CHAPTER – ONE

INTRODUCTION

1.1 General Background

This study is designed to assess the socio-economic impact of bio-gas plant in Keroun V.D.C.of Morang District. It also examines the effect of bio-gas slurry in agriculture production of the respondents of the study area. Moreover, impact of biogas on the health and sanitation, time and money, saving, special benefits from the saving, have provided additional understanding of the topic.

Nepal is one of the poorest and least developed country in the world with lowest per-capita income $1 per day. Nepal is a small country with an area of 1, 47,181 sq. inhabited by 2, 31, 514, 23 people (Population Census 2001). The land area can be roughly divided into three physiographic regions like: the hills, the mountains and the plains. Out of total population 86 percent live in rural areas as well as 14 percent live in urban areas. (Census, 2001)

The economy of Nepal is primarily based on agriculture and other sectors of the economy are quite small. National account data shows that at factor cost, the share of agriculture in the total G.D.P. was 32.35 percent (2007/008 MOF/GON, 2009), Most of the rural population has the tradition of raising cattle as an integral part of their farm people are depended mainly on firewood for their energy requirement. They use it for cooking, space heating and other purposes.

The low level of economic development is reflected in the lesser range of energy consumption. Per – capita energy consumption in Nepal is 336kg of oil equivalent (kgoE) [2] (BSP bulletin, December 2004.). Energy consumption pattern is divided into three parts by their sources, namely traditional, commercial and renewable. Large proportion of energy consumption is met by traditional energy resources with increasing pressure on forest resources leading to environmental imbalances to rise with increasing pressure of population growth. Nations demand for fuel is increasing at an alarming rate. About (86-90%ssss) total energy demand is met by firewood, animal dung and Agriculture residue (NPC – tenth Plan (2002 – 2007).

Nepalese rural economy, predominated by subsistence agriculture is based on combination of crop production and animal husbandry. The average size of small – scale farm is about 0.96 hectors per holding.

Animal husbandry makes up a vital part of agricultural production system of Nepal. It has always been complementary to the crop production in the traditional agriculture system in Nepal. In rural area, average farmer hold cattle and buffaloes for dairy products. Dung is used to make compost for the field and usually under condition of resource stress, as a raw material for fuel. The number of cattle and buffaloes is also increasing along with households. Nepal produces about 41.4 million MT of livestock manure per year. It is estimated that about 8, 1000 MT of dry dung cake, alternate to firewood which is equivalent to 20,000 MT of oil. If we compare the electricity with energy generated from existing biogas plants, it would approximately reach 30 MW. The estimated biogas potential of Nepal is sufficient to operate 1.9 millions of biogas plants. (BSP – N 2006)

The low level of economic development is also reflected in the level of energy consumption. Per capita energy consumption in Nepal is 15GJ.There is a great disparity in the energy consumption pattern of the people as there is a disparity in the income, consumption, attitudes, aspiration and life styles. When divided energy into three parts by there sources namely traditional, commercial and renewable, traditional energy occupied - 87.8 percent, commercial energy - 11.5 percent, and the renewable energy - 0.4 percent of the total energy consumption in FY2008/2009{Economies Survey 2008/2009).The signifies that a large proportion of energy consumption is met by traditional energy sources with increasing pressure on forest recourses leading to environment imbalances to rise. The source of energy in balance of the country can be shown as follows; fuel wood -89.2 percent, Agriculture residues - 4.2 percent, Animal waste - 6.6 percent, Petroleum product - 64.2 percent, Electricity - 18.3 percent and coal - 17.5 percent and others are renewable (economic survey, 2008/2009).

Bio – gas as an alternative energy, so it is essential in these days. There are so many alternative energy such as hydro power, solar power, wind energy, biogas and so on. Thus, biogas remains the best alternative source of energy that stands technically, socially, economically, biologically and environmentally feasible. The cost of wind and solar power are expensive for the rural people than biogas.

The biogas technology to be the simple convenient and reliable then other sources of energy. It helps to reduce firewood and kerosene consumption, conserving environmental, reduce sanitation problem, reducing work load to women, children and also increase agriculture production. So, bio-gas energy is more useful in the context of Nepal. This is also feasible and cheap then other energy. Policy of HMG/N is to promote biogas technology. In

Nepal, 1, 23,395 family size bio-gas plants have been installed in the end of 2004. Bio-gas programmed has been run in 65 districts of Nepal. The bio-gas plants are located in Nepal are, 57 percent Terai, 37 percent Hills, and 6 percent in Mountain regions (Bio-gas Nepal, 2004; Published by BSP).

This technology increasingly accepted by all ethnic groups in both the hills and the Terai. There is not any significant social barrier to the technology especially when cow, buffalo dung is used as slurry. Since, combustion of biogas does not produce toxic fumes and carbon residues on the bottom of pots and pans, health conscious rural people (especially women) favor this technology. The plant owner in the Terai reported that the level of gas production decreased by about 25 percent during winter. It may go beyond 50 percent in Hills. (Impact study of Bio-gas installation in Nepal, Agricultural Development Bank).

This study is important not only for rural area of country but also the resource management in the nation as a whole. It also helps to formulating policies and strategies in the field of bio-gas technology.

1.2 Historical development of Biogas in world and its potentiality in Nepal

Biogas technology has been gaining popularity now a day as a good alternative source of domestic energy, the origin and development of such popular biogas was used for heating both water in Persia during the 6^{th} century. Marco polo mentions the use of covered sewage tanks. It probably goes back 2000-3000 yrs ago in ancient Chinese literature. In 1808, H. Davy made experiments with strawy manure in a retort in a vacuum and collected biogas. He wasn't interested in the gas but rather rotten or not

rotten manure. However, He determined that methane was present in the gases produced during the anaerobic digestion of cattle manure (CES i 2001).

Jan Baptita van Helment first determined in the 17th century that flammable gases could evolve from decaying organic matter. An Italian National count Alessandro Volta concluded in 1776 that there was direct correlation between the amounts of decaying organic matter and amount of inflammable gas produced. He wrote to a friend about combustible air. He wrote that submerged plant materials in the ponds and lakes continuously give off such gas later Volta's gas was shown to identical with methane gas.

It took over hundred years to use the gas for man kind: The plant for methane generation was set up in 1900 in leper asylum in India. Another plant was installed in Indonesia in 1914. Interest in biogas rose very high at the time of beginning of 2nd world war. By 1950, about 1000 biogas plants were built by French German converted their some 90,000 automobiles to run on biogas to save petroleum fuel during the world. The energy crises followed after the was drew attention of many countries towards biogas (Karmachrya: 1992).

The first bio-gas plant was constructed in Nepal by B.R. Saubolle, a school teacher in 1995 at St. Xavier's school, Godavari. In 1968, Khadi and village Industries commission (KVIC). India built a plant for an exhibition in Katmandu. The agriculture department of HMG/N launched bio-gas plants construction programmes in a systematic way. During fiscal year 1975/76, which was declared as the "Agriculture year" by His Majesty's Government of Nepal (HMG/N) The Agriculture Development Bank (ADB/N) provided free of interest

credit to install 196 plants against a target of 250 of the “drum type” bio-gas plants (New ERA 1985:7).

The development and dissemination of biogas technology in Nepal was initiated in an organized way after the establishment of Gobar Gas Tatha Krishi Yantra Vikash (P.) Ltd. (Gobar Gas Company – in short) in 1977 with three main shareholders, the Agriculture Development Bank (ADB/N). The fuel corporation of Nepal (FCN) and united Mission to Nepal (UMN). In 1974, Development & consorting services (DCS) built four floating drum plants of KVIC design. Ever since its establishment the Gobar Gas Company has been solely responsible for promoting and installing Gobar gas plants all over Nepal. However, the result of the programme of the company in the initial years was not so encouraging in comparison to its national potentials.

Research on various design of biogas plants such as floating steel dome design, concrete fixed dome design, breasted tunnel design plastic bag bio-digester. Ferro cement gas holder, brick mortar dome and mud dome were tested and experimental at Butwal. Fixed dome design a Chinese modification plant was introduced in Nepal in 1980. After several modifications, fixed dome design, which is more popular in Nepal?

During the period of 1981 to 1986, GGC developed and tested various designs of biogas plants such as floating drum design, fixed dome design, tunnel design. Plastic bag design bio-digester and so on. Similarly, various types of biogas appliances such as gas pipes, mixture machines gas taps, stokes, lamps, water drains, gas meters, agitators, manometers etc were developed modified and tested. Slurry coming from the plant was applied to various croup, e.g. vegetable and cereals. It was also used for feeding fish and

animals. However, most of the research on the subject was limited to experiments and papers.

Research was also conducted in the application of gas for running engines for agro-processing, pumping water for irrigation generating electricity especially on community basis until 1986, GGC (Gobar Gas Company), installed 60 such plants. But most of them could not continue functioning due to some special problems.

In 1992 BSP was introduced at different stages for massive dissemination of the technology in the country. In 1995, Nepal Biogas promotion group (NBPG) was established as an umbrella organization of all the construction companies.

For the promotion and extension of the program. In 1996, His Majesty's Government of Nepal (HMG/N) setup Alternative energy promotion centre (AEPC) under the Ministry of science and Technology (MOST). The role of AEPC is as the networking at the central level policy making (GGC profile 2001 i 1, 2).

Biogas plant installation is increasing over the years with the government initiation. Government has promoted credit facilities to the people in the provision of land ownership certificated through ADB/N. Government are supporting to various organization and agencies for its development.

As the forest resource is decreasing, threatening the environmental problem, government is being aware to develop the biogas installation activities, including national planning process. Biogas installation program was in corporate in the seventh plan (1986-90) period and the emphasis has been continued even in the tenth plan (2002 – 2007). In this

course, HMG/N has made strategies for the further development of biogas. Privatization Policy is becoming the key efforts to the government to increase biogas plants in the country (WECS: 1994/95).

Table 1.2: Subsidy Rate for Biogas Plants

Plant size	Terai Districts	Hill districts	Remote Hill Districts
4 & 6 cubic meter	Rs 6,500	Rs 9,000	Rs 12,000
8 & 10 cubic meter	Rs 6000	Rs 9,000	Rs 12,000

Source: Biogas support program, 2008

A total of 18 districts are categorized as Low Penetration Districts (LPDs) for now. These districtys receive extra Rs. 500/- subsidy per plant. These districts are Achham, Dailekh, Okhaldhunga, Rukum, Baglung, Baitadi, Dadheldhura, Doti, Panchthar, Rolpa, Salyan, Taplejung, Dhanusha, Mahottari, Parsa, Rautahat, Saptari and Siraha.

The potential for biogas generation is based on the number of cattle and buffaloes. In Nepal, house hold with animals are 27, 84,585 and the potential biogas household is 19, 37,015 (BSP, 2005), regarding the potentiality of Biogas is higher in Terai then hill, remote hill and mountain.

Source: - Final report on the bio-gas support programme, phase III

1.3. Introduction to Biogas

Bio gas from manure, vegetable waste and algae, considered for the Isle of Man. Biogas can be substituted for natural gas or prepare as fuel for boilers and electrical generations, Biogas systems convert animal dung into methane gas, which is flammable and can be used as a domestic fuel for cooking and lighting – slurry is used for organic fertilizer.

The given data are useful in the design of biogas plant

Table 1.3: Design of biogas plant

Suitable digesting temperature	$20\text{-}35^{0\,c}$
Retention time	40-100 days
Biogas energy content	6 kwh/m3=0.61x diesel fuel
Biogas generation	0.3-0.5m3 gas/m3
	Digester volume x day
1 cow yield	9-15kg dung/day = $0.4m^3$gas
Gas requirement for cooking	$0.1\text{-}0.3m^3$/person
Gas requirement for lighting 1 lam	$0.1\text{-}0.15m^3$/h

Source: 2nd National conference on science & tech Ronast: Kathmandu

These type of Gas found in Bio-gas

Description	Percent (Quantity)
Methane	50-60 percent
CO_2	30-40 percent
Hydrogen	5-10 percent
Nitrogen	1-2 percent
Water vapor	0-3 percent
Hydrogen sulphide	Little

Source: - Singh. R.B; A Technical Evaluation of Renewable Energy Biogas in Nepal. SCITECH Journal NEC April 2004, Vol 7 No.2

Figure no. 1

Type of dome

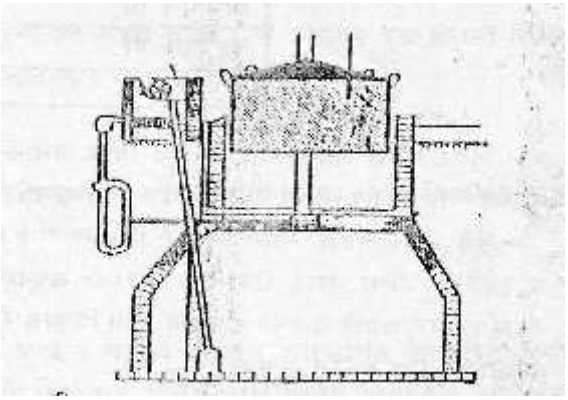


Figure no. 2

Type of drum

1.4 Statement of the Problem

Energy is a critical component of the development process. It is needed in all sphere of life which are directly connected with mans survival progress as in cooking, lighting, heating etc. Many developing countries are facing the problem of energy due to price high of fossil fuel and periodical shortages and international dispute in fuels. More of the houses in rural area are using firewood, animal dung and agriculture residue.

Almost all Nepalese depend on traditional type of cooking stove (Chulu) that consumes unnecessarily large quantity of firewood. Using firewood causes indiscriminate destruction of the forest resources. It shows that the deforestation results into natural calamities such as, landslides, flood, soil erosion etc.

Consequently, firewood collection consumes more time, more expenditure and ultimately produces ill health of the people. Therefore, people spend life always in poor condition, socially, culturally, economically and environmentally hazardous. Other alternative source of energy such as solar power, wind energy. Micro hydro power is in negligible in use of high cost of installation. To reduce these problems, alternative sources of energy like bio-gas should be utilized. Thus, it is sure that bio-gas technology remains as a major sources of energy in Nepal.

In Nepal, considerable amount of domestic energy requirement is met by the direct burning of dung. Such practice of using cattie dung as a source of energy has grave consequence on agricultural productivity. Not putting the manure back on the agricultural land as fertilizer deprives the soil of valuable nutrients and material which drastically reduce

crop production and results in food shortage. However, dung has other competing uses .Dung obtain from cows, buffaloes, ox and other animals can be better utilized if converted into biogas .Biogas is an of alternative sources of energy, which replaces other expensive and pollution full energy sources. It plays vital role for the conservation of forest and environment, reduction of fossil fuel and self sufficient in energy production.

Considering the above, the chief importance of this study is to decrease the rate of deforestation to improve the health situation of rural women and children and to utilize the saved time on income generating activities in Keroun VDC of Morang district. Digested slurry reduces the undue use of chemical fertilizer leading to higher productivity in Keroun VDC, Morang Nepal.

Due to the above difficulties on firewood using, biogas technology is an only appropriate sources of energy in rural area which is feasible for installation and convenient to use. Biogas plant requires animal dung and human excreta or vegetable organic matters as raw materials which are easily available in rural area.Hense the problem in the field of conventional energy need to be solved with proper measures.

1.5 Objectives of the Study

The general objective of the study is to analyze the socio - economic impact of bio-gas plant to its users.

The specific objectives are as follows:-

1. To assess the Socio-economic characteristics of bio-gas users.
2. To study the bio-gas as an alternate fuel source to forest resources.
3. To study the benefit of biogas slurry.

1.6 Significance of the Study

It is well realized that bio-gas technology is very much suitable for Nepalese context. Bio-gas technology has no doubt, a good contribution in the energy sector. This simple technology contributes to preserve down the use of forest resources. By promoting bio-gas installation, we are preventing deforestation. Thus, it is regarded as a sustainable source of energy. As we know, bio-gas as a renewable energy clearly offers the great significance of this study. The introduction of bio-gas technology in the study area will be helpful for reducing the dependency on forest resources for household purposes. It helps to save money and time in collecting firewood and cooking activities. It provides the smokeless environment in kitchen. Raising rate of chemical fertilizer helps to increase production cost and decrease the soil fertility day by day on national level, the introduction of the bio slurry as an organic fertilizer can generate highest productivity without spending the money on buying chemical fertilizer.

The bio-gas plant benefited the people to increase agriculture productivity reduces the emission of smoke and improving the quality of life of the people in this area.

All these advantages show the importance of bio-gas. It's found that the use of bio slurry fertilizer is better than the chemical fertilizer. As the study is aimed to see the impact of bio-gas in rural areas and found that the use of slurry (fertilizer) is better than chemical fertilizer in terms of cost and productivity. It is especially beneficial for a poor agrarian economy like ours. It provides a renewable source of energy, when the entire world is today scared of saturation of the non-renewable sources of energy fossil fuel

This study which confines to only Keroun VDC where the main sources of income is agriculture and animal husbandry is in practice since time immemorial. It is expensive for the people of these areas to use other commercial sources of energy such as oil, Kerosene or gas. Burning of firewood or other biomass fuels in traditional cooking stoves generally produces excessive smoke and can causes serious damage to health especially that of women who directly involves in cooking. The development of the biogas plant which reduces the emission of smoke can therefore significantly contribute towards improving the quality of life of the people in this area. It also to keep good environment in the concerned society to some extent. In case of negative impacts the offers an opportunity to come up with mitigating measures.

1.7 Limitations of the Study

This study has attempts to analyze the Socio-Economic impact of biogas plant in Keroun VDC, Morang districts. However, it has following limitations

1. This study is focus on the domestic bio-gas system only
2. It only covers Ward no. 5 and 6 of Keroun V.D.C., of Morang district
3. It focuses on socio-economic impact of bio-gas in concerned VDC.

1.8 Organization of the Study

The study in total consists of six chapters. The first chapter of the study includes introduction, brief history of biogas and its potentiality in Nepal. Statement of the problem objectives, significance and limitation of the study.

In the second chapter, literature review is presented. The third chapter include methodology, where research design, nature and sources of data techniques of data collection, selection of the study area, brief introduction of the study area, sample size, and method of data analysis are given.

Socio-economic impact of Biogas plant owners of the respondents are given in chapter four. Whereas, chapter five discusses the use and impact of biogas, Summary, conclusions and recommendations are given in chapter six.

CHAPTER: TWO

LITERATURE REVIEW

There are some books, booklets, bulletin published in the subject bio-gas plant. Most of them are published by foreign writers but only the few books are published by the Nepalese writers. The books of Nepalese writer are not enough for only regarding the bio-gas plant. Among the several books, booklet, bulletins, published and unpublished documents, thesis Dissertation,Journals,Articles,Plans and Policy in the concerned topic. The literature review will be collect from selected number of books and related field.

Biogas is the mixture of gas produced by methanogenic bacteria while acting upon hide gradable materials in an anaerobic condition. It is mainly compassed of 50-70 percent methane, 30-40 percent carbon dioxide, and some other gases. It about 20 Percent lighter than air. It is an odorless gas that burns with clear blue flame similar to that of LPG gas (BSP 2007).

Biogas is wet gas as it picks up water vapour from the slurry. Biogas is 20 percent lighter than air. The main component of biogas is methane which is colorless, odorless and tasteless. But due to the presence of other gases, it gives some smell similar to that of garlic or rotten eggs (GGC profile, 2002).

According to bio-gas support program (Phase III). The bio-gas technology is one of the viable devices among alternative energy source in the country Nepal. 172,000 numbers of plants are built by BSP – Nepal in the end of 2007. If this capacity could be utilized in an effective manner. It can fulfill about 10 percent of the country's total energy requirement

without adversely effecting the production of the agriculture. Based on the estimated that a total number of 1.9 million domestic bio-gas systems can be installed in Nepal.

According to the final report of bio-gas use survey 2007/2008. A Bio-gas user household saves 990kg of firewood & 6 liter of kerosene oil per year. The gas production was insufficient of in the winter as reported by majority of the respondents one third of the household are attached their latrines to the bio-gas plants. Above half of the respondents used the slurry in the cultivated land and other uses in gardens. The decrease in occurrence of disease was the positive benefit of bio-gas plant installation. However negative part of installation was increased prevalence of mosquito and some even reported occurrence of typhoid. Most of the household were in the value of male. The major problem in the bio-gas plant in the value problems, high rate of interests, high cost and non-availability of spares, increased prevalence of mosquito.

BSP Year Book (2008) focus that BSP has been the first CDM project in Nepal with registration of two CDM Project in December 2005 of 19,396 Plants Constructed under BSP Phase – IV, have been registered with and approved by the CDM Executive Board. An Emission Reduction Purchase Agreement (ERPA) for the two Projects has been signed with the Word Bank for trading of the Emission Reductions from the two projects for first Seven Years Starting 2004/2005 as the first crediting years 2004/2005 has been completed and payment has been made too.

Winrock International Nepal, in partnership with Eco Securities Limited, developed a Project Design Document for Biogas Support Program (BSP/SNV) to develop sustainable Financing through the Clean Development Mechanism (CDM). The reductions in Greenhouse Gas (GHG) emissions by household biogas digesters as a result of substituting

firewood, agriculture residue, burning of dung cakes or kerosene, and capturing methane which is naturally released in the atmosphere are being translated to' carbon credits' through this project. BSP has already installed more than 110,000 biogas plants and targets to install an additional 200,000 by 2009. It was estimated that each biogas plant can generate carbon credit of around 5 ton CO2equivalent per year.

These credits can be traded in both the voluntary and compliance markets (as required for industrialized countries by the Kyoto (Annual report of BSP 2003).

Biogas is about 20 percent lighter than air. It is colorless and odorless gas that burns with clear blue flame similar to that of LPG gas. Its calorific value is about 20 mj per m^3 and burns with 60 percent efficiently in a conventional biogas stove. Biogas technology is a complete system in itself with its set objectives (cost effective, production of energy and soil nutrient factors such as microbes, plant design, construction materials, climate, chemical and microbial characteristics of inputs) and the interrelationships among these factors influence production of gas in a digester. The slurry from the biogas plant is supposed to be very fertile and its use in agriculture increases the productivity of crop tremendously (AEPC, 2000).

(Shrestha 2002, 3)- Bio-gas plant is a device to produce bio-gas. The structure of the plant consists of central pit covered with dome structure. The pit serves as digester and the done serves as gas holder. Animals dung is mixed with water and through by inlet. The dung in the pit is an aerobically digested by the bacteria with generation of gas. The gas bubbles up and collects in the dome. Which is then supplied to house for its use through the pipeline. After digesting the digested slurry flows outsides through the out let.

(Pokhrel 2001: 8): Bio-gas promotion has suffered due to the initial capital cost required for the plant, low yield of gases in region with cold climate and low social acceptance of use of gas. The capital cost involved in the stage still discourages the most rural people from making effective use of bio-gas potential. A possible alternative is identified as being the community sized Issues are concerning the mode of community ownership, its organizational form for day to day operations and equitable distribution of the benefits from the byproducts still remains unanswered.

Sigdel and Das (1990): had done a study entitted “Bio-gas development in Kaski district” in rural context. They had surveyed 13 biogas plants in Leknath V. D.C. The report revealed that there was a growing awareness in this technology as forest saver. People felt that it would be applicable in a semi-urban area where people were richer since majority of the village people suffered from problem of found capital to repay loan and installation cost was found to be high. Realization of subsidy could be observed.

(AEPC, 2001: 1) Biogas technology is a complete system in itself with its set objectives (cost effective, production of energy and soil nutrient). Factors such as microbes, plant design, construction materials climate, chemical and microbial characteristics of inputs and the inter relationships among these factors influence production of gas in a digester. The slurry from the biogas plant is supposed to be very fertile and its use in agriculture increases the productivity of crop tremendously.

The government has also made the policy to encourage private sector participation and realizing the fact that the GGC alone with its human resources can not meet the ever increasing demand for more biogas plant. At present, there are about 60 biogas companies which were established in the year 2005/06 (Biogas Nepal, 2006: 14). In 1992 Biogas support programme

was introduced at three different stages for massive dissemination of the technology in the country. The BSP was initiated in 1992 by the Netherlands Development Organization (SNV) and funded by the Dutch Development Co-operation (Mendis and Nes 1999: 15). For a long time, there was no responsible government body to oversee the biogas programme in Nepal. Ultimately, this gap was fulfilled on November 3, 1997 by the formation of Alternative Energy Promotion Centre (AEPC) under the umbrella of Ministry of Science and Technology (MOST). AEPC as recognized government body has access to support and founds from HMG/N and donors for the promotion of alternative energy in Nepal. The role of APEC is as the networking at central level for policy making (GGC Profile, 2002: 2).

The Ministry of Forestry and Soil Conservation (MOFSC) implemented a project titled support for the development of a National Biogas programme from 1995 to 1996 under the technical co-operation programme of Food and Agricultural Organization of the United Nations (FAO). The activities included mainly training of government officers, masons of biogas users, utilization of digested slurry on fertilizer and production of biogas training manual for extension. The other national and international agencies notably Plant International, Consolidated Management Services (CMS) Nepal, Nepal Biogas Promotion Group (NBPG), NGO Coalition for Biogas and Alternative Energy (NCBAE), Alternative Energy Promotion and Development Forum (AEPDF) etc. have act made significant contribution in the institutional growth of biogas technology in Nepal (REPPON, 2000: 132). On the other hand, by realizing the benefits of biogas, the government has made a target for the installation of 200000 biogas plants during the tenth plan period with assistance from the Netherlands Development Organization (SNV) and Netherlands Development Agency (NEDA).

Theoretically all biodegradable materials can be used to produce biogas through anaerobic decomposition. However, in practice, it is only the animal dung (especially cow dung) that has been primarily used as feedstock for methane generation. In the context of Nepal, the technology is appreciated and used mainly as an alternative source of gas energy for household cooking and lighting and the digested slurry as better organic manure for agricultural crops and vegetables (Karki and et. al, 1994: 932)

Biogas technology has various benefits. It provides fuel for cooking and also lighting. Other fuels can be served considerably namely the consumption of firewood, kerosene, and LPG. Time and money can be saved as cooking; biogas is faster than using kerosene or firewood.

Due to the clean and healthy environment the living standard of the people may advance. Biogas also provides the highly nutritious organic manure for field (land) which raises the productivity and lessens the requirement of chemical fertilizer. From the macro perspectives it saves the natural resources such as forest and prevents the problem of deforestation.

WECS (1994:95): stated that it is imperative to develop and implement technologies which prevent this important source of farm input from direct burning. In the context, biogas technology has proved to be very successful. Since, it not only produces gas for house hold purpose such as, heating, cooking, lighting and industrial propose such as , generating mechanical power, but also provides good fertilizer in the form of digested slurry with significant nutrient value. Thus, improving the soil fertility of agricultural land.

Ghimire (2001) has shown the biogas in relation to forest. He has estimated that installation of 1.3 Million biogas plant (total potentiality of Nepal) would save about 4 Million total of firewood Per Year.

Economic analysis, which is not done in this case, this study has only dealt with the general impact of the biogas plant on the users. In general, biogas plants are found to have very positive impact on the users which is well appreciated by them. The total saving of 1.22 hours/days/family on an average from the installation of biogas plants suggests that it has been successful to lower the family workload.

Karki (2001) has implemented the research programme to study the influence of bio-slurry application on maize and cabbage in lalitpur district. The result of the experimentation has revealed the supremacy of organic manure in all forms FYMC (farm Yard Manures) slurry compost and liquid slurry over the inorganic manure. The increment in the field of cabbage and maize was realized after the application of slurry comport.

Karki, et.al, (2002) have to use the study in Dhading district. The study was mainly focused on the adoption of renewable Energy Technology (RET) and its impact on income generating activities. The outcome of this study show that among the five of bridge as outcome of this study show that three among the five of biogas user reported an increase in crop production by 5 to 10 percent due, to the application of bio gas slurry. However, use of other type of renewable energy technology (RET) did not report increase in crop production as experienced by the bio gas users. The bio gas users house hold main income generating activities are agriculture based like vegetable , butter (ghee) and local wine (Rakshi)

production, fertilizer required for vegetable production has reduced and so the amount of money spending on chemical fertilizer.

Centre for rural technology had carried out a study entitled. “Bio gas latrine project Assessment” for UNICEF. According to the report, attachment of toilet to bio gas has helped in creating better sanitation around the house and improved health of users. The adoption of bio gas technology has result in saving of 12.9 metric ton of fuel wood and it has helped in protecting 108 hector of forest area. Likewise agriculture production has been increased up to 20-25 percent after the use of bio gas slurry (CRT: 1994)

New Era, in its *"**Survey of users of biogas plant in Nepal**"* (1995) has tried to find out as to what extent of the use of biogas plant has benefited the owners of biogas plant. In this survey, a Nepali version of questionnaire was used to get required information from the sample households. This survey study concluded that the considerable amount of time is saved through the use of biogas and who already have eye diseases, respiratory diseases got some relief.

A survey conducted by East consult entitled *"Biogas users survey 1994-1995"* has aimed to find out the effect generated from biogas plant. The methodology of this survey consisted of preparing questions. It concluded that the considerable amounts of time, firewood, kerosene were saved through the use of biogas. It also revealed that the adverse effect of biogas were insignificant and negligible.

Review study conducted by Silwal A. B. entitled *"A Review of the Biogas Programme in Nepal"* (1999) has made some important findings. This study has revealed that the tangible impact in terms of savings in firewood, Kerosene and savings in time that would be required in

the absence of biogas plant and the intangible benefits such as the reduction in the respiratory diseases plus other benefits all are perceived to be quite significant by the users.

Nepal has over 187000 household size biogas plants and over 300 institutional size plants constructed in some 2650 of 3915 Village Development Committees (VDCs) or Municipalities in 68 Districts out of 75 District in Nepal. Plant Construction has also recently started in Bajura, Jumla, Manang and Mustang. BSP has a plan to construct at least few plants in the remaining 3 District by mid 2009, with these achievements, BSP is the second largest (to improve cooking stove Programme) alternative rural energy programme in Nepal and probably the largest in terms of VDC out reach. BSP also become first Clean Development Mechanism (CDM) Project of Nepal (BSP Year Book, 2008).

The outcome of this survey indicated that in production of biogas has impact on the control of cough, symptomatic eye infection, incidence of dysentery and ape worm infection. Besides these it also indicated that the demand of fuel woods and kerosene were decreased significantly.

All the above mentioned studies have mainly indicated that installation of biogas has positive impacts on them. However, it has been seen that some of the users have also experienced negative impacts on health, economy, and social life while others have problems with the loans and same others have problems due to poor services of the company. This research study aimed at addressing these negative impacts too.

Policy of Government

Tenth Plan

Only 7 percent of the total people living in the rural areas are currently using electricity service generated from sources of alternative energy. While looking into the total national power consumption trend of last five year traditional source of energy is only contributes 80-90 percent while the share of commercial energy is only from 10-14 percent. In totality 77 percent of the total power consumption is generated from firewood while 9 percent from agriculture by products dung and remaining 14 percent from imported petroleum product, coal and electricity. The per-capita Nepal is equivalent to 336 kg oil energy while per-capita consumption of power from commercial sources is 46 kg oil energy.

Quantities Targets

1) Providing electricity services to 12 percent of the rural people from the source of alternative energy. Under this plan, electricity will be supplied to 1000 VDC's.

2) Proving 44 MW energy by installing 2, 00,000 biogas plants in 65 districts.

Bio Gas Program

As the popularity of biogas is growing among rural families due to its diverse benefits, it would be expanded since it saves fire wood, reduce dependency on imported energy and there is no negative impact in the people's health. In addition, the use of bio gas plant brings no environmental pollution and the slurry, which came out from the plant as by product is use as the best fertilizer. So, the tenth plan has target of installing a total of

2,00,000 bio gas plant, including 199,500 private bio gas plants and 500 community bio gas plants. Priority will be given to suitable and relatively smaller size plants and necessary researches would be carried out for its expansion in the Himalayan region and to reduce costs.

The forest serves as the main source of fire wood. Excessive use of fire wood has posed a serious burden on the forest. Our population is increasing day by day while the forest area is decreasing. So the forest alone is not capable of sustaining the increasing energy demand of growing population. In this situation there is a threat of depletion of the forest. This depletion will lead to many natural calamities such as soil erosion, land slide, flood and destruction of natural balance.

For, the collection of fire wood, rural women spent a great part of time further more, they spend considerable amount of time in cooking. Another problem of using firewood in kitchen is smoke produced which makes the women suffer from indoor air pollution.

To understand about bio gas provided direct benefit, especially rural area. For reduction work load when shifting from cooking on fire wood. It saves 3 hours time a day per family due to the reduction in time used for collecting fuel-wood, cooking and cleaning utensils.

CHAPTER –THREE

RESEARCH METHODOLOGY

This chapter discus a set of method, which is employed to conduct the research. The whole study is carried out on the basis of primary as well as secondary data. So, the relevant and reliable data made possible only by applying scientific method. There are described below. Research Mythology is an important part of a research work.

3.1 Research Design

The research has been carried out with exploratory research design. In order to fulfill the objectives, information has been collected from the field study, household survey, interview and observation are the main techniques that has been utilized to obtain the information from bio gas users only the bio gas users families have been taken into consideration for interview. Primary as well as secondary data has been utilized. Analysis of data has been made from the averages and percentage.

3.2 Introduction of the study area

The present study has been carried out in Keroun VDC of Morang district, which is located in the Eastern development region in Koshi Anchal. The socio-economic status of this district is normal. Main sources of energy are traditional source of energy but in urban area fossil fuel is use properly the present study aims to evaluate the socio-economic impact of bio- gas in Keroun V.D.C of Morang district.

The reason for selecting Keroun V.D.C as the Study area is that the researcher is familiar to the study area. He is also familiar with the local bio gas companies and the local people. Therefore, by selecting of this area, it is believed that more accurate information could be collected during the study area.

3.3 Brief Introduction of the study area

The study is related to the Keroun V.D.C. of Morang district. The total area of this is 1855 sq. km. according to the census 2001 the population of Morang is Male 422,895 and Female 420325.

All of the 66 V.D.C in Morang district, Keroun V.D.C. is big in terms of population. This V.D.C. has the connection of the east-west Mahendra highway. This is the situated to the south-east part of the district. The V.D.C borders with Bayaraban V.D.C in the east and Bahuni V.D.C in the west. The total households of this V.D.C. is 2541 and total population 12435. Among which 6083 are male and 6352 are female (Census 2001).

Table 3.3: Population of ward wise and sex – wise distribution.

Ward No	Total Households	Population				Total Population
		Male	Percent	Female	Percent	
1	865	1998	32.84	2227	35.05	4225
2	145	356	5.85	353	5.55	709
3	244	596	9.79	644	10.1	1240
4	339	896	14.72	806	12.6	1702
5	315	758	12.46	802	12.6	1560
6	154	343	5.6	377	5.93	720
7	105	255	4.19	259	4.07	514
8	120	287	4.71	293	4.61	580
9	254	594	9.76	591	9.3	1185
Total	2541	6083	100.00	6352	100.00	12435

Source: Population census, CBS, 2001.

Despite being most of the people in the study area speak Nepali language some ethnic group like Tharu, Gurung, Rai, Limbu, Rajbanshi speak their own language. Agriculture is the main

occupation of people consequently some are involved in business service etc. The major crops of the agriculture are paddy, wheat, maize, millet. This place is very suitable for spent life.

This VDC has been facilitated with 6 high school, (3 government school, 2 English medium school, and 1 community school). 15 primary school, one plus two, one campus (affiliated by T.U), one post office, Eight Cooperative bank, one police office, one forest office, one health centre, Agriculture research centre and one veterinary. The major inhabitants of the VDC are Brahaman, Chettry, Damai, Sharki and other ethnic group likes Gurung,Limbu, Rai, Rajbanshi,Chaudhary etc.while analyzing the occupation status of the study area, agriculture dominate the entire economy of this area. More than 94 percentages of the people are dependent on agriculture.

Due to the facility of irrigation, paddy is produced twice a year. Early paddy is planted in April\May and harvested in june\july.late paddy is planted in mid July\mid August and harvested in September\October. A part from paddy people also cultivates pulses like mash, Musuro in small area of land. Vegetables are grown near the homesteads mainly for home consumption. Main vegetables grown are potatoes, radish, cabbage, Bhanta, and leafy vegetables (Rayo, Palungo, and Chamsur).The production of fruit is very low in this study area. Fruits production is confined only to the household consumption not for the selling purpose.

3.4 Sources of Data

This study aims to bring socio-economic information for the Bio-gas users in Keroun V.D.C of Morang District. Both primary and secondary data/information has been used. Primary data has been collected through field survey, interview and observation.

Secondary data/information has been used for reviewing the status of previous study. That has been collected from various. Published and unpublished sources Data will be aggregated of facts and numerical.

3.5 Techniques of Data Collection

The data used in the study has been collected from field survey conducted in Nov 2009. The present study is based mainly on primary data. They are used to estimate and analyze the socio-economic impact of biogas on the surveyed household. The survey is conducted through the formal method of interview in a structured questionnaire, interview and observation. Following techniques have been used for data collection.

3.5.1 Household Survey

The household survey has been conducted in order to collect qualitative and quantitative facts about socio-economic aspect of the users and impact bio-gas. Information also has been collected through discussion with the people. The primary data has been collected from the selected house of V.D.C. Questionnaire has been used as a tool for interviewing the user of biogas plants. The respondent of the household has filled the questionnaire. The nature of study is based on primary source

3.5.2 Observation

Certain information mentioned in this study is via the observation made by researcher. The working of the plants and especially the use of slurry has been observed carefully before going into its study.

3.5.3 Key Informant interview

The primary data also has been collected from key informant using the structured or unstructured interview method as well as open and close ended questions. The interview has been taken as cross checking for data obtained from interviewing those key informants. The key informants are energy specialist, staff of Biogas Company, intellectuals of biogas, local biogas user people who are not include for household survey.

3.6 Sample Size

Selected study area Keroun VDC has 9 wards. But the present study has been concentrated only on ward no. 5 and 6 of this VDC. These wards are the main area for biogas plants in this VDC. There are altogether 469 households in ward 5 and 6 of the VDC. Out of the total households having biogas plant of Keroun VDC of Morang district at ward 5 and 6, only 10 percent of biogas users household have been taken as samples. About 250 Biogas plants have been established in these two wards but I have taken only 50 samples (about 10%) from this ward 5 & 6 by using simple random sampling technique.

The name of the selected households has been transformed into questionnaires and the house of these owners has been searched purposively and survey conducted. The household head is selected for the interview. In case of absence of household head other senior family members have been interviewed of the sampled household

3.7 Method of Data Analysis

Information collected from questionnaire has been transformed into a master sheet and data is tabulated on the basis of master sheet. Information is grouped, sub-grouped and classified as per the necessity so as to meet the objective. After the completion of data collection data has been processed with the help of computer. It has been analyzed by using manual chart, diagram, Percentage, table, chart and classifications of the variables. After analyzing data, it has been carried out to maintain consistency.

CHAPTER- FOUR

SOCIO-ECONOMIC STATUS OF BIOGAS PLANT OWNERS

This chapter deals with the socio-economic condition of the biogas plant owners in Keroun V.D.C. caste occupation, Cast \ Ethnicity, family size, land holding pattern, livestock population are the main variables considered in this study.

4.1 Occupation

The main Occupation of the plant owners is agriculture. Besides agriculture, service and business are the main occupation of the plant owners. Major occupation practiced by the sampled households is given in the table 4.1

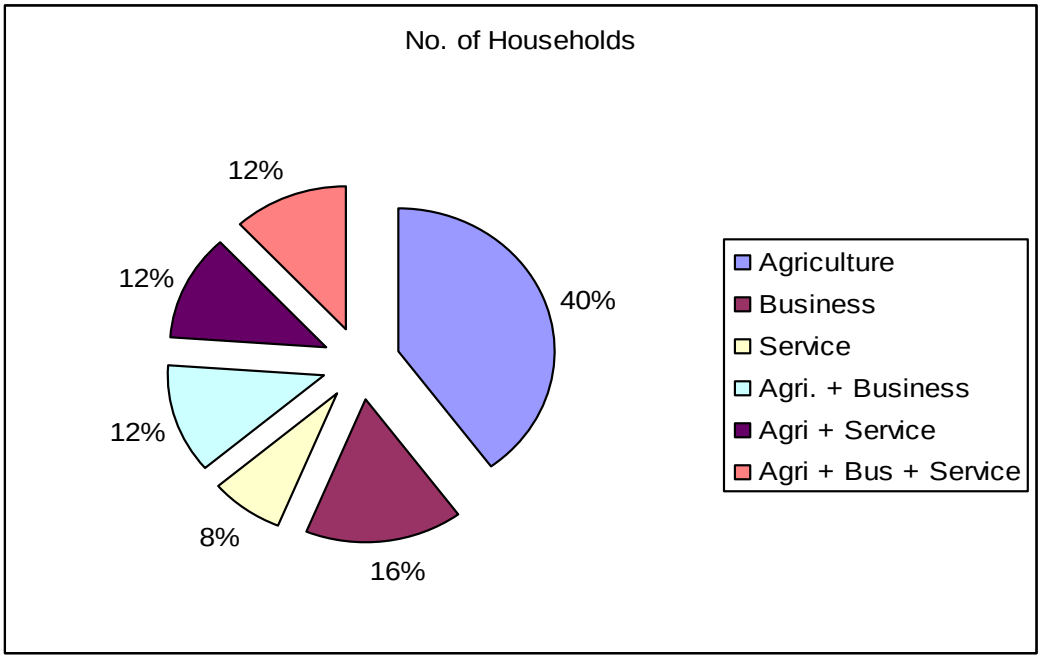
Table 4.1: Distribution by Occupation

S.N.	Occupation	No. of Households	Percentage
1.	Agriculture	20	40
2.	Business	8	16
3.	Service	4	8
4.	Agri. + Business	6	12
5.	Agri + Service	6	12
6.	Agri + Bus + Service	6	12
Total		50	100

Source: Field Survey, 2009.

Table 4.1, shows that the higher percentage of the plant owners is engaged in agriculture sector. About 40 percent of the plant owners are involved in agriculture, 12 percent in agriculture plus service, and 8 percent in service, 16 percent in business, 12 percent in agriculture plus business and 12 percent in agriculture plus business plus service. The farmers have more land and more animals for the dung needed for biogas in comparison to the serviceman and businessman. Besides agriculture, most of the households has

secondary source of income as well. They are government service pensions and other business. It supports them economically to fulfill basic requirements.



4.2 Family Size

The result of the survey reveals that average family size of the sampled biogas household is 5.6 (Table 4.2). Household with maximum number of family members have 9 whereas the minimum number is 3 (Table-4). Table 4.2 shows that distribution of households by family size.

Table 4.2: Distribution of Households by Family Size

S.N.	Family Size	No. of Households	Percentage
1.	1-3 person	10	20
2.	4-6 person	20	40
3.	7 and above	20	40
Total		50	100
Average family size is 5.6 per household.			

Source: Field Survey, 2009

Table 4.2 shows that among all 50 plant owners, 10 households (20%) have 1 to 3 Family members. 20 households (40%) have 4 to 6 family members and 7 above member's households (40%). The average family size is 5.6 per household.

4.3 Educational Status

Most of the plant owners are educated. They have admitted their children to school about 28 percent owners out of total interviewed completed class 1 to 5. 28 percent have completed grade 6 to SLC and remaining 28 percent of total plant owners have completed grade SLC and above .Table 4.3 shows educational status of the sampled plant owners.

Table 4.3: Distribution by Educational Status

S.N.	Education	Male		Female		Total	
1.	Illiterate	4	13.3	4	20	8	16
2.	1 up to 5 Class	10	33.3	4	20	14	28
3.	6 up to SLC	6	20	8	40	14	28
4.	SLC and above	10	33.3	4	20	14	28
Total		30	100	20	100	50	100

Source: Field Survey, 2009

The data presented in table 4.3 reveals that majority of the plant owners are literate (84%). Among male 20 percent respondents have completed class 6 up to SLC. Among female only 40 percent have completed grade 6 up to SLC. This result shows that only 8 persons (16%) are illiterate and they are old. Only 13.33 percent of total illiterate male whereas 20 percent are illiterate out of total illiterate female. So, the education status of the plant owner is satisfactory.

4.4 Landholding

The main occupation of all plant owners being agriculture, all of them have their own land to cultivate. While calculating the landholding, only operational land holding has been taken into account. It is found in most of the cases that the land is cultivated by owners themselves. Table 4.4 shows the distribution of land holding of the plant owners.

Table 4.4: Distribution by landholding

S.N.	Land area in Bigha	No. of Households	Percentage
1.	Below 1	10	20
2.	1 to 2	14	28
3.	2 to 3	8	16
4.	3 to 4	10	20
5.	4 and above	8	16
Total		50	100

Source: Field Survey, 2009.

Table 4.4 shows that 20 percent, 28 percent, 16 percent, 20 percent, 16 percent of houses with land below 1 Bigha, 1-2 Bigha, 2-3 Bigha, 3-4 Bigha and above 4 Bigha respectively. So the highest and lowest responses are recorded in respondent having land of 3-4 Bigha and 1 Bigha.

4.5 Caste/Ethnicity

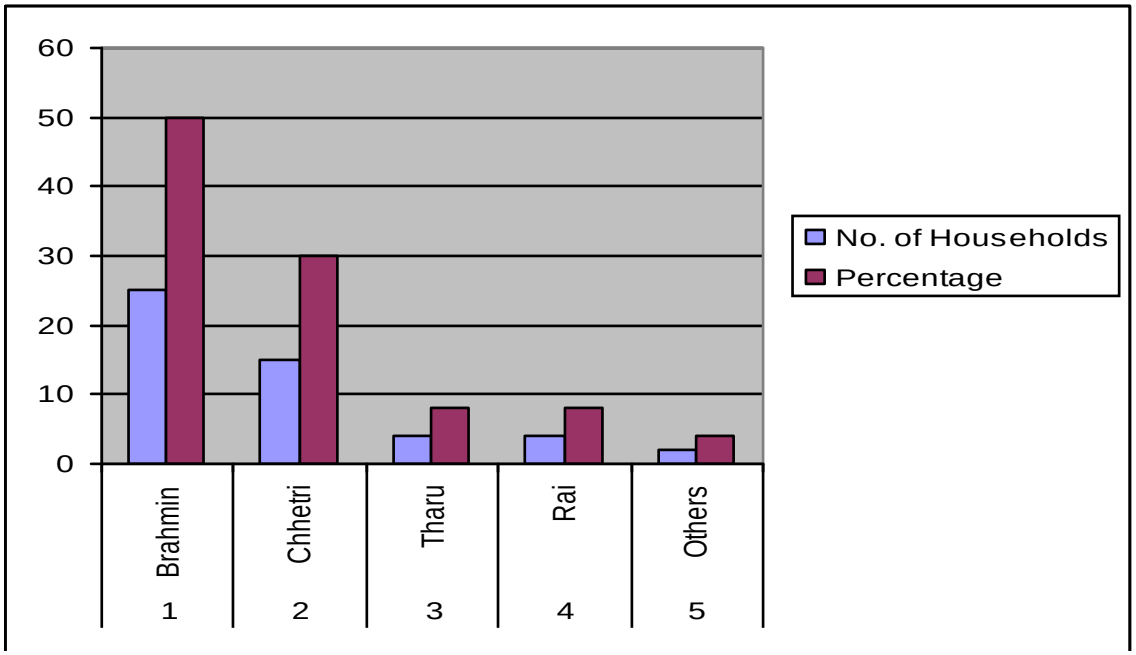
There are different castes and ethnic groups in Keroun V.D.C, Morang. The data on ethnicity of the sampled biogas household is given in Table 4.5.

Table 4.5: Distribution of Caste/Ethnicity

S.N.	Caste/Ethnicity	No. of Households	Percentage
1.	Brahmin	25	50
2.	Chhetri	15	30
3.	Tharu	4	8
4.	Rai	4	8
5.	Others	2	4
Total		50	100

Source: Field Survey, 2009.

Table 4.5 shows, that the majority of the households under study are Brahmins (50%) followed by Chhetri (30%), Tharu (8%), Rai (8%) and others (4 %). The reason behind the higher percentage of biogas users (Brahmins) is found that they are socially and economically forward in each and every sector.


60
50
40
30
20
10
0
Brahmin
1
Chhetri
2
Tharu
3
Rai
4
Others
5
No. of Households
Percentage

CHAPTER - FIVE
USES AND IMPACTS OF BIOGAS PLANT

5.1 Size of Biogas plant

Many types of biogas plants were introduced in world. Properly used size of biogas plants are $6m^3$, $8m^3$, and $10m^3$ .The factors e.g. capacity of land holding, capacity of livestock are the source for determining the size of the plant. Size of biogas plant is given in the Table 5.1. Widely used size of biogas plants. But biogas plant of 6m3 is appropriate in rural area.

Table 5.1 Size of the Biogas Plant

S.N.	Plant Size	No. of Households	Percentage
1.	$6m^3$	32	64
2.	$8m^3$	12	24
3.	$10m^3$	6	12
Total		50	100

Source: Field Survey, 2009.

Table 5.1 shows that only three types of biogas plan sizes, $6m^3$, $8m^3$ and $10m^3$ were reported. About 64 percent people in this study area installed $6m^3$ Biogas plants, 24 percent people in the study area installed $8m^3$ of Biogas plant and 12 percent people in this study are installed $10m^3$ Biogas plant. So, the $6m^3$ Biogas plant were popular in this study area.

5.2 Construction Company

Recent data reveal that more than 50 private construction companies have been established. They contribute to promote and develop biogas. Table 5.2 shows that distribution of Construction Company.

Table 5.2 Construction Companies

S.N.	Construction company	No. of Households	Percentage
1.	Mechi Gobar Gas	15	30
2.	United Biogas Company	13	26
3.	Suryadaya Biogas Company	10	20
4.	Sana Krishak Shamudayak Gobar gas Company	8	16
5.	Nepal Gobar Gas	4	8
Total		50	100

Source: Field Survey, 2009.

5.2.1 Financing Company

Many finance companies have provided loan for the establishment (installation) of biogas plant. They are mainly ADB/N, Rural Development Bank and saving and Co-operative Bank. However, some of the plant owners have installed biogas on self.

Table 5.2.1 Financing Company

S.N.	Financed by	No. of Households	Percentage
1.	ADB/N	10	20
2.	Saving and Co-operative Bank	28	56
3.	Rural Development Bank	4	8
4.	Self	8	16
Total		50	100

Source: Field Survey, 2009.

Table 5.2.1 shows that majority of the plant owners out of total interviewed have taken loan from ADB/N (20%), followed by saving and co-operative bank (56%), rural development bank (8%) and self finance (16%).

5.2.2 Loan

Many financial institutions have provided loan for the purpose of installing the biogas plant. Majority of the people have used to take loan from these (financial) institution and few of them have not taken loan while installation of biogas plant.

5.2.3 Biogas Plant Installation on Loan

Majority of the households have taken loan from financial institutions. Few of have not taken loan from these institutions. Table 5.2.3 clearly shows the situation of loan taken of sampled households.

Table 5.2.3 Installation of Biogas Plant on Loan

S.N.	Loan	No. of Households	Percentage
1.	Loan taken	42	84
2.	Loan not taken	8	16
Total		50	100
16 percent households out of total interviewed have not taken loan			

5.2.4 Interest Rate of loan

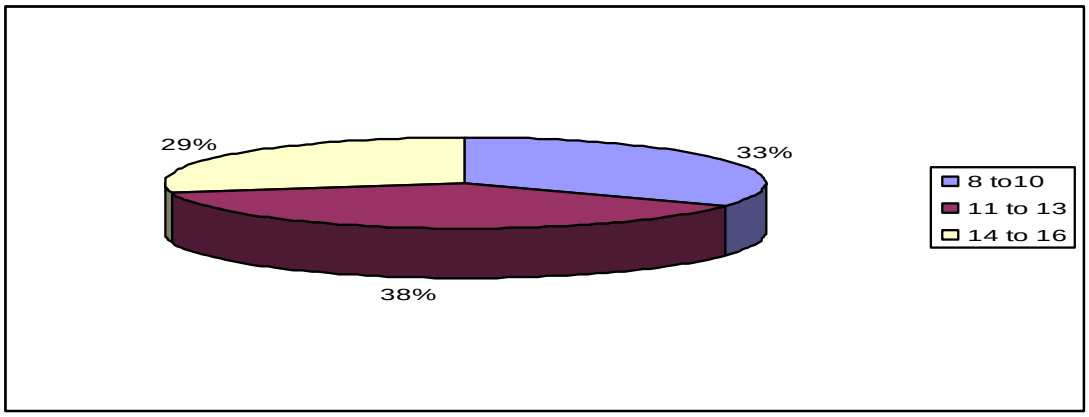
As we know in earlier table the major source of investment is loan from financial institution. Persons those who want to take loan should pay certain interest rate. Interest rate is presented in table 5.2.4.

Table 5.2.4 Interest Rate on Loan

S.N.	Interest Rate (in percentage)	No. of Households	Percentage
1.	8 to10	14	33.4
2.	11 to 13	16	38
3.	14 to 16	12	28.6
Total		42	100
Average interest rate is 11.8 percent.			

Source: Field Survey, 2009.

Table 5.2.4 shows the distribution of interest rate on loan. About 33.4 percent plant owners out of total interviewed reported that they have taken loan by paying 8 to 10 percent, 11 to 13 percent of interest on loan followed by 38 percent has paid 14 to 16 percent of interest on loan. The average interest rate is 11.4 percent.



5.2.5 Perception on Existing Interest Rate

In this study it is found out that the plant owners have different perception regarding the existing interest rate on loan. Perception of plant owners for interest has been presented in table 5.2.5.

Table 5.2.5: Perception on Interest Rate

S.N.	Perception	No. of Households	Percentage
1.	Satisfied	4	9.7
2.	Unsatisfied	38	90
Total		42	100
If not satisfied, tentative interest rate.			
S.N.	**Rate of Interest (in %)**	**No. of Households**	**Percentage**
1.	3-5	34	81
2.	6-8	8	19.
Total		42	100
Average Tentative Interest Rate is 4.6%.			

Source: Field Survey, 2009.

Table 5.2.5, shows that the perception of plant owners to the existing interest rate and tentative interest rate on loan which is provided for the installation of biogas plant. Among 42 plant owners those who have taken loan from financial institution, about 90 percent are not satisfied with the existing interest rate on loan whereas only 4 percent are satisfied with the existing interest rate of loan for biogas plant installation.

This study also found out that about 81 percent respondents out of total unsatisfied plant owners interviewed reported that the tentative interest rate is 3-5 percent and only 19 percent respondent's tentative interest rate is 6-8 percent. The average tentative interest rate is 4.6 percent.

5.3 Source of Information

There are several sources of information about the biogas plant installation. Radio/T.V., Newspaper, Neighbor, Gobar Gas Construction Company is major source of information.

Table 5.3 Sources of Information for Biogas plants

S.N.	Source	No. of Households	Percentage
1.	Radio/T.V.	8	16
2.	Newspaper	9	18
3.	Neighbor	27	54
4.	G.G.C.C.	6	12
Total		50	100

Source: Field Survey, 2009.

Table 5.3 shows that majority of the plants owners (27%) has neighbor as a source of information followed by newspaper (18%), Radio/T.V. (16%) and Gobar Gas Company (12%).

5.4 Reasons for Biogas Plant Installation

There are so many reasons behind the installation of biogas plant. Among them, cooking is the main reason for biogas plant installation.

Table 5.4 Reasons for Biogas Plant Installation

S.N.	Reasons	No. of Households	Percentage
1.	Easy and Smokeless Cooking	23	46
2.	Toilet	2	4
3.	Environmental Protection	11	22
4.	Resource Conservation	6	12
5.	Get rid of Firewood Collection	8	16
Total		50	100

Source: Field Survey, 2009

Table 5.4 Shows that the main reason behind the installation of biogas plant is easy and smokeless cooking (46%) followed by due to lack of toilet (2%), to get rid of firewood collection (116%), environmental protection (22%) and only 12 percent out of total interviewed reported that main reason for biogas plant installation is recourse conservation.

5.5 Livestock

Since livestock dung is the main raw material for installing biogas plant. Livestock is an integral part of agricultural farming in Nepal. It fulfills the demand of manure for land, meat to eat and milk to drink.

5.5.1 Livestock Population

The situation of the livestock holding in the sampled household in the study area is presented in table 5.5.1.

Table 5.5.1: Livestock Population

S.N.	Total no. of Livestock	No. of Households	Percentage
1.	Below 3	21	42
2.	4 to 6	20	40
3.	7 and above	9	18
Total		50	100
Average livestock population is 4.3 per household.			

Source: Field Survey, 2009.

Table 5.5.1 shows that the average livestock population is 4.3per household. About 42 percent respondents out of total interviewed reported that their livestock population is below 3. 40 percent or majority of the respondents have 4 to 6 and only 18 percent out of total interviewed stated that their livestock population is 7 and above.

5.5.2 Dung Produced

The raw material for bio-gas plant is dung Quantity of dung is necessary for finding enough gas. Amount of dung fed was as follows.

Table 5.5.2: Dung fed in bio-gas plant

No	Plant size	Average dung fed kg/per day	High/low
1	6m3	45	Sufficient
2	8m3	60	Sufficient
3	10m3	75	Sufficient

Source: Field Survey, 2009

Dung feed in $6m^3$ is 45kg/, Dung feed in $8m^3$ is 60 kg and Dung feed in $10m^3$ is 75kg. So the dung feed in $6m^3$, $8m^3$ and $10m^3$ equally to recommend from Biogas Company.

5.5.3 Use of Biogas

Most of the household used biogas for cooking purpose. So, the finding shows that most of the sampled household had used two burners in their kitchen. On an average, one household used biogas for 3 hours per burner. The minimum use was 2 hrs while maximum was 5 hrs. This cooking time is less than firewood cooking time.

5.6 Social Impacts of Biogas installation

The section includes the impacts of biogas in reduction of workload: impact of health, sanitation and other impacts.

5.6.1 Saving on Time and Reduction in Workload

This study shows that the use of biogas technology has been able to save time and also to reduce workload in household. Table 5.6.1 shows that situation of saving in time in detail.

Table 5.6.1 Saving on Time and Reduction in Workload

S.N.	Activities	Average time taken (hours/day)		Reduction in workload (saving in times) hours/day
		Before installation	After installation	
1.	Firewood collection	2hrs	1hrs	1
2.	Cooking	2½hrs	1½hrs	1
3.	Washing utensils	2hrs	1	1
Total average time taken per house per day		6 ½ hours	31/2 hr	3 hrs

Source: Field Survey, 2009.

Table 5.6.1 shows that the average time taken per day before installations 6½ hrs. After installation, 3½ hrs per day is spent on all activities and the saving of time per day is 3 hrs. This time (1 hrs per day) is used in different activities. Saving of time directly reduces workloads in household's activities.

5.6.2. Saving of money on energy

In this study, money is saved after the installation of biogas plant as compared to before installation of biogas plant. Especially in energy consumption. The situation of saving of money on energy in sampled households is presented in table 5.6.2.

Table 5.6.2 Average Saving of Money on Energy

S.N.	Types of Energy	Average Consumption of Energy (Rs./Month)		Average Saving (in Rs./month)	Cost Per Unit (In Rs.)	Average Saving (in %)
		Before Installation	After Installation			
1.	Firewood	800	300	500	150/ Bhari	62.5
2.	Kerosene	300	100	200	58/ Liter	66.7
3.	LPG	400	250	250	1125 Cylinder	50
Total Average (in Rs.)		1500	650	950		63.33
Annual saving amount of money is (950×12) Rs. 11400 1 Bhari = 50kgs. Cost per unit (Rs 3)						

Source: Field Survey, 2009.

Table 5.6.2 shows that the amount of money which saved after the installation of biogas plant. Before installation Rs. 1500/- was spent but after installation it is Rs. 650/. Hence, the average saving amount of money is Rs. 950/- per month. This table also classified that the annual saving amount of money (950×12) is Rs. 11400 can be contributed to pay the loan on installment of expenditure of biogas plant.

5.6.3 Utilization of Saved Time

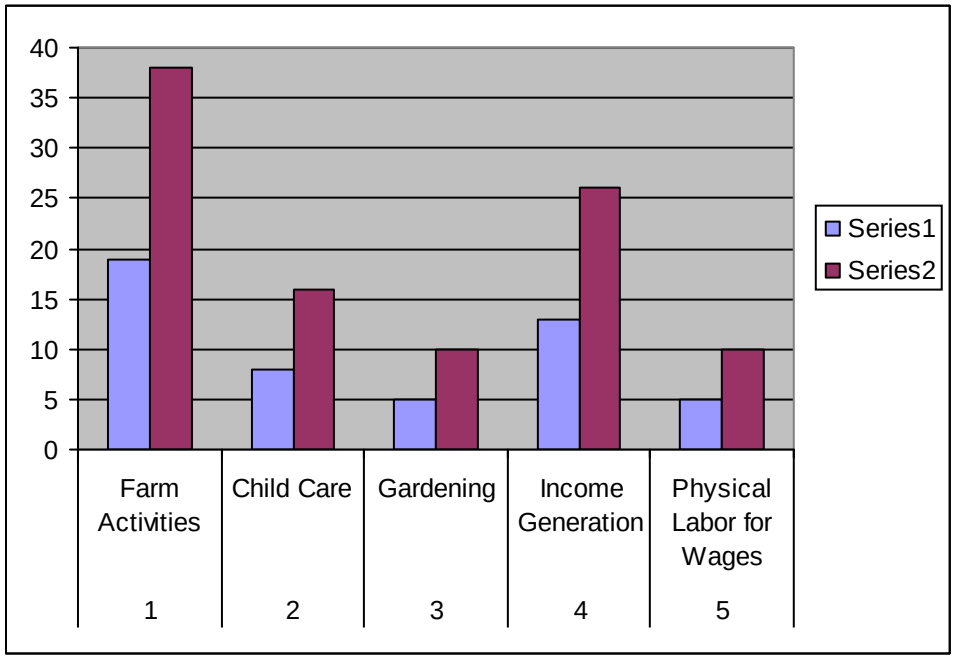
As shown in table 5.6.3 the average time saving per day is 3 hrs. It has been utilized in different activities. Saving of time has reduced the workloads in household activities. The use of saved time is presented in table 5.6.3.

Table 5.6.3 Utilization of Saved Time

S.N.	Activities	No. of Households	Percentage
1.	Farm Activities	19	38
2.	Child Care	8	16
3.	Gardening	5	10
4.	Income Generation	13	26
5.	Physical Labor for Wages	5	10
Total		50	100

Source: Field Survey, 2009.

Table 5.6.3 shows that about 38 percent of respondents out of total interviewed reported that they use their saved time on farm activities. Followed by 26 Percent use on Income generation, and 10 percent use the saved time on Gardening. 16 percent of respondent out of total interviewed sampled household reported that they use the saved time on child care and 10 percent use on physical labor for wages. Data clearly show that the saved time after the installation of biogas plant has been used on production activities.



5.7 Health and Sanitation

The study has shown that biogas has positive impacts towards health and sanitation of the respondents. Change in surrounding after the installation of biogas plant and the feeling of the menace of flies, or mosquito. Remarkable achievement has been made on health and sanitation of household. The situation of health and sanitation is presented below.

5.7.1 Change Found in Surrounding After the Installation of Biogas Plant

Table 5.7.1: Change Found in Surrounding

S.N.	Change Found	No. of Households	Percentage
1.	In Health	14	28
2.	In Hygiene	10	20
3.	In Sanitation	9	18
4.	All of Above	17	34
Total		50	100

Source: Field Survey, 2009.

Table 5.7.1 shows that about 28 percent respondents out of total interviewed reported that they found change in health, followed by 20 percent found change in hygiene. And only 18 percent respondents out of total interviewed reported that they found change in sanitation and 34 percent all of above. The change is considered the improvement in all these given aspects in this study.

5.7.2 Toilet Attached With Biogas Plant

It is found that majority of the plant owners have not attached toilet with the biogas plant.

Table 5.7.2 Toilet Attached with Biogas Plant

S.N.	Toilet Attached	No. of Households	Percentage
1.	Attached	3	6
2.	Not attached	47	94
Total		50	100
Reasons for not attach toilet with the plant.			
S.N.	**Reasons**	**No. of Households**	**Percentage**
1.	Dirty	34	72.4
2	Separate toilet	3	6.4
3	Sufficient of gas	8	17
4	Others	2	4
Total		47	100

Source: Field Survey, 2009.

Table 5.7.2, shows that majority of the households out of total interviewed reported that they have not attached toilet with biogas plant (94%) where as (6%) reported that they have attached toilet with biogas plants.

5.7.3 Feeling on the Menace of Flies or Mosquito

Table 5.7.3: Feeling on the Menace of Flies or Mosquito

S.N.	Activities	No. of Households	Percentage
1.	Decrease	6	12
2.	Increase	40	80
3.	Remained Same	4	8
Total		50	100

Source: Field Survey, 2009.

Table 5.7.3 shows the distribution of feeling on the menace of flies, or mosquito, majority of the respondent 80 percent out of total interviewed reported that the menace of flies or mosquito Increase ,Decrease majority of the respondent 12 percent and 4 percent of respondent remand same.

5.7.4 Money Spend on Health Treatment

In this study, amount of money spend on health treatment has also been studied. The money spend on health treatment is presented in Table 5.7.4.

Table 5.7.4 Money Spend on Health Treatment

S.N.	Treatment Item	Average Money Spent on Health Treatment per year (in Rs.)		Saving (in Rs.)
		Before Installation	After Installation	
1	Respiratory problem	7000	3000	4000
2	Others	5000	2000	3000
Total		12000	5000	7000

Source: Field Survey, 2009.

Table 5.7.4 shows that the amounts of money spend on health treatment before and after installation of biogas plant. It also shows the saving amount of money per year. After

installation of plant. Plant owners have been able to save Rs. 4000/- in the treatment of Respiratory problem, Rs 3000/- in the treatment of others (Headache, eyes etc) .The respondent or plant owner us able to save as 7000/-per year in the treatment of health related disease.

5.7.5. Raising in Social Status

Table 5.7.5 Rising in Social Status

S.N.	Raising in Social Status	No. of Households	Percentage
1.	Yes	38	76
2.	No	12	24
Total		50	100

Source: Field Survey, 2009.

Table 5.7.5 shows that about 76 percent respondents out of total interviewed reported that the social status has been raised after the installation of biogas plant whereas only 24 percent respondents reported that the social status has not been raised.

5.7.6 Benefited By the Biogas Plant

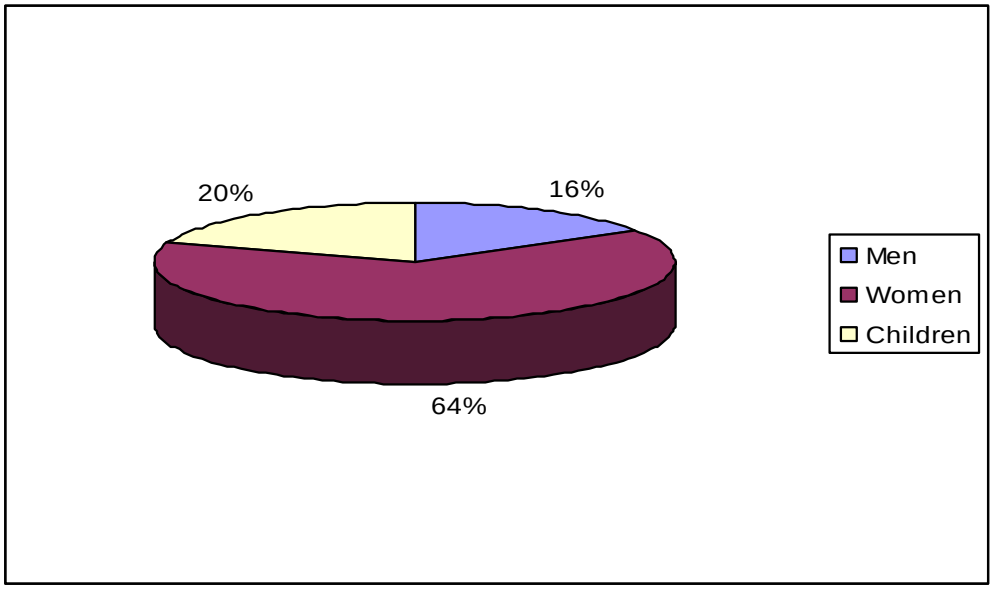
This study found that the women are highly benefited by the installation of biogas plant. It is also a social impact of biogas plant installation. The situation of benefited members of households has been presented in table 5.7.6

Table 5.7.5 Benefited Member by the Biogas Plant

S.N.	Benefited Member	No. of Households	Percentage
1.	Men	8	16
2.	Women	32	64
3.	Children	10	20
Total		50	100

Source: Field Survey, 2009.

Table 5.7.6 shows that majority of the respondents out of total interviewed reported that the woman are highly benefited by the biogas plant installation 64 percent followed by 20 percent reported that children are benefited. And 16 percent respondents out of total sampled households interviewed reported that men are benefited by the biogas plant installation.



5.8 Economic Impact of Biogas installation

5.8.1 Alternative Energy, Source, Consumption and Saving

The chief purpose behind the installation of biogas plant is to reduce the use of firewood including other fuels such as LPG and kerosene etc. Biogas technology has got popularity as an alternative energy source especially in rural area. Consumption of energy before and after installation of biogas and saving of energy as an important impact of biogas plant installation has been presented below in detail.

5.8.2 Energy Type Used Before Installation of Biogas Plant

Several types of energy were used before installation of biogas plant. They are mainly firewood, kerosene, electricity, agricultural residue and LPG. They are presented below in Table 5.8.2

Table 5.8.2 Energy Types Used Before Installation of Biogas Plant

S.N.	Energy types	No. of Households	Percentage
1.	Firewood	28	56
2.	Kerosene	6	12
3.	Electricity	2	4
4.	Agricultural residue	10	20
5.	LPG	4	8
Total		50	100

Source: Field Survey, 2009.

Table 5.8.2 shows that 56 percent of respondents out of total interviewed households reported that they use firewood for cooking purpose, 20 percent use agricultural residue, 12 percent use kerosene, LPG Use 8 percent and electricity use 4 percent. This table clarifies that majority of the respondents (28%) are dependent on firewood as an energy source for household purpose.

5.9 Slurry

Slurry is the by product of biogas from the outlet when dung is digested inside the plant (digester). Biogas is collected inside the dome and digested slurry is exited through outlet. It can be used in farm which directly leads to increase agricultural productivity.

5.9.1 Slurry Used in Farm

Digested slurry is used in farm. Majority of the respondents have used digested slurry in farm. The use of slurry in farm is presented in table 5.9.1.

Table 5.9.1 Slurry Used in Farm

S.N.	Farm Item	No. of Households	Percentage
1.	Crop	8	16
2.	Maize	13	26
3.	Wheat	7	14
4.	Vegetable	12	24
5.	Paddy	10	20
Total		50	100

Source: Field Survey, 2009.

Table 5.9.1 shows that majority of the respondents (26%) out of total interviewed reported that they use slurry on maize. About 16 percent respondents use on crop followed by 14 percent use slurry on wheat and 20 percent use the digested slurry on paddy. Remaining 24 percent is used on vegetables.

5.9.2 Forms of Slurry Used

Slurry is used in different forms. They are presented below. (Table 5.9.2)

Table 5.9.2 Forms of Slurry

S.N.	Forms of Slurry	No. of Households	Percentage
1.	Directly Liquid	31	62
2.	Making Dung	5	10
3.	In Dried form	8	16
4.	With Irrigation water	6	12
Total		50	100

Source: Field Survey, 2009.

Table 5.9.2, shows that forms of slurry used on farm. Majority of the respondents out of total interviewed reported that they use slurry in dried from (16%). About 62 percent respondents out of total interviewed reported that they use slurry in directly liquid form followed by 12 percent use with irrigation water and only 10 percent use by making dung.

5.9.3 Impact of slurry on Agriculture Production

In this study, slurry use has increased productivity mostly. The impact of slurry is presented below (Table 5.9.3).

Table 5.9.3: Impact of Slurry

S.N.	Impact of Slurry	No. of Households	Percentage
1.	Increased	41	82
2.	No change	5	10
3.	Don't know	4	8
Total		50	100

Source: Field Survey, 2009.

Table 5.9.3 shows that about 82 percent out of total interviewed households expressed that their agricultural production has increased whereas only 10 percent reported that the agricultural production is no change. 8 percent reported that they don't know about the situation of agricultural production after the use of digested slurry.

5.10 Problems and Perceptions the Use of Biogas Plant

There are so many problems of the use of biogas plant, maintenance, operational, dung availability, temperature, water availability, gas leakages and paying loan are the major problems of biogas use. In this section perception of respondents also have been dealt in detail regarding the use of biogas.

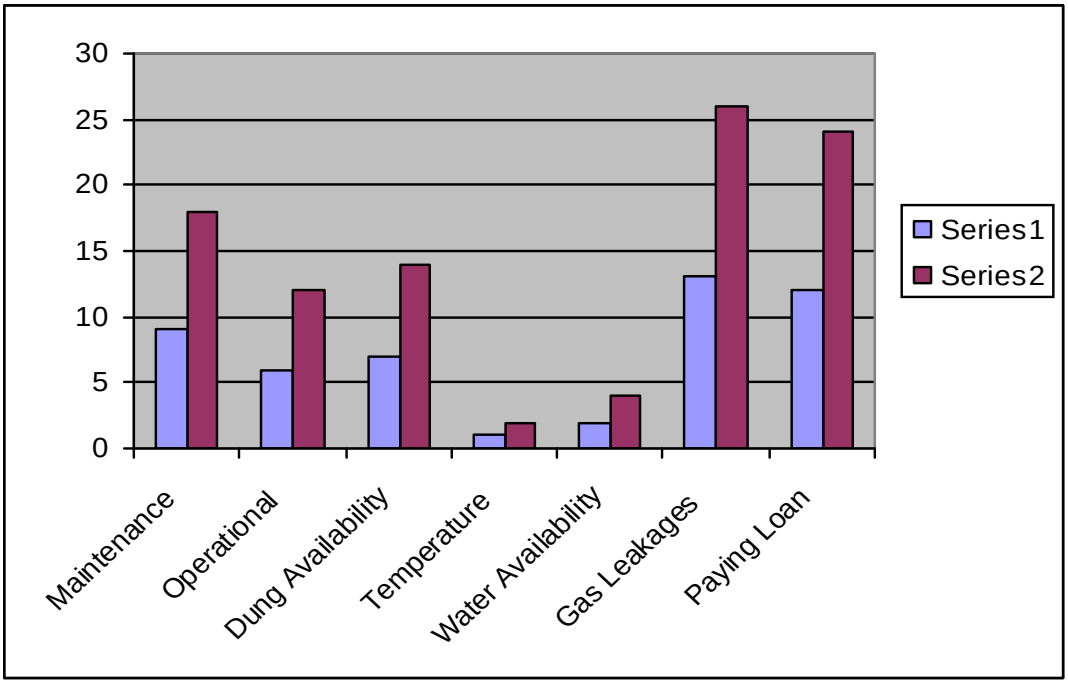
5.10.1 Problems of Biogas Plant

Table 5.10.1: Problems of Biogas Plant

S.N.	Problems	No. of Households	Percentage
1.	Maintenance	9	18
2.	Operational	6	12
3.	Dung Availability	7	14
4.	Temperature	1	2
5.	Water Availability	2	4
6.	Gas Leakages	13	26
7.	Paying Loan	12	24
Total		50	100

Source: Field Survey, 2009.

Table 5.10.1, shows that about 26 percent respondents out of total interviewed reported that they have problem of Gas Leakages followed by paying loan 24 percent, Problem of maintenance 18 percent , problem of operation 12 percent, Dung Availability 14 percent, problem of Water Availability 2 Percent and 2 percent respondent have problem of temperature especially in winter season .



5.10.2 Perception of Respondents

Table 5.10.2: Perception of Respondents

S.N.	Utility of Plant	No. of Households	Percentage
1.	Useful	21	42
2.	Very Useful	26	52
3.	Not Useful	3	6
Total		50	100

Source: Field survey, 2009.

Table 5.10.2, shows that about 52 percent respondents out of total interviewed reported that biogas is very useful and 42 percent respondent reported that biogas is useful.6 percent respondents out of total interviewed reported that biogas is not useful.

5.10.3 Opinion on the Overall Energy, Environment and Economic Condition

There are several opinions regarding the overall energy, environment and economic condition of the biogas plant installation. Opinions have been presented in Table 5.10.3.

Table 5.10.3 Opinion on the Overall Energy, Environment and Economic Condition

S.N.	Opinions	No. of Households	Percentage
1.	Improved	33	66
2.	Remained same	9	18
3.	Don't know	6	12
4.	Worse	2	4
Total		50	100

Source: Field survey, 2009.

Table 5.10.3, shows that about 66 percent respondent out of total interviewed reported that the overall energy, environment and economic condition has been improved. About 18 percent respondents out of total interviewed reported that the overall energy, environment and economic condition have been remained same. About 12 percent respondents reported

that they don't know and 4 percent respondents opined that the overall energy, environment and economic condition have been worst.

CHAPTER - SIX

SUMMARY, CONCLUSION AND RECOMMENDATIONS

6.1 Summary

Biogas technology is an appropriate alternative source of energy for household purpose. Forest resources are only the source of fuel wood for daily requirement of energy in rural area. Excessive use of firewood directly leads to deforestation. So the promotion and development of biogas is essential in the context of Nepal. In this context, the present study on the socio-economic impact of biogas plant installation in rural area was made.

This study was conducted in Keroun VDC of Morang district. This study is based on the sample of 50 households who were selected by using simple random sampling technique. In

this VDC, there are 2541 households. Out of them 315 households in ward no.5 and 154 households in ward no. 6. There are 1560 people live in ward no.5 and 720 in ward no.6. Total sampled households are 50. Total sampled households occupy only 6.39 percent of the total households in ward no. 5 and 6.

Before conducting the study, a brief review on existing literature was made. The review focused mainly on the impact studies. For the reviews, central library of TU, BSP office and biogas experts and biogas companies were consulted.

The major findings of the study are summarized as follows:

- Size of $6m^3$ biogas plants was more popular in this area as compared to other size of plants ($8m^3$, $10m^3$).
- This study found out that there were also the size of $8m^3$ biogas plants (24%) and $10m^3$ biogas plants (12%) installed. But these sizes of plants were installed before 10 years.
- The main source of loan for investment was saving and co-operative (56%).
- People installed biogas as a substitute to firewood and to have ease in cooking.
- The use of biogas is only for cooking nowadays but before the availability of electricity biogas was also used for lighting purpose.
- There is a considerable reduction in the workload of the family member and women are highly benefited (64%) by the biogas plant installation.
- Subsidies provided by the BSP were very encouraging factor for installation of biogas.
- Majority of time has been saved and the saved time has been used mostly in farm activities (38%) followed by income generation activities (26%).
- Average amount of dung feeding was lesser than the capacity of plant.

- Majority of the households have not connected toilet (94%) with the biogas plant.
- Medical expenses also have been reduced after the installation of biogas plant.
- Average livestock population size is 4.6 per household.
- Indoor air pollution of smoke or kerosene fumes had been reduced
- Average family size is 5.6 per household.
- Landholding size is 1 Bigha per household.
- The users felt reduction in health related problems such as Respiratory problem and others such as, headache and eye problems.
- Majority of the plant owners are not satisfied with the existing interest rate for loan and they also want to decrease the interest rate of the installation of biogas plant.
- Almost of all plant owners use slurry on farm and agricultural production has been increased.
- Majority of the respondents felt that the menace of flies or mosquito has been increased (80%).
- 76 Percent of respondents reported that the social status has been raised.

Majority of the respondents reported that the overall economic, environmental and energy condition has been improved

6.2 Conclusion

This study was conducted in Keroun VDC of Morang District. Thirty households out of 469 households have been taken as sampled households in two wards. This study was confined only in ward no. 5 and 6 of this VDC.

Being an appropriate alternative source of energy biogas technology has been proved very useful especially in rural setting.

Biogas has improved the socio-economic condition of biogas plant owners. It has reduced the workload of women in household activities because before installation of biogas plant they had to invest more time and after the installation of biogas plant they have spent less time on cooking, cleaning utensils and collecting firewood.

Biogas technology has also improved the health and sanitation situation. It has helped to reduce the prevalence of smoke borne disease such as respiratory problem, headache and eye Problem etc. This technology has also improved the overall energy, environment and economic condition of the plant owners.

This study also has reduced the rate of deforestation so it is highly effective on reducing the rate of deforestation. Before installation of biogas plant each household used to collect firewood from forest in large amount whereas after installation it has been reduced by 80 percent. Biogas plant has improved the surrounding environment. And it also has improved the economic condition by saving money spent on energy source such as kerosene, firewood and LPG.

This study has also found that the biogas plant by product (slurry) has many potential benefits as fertilizer for agricultural production. Bio Slurry has curtailed the use of chemical fertilizer and increased agricultural productivity with sustainability.

In a nutshell, biogas technology has been proved as an appropriate alternative source of energy to fulfill the increasing demand of energy requirement for growing population in rural setting of Nepal. It also has been able to protect the forest resource which is the main source for firewood in rural setting. Hence, biogas technology is very useful technology for rural households.

6.3 Recommendations

Following recommendations have been derived from the present study. It is recommended that the concerned organizations should take necessary steps to implement the recommendations of this study in the coming days.

- It is found that, all the plant owners have used the gas for cooking purposes. Thus, it is necessary to conduct detail studies about the uses of bio-gas to other income generating sector also.
- The use of human excreta and its advantages must be made known to the installers for this purpose training, seminars and workshop should be induesed regularly.
- Initiate R&D (Research and Development) for developing low cost models appropriate for the poorest section of the population.
- Encouragement should be given to utilize the saved time in the productive sector.
- Insufficiency of the gas in cold season has been the major problem for the biogas users. So proper alternative design of biogas plant is becoming a need.
- Provision of easy loan and cheap interest rate on loan should be made including higher percentage of subsidy
- Most of the villagers produce vegetables to sell. Information should be given to them for apply bio-slurry on high valued cercal crops. It may helps to increase the production and income to the concerned people.
- A great deal of time and money of households has been saved after installation of biogas plant. Therefore, women members should have chance to work in income generation activities. Concerned authorities should pay attention to this.
- Importance and benefits of the biogas plant should be demonstrated.
- Application of bio slurry on farm should be studied systematically, qualitatively and quantitatively.
- Due to the lack of resources and manpower, the GGC may not be able to send technical manpower to all constructed plants but this problem can be solved if the respective plant owners are provided with an operation and maintenance training. This will be more useful because plant owners can easily repair and maintain biogas plant themselves.
- Supervision which has been conducting by BSP should be regularizing because low quality construction may bring negative impacts on the users.

REFERENCES

AEPC (2001), *An Introduction to Alternative Energy Technology in Nepal,* Ministry of Science and Technology, Kathmandu, Nepal.

BSP (2007), *Biogas Sector In Nepal*: *Highlighting History Heights and Present Stats.* Kathmandu, Nepal, Biogas Promotion Group.

BSP (2007), *BSP Year Book, 2007,* April: Kathmandu: Biogas Support programme.

BSP (2008), *Annual Report 2007 BSP/Nepal*. Biogas Support Programme. Kathmandu: Biogas Support Programme.

BSP (2004), *Annual Bulletin*, Lalitpur, Nepal.

CBS (2002), *Population Census Report of Nepal-2001,* Kathmandu: Central Bureau of Statistics.

DDC (2062), "*DDC Profile*", District Development Committee, Morang, Nepal.

Devpart-Nepal (2001), *Research Study on Optional Biogas Plant Size, Daily Consumption pattern and Conventional fuel saving.* Final Report, Kathmandu: Biogas Support Programme.

Ghimire, P. (2001), *Biogas in relation to other Disciples (Environment, Ecology, Agriculture and Health*): Training materials in advanced Biogas technology for the teachers of the institute of Engineering centre for Energy Studies, IOE, Pulchowk, and Lalitpur, Nepal.

GGC Profile (2001/002), *Gobar Gas Tatha Krishi Yantra Pvt. Ltd.,* and Kathmandu, Nepal.

GGC (2001), "*GGC Profile*", Gobar Gas Company, Kathmandu, Nepal.

Karki, A.B. and Khadka, A. (2002), *A Study of Renewable Energy Technology with a Focus as Income Generating Activities,* ADPC, Lalitpur.

Karki, K.B. (2001), *Response to Bio-Slurry Application in Maize and Cabbage in Lalitpur District-Final Report,* ADEC, Jhamsikhel, Lalitpur.

Karmacharya, R. (1992), "*An Analysis of the socio-Economic impact of Biogas plants in Nepal*," unpublished M.A (Economics) Thesis submitted to Central Department of Economic, Tribhuvan University, and Kirtipur, Nepal.

MOF (2009): *Economic survey 2008/2009* MOF/GON/N, Singha Durbar, Kathmandu, Nepal.

MFSC (1999), *Forest Resource of Nepal, Forest Resource Information System Project.* MOF/ASC/HMG/Nepal

NEW ERA, JULY 1985, Biogas plant in Nepal, "*An evaluative study prepared for UNICEF*," Nepal.

NEPECON (2001), "*Biogas users' survey 200/2001, Final Report:* Alternative Energy Promotion Centre, Kathmandu.

NPC (2002), "*Tenth Plan" (2002-2007) NPC/HMG/N, Kathmandu, Nepal.*

RONAST (1994), "*Proceedings of IInd National Conference on Science and Technology* "– June 8-11, Kathmandu, Nepal.

Singde, S.K and Das, A.K. (1990), *Biogas development in Kaski district, project Report* Institute of forestry, T.U. Pokhara.

SNV-NEPAL (2004), *Final Report on the Biogas Support Programme Phase iii*, SNV, Kathmandu.

Singh, R.B. (2004), *A technical evaluation of Renewable Energy Biogas in Nepal* SCITECH Journal NEC, Vol 7 No. 2.

Shrestha, L.K. (2002), *Socio-Economic Impact of Biogas Installation in Rural Nepal,* M.A. Thesis submitted to Central Department of Sociology/Anthropology. Tribhuvan University, Kirtipur, Kathmandu, Nepal.

. **ANNEX – I (Photographs of study area site)**

Animal Husbandry

Farmer Collecting Dung

Worker Constructing Gobar Gas plant

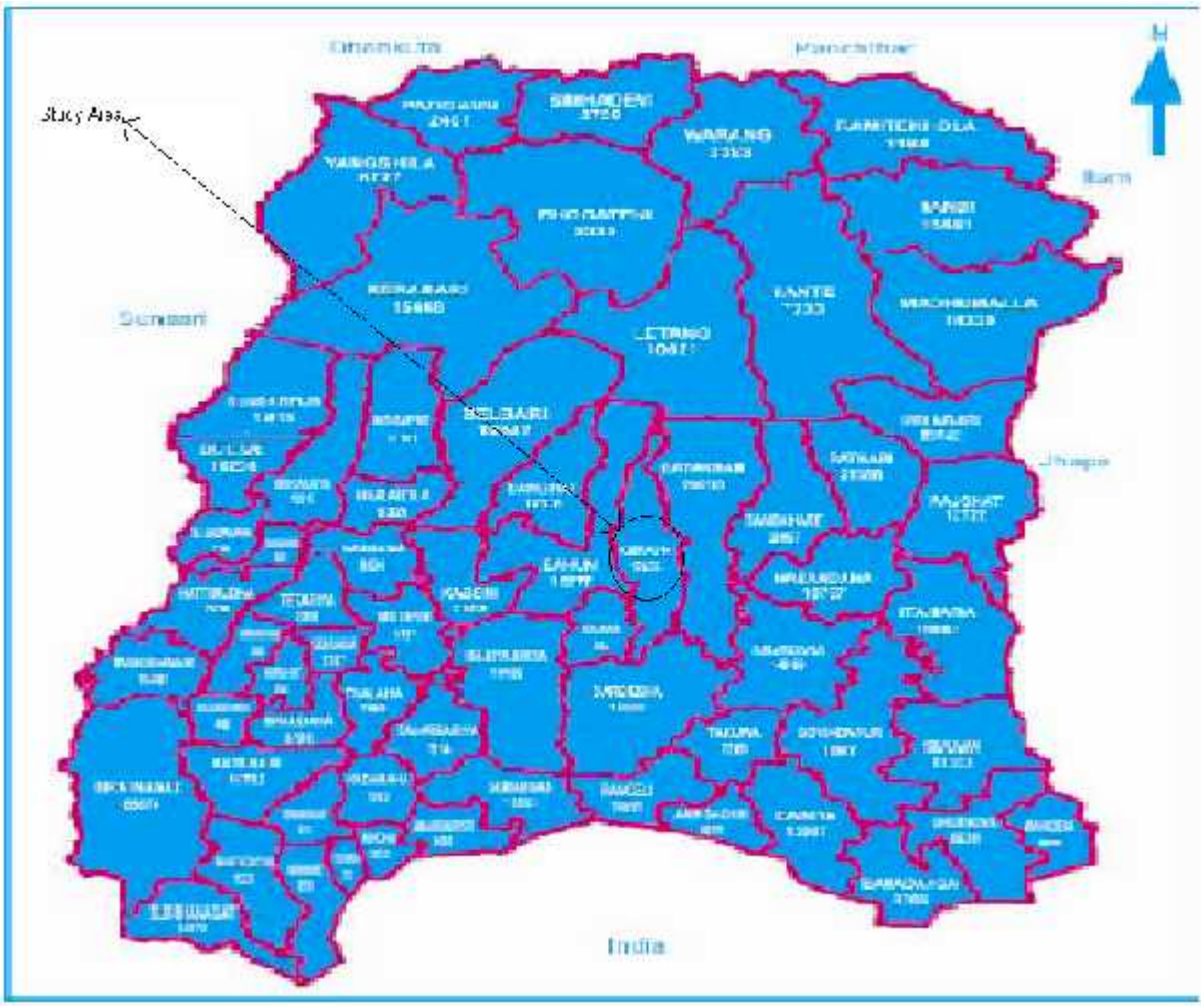
Worker Constructing Dome

Upper Part of Dome

Woman Cooking Food in Gobar Gas Stove

ANNEX – II

Map of Morang District



ANNEX - III

Household Survey Questionnaire

A. General Information:

Name of Plant Owner/Respondent.....
District: VDC: Ward No.:
Age/Sex: Caste/Ethnicity:
Education completed…
Name of Construction Company…
Name of financing company:
Family size… Plant size… m^3

1. What is your family occupation?
   a) Agriculture b) Business c) Service
   d) Agri. +Business c) Agri.+Service
   f) Agri.+Business+Service g) Others (specify) …….

2. How much agricultural land do you have (in kttha)?
   a) Below 10 b) 11-20 c) 21-30
   d) 31-40 e) 41 and above

B. Information on Biogas:

1. How did you come to know about biogas plant?
   a) Radio/TV b) Newspaper c) Neighbors
   d) GGC e) Others (specify) …….

2. Who encouraged you to install the biogas plant?
   a) Self interest b) NGOs c) Biogas company
   d) Bank e) Others (specify) …….

3. What are the reasons behind the installation of biogas plant?
   a) Easy and smokeless cooking b) Toilet
   c) Environmental protection d) Get rid of firewood collection
   e) Resource conservation

4. Cost of installation of biogas plant (in Rs.)

Total cost	Source of investment	Govt. subsidy amount

5. When did you install this plant?
   Year: …… Month: …….

6. Have you attached toilet with this plant?
   a) Yes b) No

7. If not, why?
   a) Due to the concept of unholy b) Dirty
   c) Separate toilet d) Sufficiency of gas
   e) Others (specify) …….

8. If yes, why?
   a) Due to lack of toilet b) To increase gas
   d) Lack of sufficient dung d) others (specify).....

9. How much dung is necessary for this size of plant (in kg)?
   .....

10. How much water is necessary for mixing the dung (in liters)?
    .....

11. What is the source of water to mix dung?
    a) Canal b) Pipe tap c) well d) Electric motor
    e) Others (specify) ……..

12. What is the chief purpose for the installation of biogas plant?
    a) Cooking b) Lighting c) Heating
    d) Digested slurry e) others (specify) ……

C. Livestock:

1. Dung production

Livestock	No. of livestock	Dung produced/day
Cattle		
Buffaloes		
Pigs		
Total dung produced per day		

2. For what this amount of dung is sufficient to feed your plant for your domestic purpose?
   a) Cooking b) Heating
   c) Lighting d) Others

3. Use of bio-gas:

Purpose	Number of burner	No. of mantles	Use hours/day
Cooking			
Lighting			
Total gas used per day (in hour)			

D. Slurry:

1. How much slurry do you generate daily (in kg)? .....
2. How much chemical fertilizer do you use?

Use of C.F.	Consumption		cost per unit	Saving	Saving amount (in Rs.)
	Before installation	After installation			
C.F.					
Total saving per month (in Rs.)					

3. In which crops do you use most of the slurry?
   a) Crop b) Maize c) Wheat d) Paddy
   e) Vegetable f) others (specify) …….
4. How do you use digested slurry?
   a) Directly (liquid) b) In dried form (solid)
   c) Making dung d) With irrigation water

E. Alternative Energy Source, Consumption and Saving:

1. Which source of energy did you use before installation of plant?
   a) Firewood b) Electricity c) Dung cake
   d) Kerosene e) Agricultural residues f) LPG
2. Do you save fuels after the installation of biogas plant?
   a) Yes b) No
3. If yes, how much fuel is saved in terms of money?

S.N.	Energy type	Consumption		Saving unit	Cost per unit (in Rs.)	Saving amount (in Rs.)
		Before installation	After Installation			
1.	Firewood (in kg.)					
2.	Kerosene (in liter)					
3.	LPG (in cylinder)					
					Total saving amount of money per month	

4. How much time do you require for cooking, firewood collection and washing utensils?

S.N.	Activities	Responsible person	Time allocated		Time saved per day (in hr)
			Before installation	After Installation	
1.	Firewood collection				
2.	Cooking				
3.	Washing utensils				
				Total time saved per day (in hour)	

5. in which activity, do you utilize this saved time?
   a) Farm activities b) Child care
   c) Gardening d) Physical labor for wages
   e) Income generating activity

F. Loan:

1. Did you take loan for installing the biogas plant?
   a) Yes b) No
2. If yes, which is the source of loan?
   a) Moneylender b) Commercial Bank
   c) ADB/N d) Rural Development Bank
3. How much percent interest do you pay for loan?
   a) 8-10 b) 11-13 c) 14-16
   d) 17-19 e) 20-22

4. Are you satisfied with the existing interest rate of loan?
   a) Yes b) No
5. If not, what rate do you think is appropriate?
   a) 3-5 b) 6-8 c) 9-11 d) 12-14
6. Is the saving from fuel wood, kerosene and or LPG sufficient to pay the annual installment?
   a) Yes b) No

G. Health and Sanitation:

1. Is there any health problem before installing the biogas plant?
   a) Yes b) No
2. If yes, which type of disease?
   a) Eye illness b) Lung disease (T.B.)
   c) Respiratory problem d) Asthma
   e) Headache f) All of the above
   g) Others (specify) …….
3. If there any change after the installation of biogas plant?
   a) In health b) In hygiene c) In sanitation
   d) All of above e) Others (specify) ……
4. What is your feeling on the menace of flies, or mosquitoes in and around your houses after the installation of biogas plant?
   a) Decrease b) Increase c) Remained same

5. Money spends on Health treatment.

Treatment item	Money spend on treatment		saving
	Before installation	After installation	
Lung disease			
Asthma			
Respiratory problem			
Others			
Total amount of saving per month			

H. Social Impact:

1. Does biogas plant raise social status of the family?

a) Yes b) No

2. Which member of family is highly benefited by the plant?
   a) Man b) Women c) Children

I. Perception of Respondent:

1. What are the problems faced with the installment of bio-gas plant?
   a) Maintenance b) Operational c) Dung Availability
   d) Temperature e) Water availability f) Gas leakage
   g) Others (specify) ……...
2. What do you think about the plant?
   a) Useful b) Very useful c) Not useful
3. What is your opinion on the impact of biogas plant on your overall energy, environment and economic condition of the household?
   a) Improved b) No change
   c) Worse d) don't know

Thank You!