieve benefit from CDM under the Kyoto Protocol
- Necessary mechanism will be developed and implemented under the principles of "Polluters Pay" & "Pollution Prevention Pays"

Programmes

(Ch. 35; Science & Technology- Clause 8)

- Necessary study and research will be carried out to use bio-ethanol as fuel

Three Years' Interim Plan, 2007/08-2009/10

Long Term Vision (Ch. 35; Science & Technology- Clause 4)

- RE promotion contributing to rural development, enhancing rural economy and quality of life, increasing the employment opportunities and environmental sustainability
- Reducing the dependence on the external sources of energy
- Reducing the dependence on the conventional energy sources
- Generating financial resources through carbon trading
- Contributing to the broader national goal of achieving social inclusion and gender mainstreaming

Three Years' Interim Plan, 2007/08-2009/10

Quantitative Targets (Ch. 35; Science & Technology- Clause 6)

- Development of 300,000 units of improved cooking stove and installation of other bio-energy technologies

Source: Nawa raj Dhakal, Senior Training Officer (AEPC); Government Policy and Programme on Biofuel in Nepal, Report, 2008.

Strategies (Ch. 35; Science & Technology- Clause 7)

- Priority to development & promotion of bio-energy, … … considering the needs & resources available in rural areas
- RE promotion through decentralization (DDC: DEEU/S)
- R & D, technology transfer; programs on cost reduction and capacity enhancement

Three Years' Interim Plan, 2007/08-2009/10

Policy and Working Policies (Ch. 35; Science & Technology- Clause 8)

- Capacity development for utilization of available bio-energy resources in the rural areas

- Reduced dependence on imported energy sources with the development of alternative energy sources
- Promotion of bio-energy technologies and awareness building for the utilization of these technologies
- Public and private sector participation
- Financial supports: subsidy and credit

Three Years' Interim Plan, 2007/08-2009/10

Programs (Ch. 35; Science & Technology- Clause 9)

- **Bio-energy Program**
    - Total of 300,000 improved cooking stove and other bio-energy systems are proposed to be developed
    - Research and studies on bio-fuel
    - Feasibility study and promotional activities on such energy technologies as gasifier, briquettes and bio-fuel

Major Govt. Interventions so far

- RECAST has conducted test on diesel engine with un-esterified plant oil
    - 800 hrs test completed with positive results
    - Proposed for field test
- Plantation of *Jatropha* in western Nepal
    - Land provided by Institute of Forestry, Pokhara
    - Cultivated by women groups
    - Equal sharing of profit between 2 parties
    - Sundhara Oil Expeller designed by Development and Consultancy Services can be bought in market

Major Govt. Interventions so far

- AEPC organized was in Nov 2007 to bring forward different interventions and interest to a forum
    - As a result, various organizations started intervention

    - Non-edible plant oil for running electric generator in Okhaldhunga and irrigation pump in Siraha
    - SNV and WWF organized a study on assessing the potential of bio-fuel in Nepal
- Alternative Energy Task Force of GoN recommended utilization of bio-fuel in Nepal
- AEPC study in 2007 on the economic, technical and environmental aspects of using E10 and E20
- Positive findings and recommendations
- GoN in November 2008 has again decided to blend 10% ethanol in petrol
- MoCS floated a tender to purchase anhydrous ethanol to blend in petrol to produce E10

GON's Bio-fuel Programme

- One of the special programmes for building New Nepal in the current FY 2008/2009
- Major activities:
    - Awareness raising, production and dissemination of information materials on bio-fuel
    - Formulation of bio-fuel promotion strategy
    - Establishment of *Jatropha* Nurseries in different regions
    - Capacity building for *Jatropha* plantation
    - Installation of biodiesel processing centers and biodiesel filling stations in five regions of Nepal
    - Conduction of pilot projects on bio-fuel

Source: Nawa raj Dhakal, Senior Training Officer (AEPC); Government Policy and Programme on Bio-fuel in Nepal, Report, 2008

CHAPTER-THREE

3. RESEARCH METHODOLOGY:

In this chapter the data collection, the selected theory and the different methodological considerations regarding the theory and case of choice, the elaboration of the indicators all are presented. The study was carried out using primary as well as secondary information. For primary information, various organizations and people involved in development, promotion and dissemination of technologies were contacted using formatted questionnaire. Sources of secondary information were various published and unpublished reports, technical manuals, bulletins, brochures etc.

The following methods were followed to derive the information:

- The relevant literatures related with bio-fuels, mainly socio-economic aspects/publications were collected and reviewed. Some relevant materials were also collected from relevant websites.
- Various stakeholders (I/NGOs, private sector, promoters of technologies, projects and programs, Government, academic/research institutions, manufacturers etc.) involved in promotion of biomass based technologies were identified and interviewed.
- Direct observation in few rural areas in Lamjung district.
- Description of the technology with detailed sketches, figures and photographs.
- Analyze the prospects and constraints, effectiveness and efficiency (with respect to acceptability, clean environment, income generating activities and fuel and time saving) of bio-fuels especially *Jatropha*.
- Identification of appropriate technologies for different socio-cultural settings, weather, geography, availability of fuel types and cooking behavior.

3.1 Rationale for the selection of the study site:

The study is expected to contribute in understanding investment requirement for a minimum feasible commercial farming and the benefits of *Jatropha* cultivation in rural parts of Nepal. The

study is further expected to identify the potential area for promoting *Jatropha* and to uplift the living condition of pro-poor rural community of Nepal.

3.2 Nature and Sources of data:

The study is based largely on both secondary as well as primary data. Primary information was obtained to assess the farming status from the project site at Chandreshwor and Duradanda VDCs in Lamjung District and from the one day seminar in Kathmandu organized by Alternative Energy Promotion Center, Khumaltar. Secondary source materials were drawn from printed literatures, websites, journals, proceedings, books and reports prepared by the concerned authorities.

3.3 Sampling Procedure:

The respondents for the study have been selected by convenience sampling. The people engaged in the *Jatropha* farming are limited and the way they are farming is also very few in the study areas. Since the study population is limited and very few, convenience sampling has been performed to select the sample respondents. However structured questionnaire were asked for 20 people either they were engaged in the Jatropha farming or showing interest for *Jatropha* cultivation.

3.4 Research Design:

The ultimate target of this study is to identify the potentialities, problems and prospects of *Jatropha* cultivation in Lamjung. The design to the study is made to derive conclusion answer to the subject matter. This study followed the combination of exploratory or formulative, descriptive and diagnostic research design. The research study assesses the status and potentialities of *Jatropha* use in the study areas and the way it is being used at present. It also determines the different aspects of Jatropha uses for of peoples' life as energy, income and for clean environment.

3.5 Data collection, Techniques and Tools:

The tools used to obtain information for this study were formal and informal interview with key informants and literature survey. The structured questionnaire, checklist, field observations were operationalized for collecting primary information.

The primary data have been collected by using the following techniques and tools.

Table: 3. 1 Tools and Technique

S.N.	Techniques	Tools
1.	Interview	Structured questionnaire /interview guide
2.	Observation	Checklist
3.	Seminar	Checklist

I. Interviews/FGDs:

Interviews were taken to gather information regarding forest, rural enterprises, available rural technologies with the concerned line agencies and stakeholders in the district. Ex- chairpersons and key informants from the study VDCs were also interviewed. Information obtained through these interviews was useful in arriving at a firsthand picture of the study area and later verified and triangulated during FGDs and questionnaire survey. FGDs were conducted in local level. The key informant interview has included interaction with knowledgeable persons, school teacher, local learned person, members of Mothers Group, etc to collect the information on Bio-fuel activities. Resource maps are prepared during FGDs, and information collected through interviews was also verified.

II. Observation:

The study areas and farming sites, farming pattern, involvement of family members were observed using checklist**.** The places of research study were visited based on information gained from FGDs. Development of Jatropha especially bio-fuels based technologies and its impact on socio-economic status was focused. Likewise, settlements/places favorable to use/promote Jatropha were also observed. For the survey, an appropriate checklist has been devised.

III. Seminar:

All the *Jatropha* experts were invited for the second national seminar in *Jatropha* held in Kathmandu by AEPC, where each and everyone shared their experience about *Jatropha* cultivation.

3.6 Data analysis:

After completion of field survey/interview schedule from primary collection of data had been preceded. Various computer programmes had been taken and simple statistical tools like; table, graphs has been used for data analysis. In this process, descriptive methods were used for qualitative data. The data has been presented on the tables and graphs/figures according to the study. Some photographs have been presented wherever they are useful.

CHAPTER-FOUR

4. CASE STUDY AREA:

4.1 Introduction of Lamjung district:

In the case of Lamjung district, the farmers either grow the Jatropha from seeds or seedlings provided by the Support Organization, Paudikhola Jaladhar Kshyetra in Chandreshwor and Duradanda VDCs of Lamjung district. Also, few are grown from cuttings there.

4.1.1 Geographical Status:

The study area Lamjung district lies on the west of Gorkha, east of Kaski, south of Manang, and north of Tanahun districts. It has an area of 1692 km^2 lies on Gandaki zone between the longitude $84^0 11' 23"$- $84^0 38' 10"$ due east and latitude $28^0 03' 23"$- $28^0 30' 38"$ due north whose headquarter is Besishahar.

Table: 4. 1 Geographical location

Area	1692 km^2, 1,69,200 hectares
Latitude	28^0 03' 19"-28^0 30' 38" N
Longitude	84^0 11' 23"-84^0 38' 10" E
Height	385m-8162m (above sea level)
Headquarter	Beshishahar, 8000m

Table: 4. 2 Boarders

East	Gorkha
West	Kaski
North	Manang
South	Tanahun

4.1.2 Land-Utilization:

The total land area is 1, 69,200 in hectares. The forest covers the largest area at about 66,216 hectares which is 39.13% in totality. The remaining portion of lands are agriculture land that is both used and unused, snow covered/ rocky land, pasture land, residential area, others (road/way/rivers/streams) covers an area of 45,050 hectares, 16768 hectares, 5,891 hectares,

25,154 hectares, 919 hectares, 9,202 hectares and 26.62%, 9.91%, 3.48%, 14.87%, 0.54%, 5.45% of the total land area respectively. The residential area is the least one according to the table below.

Table: 4. 3 Land utilization

S.N.	Types		Area in hectares	Percentage
1	Forest land		66,216	39.13
2	Agricultural land	Used for Agricultural	45,050	26.62
		Unused land	16,768	9.91
3	Snow covered/Rocky land		5,891	3.48
4	Pasture land		25,154	14.87
5	Residential		919	0.54
6	Others (Road/Way/River/Streams)		9,202	5.45
	Total		1,69,200	100%

Source: District Profile, 2065/66 FY

4.1.3 Population Distribution:

According to census report, the majority of population is Gurung 31.54% which is followed by Brahmin 15.7%, Chhetri 15.45%, Kami 7.54%, Tamang 6.52%, Sarki 3.86%, Damai 3.36%, Gharti 2.11%, Magar 2.04%, Dura 1.96%, Rai 1.24%, Thakuri 0.93%, Kumal 0.87%, Sanyasi 0.78%, Muslim 0.44%, Thakali 0.03%, Chepang 0.02%, some of unidentified castes 0.99% and others caste groups 0.82% in totality from the census of 2058. (Source; Census, 2058)

Table: 4. 4 Population distribution

S.N.	Castes	Percentage	S.N.	Castes	Percentage
1	Gurung	31.54	2	Chhetri	15.45
3	Brahaman	15.7	4	Kami	7.54
5	Tamang	6.52	6	Sarki	3.86
7	Newar	3.8	8	Damai	3.36
9	Gharti	2.11	10	Magar	2.04
11	Dura	1.96	12	Rai	1.24
13	Thakuri	0.93	14	Kumal	0.87
15	Sanyasi	0.78	16	Muslim	0.44
17	Thakali	0.03	18	Chepang	0.02
19	Unidentified	0.99	20	Others	0.82
	Total	**100%**			

Source: Census, 2058

4.1.4 Food Distribution

Table: 4. 5 Food distribution

Duration	Total Households in Lamjung
1-3 Months	5088
3-6 Months	3433
6-8 Months	19411
Whole Year	4335
Saving foods	1286
Total	**33553**

Data Source: District profile Lamjung, 2065

Among the 33,553 households food distribution is obtained in the tabular form. Accordingly 5088 households have enough food for 1-3 months, 3433 households for 3-6 months, 19411 households for 6-8 months, 4335 households for whole year and remaining 1286 household would have saving foods. Though from the analysis food sufficient for 6-8 months have the leading position.

4.1.5 Energy Distribution:

Table: 4. 6 Rural cooking behavior

Description	Percentage
Fuel-wood/Fire-woods	82.22
Kerosene	5.85
LPG	3.39
Biogas	7.74
Others	0.8
Total	**100%**

Data Source: District Profile Lamjung, 2065

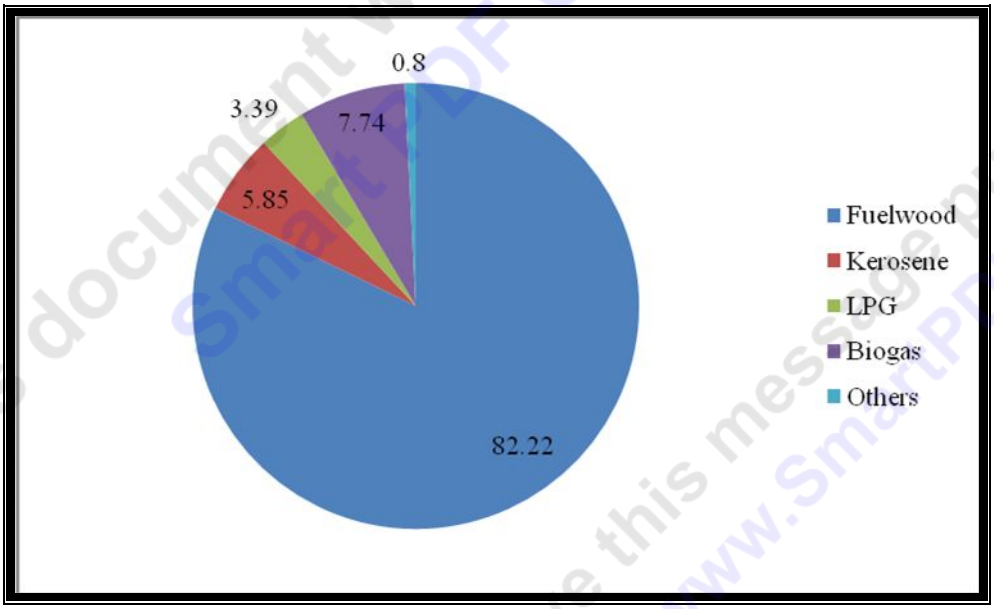

Figure: 4. 1 Rural Cooking Behavior

Most of the using energy trend is for firewood for cooking purposes that is 82.2% which is greater than that the use of biogas and kerosene which is only 7.74% and 5.85% respectively. The people have used lesser amount of LPG that is only 3.39% and other sources is 0.8% as the cooking energy resources which can be easily identified by the figure 4.1 in the study area.

Table: 4. 7 Energy sources for lighting purpose

Description	Percentage
Electricity	31.18
Kerosene	67.14
Others	1.68
Total	**100%**

Data Source: District Profile Lamjung, 2065

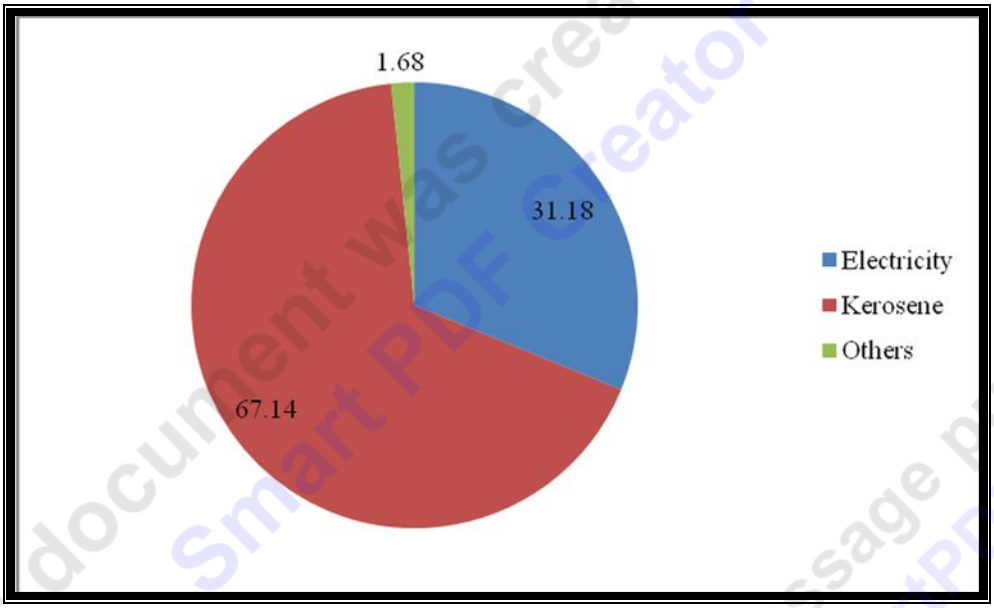

Figure: 4. 2 Energy Sources for lighting purposes

The main energy resource used for lighting purpose is kerosene which is 67.14 %. After then the use of electricity and other sources for lighting energy sources respectively contain 31.18 % and 1.68% in totality in the study area which is shown in figure 4.2.

4.2 Introduction to Case Study Area:

The case study is taken from both VDCs Chandreshwor and Duradanda of Lamjung District. The area can be reached there about 2.5 hours walking distance from middle Marsyandi Hydropower Project, Siundibar, Lamjung. The people of case study area were found mainly farming as primary occupation. In total 20 households were selected for sampling procedure as mentioned in above methodology.

4.2.1 Community Access to Different Facilities:

From the mentioned table below, the accessibility pattern of the area is clearly identified. There can be easily access of the primary facilities as unpaved road for walking, transportation, post-office for the communication, access to education by the primary, high school, secondary school and university, market for shopping of daily needs and agro products, helping agency as NGO, rice mill, bus station, grocery, milk booth, and pharmacy within the community of the study area. The different access is for the bank which is 25km far away from the community due to the paved road facility at about 7 km away from the community center.

Table: 4. 8 Community access to different facilities

S.N.	Facilities	Whether within Community Yes ….1, No…..2	If not within Community, then distance from the Center of the Community (km)
01	Hospital	1	0
02	Health Center	1	0
03	Pharmacy	1	0
04	Primary School	1	0
05	High School	1	0
06	Secondary School	1	0
07	College/ University	1	0
08	Post Office	1	0
09	Milk Booth	1	0
10	Provision/ Grocery	1	0
11	Market	1	0
12	Rice Mill/ Wheat	1	0
13	Bus Station	1	0
15	Bank	2	25
16	NGO	1	0
17	Agriculture Extn.	1	0
18	Paved Road	2	7
19	Unpaved Road	1	0

Data Source: Primary Field Survey, 2066

4.2.2 Education:

Table: 4. 9 Educational status

Education Status	Gender	Number
SLC pass	Male	28
	Female	20
	Total	48
Literate	Male	40
	Female	26
	Total	66
Children without School	Male	5
	Female	8
	Total	13
Illiterate	Male	15
	Female	21
	Total	36
Total family members		**102**

Data Source: Primary Field Survey, 2066

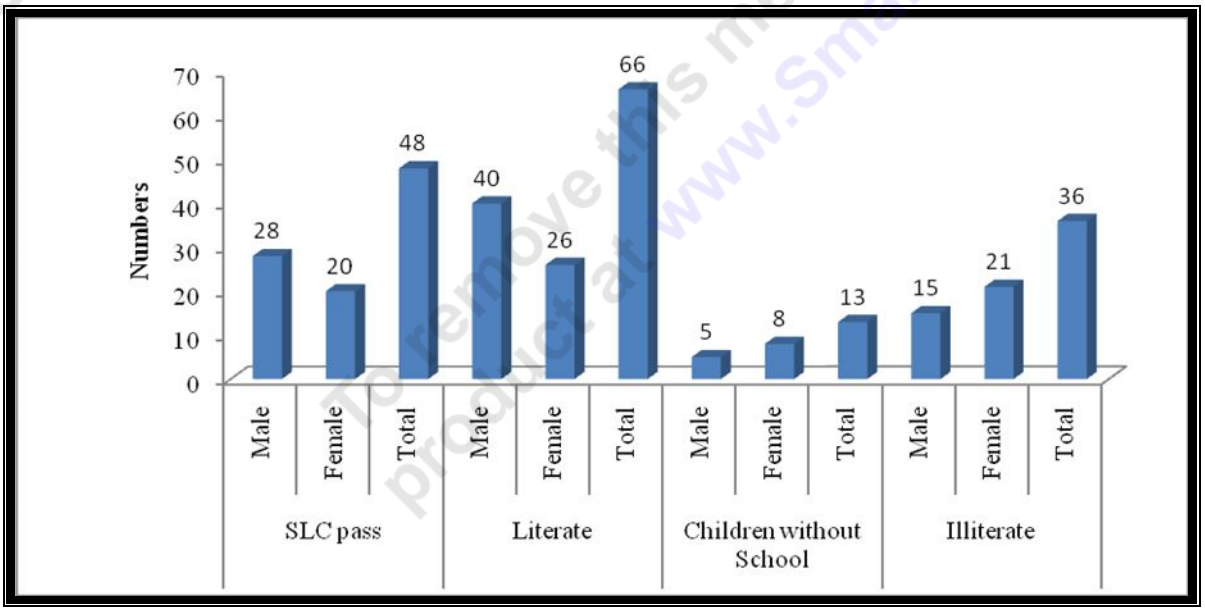

Figure: 4. 3 Educational Status of Surveyed rural families at Duradanda.

Literacy level of respondent indicates understanding and communicating level of acquired knowledge and experiences. For common understanding literacy has been classified into four categories (i) Illiterate, (ii) Children without school, (iii) Literate, (iv) SLC pass. Literate refers to the one who can read, write and do small calculation. Literacy seems to be factor in promotion of Jatropha (bio-fuels). In study, total 102 no. of people's information were collected for the analysis of educational status of the rural families at Duradanda. The grading according to the status has been plotted in the figure 4.3. Among 48 SLC passed people 28 were found the male population while 20 were female population. Similarly, among 66 literate 40 were found male population while 26 were female population. Among 13 children without school 5 were the male population while 8 were female population and among 36 illiterate 15 were found male population while 21 were female population. Thus it would explain that the male population are more literate than the female population in every angle that is either general literate or above SLC passed and even the illiterate no. of male is lesser than that of female too.

4.2.3 Income Ranges (Annual):

Table: 4. 10 Annual income ranges

S.N.	Annual Income Range	Total Number of Responses
	0-10,000	5
	10,000-20,000	6
	20,000-30,000	2
	30,000-40,000	2
	40,000-50,000	3
	Above 50,000	2
	Total	**20**

Data Source: Primary Field Survey, 2066

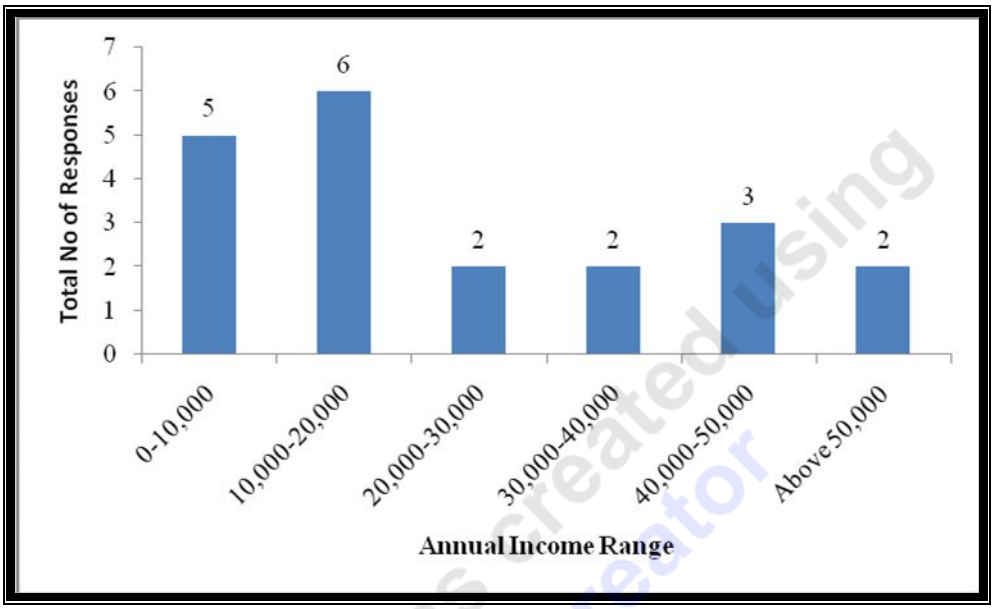

Figure: 4. 4 Annual Income range of surveyed households

In total 20 responses were collected about the annual income ranges in household survey. The source of income in the area, is largely varied from the ranges of the responses of the people whereas the ranges between 10,000-20.000 per annum lead the highest position with 6 no. of responses, the latest position of ranges between 20,000-30,000, 30,000-40,000 and above 50,000, per annum with 2 responses of individually each, 40,000-50,000 of 3 responses and 0-10,000 of 5 no. of responses.

4.2.4 Family's Main Sources of Income:

Table: 4. 11 Main sources of income

Main Sources of Income	Total Number of Responses
Agriculture	15
Animal Husbandry	11
Trade/Business	7
Job Holder	4
Others	9

Data Source: Primary Field Survey, 2066

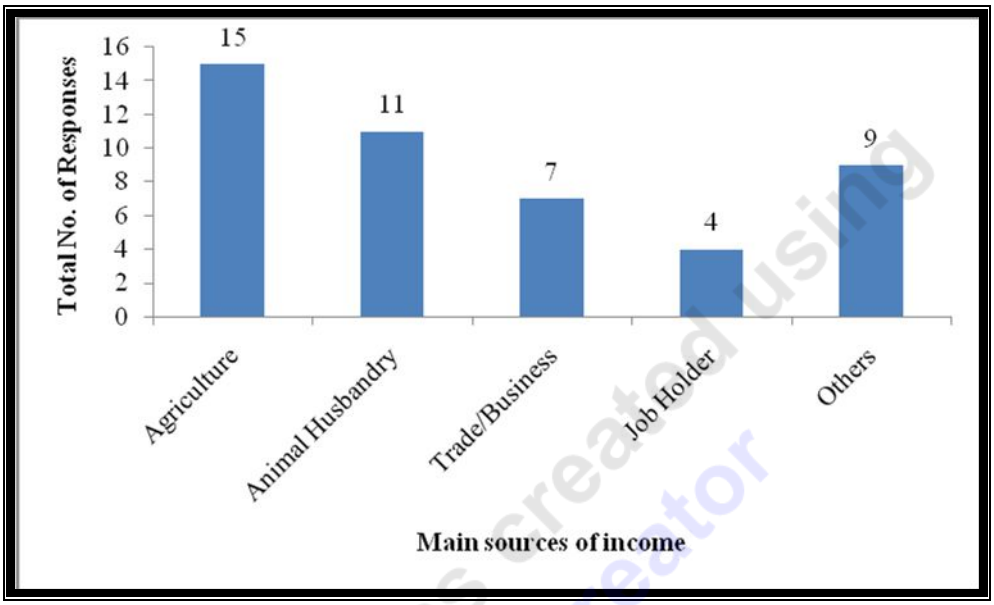

Figure: 4. 5 Main Income Sources of Family

The household income constitutes agriculture, salary or wage earnings, business, rent earning from land, remittance and combination of these means. The response was largely varied by sources of income. The higher responses was found for the agriculture (15) followed by animal husbandry (11), others (9), trade/business (7), job holder (4) among the total no. of 36 responses. Therefore the analysis shows that the agriculture is the pre-dominated or the main source of income in the study area.

4.3 Information about *Jatropha*:

To collect various information regarding with *Jatropha* farming (Bio-fuels) at Chandreshwor and Duradanda VDCs of Lamjung district, some questionnaire were asked with respondents there.

4.3.1 Source of Information about *Jatropha*:

Access to information is the first step towards positive and progressive change in the attitude. Radio, TV programs and audio, video, cassette players are modern and the fastest mode of information, which has been found inducted in the rural community extensively.

Table: 4. 12 Sources of information

Source of Information	Total Number of Responses
AEPC	2
Radio/Television	6
Local NGOs/CBOs	7
Newspaper	3
Others	4
I don't Know	5

Data Source: Primary Field Survey, 2066

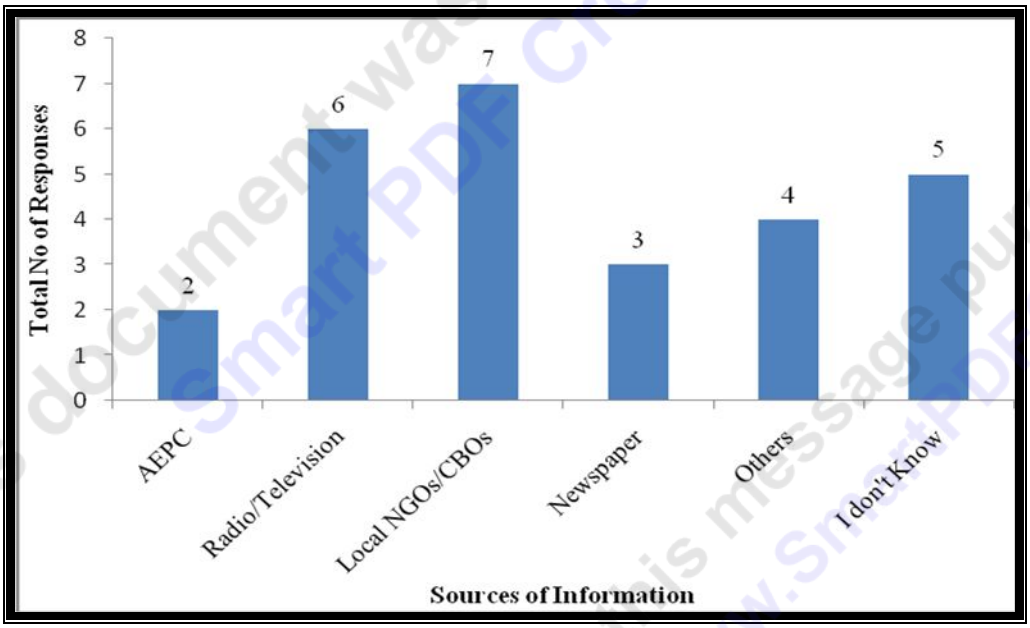

Figure: 4. 6 Source of Information

The total 27 responses were collected for the sources of information about Jatropha. The analysis is carried out by the figure 4.6. The local NGOs/CBOs leads on top ranking about 7 responses, radio/television by 6 responses which is two times greater than that of newspaper by 3 responses, three times greater than that of AEPC by 2 responses. Similarly, 4 responses were found that they have known it by other sources and 5 responses were unknown about *Jatropha*.

4.3.2 Awareness Level:

Table: 4. 13 Level of awareness

Level of Awareness	Total Number of Responses
Excellent	1
Fully Satisfactory	5
Almost Satisfactory	4
Poor	3
I don't know	7

Data Source: Primary Field Survey, 2066

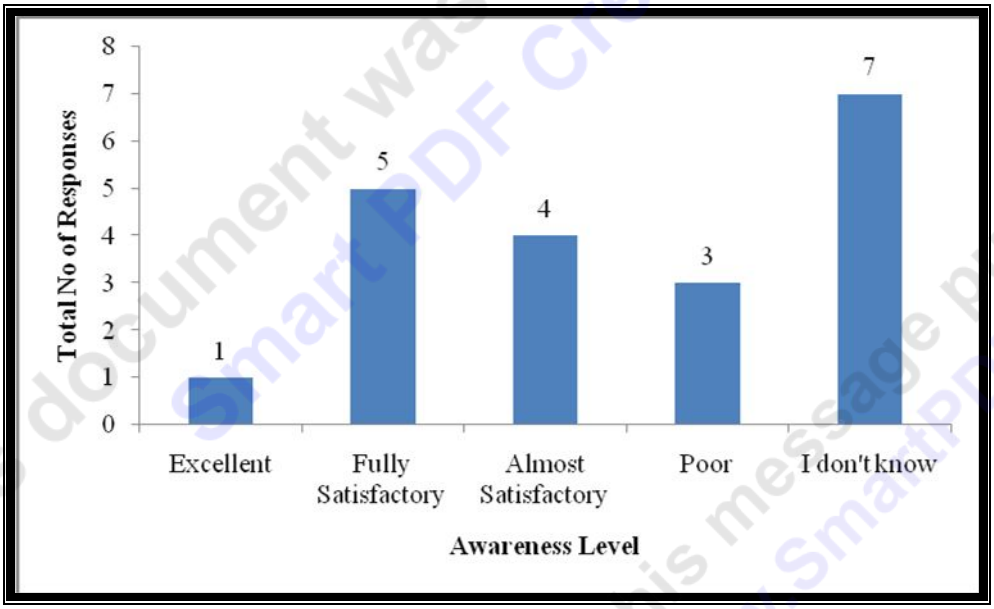

Figure: 4. 7 Level of Awareness

Figure 4.7 display the total no. of responses for the awareness level in the study area. The responses were largely varied and the higher responses were found for the unknown (7), followed by fully satisfactory (5), almost satisfactory (4), poor (3), excellent (1) and shows that the unknown level of awareness have the higher rank with comparison to the excellent level of awareness as lower rank for the promotion of *Jatropha* farming in the study area for the promotion of bio-fuel.

4.3.4 Basic Requirements at Local Level:

Table: 4. 14 Pre-conditions to promote *Jatropha*

S.N.	Pre-conditions to promote *Jatropha*	Total Number of Responses
1.	Skillful Human Resources	7
2.	Technical Trainings	8
3.	Awareness	17
4.	Working Capital Assistance	13
5.	Financial Institutions	9
6.	Co-ordination of National Level Line Agencies	4
7.	Promotion of Required Materials	11

Data Source: Primary Field Survey, 2066

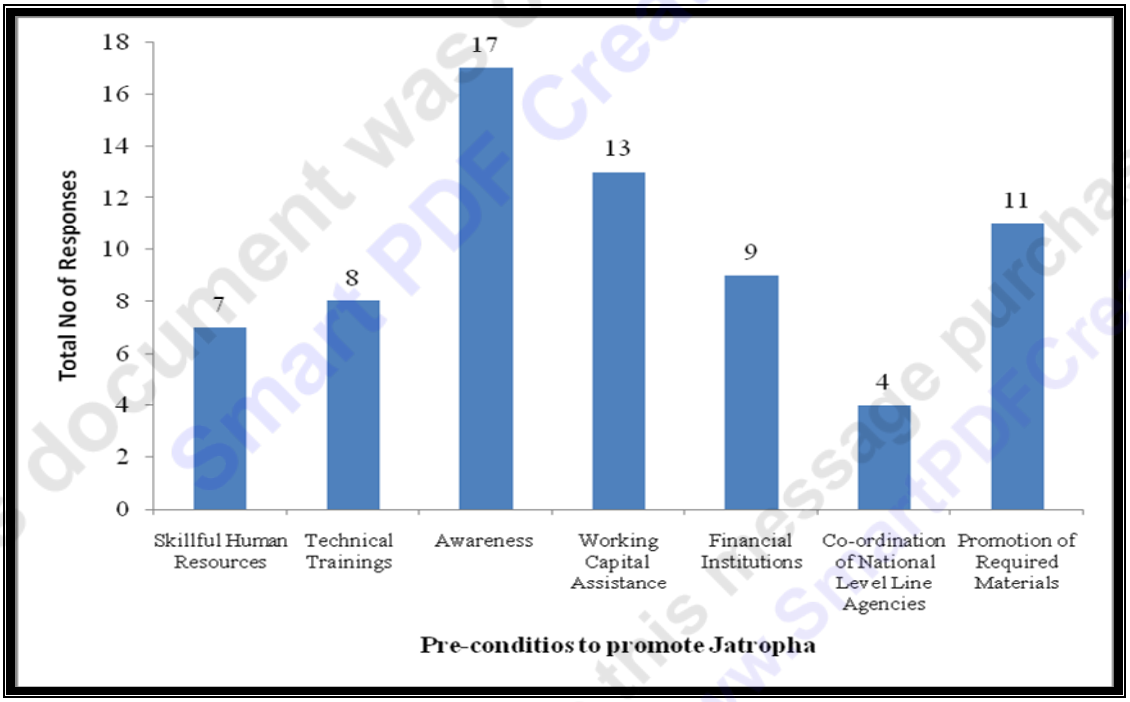

Figure: 4. 8 Necessary pre-conditions to promote *Jatropha*.

For the promotion of Jatropha in the study area, the required pre-condition were found awareness, working capital assistance, promotion of required material, financial institution, technical training, skillful human resource and co-ordination of National level line agencies. Most of the respondents mentioned that working capital assistance is the primary factor to establish Jatropha nursery, then after only they can go for marketing. Some financial institutions are necessary to invest in rural areas of Nepal. Side by side proper and efficient management of established nursery plants and then the technical trainings is also necessary.

4.3.5 Major Problems in *Jatropha* Farming:

Table: 4. 15 Major problems in *Jatropha* farming

Major Problems	Total Number of Responses
Technical	8
Financial	12
Social	6
Managerial	5
Others	3

Data Source: Primary Field Survey, 2066

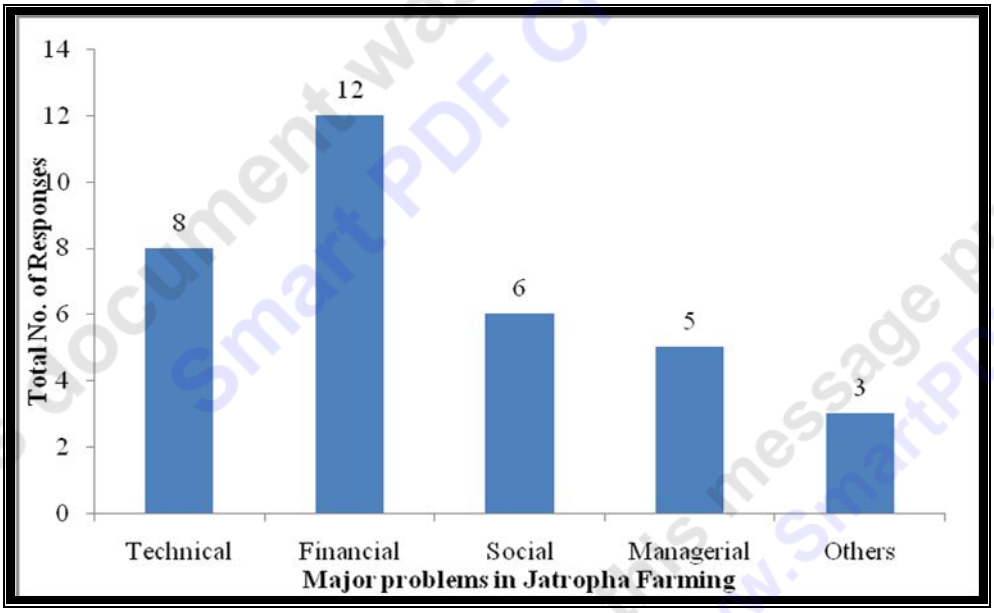

Figure: 4. 9 Major problems in *Jatropha* farming.

Major problems for the Jatropha farming system had been analyzed from figure 4.9. Financial problem had been the pre-dominated with the no. of responses 12 followed by technical 8, social 6, managerial 5 and other problems responses 3.

4.4 Gender Sensitization:

Table: 4. 16 Types of women participation

Types of Women Participation	Total Number of Responses
Strong Participation	2
Participation	3
Forceful Participation	12
Zero Participation	3
Others	4

Data Source: Primary Field Survey, 2066

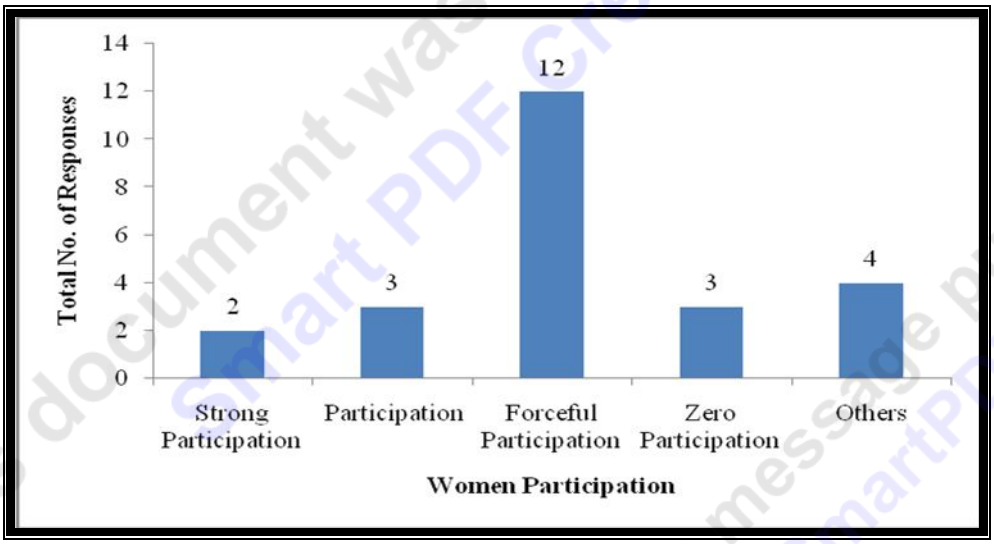

Figure: 4. 10 Status of Women Participation in RD

The status of women participation in Rural Development is plotted in the figure 4.10. It is clear that the forceful participation of women participation is the greatest that is 12 in no., and the strong participation is the least one that is 2 in no., participation and zero participation both are 2 in no., and other participation is 4 among the total no. of 24 responses for the project area.

4.5 Rural Setting and Environment:

Socio-economic characteristics is a key component to success development projects thus there is a need for better understanding the social consequences of projects, programs and policies. It is important to consider the social equity or distribution of both benefits and impacts in the rural society. Socio-economic and cultural environment plays vital role to bring both positive and

negative impacts in the development of Renewable Energy Technologies (RETs). Also construction and operation of development projects creates sometime conflicts in the rural society. The socio-economic status and cultural issues of proposed area were identified through available data from project sites.

The majority of people are mainly Dura and Brahmins in the case study area of Lamjung district. The public health and situation in the Chandreshwor and Duradanda VDCs found very good. There is good facility of modern toilets. Access of drinking water is also very easy. This community has a strong social capital base because of its rich Dura culture and strong sense of solidarity. Many people in the village have joined the army. However, socio-economic condition of local people at rural area is not good as compared with other people who are nearer to the urban areas.

The fair weather/seasonal agricultural road is being constructed. The constructed road has vital role to improve livelihood. It helps to bring positive impacts for the local people and their socio-economic conditions as well. The rural households were in scattered forms.

4.6 Geo-physical characteristics:

Nepal has the rugged mountain topography, complex and fragile nature of the geological structures, soft soil cover, and high intensity rainfall in the monsoon season and frequent earthquakes; the mountains are vulnerable to landslides, soil erosion and mass wasting phenomena. This country also comprises sloppy mountains, plains, gorges, hills, low lands, marshlands etc. The geological variation in landscape has directly influenced the availability of natural resources as well as the life style of people.

The development of infrastructures like the roads, irrigation, hydropower and other projects have the potential for imposing significant environmental costs if they are not properly designed and implemented. Development activities for the construction of roads, irrigation canals, dams, buildings in sloppy area without proper environmental assessment caused damages and loss of huge economic value and properties. The geo-physical characteristics of the location have also been analyzed to identify its suitability for *Jatropha* cultivation.

Slope instability and erosion:

Soil loss is probably Nepal's single most serious conservation problem. Loss of topsoil from cultivated land is a major concern in Chandreshwor and Duradanda VDCs of Lamjung district. Mass movements of slopes including rock failure, landslides, debris and slums cause large scale destruction in the hill ecological region. High intensity rainfall, deforestation and other anthropogenic factors are also responsible for slope instability and erosion. The soils encountered within the case study area are mainly; alluvial, colluvial and residual types. There are no serious type instability problems around studied area**.** The p^H of Soil was found 6-9(data source: Agriculture Extension Office, Duradanda) and which is very suitable for *Jatropha* cultivation.

Hydrology:

There are no major water sources like rivers and lakes near to the case study area. There is no risk from any sources of water. However, during rainy season high intensity rainfall may act as an agent for erosion. There is no any flood prone area around the studied VDCs of Lamjung district. The required rainfall 300-1000mm or above is available there. Thus it seems promotion and cultivation of *Jatropha* as a bio-diesel plant in that location is acceptable.

Biological resources:

Nepal presents a great diversity of flora and fauna. These biological resources are to be considered as important factors for the development. Community participation through demand driven development programs are to be implemented for biodiversity conservation and their proper utilization. The main vegetation found in case study area are; Salla (*schima wallichi*),Chilaune, Badahar, Kalo bans (*Dendrocalamus hookeri*), Thakal *(Phoenix humilis),* Khar *(Cymbopogon microtheca)* and others. Forests are sources of firewood, fodder, timber etc. Local people of both studied VDCs have been participated for the conservation, management and sustainable use of forest resources. The possible adverse impacts on species diversity of local wildlife population are negligible due to cultivation of *Jatropha*.

CHAPTER-FIVE

5. DATA ANALYSIS AND INTERPRETATION:

The purpose of this chapter is to analyze the livelihood impact for the small-scale farmers producing and further use of the Jatropha seeds. In the following (section 5.1) an introduction to the Jatropha tree will be given. Subsequently, the case study of Lamjung district and the characteristics of the *Jatropha* tree will be reviewed in relation to the rural livelihood in order to analyze the possible impacts, positive as well as negative, on the livelihood of rural small-scale farmers.

5.1 General Description:

Jatropha curcas L. (*Jatropha*) is a small tree/shrub receiving heightened attention due to its specific characteristics of being drought resistant and able to grow on marginal lands. Jatropha (Sajiban, Neem or Kadam) can be grown in arid and semiarid areas in the tropic and sub-tropics. Even though Jatropha has its natural dissemination in the north-eastern part of South America, it is now found abundantly in many tropical and sub-tropical regions throughout Africa and Asia.

The oil-containing fruits can be used as oil-based bio-fuel, which can be used in old diesel-motors, directly in a rural energy production (without grid connection), modified generators which either can be connected or to the grid or used for oil lamps. Jatropha oil for lighting can be adapted in simple oil lamps.

Furthermore, the residues from pressing the oil (seed-cake) can be used as fertilizer, due to the nitrogen content, and for biogas production (FACT, 2006). Several reports on Jatropha bio-fuel production point out, that the ability of using the residues as fertilizer is one of the major benefits of Jatropha production.

Jatropha is known to be resistant to periods of stress (cold weather, drought and low radiation) partly due to its ability to relocate its nutrients in its stem and root system. This ability to survive in stressed environments has led to the assumption that it is a good crop for marginal lands, but survival in these conditions does not imply that it can yield high or sustainable quantities of oil, especially considering that its main survival mechanism under conditions of stress is to relocate its resources away from the leaves, flowers and fruits/seeds. The productivity and profitability of

the plant therefore depends on the agro-climatic conditions of the area where it is cultivated. In order to get a good quantity of high quality seeds, Jatropha must be grown in fertile land or with additional nutrition, must be grown in areas with high rainfall or irrigated, and requires efficient pest control implementation.

The fruits are approximately 40 mm long, and each fruit contains three seeds. It takes about 1.300 seeds to get one kg of oil, and the seeds contain more than 30% oil by weight (FACT, 2006:8). The energy value in one tonne of Jatropha fruit yield gives about 270 kg of oil, with a lower heating value of 39.5 MJ/kg4 (Reinhart *et.al*, 2007:8).

The fruits of the tree consist of different parts – husks, seeds, shells and the oil containing kernels (see below). Different components of the physic nut (Jatropha curcas L.): a – flowering branch, b – bark, c – leaf veins, d – pistilliate (male) flower, e – staminate (female) flower, f – cross-cut of immature fruit, g – fruits, h – longitudinal cut of fruit (Jongschaap*et.al*, 2007:intro)

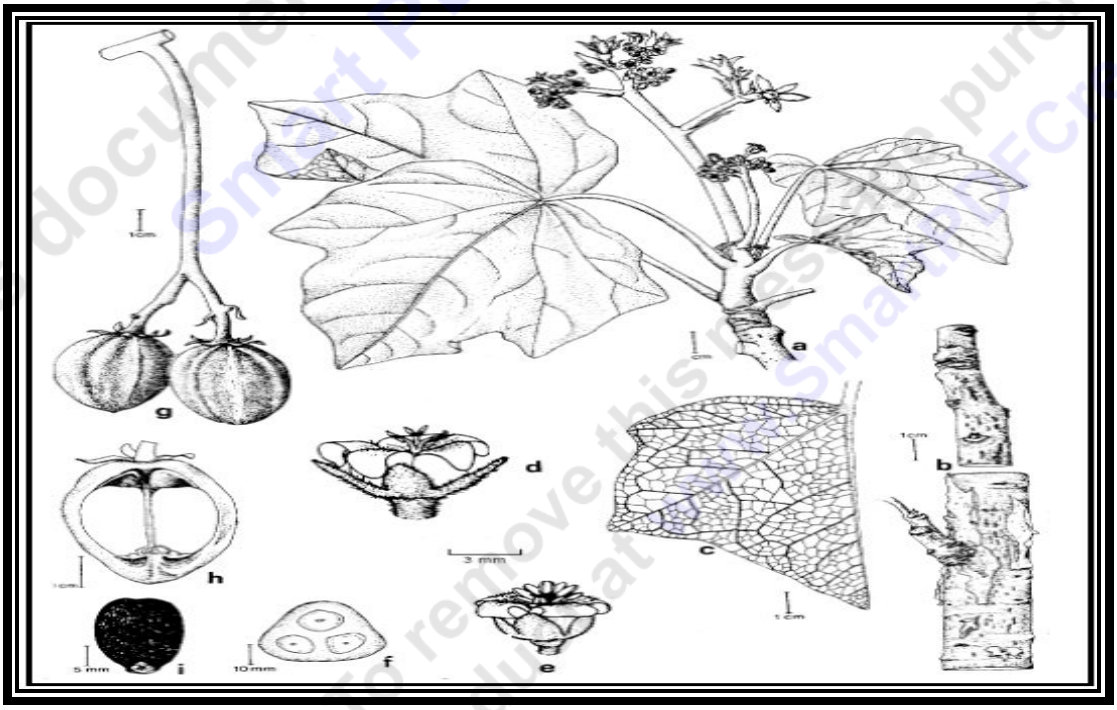

Figure: 5. 1 Different components of *Jatropha* (Source: www.jatrophaworld.org)

Classification:

Class: *Rosidae*

Order: *Malpighiales*

Family: *Euphorbiaceae*

Sub-Family: *Crotonoideae*

Tribus: *Jatropheae*

Genus: *Jatropha*

Species: *Jatropha curcas L*

External factors such as rainfall, temperatures, soil nutrients and the agricultural practices under which Jatropha is grown determine the yield. A plantation of Jatropha normally consists of 1,000 trees per ha with 3x3 meters spacing. Even though the yield varies a lot (from 0.3 kg to 12 kg per tree) (Freim, 2008:45), studies on Jatropha account an average yield of 6 kg/year per tree (Freim, 2008:45, GTZ Jatropha Manual, www.jatrophaworld.org).

As the Jatropha tree has not been harvested yet, there are variations of how many fruits each tree produces. By using cuttings from productive trees, the production could be secured as the new tree will have the same genetic structure as the old one and would produce about the same amount of fruits. The disadvantage of this cultivation method is that the root system will not be as developed as when grown from seeds or seedlings, and the trees will have a shorter productive life period.

The yield of the tree also depends on how many branches the tree has, as the inflorescence only develops at the end of a branch. Consequently it is important to prune the tree in order to get as many branches as possible. When the branch is cut back, three to five new shots of branches will be developed. (Rijssenbeek *et. al*., 2007:5) Furthermore, pruning is essential for the possibility of intercropping the Jatropha with food crops after the first three to four years.

5.2 Challenges in Integrating Energy and Rural Development:

Attempts to promote rural development to eradicate poverty must include efforts to ensure energy supply in rural area, not an end in itself but as an integral component. Ensuring basic human needs lies at the core of the rural development concerns, and energy services to rural people should be one of the central objectives. Following are the major challenges in Nepal to integrate energy and rural development.

• Overcoming lack of scale and difficulty of access

The small scale and wide geographical spread of rural settlements pose particular problems for meeting their development needs.

• Satisfying basic and productive energy needs

The high incidence of rural poverty and low-income levels of the rural people mean that satisfying basic energy needs is much more critical in the rural context.

• Meeting energy needs of the poor

The real challenge in meeting the energy needs of the rural poor is, of course, to remove or mitigate the conditions that perpetuate poverty.

• Developing energy self-reliance

There are limits beyond which self-sufficiency cannot be pursued; economic development can strengthen rural self-reliance by providing the means to access different energy options.

• Managing rural energy transitions

Modernizing rural energy supplies means a higher degree of monetization of rural energy markets and of rural economies as a whole.

• Enhancing energy technology absorption capabilities

Rural energy users are required to not only adopt sophisticated technologies, but to also learn to operate, maintain and utilize them effectively. Equipping them to accept such multiplicity of roles is a major aspect of rural energy development.

• Ensuring the sustainability of biomass energy sources

This call for a close understanding of the interrelationship between biomass production processes and end-use activities, both for energy and non-energy applications, also, more importantly, land use changes.

Box 1: *Jatropha* Farming and Nepal

 Shree Prasad Adhikary, a social worker and researcher preaches the benefits of *Jatropha* to the villagers and anyone he meets on the way. He is dedicated to introduce bio-fuels in Nepal. "Almost three liters of bio-fuel can be extracted from 10 Kgs of Jatropha seeds," he says. "The by-product can be used as fertilizer or insecticide."

Thanks to the *Jatropha* researchers - petty farmers are gearing up for *Jatropha* cultivation albeit in scattered small plots of land. The local names of Jatropha vary with the geography, namely Baghandi, Sajiwan and Kadam. Jatropha grows in all climates including arid, semi-arid, and tropical. "*Jatropha* grows well in wastelands and requires very little water," says Shree Prasad.
Its ability to grow in all conditions has given it another name, 'Saruwa', meaning 'able to grow and take roots'. The word has spread among the community forest users and they are willing to plant Jatropha saplings and branches (the cuttings take roots easily) in the community forests.

5.3 Threat of monoculture and deforestation:

The community forests which are the living examples of community conserving forests and reaping benefits have been the alternative source of income for the users. Now if the users start planting Jatropha everywhere in these forests, the chances of creating a monoculture are high.
Even the farmers will be lured to cultivate the better paying and much easily grown Jatropha which is not eaten by even cattle and goats. And can you imagine huge landscapes bearing just Jatropha? The obnoxious smell will waft around instead of sweet aroma of rice and wheat. All insects and birds that form the ecosystem will face a jolt with the seismic shift in cultivation. By the time the scientists come up with bio-fuels extracted from grass, straw or wood, the damage will have been done.

Box 2: Siyaram Nursery at Thimi

The newly planted branch cuttings of *Jatropha* have taken roots in Siyaram Nursery at Thimi and the proud owner says, "Promoting bio-fuel will be my main concern in the coming days." He says he is ready to shift to bio-fuel production from his business of machinery imports.

As he wakes up early in the morning, Tej Narayan Yadav is quite happy to see his Jatropha saplings growing every day. He goes round the nursery inspecting each plant with eagerness. At his office in Gopal Charity Trust, he has displayed a line of mineral water bottles filled with yellow liquid and black cakes packed in plastic packets. He proudly explains the varying color of Jatropha oil in the bottles - the refined ones are paler than the ones directly milled in the local mills. The glycerin in small bottles and the black cakes are the by-products. The black cakes can be used as a fertilizer or insecticide. Tej Narayan is optimistic in his mission and he is ready to support any newcomer who wants to cultivate Jatropha.

5.4 The controversy and the future:

Around the globe bio-fuels 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 richer 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. Seeing the overall benefits of Jatropha, the two major emerging economies India and China have resorted to Jatropha cultivation to meet the demands of the hungry economies. By 2010, China plans to plant an area the size of England, or 13 million hectares, with trees from which bio-fuel can be extracted as a source of clean energy, Jatropha being considered as the main ingredient in the production of biodiesel. DaimlerChrysler has joined with experts from Germany and India in a five-year project to explore whether the Jatropha plant is suitable for cultivation and if its oils could be used as a resource for biodiesel production.(Source: www.jatrophaworld.org)

5.5 Community Based Jatropha Farming for Rural Economic Growth in Nepal

Biodiesel, an emerging renewable source of energy, has not been promoted adequately in Nepal despite its potential. Being agriculture dominated economy; agro based fuel such as biodiesel can be promoted as a sustainable and affordable source of rural energy in Nepal. Community based motivation to use the Jatropha seeds growing in the community waste lands and as hedges in the private lands to produce biodiesel locally and use it for rural applications mainly for operating diesel engines. This community based modality will support such households to locally produce Jatropha biodiesel. Community based approach would be more applicable in farming Jatropha seeds, utilizing biodiesel plant and clean energy appliances. This is believed to lower the cost for the imported petroleum fuels and ensure a sustainable source of fuel. The economic growth of such households will result through savings on energy consumption, increase in crop yield and savings on fertilizer (as oil cake will replace the chemical fertilizer). The promotion of Jatropha cultivation will also support in financing technologies, building local capacity, raising awareness, etc. Works were also carried out in both Duradanda and Chandreshwor VDCs to build inventory of other potential areas where this pilot initiative can be replicated. It seems necessary to build partnerships with AEPC and other stakeholders to up-scale this initiative in future.

The bio-fuel was the only alternative to Nepal at a time when it was passing through problems like energy crisis, high pollution and global warming. Nepal government had given special priority to the alternative energy sector.

Finally, why Lamjung district?

Development of commercial bio-fuel has a great potential in Nepal. This can reduce dependency on imported petroleum products from abroad. 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 other production is not possible but for the better yield following factors are important which are suitable in Lamjung district of Nepal.

Climate:

Lamjung district and the study area has tropical and subtropical climate which is favorable climatic condition for *Jatropha* cultivation.

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 good for better yield.

Elevation of land:

Most of the lands in Lamjung districts are extended between 500m to 3000m altitude. The altitude is favorable for Jatropha growth.

Availability of technical manpower and farm labor:

There are numbers of graduates from Agriculture, Forestry, Environment and Rural Development from different Universities. There are sufficient numbers of labor and women who can be hired as farm labor. It will increase women empowerment and livelihood of people of those areas.

Market:

Nepal imports more than 80% of fuel so there will be a huge market for bio-diesel in Nepal.

Box 3: Create green jobs to improve the livelihood of the poor section of the Nepali society

Mr. Shyam Mohan Shrestha adds that the Future Energy International (FEI) is an outcome of two experienced companies from Republic of Korea- Ecosian Co. Ltd, and Nepal- S.R. Enterprises P. Ltd, venturing for the establishment of this pan-oplie natural resource that contributes on the one hand economy of the country and on the other, a reduction measures to the environmental degradation of the mother earth today. "What is primarily important is that the Carbon-dioxide emission from Jatropha extracted Diesel is half of the same emitted by fossil fuel", says Mr. Shrestha. "Keeping the environment free from pollutants too has been taken into proper account. We plan to invest, attract investors and technical support with worldwide connections in order to make this industry a success story of the country even prior to big hydro power projects in the country become operational", said Mr. Shrestha talking to the telegraphnepal.com scribe in the sidelines of a seminar organized to discuss **Jatropha** development in Nepal, April 9, 2009, at Hotel Annapurna.

He says that over 500 thousands hectares of unused/waste land in Nepal could well be used for **Jatropha seed** cultivation that can produce bio-diesel and reduce dependency on imported petro-products. "**Jatropha** development in Nepal can change the geographic and economic scenario of the entire country in days and years to come".

According to Mr. Shrestha, the objective is to "create green jobs to improve the livelihood of the poor section of the Nepali society".

5.5.1 Capacity building:

Capacity building is a key feature to implement Jatropha project at Lamjung district. Since use of Jatropha as a source of energy is relatively new in Nepal, a series of awareness workshops should be organized for the target households on farming, storing, and using Jatropha oil and oilcake. Training should be provided on cultivation of Jatropha and production of bio-fuels. The training include instructions on how to use Jatropha oil cake (the residue left over after the oil has been squeezed out of the seeds) as fertilizer to increase agricultural production. Income generation training also should be provided to target households, presenting ways of using improved irrigation and bio-fertilizer to improve their vegetable production, and better ways of marketing of their products.

5.5.2 Community mobilization:

Currently, Paudikhola Jaladhar Kshyetra has developed a community mobilization strategy to prepare the selected households for implementation of Jatropha nursery. The households are grouped into community groups. On average each group includes 5 households. Awareness programmes are organized for these groups on Jatropha seeds, and on production and energy-related issues. One coordination committee is formed for 20 households. The coordination committees manage all activities related to Jatropha seed collection, farming, harvesting and finally distribution/marketing of oil seeds to the business companies.

5.5.3 Environmental conservation and emission reductions:

The rural community at Chandreshwor/Duradanda aims to replace fossil fuel (diesel) with bio-fuel (Jatropha oil) to improve their economic condition as far as possible. This will allow significant reductions in environmentally harmful emissions, particularly of greenhouse gases.

Accordingly, In addition, use of Jatropha oil cake as fertilizer will replace applications of chemical fertilizers. This will reduce harmful emissions resulting from the production, transportation and use of chemical fertilizer. Some chemical fertilizers contain internationally-regulated persistent organic pollutants (POPs), which can cause soil and water contamination, and risks to the health of people and animals. Using the leftover Jatropha oil cake as fertilizer is also expected to save costs and increase agricultural production, and hence income for the targeted households. If Jatropha oil cake can also be used to produce biogas, methane emissions will also be reduced, and using biogas for cooking can result in reduced use of forest wood.

5.5.4 Awareness Raising Program on *Jatropha*:

The activity related with awareness raising program at study area were found as follows;

- Jatropha seed collection and establishment of Jatropha nursery there.
- Rural household's ability to achieve some degree of energy self sufficiency that will yield higher income as far as possible.

5.5.5 Technical training for income generation to the rural households:

The activity has been focused on the promotion of income generation activities within farming communities. Based on a need of accessible market and local absorptive capacity this activity,

there is urgent need to organize training programs on vegetable production, micro irrigation technology, enterprises development, business plan development, marketing and skill development.

5.6 Linkage establishment between Farmer groups, PAF and micro financing institutions (MFIs):

Micro financing support to the rural households is important in Jatropha cultivation to help procure seeds, fertilizers and others. There is no active interaction program between local farmers, entrepreneurs and MFIs representative. The activities and the results of the Jatropha farming, there is no wider dissemination to government agencies, NGOs and bilateral and multilateral partners. The baseline survey and coordination with partner organizations helps to arrange a workshop for interaction dissemination and stakeholders. The interaction and the impact assessment have been helping in institutionalize the Jatropha oil based bio-fuel promotion program within the government and donor programs. It should help to provide supportive role for expansion of such activities as well as policy formulation in Nepal.

CHAPTER-SIX

6. GENERAL FINDINGS:

6.1 Trans-esterification Process:

Trans-esterification stage in which raw oil is trans-esterified to bio-diesel, which is methyl or ethyl ester based on whether methanol or ethanol is used in the production process. The capacity of the trans-esterification plant is dependent on the amount of raw oil that has to be trans-esterified into bio-diesel. The capital cost of the trans-esterification plant depends on its capacity

The molecular weight of Jatropha curcus oil with major chemical constituents was determined as 870 [Ramesh, 2004]. Since the oil also contains other minor constituents, the approximate molecular weight of Jatropha curcus oil was taken as 900.As per the trans-esterification reaction, 3 moles of methanol were required to react with 1 mole of vegetable oil [Kavitha, 2003]. The molecular weight of methanol is 32 and hence 96 g of methanol were required for the trans-esterification of 1 mole (or 900 g) of Jatropha curcus oil, which amounted to 10.67 % methanol. The optimum concentration of methanol required for effective trans-esterification of Jatropha oil was 20 % the optimum concentration.

Lurgi's process of trans-esterification is used most widely in the world. The process involves intensive mixing of methanol with the oil in presence of a catalyst and then separation of lighter methyl ester phase by gravity from the heavier glycerol. The process flow chart for production of biodiesel is illustrated in Figure below.

Oil, methanol and sodium methylate catalyst are mixed in the reactor and allowed to separate into two phases. The lighter methyl ester/oil phase is mixed with additional methanol and catalyst in the reactor (R-II) followed by gravity separation. This second reactor stage maximizes the biodiesel yield and quality. The lighter phase is washed with water to remove residual glycerol or methanol dissolved in the ester phase, followed by vacuum drying to yield biodiesel. The denser glycerol phase from R-II containing excess methanol and catalyst is recycled to the front end of R-I. The denser glycerol phase leaving R-I still containing excess methanol is distilled for its recovery in the Methanol Recovery Column and sent back to R-I. The wash water from the Water Wash Column is used in the Methanol Recovery Column. Thus the entire

methanol is consumed in the production of methyl ester. The heavier fraction from the Methanol Recovery Column is processed in the Glycerin Water Evaporation Column to recover crude glycerin (conc. 80-85%) as a byproduct. This can be further upgraded to pharmaceutical glycerin by distillation, bleaching, if required, and vacuum drying[11].

Almost all the biodiesel is produced using the base catalyzed trans-esterification process as it is the most economical one requiring only low temperatures & pressures with 98% yield.

6.1.1 Processing of Oil:

The quality of feed vegetable oil particularly FFA content plays an important role in identifying the suitable technology. The important factors to be considered for a biodiesel production plant include:

- Process ability of variety of vegetable oils without or minimum modifications
- Process ability of high free fatty acid (FFA) containing oils/feed-stocks
- Must be able to process raw both expelled and refined oil
- Process should be environment friendly with almost zero effluent

The selection of appropriate technology for production of biodiesel calls for careful selection of processing steps, catalyst and downstream process integration.

[11] Source: Alternative Energy Promotion Center, Bio-fuels Report 2008.

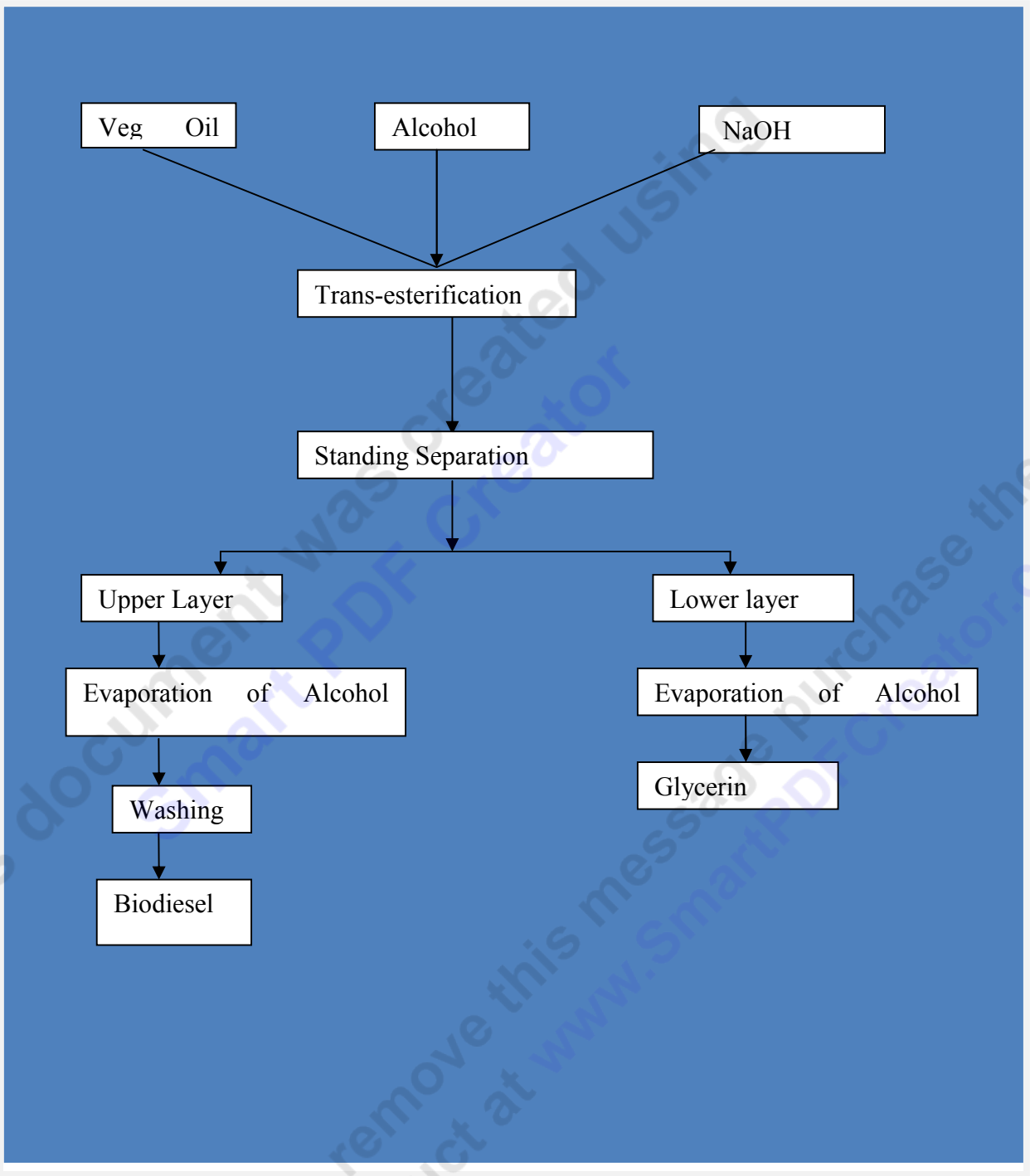

Figure: 6. 1 Process of biodiesel and glycerin separation from the Jatropha oil (Source: adopted from AEPC, Report 2008)

6.1.2 Biodiesel production process:

The processing steps for the most commonly used method viz. base catalyzed trans-esterification would be as follows:

The Steps below is a very much summarized general guideline. Many tips and tricks and safety recommendations have been left out for the sake of compactness. It is good to read more about this before starting. If we would like to use used cooking oil, ethanol or another catalyst instead, many Internet sites can help us adapt the recipe. Please notice that the methanol and lye involved are quite dangerous chemicals. We must know what we are doing, work in a well ventilated area and wear protective clothes and glasses!

The following resources are required (all quantities are expressed per liter of Jatropha Oil:

1liter of J Oil; 5 grams of lye (caustic soda; NaOH; (> 95%) or KOH (> 85%)); at least 220 ml of methanol (> 99%)

First dissolve the lye into the methanol. Shake or swirl until all the lye has dissolved. This may take 10 minutes. It is normal that temperature rises. This mixture is called sodium methoxide. Now make sure the Jatropha Oil is in a vessel large enough (at least 150% of its volume), preferably with a valve at the bottom, and heat it to about 60 °C, then stop heating. Then add the methoxide mixture and make sure it is mixed well for at least 10 minutes. Leave the vessel and let the different constituents separate by sedimentation

The glycerin will settle out at the bottom. After 8 to 24 hours the sedimentation is complete and the glycerin can be drained off. What remains is raw biodiesel. If the reaction went well and the biodiesel is clear, it may be used straight, although its quality may be inferior because of impurities. Water washing will remove most of these impurities.

Trans-esterification, also called alcoholysis, is the displacement of alcohol from an ester by another alcohol in a process similar to hydrolysis. Methanol is most commonly used for the purpose since it is the cheapest alcohol available. Using higher molecular weight alcohols

improves the cold flow properties of biodiesel but reduces the efficiency of trans-esterification process.

Methods commonly used for producing biodiesel are batch and continuous processes. In general, smaller capacity plants and variable feedstock quality warrant use of batch systems. Continuous systems generally lead the operation on a 24x7 basis, requiring larger capacities to justify larger staffing needs and also requiring uniform feedstock quality. The trans-esterification works well when the input oil is of high quality. However, quite often low quality oils are used as raw materials for bio-diesel preparation. In cases where FFA content of the oil is above 1%, difficulties arise due to the formation of soap, which promotes emulsification during the water washing stage. If the FFA content is above 2%, the process becomes unworkable. (Source: www.jatrophaworld.com)

The factors affecting the trans-esterification process are;

- Oil temperature
- Reaction temperature
- Ratio of alcohol to oil
- Catalyst type & concentration
- Intensity of mixing
- Purity of reactants

Table: 6. 1 The approx. process constituents are listed here under

***Jatropha* oil**	**Alcohol**	**Catalyst (Sodium or Potassium Hydroxide)**	**Glycerin**	**Biodiesel**
100 kg	12kg	1kg	11kg	95 kg

Trans-esterification process (Source: www.jatrophaworld.com)

6.2 Biodiesel: Physical Characteristics:

Table: 6. 2 Physical characteristics of Jatropha fuel

Properties	**Values**
Specific gravity	0.87 to 0.89

Kinematic viscosity@ 40°C	3.7 to 5.8
Cetane number	46 to 70
Higher heating value (Btu/lb)	16,928 - 17,996
Lower heating value (Btu/lb)	15,700 - 16,735
Sulphur wt %	0.00 - 0.0024
Cloud point °C	-11 to 16
Pour point °C	-15 to 13
Iodine number	60 - 135

Source: AEPC Report, 2008.

Table: 6. 3 Methods of *Jatropha* cultivation

Propagation Methods
Generative Propagation
Direct seeding
Transplantation of pre-cultivated plants Seeds beds(bare roots) Poly bags
Vegetative Propagation (cuttings)
Direct planting
Transplanting of pre-cultivated plants Seeds beds(bare roots) Poly bags

Source: AEPC, 2008.

6.3 Plantation and Production Potential of *Jatropha* in Lamjung:

A number of studies have been carried out in Nepal to overview potentiality of Jatropha Curcas in Nepal. It can be found that about 30 percent (4.41 million ha) of Nepal's total land (14.7 million ha) is climatically favorable for the cultivation of *Jatropha*. Even if only 10 percent (0.441 million ha) of the climatically favorable area is used for Sajiban cultivation, 1.1 million tons of biodiesel can be produced annually with the yield assumption of 10 tons/ha and 25% oil content) - almost twice amount of total petroleum fuel (i.e. 0.67 million kiloliters) imported into

country in 2004/05. Similarly, with the yield assumption of 5 ton/ha and cultivation in 6% of wasteland (0.2645 million ha), produced bio-oil is sufficient to meet present level of diesel demand (Sharma. et.al. 2006).

In the same context during the preparation of this report, the researcher has carried out an analysis on the potential land to cultivate Jatropha in different scenarios of Lamjung district in western Nepal. A detailed analysis of available uncultivated land and hills has been carried out to estimate the plantation area, production of seeds and oil. Some of the assumptions and basic parameters adopted during the analysis are as follows;

- Plant Spacing: 2 m X 2 m
- Plant Density: 2500 plants/ha
- Yield Rate: 2 kg/tree
- Survival Rate: 80 %
- Jatropha Seeds Collection Loss: 20%
- Oil Content: 30 %

Cultivating Jatropha Plant in 100% of the uncultivable areas, in this scenario about 16588 ha of uncultivated land areas of hills belt of Lamjung district has been considered as a potential land favorable for Jatropha cultivation.

6.4 Initiation of Nepal towards Bio-Diesel Production:

It has been found that a number of demonstrations on Jatropha cultivation and use of Jatropha oil have been made in different parts of the country, which are successful to some extent, for increasing awareness on the potentiality of Jatropha Curcas as an Alternate Source of Renewable fuel. Alternative Energy Promotion Centre (AEPC), the government body, which have been involved in the promotion of alternative energy technologies in the country, realizing the bio-fuel technology as one of the possible backbone to enhance local development, has started to execute pilot projects. AEPC has been found selecting a number of entrepreneurs, researchers to carry out different activities like cultivation training to farmers, nursery establishment training, and pilot project to operate diesel engine based end-uses and pilot project for processing of Jatropha oil (trans-esterification). Likewise, Winrock International, Nepal (an international NGO) is also working in carrying out a pilot project activities for operating irrigation pumps. Likewise,

Netherlands Development Organization Nepal (SNV) has also been found involved in carrying out Value chain analysis of Jatropha production in CDR. In addition to this, a series of academic researchers have been also made in the country. Similarly, individual farmers, entrepreneurs, business man can be also found starting the business of Jatropha seeds, initiating the establishment of nursery for raising Jatropha seedlings, cultivating in different parts of the country. (**Source**: Alternative Energy Promotion Centre, 2009)

6.5 Economic Perspective for *Jatropha* Cultivation:

The primary challenge to the long-term success of the project is maintaining a sustainable supply of Jatropha seeds and plants. The project currently depends on use of existing wild and hedge-grown Jatropha plants to supply seeds. However, after the successful demonstration, it is expected that demand for Jatropha oil will grow and there will be a need for new plantations to ensure a sustainable supply of seeds.

One solution to meet future demand growth without jumping into mass commercial plantations is to encourage every household to plant 100 to 150 Jatropha plants in their private waste lands or the comparatively poorest sections of their land or fields. This could be on the border of the fields or on a specific part of the field which is relatively poor. Communities can also decide to make use of public waste lands in the vicinity, with necessary approval from local authorities, for new Jatropha plantations and develop modalities for tending, collection, distribution and so on.

Jatropha cultivation in Nepal is a new concept however it can be made an integrated approach to create income and supply of bio-diesel for rural development. Its application is not only for bio-diesel production but it also can be used for manufacture of candles and soap, in the cosmetic industries, for cooking and lighting.

The promotion, dissemination and distribution of Jatropha plant in wastelands/marginal lands helps to reduce the poverty and provides opportunity for the rural development through up-liftment of pro-poor/ultra poor in rural areas. Bio-diesel is produced from the seed of *Jatropha* and can be mixed with kerosene and diesel to produce bio-fuels. Thus, *Jatropha* cultivation and production of bio-diesel significantly helps to reduce outgoing cash for the imported petroleum fuels in Nepal.

6.5.1 Cost and benefit for *Jatropha* Cultivation:

Table: 6. 4 Estimated Cost and Income Details for 1hactor

Year	Production/plant(kg)		Production/ hector (Kg)	Production cost (Rs.12/Kg)	Cost	Income
	Unirrigated land	Irrigated Land				
1st						-31,500
2nd					3,000	-3000
3rd	2	3	5,000-7,500	60,000-90,000	12,000	48,000-78,000
4th	2.5	3.5	6,250-8,750	75,000-1,05,000	12,000	63,000-93,000
5th	3	3.5	7,500-8,750	90,000-1,05,000	15,000	75,000-90,000
6th	3.5	4	8,750-10,000	1,05,000-1,20,000	15,000	90,000-1,05,000
7th	3.5	4	8,750-10,000	1,05,000-1,20,000	15,000	90,000-1,05,000

Source: Poudel, P (2008). *Nepal ma biodiesel Ko Kheti,* Sha, T.N. Poudel K.P. Publication, Kathmandu,

6.5.2 Costs and Returns from *Jatropha* Cultivation:

An estimated costs and returns from the *Jatropha* cultivation in Nepal is very difficult to analyze and its role in rural development. Both the cost and returns are obtained in different stages of plantation, growing, harvesting and the production/end uses of different aspects include both tangible and intangible forms. For any economic analysis of *Jatropha* cultivation following costs head is very essential here:

1. Cultivation of *Jatropha*

- Planting costs
- Establishment costs
- Tending costs
- Other costs (specify)

2. Wood

- Pruning
- Thinning
- Felling
- Firewood production
- Charcoal production
- Pole production
- Other products specify
- Storage costs of products
- Transport costs
- Other costs specify

3. Fruit

- Collection
- Removal of flesh
- Removal of shells
- Extraction of oil, (state method)
- Charcoal production from shells
- Storage of products (oil, cake, shells, flesh, etc.)
- Transport costs;
- Other costs (specify)

4. Capital & Labor costs

- Buildings
- Machinery and equipment
- Labor as per respective activity

Similarly several types of returns from the growing and use of the products from *Jatropha curcas* need to be carefully estimated. The bi-products obtained from *Jatropha curcas* can be sale in different market price as far as possible.

6.5.3 Expected Output from *Jatropha* Cultivation

The expected outputs from *Jatropha curcas* cultivation are as follows:

- It helps to create good understanding about bio-fuels and its role in rural development of Nepal.
- Cultivation of *Jatropha* will help to reduce energy crisis in Nepal and it also will minimize fuel dependency of Nepal.
- It helps to attract more investment in bio-fuels sector in future.
- Utilization of waste/marginal land and up-liftment of poor rural family.
- Environment protection and biodiversity conservation

Table: 6. 5 In case of cultivation in land we can get following pattern of production

Year	Kg per tree
1st year	3 kg/tree
2nd year	6kg/tree
3rd year	9kg/tree
4th year	10-12kg/tree
5th year	10-15kg/tree

Source: Bhattarai, K. R. (Jan, 2008); *Sajiwan bata biodiesel- Jatropha Bio-diesel*

Table: 6. 6 Financial Investment for *Jatropha*'s farming in Rs.

Topics	1st year	2nd year	3rd year	4th year	5th year
Land preparation	5000	-	-	-	-
Cost of plant	12,500	-	-	-	-
Fertilizer	4,000	2,000	2,000	2,000	-
Labour Charge (planting)	3,000	-	-	-	-
Cutting, Pruning	3,000	1,000	-	-	-
Other Expenses	4,000	-	-	-	-
Collection, Drying	-	-	10,000	10,000	15,000
Total	31,500	3,000	12,000	12,000	15,000

Source: Bhattarai, K. R. (Jan, 2008); *Sajiwan bata biodiesel- Jatropha Biodiesel*

6.6 Benefits From *Jatropha:*

a. Fencing (protection from cattle, reduced landslide, control grazing):

In addition, the authors of *Hope in Jatropha* further claim that "*Jatropha* naturally repels both animals and insects —it can be planted along the circumference of farms to protect other crops.

b. Fertilizer (by product oilcake being used as compost fertilizer):

Jatropha seedcakes, produced as a by-product of pressing the oil, make an excellent organic fertilizer or protein-rich livestock feed, and another by-product is glycerin.

- **Benefits to men and women**

The use of an agriculture-based fuel, the Jatropha promotional activities are easily adaptable to the rural lifestyle in Nepal. Using Jatropha seeds to produce oil and cake and applying these products to enhance agricultural output, is similar to the current use of mustard seeds. This may positively affect the involvement of women, as both men and women are equally knowledgeable on the process. Women engaged in vegetable farming will benefit directly from making use of the Jatropha oil cake as fertilizer and Jatropha oil to provide adequate irrigation. However, to ensure a better role for women in the use of Jatropha oil and cake, targeted technical and business training will be necessary to build the skills of women in preparing fertilizer from oil cake, using the oil cake and Jatropha oil irrigation pump to improve agriculture production, producing cash crops like vegetables, and marketing and selling these vegetable in the local markets.

As Jatropha oil is produced locally, with land and labor being the main inputs, the price and supply of the oil will be largely in control of the rural users and will be much less sensitive to the sorts of external factors pertinent to fossil fuels. If this project is successful in allowing the rural users to have almost total control over fuel supply and price, then it can be considered as a best practice in sustainable rural energy access.

Because this project is simple in terms of the nature of the fuel and technology used, and is similar to current agricultural activities performed by local men and women, the probability of

women's involvement in the process of fuel production, pricing and use is higher than in management of other more complex rural energy technologies.

- **Saving of firewood and kerosene:**

The use of bio-fuel replaces the imported petroleum products like kerosene, which has to be collected from the nearby market and is difficult to get regular. Use of bio-fuels reduces expenses required for purchasing kerosene and fuel wood.

- **Saving of Time and money:**

The use of bio-fuel in rural household where is no grid connection helps to save time required for collecting kerosene. It is also effective for money saving and other income generation activities.

- **Environmental Benefits:**

The introduction of Jatropha cultivation in Lamjung is a new concept and it has significantly contributed to minimize the environmental pollution in local level. The indoor and outdoor air pollution is one of the major causes of different long term diseases in the rural areas. The promotion of bio-fuels will contribute to reduce both indoor and outdoor air pollution and support for the sustainable use of the available potentially renewable resources.

The most important part of bio-fuels is that they do not produce greenhouse gases to contribute global warming. If the bio-fuels conversion process does not involve contamination of synthetic chemicals, the carbon dioxide (CO_2) and other gases produced from bio-fuels are acceptable to plants. Emission of greenhouse gas particularly CO_2 is of great concern today. Even though CO_2 is considered as one of the major greenhouse gases, production of natural CO_2 is essential for maintaining life on earth. Note that all, CO_2 are not same and plants apparently do not accept all types of CO_2 for photosynthesis. There is a clear difference between the contaminated CO_2 from industrial process and clean CO_2 produced from renewable bio-fuels such as from wood burning and human respiration. As various toxic chemicals and catalysts are used during fossil fuel refining, the danger of generating CO_2 with higher isotopes cannot be ignored. Hence, it is clear that CO_2 itself is not a culprit for global warming but the industrial CO_2 which is contaminated with catalysts and chemicals, likely becomes heavier with higher isotopes and as a consequence plants cannot accept this CO_2. As the plants have lives as humans have, they always discriminate lighter CO_2 against heavier portion of CO_2 from the atmosphere. While taking into account the

impact of CO_2 for global warming, we must distinguish between natural and industrial CO_2based on the source from which it is emitted and a pathway of the fuel that emits CO_2following from source to the combustion. Thus, development of bio-fuels in Nepal not only helps achieve sustainable economic growth but also helps save the environment. There should be policy shift to consider bio-fuels as mainstream energy sources and petroleum fuels as alternatives[12].

"*Jatropha* has also been proven to have strong anti-erosion qualities which make it ideally suited for use in Haiti. A recent study on watershed preservation commissioned by USAID this year reinforced this fact, adding that it was more effective than the tree-planning efforts that have been used to help reforest Haiti. It grows 5 to 10 feet high, and is capable of stabilizing sand dunes, acting as a windbreak and combating desertification." (Source: www.jatrophaworld.org)

- **Generation of employment activities:**

The supporting program for that kind of activities gives education and training for the local people which help to create job facilities for the local people.

- **Sustainability:**

It is the most important benefits for the present and future generation by the use of this technology.

[12] Source: Alternative Energy Promotion Center (AEPC), Report 2008

CHAPTER-SEVEN

CONCLUSION AND RECOMMENDATIONS

7.1 CONCLUSION:

Based on the research study and findings it can be concluded that advantages of *Jatropha* plantation through establishment of nursery is encouraging more investment in bio-fuel sector. There is no doubt the fossil fuel reserve is depleting day by day and it is necessary to think about the alternative fuel. Nepal is heavily dependent on the fossil fuel; the fluctuation in 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. It is obvious to say and ask a question that "Do the country have proper base to enter into liquid bio-fuel to substitute fossil fuel (petro-diesel)?" But until and unless the step is not forwarded this kind of question will always rise. The only solution is; now it's the time to make complete awareness to the technology, start nurseries, and train local farmers for cultivation, collection, processing, marketing and distribution of bio-fuel resources. *Jatropha* based bio-diesel consumption can be started from the local level where different end-uses like irrigation pumps, agro-processing equipments, decentralized electricity generation etc can be operated. If initially, promotion of *Jatropha* is started to meet the demand of local level for operating different need based end-uses and cultivation is done so as to meet the energy requirement to do so, it could be one of the appropriate technology in the context of Nepal. Integration of such small pockets scattered in different areas can lead to enormous resource base to compliment the national perspective of partial substitution of diesel in future.

In addition to this, it is one the means to enhance local economy through entrepreneurship development and employment generations. Poverty reduction is the main thrust of economic development in the country. Accessibility of higher form of energy has been one of means to addressing poverty reduction in Nepal. However, to expedite sustainable rural energy supply in future, special emphasis has given to promote rural energy program to ensure services to the poor people. There is also an opportunity for revenue generation from carbon trade under the clean development mechanism (CDM) of the Kyoto protocol.

The potentials for generating income remain underutilized, until the barriers of remoteness and market accessibility are overcome. Solving the marketing problem in the village is just as fundamental as solving the power problems. In short, community development strategy in integrated approach helps to raise the potential income generating activities in rural development process.

Poor people frequently lack access to affordable, reliable, safe and environmentally benign sources of energy. This hinders their efforts to move out of poverty and seriously constrains their ability to improve their living situations. People without modern energy services must spend more of their time and physical energy on survival and, therefore, have fewer opportunities to pursue educational and income-generating activities. 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.

Bio-fuels should be integrated within a broader context of investment in rural infrastructure and human capital formation. Low-income communities should assess whether the underlying conditions for a successful bio-fuel programme exist or could be developed in the near-term, including infrastructure and essential public services. *Jatropha* is a valuable multi-purpose crop to alleviate soil degradation, desertification and deforestation, which can be used for bio-energy to replace petro-diesel, for soap production and climatic protection, and hence deserves specific attention. *Jatropha* can help to increase rural incomes, self-sustainability and alleviate poverty for women, elderly, children and men, tribal communities, small farmers. It can as well help to increase income from plantations and agro-industries. Landless and marginalized people can be made potential beneficiaries of employment opportunities.

At the national level, producing more bio-fuels will generate new industries, new technologies, new jobs and new markets. At the same time, producing more bio-fuels will reduce energy expenditures and allow developing countries to put more of their resources into health, education and other services for their neediest people. Environmental protection has a social value. Utilization of plant oils for rural energy would both conserve and enhance natural forest resources as well as reducing the consumption of agricultural residues for fuel. Agricultural residues and oil cake would then be available to boost crop yields and at the same time reduce the consumption of costly and imported chemical alternatives. Cultivation of plants around field

boundaries boosts crop yields by pre-empting browsing livestock; root systems and leaf-shed improve soil stability and quality. Clean, available fuel impacts positively on health and drudgery and ultimately economic productivity.

7.2 RECOMMENDATIONS:

Jatropha curcas is the gold mine for the rural development and promotion of it should be strongly started, otherwise the country will be set far behind in the global/continental race to foster alternative fuel. Since, it is technically, socially and economically viable, some of the recommendation towards fostering bio-fuel and sustainability in Nepal are as follows;

- Bio-diesel can be produced from *Jatropha* which bears non-edible oil bearing seeds. Hence, the resource potentiality should also needs exploration, which can help to promote *Jatropha* in massive scale.

- *Jatropha curcas* since needs cultivation, a strong legislation and policy needs to be developed to ensure farmers and entrepreneurs of not cultivating in agricultural land. Formulation of bio-fuel friendly policy is strongly recommended to encourage investment in the cultivation, harvesting, production and distribution as a potential source for bio-diesel.
- Strong networking and harmonization among different researches and studies made by government bodies, academic institutions, research institutions, CBOs, NGOs should be developed.
- A complete value chain analysis of Jatropha based bio fuel is necessary to ensure its sustainability. The promotion types programs should be formulated to interlink the potential actors involved of *Jatropha* business starting from nursery establishment, cultivation to utilization of bi-products.
- Subsidy and soft loan is likely to encourage investment in Jatropha farming even from local community. The awareness level of people especially rural poor farmers is very low about bio-diesel from *Jatropha.* They cannot identify themselves and resources around them. The dissemination and demonstration program in rural area is necessary as far as possible.

- Financial support is a major factor for Jatropha cultivation and bio-diesel production. Nepal government should play vital role to co-ordinate all their concern line agencies for

the development of bio-fuels in Nepal. The procedures, terms and conditions to provide loan for farmers should be simple and short processing time.

- Further research and studies on liquid bio-fuel technologies especially *Jatropha* based technology should be used to increase the application areas. Programs should be brought into action for R&D and implementation on substituting imported petroleum products like diesel, kerosene etc. Thus, it is strongly recommended for more research and development on potentialities, possibilities of bio-diesel from Jatropha curcas and its significant role in rural development of Nepal.

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ANNUXURE:

ANNEX-1: Questionnaire

Questionnaire for collection of baseline Socio-economic Data:

1. General information:

Name of the Respondent				
District				
VDC/Municipality				
Ward No				
Village/Town				
Family	Type Joint ☐	Nucleus ☐	Male =	Female =
Religion				
Phone/Mobile No				

2. Household Information:

2.1 Information about family members:

SN	Name of Household Members	Sex M/F	Age	Education*	Occupation**	Income in NRs.
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						
11.						

*1- Illiterate, 2- Just literate, 3- primary, 4-Lower/secondary level (up to class 10), 5- Higher (Intermediate Level, Bachelors level, Masters Level, Doctorate)

** Occupation (major/minor): 1- Agriculture, 2- Trade, 3- Wage labor, 4- Salaried employee, 5- Foreign Service, 6-none, 7- Pensioned, 8- Others (Specify)

2.2 Status of Land Ownership:

Particulars			**Type**	
	Attributes	**Ropani**	**Used %**	**Unused %**
	Private			
	Partner			
	Public			
	Rent			
Ownership of land	**Total**			

2.3 Household Income Information:

A. Agricultural Production:

SN	**Crop**	**Unit**	**Production Quantity**	**Quantity**		**Price**	
				Buy	**Sale**	**Buy**	**Sale**
1	Rice						
2	Wheat						
3.	Maize						
4.	Vegetables						
5.	Milk						
6.	Livestock						
7.	Poultry						
8.	Fishery						
9.	Others						

B. Household Cash Income from Non-Agriculture:

SN	**Income Source**	**Unit Period***	**Amount in NRs.**	**Profit in NRs.**
1.	Small shops			
2.	Craftsmanship/Artisan			
3.	Labor wage			
4.	Remittent (Salary/Pension)			
5.	Forest Product			
6.	Rent (Land/House)			
7.	Others			

*1-Weekly, 2-Monthly, 3-Yearly

Income Ranges (Annual):

0-10,000	
10,000-20,000	
20,000-30,000	
30,000-40,000	
40,000-50,000	
Above 50,000	
Total	

2.4 Household Cash Expenditure (excluding agriculture inputs):

SN	Expenditure Heading	Unit Period*	Quantity	NRs.
1	Food & Beverage			
	Cereals			
	Spices			
	Vegetables			
	Others			
2	Education			
3	Clothing			
4	Energy/Fuel			
5	Health			
6	Social Ceremonies			
7	Interest Paid			
8	Land Tax			
9	Others			

*1-Weekly, 2-Monthly, 3-Yearly

3. Household Energy Use type pattern:

SN	Fuel Consumption for	Consumption Per Month			Amount in Rs.
		No:	Quantity:	Uses	
1	Fuel wood				
2	Kerosene				
3	Biogas				
4	Electricity				
5	Dry Cell				
6	Others (to be specified)				

*Cost price of Kerosene = *Cost price of Batteries (dry cell) =

4. What are the necessary pre-conditions to promote *Jatropha* in rural areas? Please rank in order of importance 1-5;

   Skillful Human Resources ⬭

   Technical Trainings ⬭

   Awareness ⬭

   Working Capital Assistance ⬭

   Financial Institutions ⬭

   Co-ordination of National Level Line Agencies ⬭

   Promotion of Required Materials ⬭

   Others Specify ⬭

5. What are the major problems in *Jatropha* farming?

   □ Technical

   □ Financial

   □ Social

   □ Managerial

   □ Others

6. Did you watch/listen educational program?

   Yes □ No □

   If yes, what types of programs?

   Radio □ TV □ Internet □ Video □

7. Source of Information about Bio-fuels *(Jatropha)*:

   □ AEPC

   □ Radio/Television

   □ Local NGOs/CBOs

   □ Newspaper

   □ Others

8. How is the women participation in different program run in your area?
   □ Strong participation
   □ Participation in the name of participation
   □ Forceful participation
   □ Zero participation
   □ Others

9. Which type of support will be effective for marginalized people/rural farmer? How *Jatropha* farming can be made more effective in rural areas to reduce poverty?

   _____

   _____

10. Are you planning to organize any income generation activities in near future?
    Yes □ No □

11. Are you doing something? If yes what,
    □ Farming
    □ Business
    □ Job
    □ Others (Specify)

    If no why,
    □ No agricultural land
    □ No training of any income generative activities
    □ No awareness/ideas
    □ Others (Specify)

12. What do you feel about this questionnaire with you?
    □ Very good
    □ Good
    □ Unsatisfied

Please give your opinions:

1. Renewable Energy Technologies
    a. ……..
    b. ……..
    c. ……..
    d. ……..

2. Environment Management
    a. ……..
    b. ……..
    c. ……..
    d. ……..

3. Climate Change & CDM
    a. ……..
    b. ……..
    c. ……..
    d. ……..

4. Trainings
    a. ……..
    b. ……..
    c. ……..
    d. ……..

5. Others ……
    a. ……..
    b. ……..
    c. ……..
    d. ……..

ANNEX:2 PHOTOGRPHS

Photo 1: Oil expelling at Siraha district (Source: Adopted from AEPC)

Photo 2: Well developed Jatropha fruits (Field Survey)

Photo 3: Technology for bio-diesel production (Source: AEPC)

Photo 4: Seeds collection for Jatropha Nursery (Source: Gupta Nursery, Rupandehi)

Photo 5: *Jatropha* used for fencing at Chandreshwor VDC of Lamjung district (Source: Field visit)

Photo 6*:* *Jatropha Curcas* at Duradanda VDC of Lamjung district (Source: Field visit)

Photo 7: Well developed Jatropha plant (Field Visit)

Photo 8: Petroleum Products Shortage in Kathmandu (*Source: Nawa raj Dhakal, Senior Training Officer (AEPC); Government Policy and Programme on Biofuel in Nepal, Report, 2008.)*

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