CHAPTER - ONE
INTRODUCTION

1.1 Background

Situated in the lop of Himalaya, Nepal is located between the latitude $26^0$22' N to $30^0$27' North and longitude $80^0$4 East to $88^0$12' East and elevation ranges from 90 to 8848 meters. The average length being 885 km. east to west and average breadth is about 193 km. north to sough. The country is bordering between he two most popular countries of the world, India in the east, south, west and China in the north. Nepal is land locked country and home place of natural beauty with traces of artifacts. The northern range (Himalaya) is covered with snow over the year where the highest peak of the world, the Mount Everest stands. The middle range (hills) is captured by gorgeous mountains, high peaks, hills, valleys and lakes. The southern range (Terai) is the gangaitic plain of alluvial soil and consist of dense forest area. National park, wildlife reserves and conservation area. The temperature and rainfall differ from place to place. In the geographic diversity and varied climatic conditions census 2001 enumerated more than 100 caste/ethnic groups. Population projected for the year 2006 is 25.8 million. Nepal presents an example of being united in diversity are the history and has maintained its pride to be an independent and sovereign state.

Geographically the country is divided in three regions, mountain, hill and terai accommodating 7.3, 44.3 and 48.4 percent of the population respectively in 2001. Based on areas of districts there regions comprise 35, 42 and 23 percent respectively of the total land area of the kingdom. There are 5 development regions Easter Development Region, Central Development Region, Western Development Region, Mid-Western Development Region and Far-Western Development Region. There are 75 administrative districts. Districts

are further divided into smaller units, called Village Development Committee (VDC) and municipality. Currently, there are 3915 VDCs and 58 municipalities in the country. Each VDC is composed of 9 wards, municipality ward ranges from 9 to 35. Kathmandu is the capital city of Nepal.

Economic growth of the country has not improved substantially over time to overtake population growth. As the current population growth is 2.25 percent per annum, the gain achieved by development activities has been over shadowed by growing population. Little over half (58.2%) of the population of working age reported usually economically active in 2001. Population census 2001 reports that 53.1 percent population of age 10 years and over are employed and 5.1 percent are unemployed are gradually increasing into the GDP. The preliminary estimates of per capita GDP and per capita GNI in terms of US dollar are 315 and 322 of a current price respectively for the year 2005/06. 31 percent of the population are below the absolute poverty line. The current is Nepalese Rupee.

Nepal is an agricultural country. About 80 percent of the population depends on agriculture. Livestock holding is an important element of rural life. Dung serves as chief sources of agricultural fertilizer for fields.

1.1.1 Introduction to Biogas

Biogas is the mixture of gas produced by the methanogeniuc bacteria while acting upon biodegradable materials in an anaerobic (without oxygen) condition. Biogas is mainly composed of 50-70 percent of Methane (CH_4), 30-40 percent Carbon dioxide (CO_2), 5-10 percent Hydrogen (H_2), 1.2 percent Nitrogen (N_2), 0.3 percent Water Vapour (H_2O) and Traces of Hydrogen Sulphide (H_2S). Biogas is about 20 percent lighter than the air. It is an odourless and colourless gas that burns with clear blue flame similar to that of Liquid Petroleum Gas (LPG) allowing for virtually smoke free combustion and non-

toxic. Its calorific value is about 20 MJ per m^3 and burns with 60 percent efficiency in a conventional biogas stove (Karki and Dixit, 1984).

Biogas is used for cooking and lighting, refrigeration, engine operation and electricity generation. Today, biogas is used mainly for cooking (80%) and lighting (20%) in Nepal (BSP, 2007).

The biogas plants has been constructed under BSP has following characteristics

- Fixed Dome (GGC 2047 Model).
- Sizes 4, 6, 8 and 10 cubic metres.
- Feeding materials : Cattle dung & water and Human excreta.
- Individual household plants.
- Feasible up to 2,100 meters altitude.
- Modified GGC-2047 with heap composting technique is recommended for up to 3,000 meters altitude.

Source : BSP 2007

1.1.2 The History of Biogas in World and Nepalese Contest

The first person to observe the decaying vegetation produced a combustible gas was Alessandro Volta in 1776. He had noticed that when he disturbed the bottom sediment of the lake, bubbles of gas would rise to the surface. He noticed that when the sediment contained more plant material, more bubbles came up. In 1806 William Henry showed that Volta's gas was identical with methane gas. Tappeiner in 1882/84 showed conclusively that methane was of microbiological origin. The first plan for production of methane from wastes was set up in a leper asylum in India in 1900.

The interest in biogas reached to the peak in the beginning of the Second World War. In 1940, French scientists working in North Africa developed the technology of production of biogas from agricultural wastes and it was reported that about 1000 biogas plants were in operation in France and French North Africa by 1950.

Biogas was first introduced of Nepal in early 1950s. The first historical biogas system was introduced in 1955 at St. Xavier's school in Godavari, 20 km. South-east of Kathmandu by Late Rev. B.R. Saubolle, S.J. His observation of the system's performance and the people's reaction to the technology was indeed noteworthy. After this pioneering venture attempted by Father B.R. Saubolle it took almost 20 years to draw the attention of the Industries Commission of India (KVIC) has standardized the design of biogas plants in India. Even for the smallest plant, a continuous supply of 45 kg of fresh dung per day of necessary for this gas plant which installed for an exhibition in Kathmandu. On the auspicious occasion of the "Agriculture Year", a biogas program was launched by the government as a special program in 1975/76. The occasion also marked the disbursement of interest-free-lone for bio-digester construction. Altogether 199 units of biogas systems were then established in the country which marks the beginning of the growth in the implementation of biogas systems. Further momentum in the development took place in 1977 with the establishment of the Gobar Gas Tatha Agricultural Equipment Development Company (GGC) with three main shareholders - the Agriculture Development Bank (ADB/N), the Fuel Corporation of Nepal (FCN) and United Mission to Nepal (UMN) - a pioneering and leading biogas system construction company in Nepal (BSP, 2007).

In context of Nepal, since 1990, the continuous feeding type biogas digester, GGC 2047 model recognized as a standard biogas model, has been commonly promoted. The GGC 2047 is a modified version of the Chinese model fixed dome bio-digester. The BSP established under the Netherlands

Development Organization (SNV) in 1992, also gave approval to the GGC 2047 as the only standard model for promotion in Nepal.

Latter on, with the launching of BSP, under the Netherlands Development Organization (SNV) in 1992, necessary fund and infrastructure became available in order to implement the national biogas program smoothly. Since then BSP has been the only national level programmers and major driving force in the biogas sector. Due to the consolidated efforts of various actors (organizations and individuals) involved in the promotion and development of biogas sectors in Nepal, 1886,073 family-sized bio-digesters have been installed by July 16, 2007 covering 67 districts in all the five development regions of the country (BSP, 2007).

In 1992, BSP was introduced at different stage for massive dissemination of the technology in the country. In 1994, Nepal Biogas Promotion Group (NBPG) was established as an umbrella organization of all construction companies for the promotion and extension of the program. In 1996, His Majesty's Government of Nepal (HMG/N) set up 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 marking (GGC Profile 2001).

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 programme was incorporated in the seventh (1985-90) (NPC : 1985 : 90) plan 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).

1.1.3 Potential of Biogas in Nepal

For Nepal, being an agricultural country, livestock plays an important role in the Nepalese farming system. The total households with cattle and buffalo in Nepal were estimated to be 2.7 million in 2001 (CBS : 2001). Based upon the study of technical biogas potential of Nepal, it is estimated that a total of 1.9 million plants can be installed of Nepal out of which 57 percent in plains, 37 percent in hills and rest 6 percent in remote hills or in mountain region.

Potentiality and Biogas Construction :

Technical potentiality of biogas plants (2001) - 1.9 million plants

Total economic potential of biogas plants - 1 million plants

Source : BSP 2008

1.2 Statement of the Problem

Due to the population growth the demand for energy is increasing day by day in the country. Nepal government is not capable of supplying electricity in the rural and targeted people. People are becoming aware day by day and wants the different kinds of facilities i.e. solar Pv, radio, TV, biogas so on. Majority of people share energy consumption is met through traditional source like fuelwood, animal dung and agriculture wastages. The traditional biomass sources of energy share about 85.85 percent of total energy where as commercial and renewable limited to 13.45 percent and 0.61 percent respectively (Economic survey, 2007). The share of traditional energy sources has decrease from 96 percent in 1990 to 85.27 percent in 2002 (WECS, 2001). The sustainable supply of fuelwood was estimated to be 6.5 million tons while Nepal has been consuming about 11 million tons in 2001 (WECS, 2001). It has caused a sever pressure and environmental degradation. Due to this reason living standard of rural people has decreased i.e. health condition, education status, communication and awareness has decreased or constant. The problem

therefore, arises due to over consumption of fuel wood. The renewable energy sources are to be developed and biogas promotion will be significant one to struggle for improving this condition. Biogas energy will cut both traditional and imported commercial survey.

Biogas energy is comparatively advantages than other renewable energy sources like hydropower, solar and wind energy in rural areas. Biogas helps to improve the health condition of rural women and children due to the reduction of indoor pollution. Thus, it will be advantages for biogas energy development in rural development.

1.3 Objectives of the Study

The general objective of the study is to assess the social and economic impact of the biogas plant installation to its users. The specific objective are to :

1) To find the socio-economic conditions of biogas user households.
2) To find out the impact of biogas energy in rural Nepal.
3) To analyze the problems and prospects regarding the biogas energy.

1.4 Rationale of the Study

In Nepal, the traditional use of renewable source of energy such of solar, hydro energy, wind etc date back to centuries. Initially these sources were used with crude type of technological development and invention that have taken place worldwide, more efficient technologies and end use devices were adopted to exploit the renewable energy sources. The dissemination of renewable energy technology had started only a few decades ago in Nepal. But it was in early pieties during the oil crises, the government of Nepal took initiative for the

development of a renewable energy resources as a substitution for limited supply of fossil fuels and depleting forest resources. Subsequently the government realized the head of fulfilling institutional gas that existed in the renewable energy sector for the promotion and development of renewable energy technology and created on institution known a Alternative Energy Promotion Centre (AEPC) under the Ministry of Science and Technology (MST) in 1996 (AEPC, 2007). It objectives are to develop and promote different sources of renewable energy considering the fact that the maximum utilization of these renewable energy sources could contribute to sustainable rural development and environmental conservation.

Biogas technology has a high potentiality and is more feasible in comparison to the installation of costly micro hydro power pants, solar and wind energies. Biogas technology is a rural based technology and the progress achieved in encouraging. But most of the biomass users are using biomass energy only in cooking human food stuff.

Many studies done an impact of biogas have drawn the positive impacts on women health and their socio-economic activities. The outcomes of the study will be of great importance to plan appropriately for further development of the technology and it will be helpful to solve the problem of existing energy crisis scenario.

1.5 Limitation of the Study

This study attempts to limit itself only in Phidim VDC of Panchthar district. So the generalization of this study may or may not be applicable to other parts of the nation. All economic variables have been calculated in terms of local price, if necessary.

This study considers only with the socio-economic aspects of biogas technology, it does not considered with the technical aspects of biogas plant. Though it does not cover the while aspects of biogas technology but it can be references for further studies.

The samples size of households (HHs) used for the particular study gets the 15 percent in total households in the study area and it is assumed that the study provides the representative figures of socio-economic impacts of biogas plants.

CHAPTER - TWO
LITERATURE REVIEW

Review of literature is an essential part of all research works. A critical review of the literature helps the researcher to develop a thorough understanding and insight into previous research works that relates to the present study. It is also a way to avoid investigate problems that have already been definitely answered.

2.1 Conceptual Review

Biogas is the mixture of gas produced by Methanogenic bacteria while acting upon biodegradable material in an anaerobic condition. It is mainly composed of 50-70 percent methane, 30-40 percent of carbondioxide and some other gases. It is 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 a wet gas as it picks of water rapor from slurry. Biogas is about 20 percent lighter than air. The main component of biogas is methane which a colourless, odorless and tasteless. But due to the presence of other gases, it gives some smell similar that of garlic or rotten eggs. (GGC, 2001, 7)

The volume of gas produced from the plants of both types totally depends upon the temperature inside the digester. Higher the temperature, higher is the level of daily gas production. Temperature between 30-35 degree centigrade is taken as suitable one for fermentation. Likewise pH of 7 to 8 is considered as the best (ADB/N, 1986).

According to biogas support program (phase III). The biogas technology is one of the viable devices among alternative energy sources in the country

Nepal. 172,000 number 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 biogas system can be installed in Nepal.

2.1.1 Sources of Energy and Uses

The sources of energy are primarily conventional in Nepal. The per capita energy consumption in Nepal is very low and most of the energy is being used for domestic purpose (WCCS, 2002). The energy consumption pattern in 2006, 77 percent fuel wood, 6 percent animal waste, 3 percent agriculture residue, 14 percent imported petroleum product, coal, electricity and 1 percent renewable energy (Rural Energy Policy, 2063). There data indicates the dependency on forest resources are leading dwelling of forest area and hamper in environment. Due to constraints of technology, finance, politics and other the country is unable to create a favourable environment to utilize the high potentiality of water resources.

Energy is the basic requirement of all the lives. The historical review shows the wide variety of technologies used over the centuries by human cultures to produce warmth, light, heat for industrial process and motion. Today we see that, the world energy consumption tend is rising due to the increase in the population growth and life style, but total fossil energy reserve is constant. Moreover, lots of examples in the near history has threatened us from the consequences towards harmful effects of consumption of these resources. The various energy problems exist today and they can be summarized as :

- Environment problems (Green houses effect and Global warming) climate change.

- Sustainability problems
- Social problems.

Besides these, other problems lives deforestation due to excessive use of biomass also exist in developing countries like Nepal. Biomass is still the most important sources of energy for greatest part of world's population. Main reason is the tradition of five and the availability as a non-commercialized energy which is decisive in rural areas and for economically weaker sections.

Nepal has low per capita energy consumption (ISGJ) compared to other developing and developed countries. Around 76% of the total energy consumed is met by the fuelwood. The share of the electrical energy is around 1.5 (AEPC, 2006). In addition around 40% of the population has access to electricity. Out of this around 15% of rural population has access to electricity. Because of very harsh terrain conditions and slow pace of grid extension, it is not favourable that majority of rural population will have access to grid connected electricity in near future (AEPC, 2006).

Livestock farming is an important component of agricultural system in Nepal. The households with cattle or buffaloes in Nepal was estimated to be 2.7 million in 2001 (BSP, 2004). Based on this, the technical potentiality of biogas plants installation is assumed to be around 1.9 million. A total number of 1,60,000 plants were installed under BSP by the end of Chaitra 2063 (SHH 2007).

Biogas is the mixture of gas produced by methanogenic bacteria while acting upon biodegradable materials i.e. cattle dung, human excreta condition within the temperature of 26^0c to 36^0c for a certain period. Biogas is mainly composed of 60-70 percent methane, 30-40 percent carbondioxide and some other gases (BSP, 2005). Biogas is colourless and smokeless gas that burns

with clear blue flame similar to LPG. It is 60 percent efficient in a conventional biogas stove (AEPC, 2000).

For promoting the alternative energy technology. Nepal government has set up an alternative energy promotion centre under the ministry of science and technology in 1996. There are many private companies working for the extension of biogas technology under BSP, SNV/N. Around 97 percent of the constructed plants are in operation and 80 percent of bio slurry is utilized as an organic compost fertilizer. The biogas programme has been launched in 65 district (BSP, 2004).

2.1.2 Energy Situation in Nepal

The energy resources of Nepal can broadly be classified into three categories : traditional, commercial and alternative energy. Traditional energy includes firewood, agriculture and animal wastes (dung cakes). Commercial energy consists of electricity petroleum product and coal. Petroleum and coal are imported which amounts almost one third of the country's export earning. Energy sources other than traditional and commercial energy are included in the alternative energy.

Nepal has potential Hydropower estimated of 83000 mw of which 40000 mw is considered to be technically feasible. But till to data, only 600 mw of hydropower has been installed which contributes about 1 percent of total energy requirement of the country.

Firewood contributes about 78 percent of total energy consumption, which is mainly consumed in rural Nepal. Forest (which includes commudity, public, private forest) and private firms are the sources of firewood. The resources for firewood are depleting due to overexploitation and lack of proper management. Other biomass sources, agriculture residue and animal dung contribute about 10 percent of energy requirement.

2.1.3 Energy Situation in Panchthar District

In urban areas most people use kerosene, Bhuse Chula, and liquefied petroleum gas (LPG) for cooking purpose. But in rural area, people use firewood for cooking purpose. Therefore, firewood has been the chief of energy source in the district.

Most of headquarter of Panchthar district Phidim has got electricity supply. The electricity is used mainly for lighting purpose only. Now biogas solar system, improved cooking stove are drawing attention of the rural people gradually.

2.1.4 Subsidy Rate and Achievement of Biogas Plant

The government has inspired people to install the biogas plants providing subsidies which vary according to the geographical settings.

Table 2.1

Subsidy Rtes for (2006/07)

Region	4, 6, 8 & 10 cubic meter
Terai Districts	Rs. 9000
Hill Districts	Rs. 12,000
Remote Districts	Rs. 16,000

Source : BSP : 2008

A total of 18 districts are categorized as Low penetration Districts now. These districts receive extra Rs. 700/- subsidy per plant. The government piloting of "additional subsidy for the poor" has been initiated from FY 2006/07 in collaboration with Germen bank which has a standard criteria and mobility to identify the poor and deliver services in large part of Nepal (BSP, 2008).

According to BSP, around 98 percent of the total plants installed since 1992 are operational. About 80 percent of the total plants are of four cubic metre and six cubic metre sizes; a six cubic metre plants requires around 36 kg of cow dung per day in Hilly areas and 45 kg of cow dung per day in Terai areas (mixed with an equal amount of water) to get a stove burning for 3.5 hours. This increase with altitude because of the retention time (average duration that dung remains in the digester). Around 60 percent of the biogas consumed is used for cooking (Karki, et. al., 2005).

Finally the total achievements of BSP up December 2008 are as follows:

- Installed 172,858 biogas plants and 98 percent of constructed plants are in operation.
- 102,719 toilets are constructed (65%) motivated for construction and connected with biogas plants.
- 85 percent of bio-slurry is utilized as and organic compost fertilizer.
- Biogas programme is developed as a first CDM project in Nepal.
- 1,080,000 persons are directly benefited by biogas plants.
- 11,000 persons got employment.
- Annual fuel savings : Firewood 380,000 tons, Agricultural Fossil 66,500 tons, Cow dong chips 11,400 tons, Kerosene 4,750,000 liter.

Source : BSP, 2008

1.1.5 Additional Subsidy for the Poor

In line with the programme objective and discussions with the proramme partners, piloting of "additional subsidy for the poor" has been initiated from FY 2006/07 in collaboration with relevant development organizations mainly with Germen Banks which have a standard criteria and modality to identify the

poor and deliver services in large part of Nepal. For piloting, the subsidy rates are NPR 1,500 (Euro 16.32) for Terai, NPR 2,500 (Euro 27.20) for Hill and NPR 3,500 (Euro 38.08) for Remote Hill districts. This additional subsidy provision is applicable only for plant sizes 4 to 6 cubic meters. We are targeting the poor who have at least some land and minimum of one adult cattle.

From the learning so far, it is too difficult to reach the poor, unless the additional subsidy is substantial or there is easy availability of micro credit without physical collateral, to cover around NPR 15,000 to 20,000 (Euro 165 to 220). The idea here is to pilot it in 2007 and gain experience. It is planned to undertake a review of the piloting and develop a proposal, which will include a modality and revised subsidy rates for incorporation in the government's Subsidy Policy and Delivery Mechanism.

2.2 History of Biogas Production

In the past decades, several research studies and investigations have been made in innovation and development of biogas technology. Moreover seminars, workshops, symposiums and conferences have been held both in national and international level to reach the present stage of this technology. Similarly, a number of books, booklets, journals, reports, and bulletins have been published pertaining of biogas technology. Thus a brief review of the literature on biogas technology was made to have good knowledge about the subject matter and analysis of the previous works done on the field of biogas energy sector thereby providing a solid feed back to the researcher. The review is especially focused on the socio economic impact of biogas on its user group.

The workshop on "Biogas Technology and Utilization of Asia and Pacific Region" held at Manita in 1975 was organized by ESAP. There were altogether 20 participants from 12 different countries. Every participant analyzed about working strategies, problems faced and proposed programme on biogas energy sector. The contribution of the biogas plants especially to rural people and

prospective expansion of biogas technology were also discussed in each nation's context. (ESAP)

United Nations (UN) (1979) has carried out a study of biogas. In the journal entitled "Energy Resources Development Series", it is viewed that the commercial fuels are not easily available in rural area. Despite increase in their costs day by day the villagers mainly depend on non-commercial fuels like firewood, cattle dung cakes and agriculture waste. This encourages reckless demolition of tress to meet the needs of fuel which adversely affects the rain fall. This in turn disturbs the ecological balance. Use of cattle dung as fuel deprives the soil of the organic manner which results in poor crop yield.

New ERA (1985) has made a significant study on biogas programme in past review of Nepal under the title "Biogas plants in Nepal : Alternative Study". The objective for conducting the study is to evaluate the working condition and the economics of gobar gas plants. Another reason for o this study is to see how the subsidy program for community gobar gas plants has benefited small farmers. This study attempts to evaluate the working of the gobar gas plants, both individually and community-owned, with emphasis on the plants. It also deals with the socio-economic characteristics of the plan owners versus non-owners. The volume of gas produced from the plants of both types totally depends upon the temperature inside the digester. Higher the temperature, higher is the level of daily gas production. Temperature between 30-35^{0}c is taken as suitable one for fermentation. Likewise pH of 7 to 8 is considered as the best. (ADB/N, 1986)

According to the final report of biogas use survey 2000/001. A biogas user household saves 990kg of firewood and 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 biogas plants. Above half of the respondents used the slurry in the cultivated land and

other users in gardens. The decrease in occurrences of disease was the positive benefit of biogas 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 biogas plant in the value problems, high rate of interests, high cost and non availability of spares, increased prevalence of mosquito.

According to biogas support program (Phase III). The biogas technology is one of the viable devices among alternative energy sources in the country Nepal. 1,87,000 number of plants are build by BSP-Nepal in the end of fiscal year 2007/08. If this capacity could be utilized in on effective manner. It can fulfill about 10 percent of the countries total energy requirement without adversely effecting the production of the agriculture. Based on the estimated that a total number of 1-9 million domestic biogas system can be installed in Nepal.

Biogas is a wet gas as it picks up water vapor from the slurry. Biogas is about 20 percent lighter than air. The main component of biogas is methane which is colorless odorless and test less. But due to the presence of other gases, it gives some smell similar to that of garlic of rotten eggs.

Subsidies plays a major role in biogas promotion, the annual targets have been missed since couple of years, primarily due to the conflict situation in the country. Equitable distribution of plant construction and substainabiity of the sector area serious issues. Attempts have however been to address these issues through the Multi Annual Plan (June, 2006- June 2009) and subsequent annual plans of BSP. A hope raise by CDM (Clean Development Mechanism) has been so. Lived as the developed methodology was scrapped and development of a new one become too complicated and time taking. (Raj Saroj, Executive Director BSP, Nepal)

2.3 Review of Past Studies

Bista (1981) has focused that biogas is considered as one of the most reliable alternative energy resource replacing fuel wood of which the greatest part is used for cooking especially in rural areas of Nepal. It means that there is the urgent need for substituting rural energy through non-conventional energy resources.

Karmacharya (1992) has shown the comparative analysis of installation of biogas. Dhadikot village as Bhaktapur district for will site and Phoolabari village of chitwan district for Terai site were chosen for the study. A total 20 samples were chosen, each site consisting of 15 samples.

This study has taken economic approach and the analysis is touched one the various type of benefits obtained and savings made through the installation of biogas plants. Energy situations in global and Nepalese context has been dealt in detail.

Britt (1994) has shown concise overview of studies specifically designed to measure the effects of biogas on women's workloads in different geographical setting of Nepal and the studies were done in Rolpha, Rupandehi, Nuwakot and Chitwan district.

The result from the study states that given the overwhelming workloads for women in most part of Nepal, the saving in time in the majority of instances is quite significant.

But it remarks that the introduction of biogas does not appear to fundamentally alter the position of women. So called traditional or unequal

patterns in the division of labours are sustained, with working women for long hours simply substituting one labour activity for another.

I found from the study that estimated time saving for women in Rupandehi was 4 hours and 30 minutes (on average) in Nuwakot. However, in a village based research, the estimated time saving was found to be 1 hour and 55 minutes in Pithuwa.

ADB/N (1986) has carried out a comparative study on biogas from two hilly districts namely Kavre and Kaski and two Terai from namely Jhapa and Rupandehi. The major objectives of the study of assess the saving kerosene and firewood by the use of biogas to study the benefits from the use of slurry in crop production increase and to work out economics of plant operation.

The study concluded that the biogas plant owners with an average family size of 11 in the Terai and 9 in the hills are literate and involved in agriculture. The average size of holding for the owners in the terai is 6.9 hectors while that in the hills is 2.3 hectors showing that mainly the medium and large families have installed the plants. The plant owners in both the areas with bigger size are having comparatively higher number livestock heads. The average number of livestock head in terai (9.3) is higher than the hills (5.7). although the livestock heads per plant increased by 67 percent in terai and by 73 percent in hills after the project, the increment did not suffice to meet the corresponding requirements as per norms established by the company. As a whole, livestock number with the plant owners is less by 18 percent in the terai and 35 percent in the hills.

The problem of water is serious in hills. About 49 percent in the terai and 61 percent in the hills reported that they do face the problem of shortage of water. Both the areas are using the biogas only for cooking and lighting purposes. On in average a plant owner does have more units of both biogas stoves (2.2 units) and lamp (3.5 units) in the terai as compared to hills (1.0 and 2.7 units respectively). Level of gas production for the same size of plant in the terai is higher than the hills. It is because of comparatively higher dung feeding rate as well as temperature in terai. The ratio of firewood to kerosene saving in terms of value in the terai comes to 73.27 while it is 81.19 in the hill.

The average annual slurry production from plant size of 10 cm., 15 cm. 200 c. ft and 350 c.ft. in the terai comes to 115, 206 and 369 quintals for plant size of 10 cm, 15 cm and 200 c.ft respectively in hills. The majority or owners in both areas are using the slurry into the form in the form of the compost by mixing with other fame residue.

The average annual employment per plant owner due to cropping in terai and the hills comes to 856.9 and 520.3 man days an increase of 17 percent and 9 percent respectively after the project. However the annual employment per hector of the land in the hills (236.5 man days) is higher than in terai (124.2 man - days).

Sigdel and Das (1990) surveyed biogas plants is rural context. A total of 13 plants from lekhnath village near pokhara were token into consideration. It was found that there was a growing awareness in this technology as a forest saver. People have felt that it would be more applicable in a semi urban area

where people were richer. Since the village people suffered from problems of finding capital to repay loans and installation cost was found to be high, realization of temperature constraint and the strong need for government subsidy could be observed.

Keizer (1993) carried out a research entitled "Effect of Biogas on the Workload of Women in Nuwakot District". The research was conducted with the helps of structured questionnaire. In order to obtain relevant information, interviews were conducted with female users of 50 biogas plants. All biogas plants in his research were fixed concrete dome plants constructed by GGC. Most of them (80%) had a size of $10m^3$ on the average, the plants were three years old.

Regarding division of labour tasked related to biogas, women carried out 56 percent work while the were responsible only for 11 percent of task. Other family members and servants did the remaining 33 percent task. The research revealed that the biogas influences women's workload positively. The quality of the work got improved activities as cooking cleaning the cooking pots became easier and it was held very pleasant to cook in clean environment. Less five was needed to be collected which in general is a tdious task.

The physical condition of women using biogas got improved because cooking as biogas did not cause headache, lung disease and eye problems. Interestingly, even old asthmatic women not able to cook on wood anymore, were able to cook again on biogas.

Because women have to work many hours a day. Saving time is regarded as workload reduction. The data in this research showed that biogas reduced the time spent on daily activities with approximately 2 hours and 30 minutes per household. On a while working day, for activities to be done everyday, this result is regarded as rather significant.

Ghimire (1999) has tried to document the benefits of biogas produced by harvesting the more popular and appropriate renewable energy resource cattle dung and assessed the immediate impact of biogas on respective users. The outcome of the study revealed that the main benefits of biogas plants to its owner was the cooking and lightening facilities that saved a considerable amount of money.

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 every positive impact on the users which is well appreciated by them. The total time saving of 1.22 hours per day/family on an average from the installation of biogas plants suggests that it has been successful to lower the family workload.

Karki (2001) has focused the study in Dhading district. The study was mainly focused on the adaptation of renewable energy technology and its impact on income generating activities. The outcomes of this study shows that the three among the five biogas users reported an increase in crop production by 5 to 10 percent due to the application of bio slurry. However users of other types of renewable energy technology did not report on increase in crop

production as experienced by the biogas users. The biogas users household's main income generating activities are agricultural based wine (Rakshi) production. Fertilizer required for vegetable production has been reduced and so the amount of money spending on chemical fertilizer.

2.4 Chronology of Biogas Development in Nepal

Year	Organization/Individual	Even
1995	Reverend father soubolle, St. Xaviers School, Nepal	Installation of a domestration biogas system in Godawari school, Ktm
1968	Khadi and Village Industries Commission, India	Constructed a biogas system for exhibition.
1974/75	Department of Agriculture, Nepal	Initiated a program to install 250 floating drum design biogas system.
1977	Development consulting services, Nepal	Build four floating drum type (KVIC design) biogas system.
1980	Gobar Gas Company (GGC)	Modified Chinese fixed dome design introduced.
1990	Gobar Gas Company (GGC)	Present fixed dome system recognized as the appropriate design for Nepal.
1991	HMG/N, ADB/N and GGC	A proposal under the name of biogas support program was submitted to the Directorate General for international co-operation of the Netherlands Government.
1992	HMG/N and DGIS	Formalization and initiation of SGV/BSP in Nepal. HMG/N - Subsidy component GDIS - Financial support. SNV - Managerial technical and advisory service
1997	Kfw	Provision of subsidy and credit support.

Source : Bajgain and Shakya, 2005.

2.5 Gender Issues in Biogas Plants

Biogas units are normally described as being installed in a household. The decision to invest in biogas unit is rural areas is usually taken by men in the households (Master 1989, Yound 1992, Agrwal 1997). On the other hand the women (including girls) as the household are mainly responsible for the domestic chores relating to water collection, cooking and collection or preparation of fuel (CSE 1995, Jain 1996, Kul Shrestha etal 1996). When there is a biogas unit installed in a household, the women will become its main managers and user (Gustavsson, 2000).

The gender issues in biogas plant are described as follows :

Ownership of biogas plants : the ownership of biogas plant according to sex.

Sex	No. of biogas owned HH	Percentage
Male	546	91
Female	54	9
Total	600	100

Source : An Integrated Environment Impact Assessment for the biogas support programme Nepal, Biogas support programme, Nepal 2002.

2.6 Overview Problems and Prospects

All the 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 methone generation. The technology of using other plant material as feedstock is not development fully to be commonly practiced at the field level, mainly because of inadequate research (Karki, et.al, 2002).

In the context of Nepal, the technology is appreciated and used mainly as a alternative source of gas energy for household cooking and lighting and the digested slurry as better organic manure for agricultural crops and vegetables. In biogas technology, an anaerobic fermentation of organic waste takes place causing its decomposition and a mixture of gases containing methane 60 percent to 70 percent evolves. After the fermentation, the sludge - like residue which is left behind can be used as an organic fertilizer. The gas is coloress, odorless, as well as toxic less and burns with clear flame. The slurry is not only odorless but also contains more nutrients like nitrogen, phosphorous and potash than in raw dung. (New ERA, 1995)

The volume of gas produced from the plants of both types totally depends upon temperature inside the digester. Higher the temperature higher is the level of daily production. Temperature between 30-35 degree centigrade is taken as suitable one fermentation.

21st century is the age of science and technology. By the abuse of these science and technology production of unnecessary carbondioxide (CO_2) to make the Ozea layer more damage and green house effect. So called powerful countries of the world fighting one after another. In such situation if we do not make an effort in time to preserve this ecology before the destruction of the whole environment.

In the world market, the price of petroleum product getting rise day by day. Because of which, daily life of public people turning more harder. General people are unable to effort kerosene, LP gases because limited income. But still the government has not though about alternative energy like biogas, solar micro-hydropower which is maximum available in local level of our country.

In our roads, we can see the piles of wastes. There is no systematic management and method of alternative use of wastes. By using the wastes as raw materials we can produce enough energy through biogas plant.

Because of the raising price of the raw materials including cement, rod and other thing. It seems necessary to increase the amount of subsidy by the government in rural area. Biogas technology has various benefits. It provides fuel for working and also lighting. Other fuels can be saved 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 increase. Biogas also provides the highly nutritive organic manure for field which raises the productivity and lessens the requirement of chemical fevlizevprom the macro perspective it saves the natural resources such as forest and presents the problem of deforestation.

2.7 Biogas Support Program (BSP) and Clean Development Mechanism (CDM)

Nepal has over half a century long history of biogas promotion. That started with father B.R. Saubolle's first experimental biogas plant in Godawari, Lalitpur in 1955. It is not just about the technology, but it is really about the unique and integrated modality that has been exemplary. This would not have been possible without the biogas support programme (BSP), which was established by the Netherlands Development Organization or SNV with the Dutch Government support in 1992.

Nepal has over 187000 households size biogas plants and over 300 institutional size plants constructed in some 2.650 of 3915 Village

Development Committees (VDCs) or municipalities in 68 districts out of 75 districts 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 districts by mid 2009. With these achievements, BSP is the second largest (to improved cook stove programme) alternative rural energy programme in Nepal and probably the largest in terms of VDC out reach. BSP also become the first Clean Development Mechanism (CDM) project of Nepal. (BSP Year Book, 2008)

The Biogas Support Programme (BSP) started in July 1992 with finding from the Directorate General for International Cooperative Government of the Netherlands (DGIS) of the Netherlands government through the Netherlands Development Organization in Nepal (SNV/N). Government of Nepal (GON) through Alternative Energy Production Centre (AEPC) and Government of Germany through the Kredistanstalt for Riederaufbau of Germany (KFW) also started funding the BSP from the phase III, which started in March 1997 and lasted till June 2003. Until the phase - III, BSP was directly implemented by SNV/N.

BSP Year Book (2008) focus that BSP has been the first CDM project in Nepal with registration of two CDM projects 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 2 projects has been signed with the World Bank for trading of the Emission Reductions from the two projects for first seven years starting

2004/05 as the first crediting years 2004/05 and 2005/have been completed and payment has been made too.

From these two projects, the annual carbon revenue (net of project development and verification expenses) is around US $ 600,000.

At least 5 more CDM projects can be registered. But it was halted due to problem with the earlier methodology and it took quite and effort and time to develop a new one. There have been time to develop a new one. There have been serious debates over development and approval of the new methodology for biogas and other projects that replace use of non-renewable biomass. Compared to the earlier methodology which used to give 4,99 tons of CO_2 equivalent of Green House Gas (HGS) Emission Reduction, the new methodology gives only around 2 to 2.5 tons. As the market price is rising, biogas CDM projects are still feasible. It is expected that the annual CDM revenue could reach US $ 1 million mark within few years. This meets around 40 percent of the current annual expenditure of BSP, including subsidy.

2.8 Policy of Government Relating to Biogas

By installation of biogas plant, the major benefits for women and children are seen in the changes in the cooking environment such as biogas cooking produces no smoke which means that eye and lungs disease can be reduced, cooking utensil gets less dirty. Then firewood and cooking on biogas becomes easier and faster. Similarly, it is less time consuming than collecting firewood and making dung cake preparation, girls get more time for other activities e.g. going to school.

The Seven Plan (1985-1990), for the first time, recognize the role of RETs in the conservation of forest and in providing alternative success for meeting the energy needs of the rural population. The plan incorporated few policies addressing technology like biogas, solar thermal, wind energy, improved cooking stoves (ICS) and small water mills. A few policies and program on RETs relevant to sector were as follows :

- Encouraging the development of alternative energy sources especially biogas, solar and wind energy with emphasis on making the private sector participation more active.
- Set forth the target to install a total of 4000 biogas system and provisioned 25 percent subsidy on investment costs and 50 percent subsidy on bank loans.
- Allocated a budget for on estimated expenditure of NRs 154.80 million for the development of RET and expected private sector to invest NRs 104.8 million. A sum of NRs. 50 million was allocated for subsidy and the balance was for support activities.

In the tenth plan (2002-2007), as the popularity of biogas is growing among rural families due to its diverse benefits. It would be expanded since it saves five wood, reduces dependency on imported energy and there is no negative impact in the peoples health. In addition, the use of biogas plant brings no environmental pollution and the slurry which comes out from the plant as by-product is used as the best fertilizer. So the tenth plan has set a target of installing a total of 200000 biogas plants including 199500 household's biogas system and 500 community biogas system in 65 districts. Priority will be given to suitable and relatively smaller. Size plants and necessary research would be carried out for its expansion in the Himalayan region and towards reducing the cost.

CHAPTER - THREE
RESEARCH METHODOLOGY

This chapter discusses on the methods, which are employed to conduct the research. The whole study is carried out on the basis of primary as well as secondary data. Reliable and relevant study can be made possible only by applying scientific method. Hence the primary purpose of this chapter is to discuss and design the framework for the research. Different procedures have been followed.

3.1 Research Design

The research is was based on the exploratory and descriptive research design. It is exploratory because it has tried to accumulate the primary data and it is descriptive as the study describe the different causes for and against the significance of the technology. Hence it is of importance that various conditions prevailing in the respective households selected for the study after the installation of biogas plants is also know to compare them with the conditions. The historical and other references are also taken for assistance of the micro level. In order to fulfill the objectives, information has been collected from the field survey, questionnaire, interview and observations which were the main techniques that has been used to obtain the information from the biogas users. Only the biogas user's families have been taken into consideration for interview.

3.2 Sources of Data

On the basis of nature, both qualitative and quantitative data has been agglomerated. The age, sex, occupation, income, belong to the quantitative

nature, whereas, why and how they are dependent on biogas energy is collected hereby in quantitative nature.

On the basis of sources both primary and secondary data has been collected during the entire research process.

2.3.1 Primary Data

To generate primary data for this study, key informant interview, field observation, sampling household survey, have been agglomerated.

2.3.2 Secondary Data

The information about biogas energy and its interrelation between people has been gathered from hard or soft copy of scholarly journals, books, reports, library works as the secondary data needed during the study.

3.2.3 Universe and Sample Size

According to Pathivara Gobargas company, the total of 216 biogas plants of different sizes constructed by the companies in the Phidim VDC were listed out. From those 32 plants (15%) were selected using purposive random sampling method. However while selecting households for study the following points were considered given below:

Size of Plants : As far as possible different sizes of plants was selected.

Ethnicity of Plant Owner : Possible different ethnicity of plants owners was selected.

Year of construction : Plants constructed during from 5 years were selected.

Location : As far as possible different geographical area.

3.3 Techniques and Tools of Data Collection

Mainly primary data were taken for the study and this study has been collected from the field survey. They are used to estimate and analyze the socio-economic impact of biogas on the survey. They are used to estimate and analyze the socio-economic impact of biogas on the surveyed households. The questionnaire served as the chief source of primary data while secondary data were taken from the concerned institutions and books. Following techniques has been used for data collection.

3.3.1 Household Survey

Detailed structured questionnaire was prepared various kinds of data such as socio economic characteristics of the biogas users, impacts of biogas on the users after its installation. The approved questionnaire served as a basic tools of data collection.

3.3.2 Observation

Same of the biogas plants were observed directly to have better idea about the biogas plant. Observation included following :

- Biogas plant under construction.
- Working of biogas plants.
- Working of cooking gas stoves and lights.
- Site of slurry output and its utilization in garden and fields.

The direct observation provided information about how the biogas plant was constructed. Similarly the sanitation condition around the households and cleanliness of kitchen and other areas were observed.

3.3.3 Key Informant Interview

To collect further information, questionnaire, interviews with open-ended questions was made with concerned people who included :

- Government and NGO officials.
- VDC
- Staffs of biogas companies
- Labours
- Owners of biogas plants
- Households without biogas plants.

3.3.4 Focus Group Discussion

The concerned users in the community were consulted for focus group discussion. The number of participants in each discussion ranged from 5 to 8 numbers. Information related to the impacts of biogas on environment, social life, health and sanitation and other relevant issues were collected during focus group discussion.

3.4 Methods of Data Analysis

The data obtained from the survey were edited and classified. Then the grouped and sub-grouped data converted into tables of averages and percentages. The analysis of impact was made through these averages and percentages. Actually the tables have been prepared according to characteristics of data such as plant owners, family size, land holding, castes education etc. No analytical statistical tools, were utilized for data analysis.

CHAPTER - FOUR
DATA PRESENTATION AND ANALYSIS

This chapter deals with the introduction of study area and socio-economic condition of the biogas plant owners in Phidim VDC of Panchthar district. Caste/ethnicity, occupation, family size, education status, land holding pattern, livestock holding and population are the main variables considered in this study.

4.1 Brief Introduction to the Study Area

This study is confined to the Phidim VDC of Panchthar district. It is a headquarter of Panchthar district. Panchthar district lies in the Eastern Development Region (out of five development region) of the country. The total area of this district is 1241 square km. According to the census 2001 the total population is 202056 and males and females are 99042 and 103014 respectively in the Panchthar district.

All of the 41 VDCs and Phidim VDC the headquarter of Panchthar district. So Phidim is big terms of population. This is situated to the middle part of the district. It bounded by Nagin and Ranitar VDCs from eastern, Ranigaun VDC from western, Bharapa with Nagin VDCs from northern and Chakmagu and Siwa VDCs from southern.

Most of the people in the study are speak Nepali language but some ethnic group like Limbu, Tamang, Magar, Rai etc. speak their own language. Since land is the more fertile of the area, agriculture stands as a main occupation of most of the people. Some people are engaged in other sector like service, business, labour and so on. The major agriculture production of this

VDC is paddy, maize, wheat, potato, oilseeds and vegetables. Phidim VDC is one of the most production areas of the paddy, maize, potato, pulse and different kinds of vegetables.

Since the Phidim has the facility of enough schools the education status of this areas is quite satisfactory, leaving aside the old-age population almost all the people are educated. Even Dalit caste family member also send their children to go to school for the study. While analyzing the occupation status of the study area, agriculture dominates the entire economy of this area. More than 80 percent of the population are engage an agriculture.

Due to the facility of irrigation, paddy is produced twice a year. Apart from paddy people also cultivates pulse like Kalo Dal and Dhankute Sibi and Bodi in small areas of land. Due to the available of market, many people cultivates the different kinds of vegetables for commercial purposive. Main vegetables grown are potatoes, cauliflower, brinjal (Bhanta), cabbage, radish (Mula) and leafy vegetables (Rayo, Palungo, Chamsure etc). The production of fruit is also in this study area. The fruits are also produced for home consumption.

4.2 Caste/Ethnicity

There are different castes and ethnic groups in Phidim. The total population of Phidim VDC is 13654 in which male and female composite is 6854 and 6798 respectively. There are 2927 households having average household size is 4.66.

The VDC is inhabitant by various caste and ethnic group such as Brahmin, Chhetri, Limbu, Rai, Magar, Newar etc.

Table 4.1

Ethnicity of Sampled Household

S.N.	Ethnicity	Number of HHs	Percentage
1	Brahmin	13	40.63
2	Chhetri	8	25
3	Limbu	8	25
4	Dalit	2	6.25
5	Others	1	3.13
	Total	32	100

Source : Field Survey, 2008

Table 4.1 shows that the majority of the households under study area are Brahman (40.63%) followed by Chhetri (25%), Limbu (25%), Dalit (6.25%) and the remaining (2.13%) belong to other casts. Brahman are found holding large number of biogas plants because they are socially and economically forward in each sector.

4.3 Occupation

The main occupation of the plant owners is agriculture. Besides agriculture, services and business are the main occupations of the plants owners. Major occupation practiced by the sample households are given in the table 4.2.

Table 4.2

Occupation Distribution of Total Owners

S.N.	Occupation	Number of HHs	Percentage
1	Agriculture	15	46.88
2	Service in Nepal	8	25
3	Service in Foreign Country	4	12.5
4	Trade and Business	3	9.38
5	Other	2	6.25
	Total	32	100

Source : Field Survey, 2008

Table 4.2 shows that the higher percent of the plant owners are engaged in agriculture sector. About 46.88 percent of the plant owners are involved in agriculture. Other occupations are service in Nepal 25 percent, service in foreign countries 12.5 percent, trade and business 9.38 percent and remaining 6.25 percent are engaged in other. The farmers have more land and more animals for the dung, needed for the biogas in comparison to the serviceman and business. Besides agriculture, most of the households has secondary sources of income as well. They are government service pensions, and other business. It supports them economically to fulfill the basic requirements.

4.4 Family Size

The result of the survey reveals that the total population of the 32 sampled households are 149 and average family size is 4.66. Households with maximum number of family members are 12 whereas the minimum number is 2. Table 4.3 shows the distribution of households by family size.

Table 4.3

Distribution of Sampled Households by Family Size

S.N.	Family Size	Number of HHs	Percentage
1	Small (1-4 persons)	6	18.75
2	Medium (5-7 persons)	18	56.25
3	large (8 and above persons)	8	25
4	Total	32	100

Source : Field Survey, 2008

Table 4.3 shows that among all 32 plant owners, 18 households (56.25%) have 5-7 family members which are categorized as medium family size. Only 18.75 percent of households found consisting of 1 to 4 family members and 25 v of household fund in 8 and above size group.

4.5 Educational Status

Education has played the vital role in the development of people. Most of the family members of the plant owners are educated. They have admitted to their children to school. The literate people of the selected households are found to be in total 63 percent (table 4.4).

Table 4.4

Educational Status of Sampled Family Members

S.N.	Literacy Level	No. of Person				Total	
		Male	%	Female	%	Number	%
1	Infant	20	26.32	16	21.92	96	21.16
2	Illiterate	10	13.16	8	10.96	18	12.08
3	Literate	22	28.95	13	17.81	35	23.49
4	1-SLC	20	26.32	30	41	50	33.56
5	Above SLC	4	5.26	6	8.22	10	6.71
	Total	76		73	100	149	100

Source : Field Survey, 2008

From the table 4.4 shows that majority of the family members belong to 1-SLC pass (33.56%) category and secondary 23.49 percent people have literate. Only 12.08 percent are in illiterate. This result shows that only the old people are illiterate. So the education status of this study area is satisfactory.

4.6 Land Holding

The main occupation of all plan owners is agriculture. All of them have their own land to cultivate. While calculating the land holding, only operational land holding has taken into account. It is found in most of the cases, that the land is cultivated by owners themselves. Though little, almost all the plant owners have their own land. Table 4.5 shows the distribution of land holding of the plant owners.

Table 4.5

Land Holding of Sample Biogas Households

Group	Land area in Ropani	Number of HHs	Percentage
Marginal	Below 10	12	37.50
Small	11 to 20	10	31.25
Medium	21 to 30	7	21.88
Large	Above 30	3	9.38
Total		32	100

Source : Field Survey, 2008

Table 4.5 shows that maximum households have land holding below 10 Ropani. It is found that 31.25 percent of total land falls on the small category (11 to 20 ropani), whereas 21.88 percent are of medium category (21 to 30 ropani). Similarly 9.38 percent fall under the large group.

4.7 Livestock

Since livestock dung is the main raw material for installing biogas plant all the plants owners have some kinds of livestock. On an average the plant owners own 4 heads of livestock. The number of plant owners having more than average size of livestock. The number of plant owners having more than average size of livestock is 4. The situation of the livestock holding in the sampled household in the study areas is presented in table 4.6.

Table 4.6

Livestock Population

S.N.	Livestock	Number of HHs	Percentage
1	Cow	40	41.67
2	Buffalo	30	31.25
3	OX	16	16.67
4	Goat	8	8.33
5	Other	2	6.25
	Total	96	100

Source : Field Survey, 2008

Table 4.6 shows that most of the households keep cow and buffalo. They have installed biogas for fuel for cooking only. Total number of cow, buffalo, Ox and pigs are 40, 30, 16, 8 and 2 respectively. The average number of livestock per household is 4.

Table 4.7

Distribution of Cattle among the Households Under Study Area

S.N.	No. of Livestock	Number of HHs	Percentage
1	1 - 3	10	31.25
2	4 - 6	18	56.25
3	Above 6	4	12.50
	Total	32	100

Source : Field Survey, 2008

Table 4.7 shows that 31.25 percent households have 1 to 3 livestock and 56.25 percent has 4 to 6 livestock and 12.50 percent households have above 6 livestock in their farm. Out of 32 households, one households has 12 livestock and two households have one livestock.

4.8 Economic Status

The annual income of the sampled households from the all sources ranges from Rs. 2500 to Rs. 450,000. The income of plant user has observed by auditing the total current market value of all agriculture production and total income from non agricultural sector. As shown in the table 4.8 the household with annual income below 100000 has been found 15 households to be installing the biogas plant. Proportion of households whose income range from Rs. 100000 to Rs. 150000 is higher in the sample. This shows that middle level of families are more interested in biogas in the study area.

Table 4.8

Economic Status of the Biogas Users

S.N.	Income (Rs. 000)	Number of HHs	Percentage
1	Below 100	9	28.13
2	100 - 150	15	46.88
3	150 - 200	5	15.63
4	200 - 250	2	6.25
5	250 and above	1	3.13
	Total	32	100

Source : Field Survey, 2008

Main expenditure heading of the sampled households are food, clothes, health, education interest of loan. All the sampled households live in their own house so that spending on housing is not accounted in the study. Share of expenditure on food would be greater if we count the market price if self produced goods also. Similarly, spending on education is second larger part of

the total expenditure. As the expenditure in education shows, the increment of private schools in VDC area, the increasing rate of students' enrolment as well as moving of local students to Jhapa, Biratnagar, Dharan, Kathmandu and other cities of Nepal for higher education is in growth. Increasing share of education in the study are shows the growing consciousness of people towards education. Expenditure on health end clothing are also significant parts of the expenditure. Some disease generated through the smokes and burning cases have been declined after the installation of the plants. However, due to the talk of accurate information the expenditure on health of the plant owners have saved are impossible to have been explained.

CHAPTER - FIVE

INSTALLATION AND IMPACT OF BIOGAS PLANT

5.1 Use of Biogas

Biogas technology is being widely used in both the developed and developing economics in agricultural, industrial systems. In developing countries biogas is valued more as source of energy for household cooking, lighting and slurry for its fertilizing value.

The main domestic use of biogas in household is for cooking. Actually, most of the households use biogas only for the cooking purpose, because every households has the access to electricity. The minimum use of biogas for cooking is found to be 1.5 hours while the maximum use is 5 hours.

Before the use of biogas majority of the people depend on firewood as the fuel for cooking purpose. The use of firewood for cooking brought the problem of deforestation on the one hand and one the other hand it spread many types smoke born disease like eye-illness coughing.

5.2 Owners of Biogas Plants

This research shows that maximum number (28 households) of sample biogas plant owner's households head is male. Among 32 households, 25 households and 7 households are male and female as plant owner respectively.

Table 5.1

Owners of Biogas Plants of Sample Households

S.N.	Plant Owners	Number of HHs	Percentage
1	Male	25	78.13
2	Female	7	21.88

Source : Field Survey, 2008

This table shows that more than 87.50 percent of owner are household head. However, as regard the sex-wise distribution of sampled biogas owners male covers 78.13 percent and female are 21.88 percent.

5.3 Encouraging Factors to Install Biogas

The main encouraging factors to install biogas plants are stuff of biogas company, neighbours, friends and others. Among them households are inspired from their staff of biogas company which are shown in table 5.2.

Table 5.2

Encouraging Factors to Installing Biogas Plants

S.N.	Encouraging Factors	Number of HHs	Percentage
1	Staff of Biogas Company	15	46.88
2	Neighbours	10	31.25
3	Friends	4	12.50
4	Other	3	9.38
	Total	32	100

Source : Field Survey, 2008

Table 5.3 present the information about encouraging factors for installing the biogas. Staff of biogas company 46.88 percent, neighbours 31.25 percent,

friends 12.50 percent and others 9.38 percent were the effective factors to encourage people to install biogas plants. But people have not effective information from Radio, TV, FM, Newspaper and so on.

5.4 Reason for Biogas Installation

The main reason for the installation of biogas was to get rid of the firewood collection and to have easy and smokeless cooking. While rest of the respondents replied that they installed for easy and smokeless cooking as well as to get rid of firewood collection.

Table 5.3

Reasons for Installing Biogas Plant

S.N.	Attractive Soruces	Number of HHs	Percentage
1	Easy and smokeless cooking and get rid from firewood collection.	15	46.88
2	Easy and smokeless cooking and time saving	7	21.88
3	Easily get fuel	4	12.50
4	Environment protection	4	12.50
5	For fertilizer	1	3.13
6	All of the above	1	3.13
	Total	32	100

Source : Field Survey, 2008

Table 5.3 shows that installation of biogas has many advantages. The technology is more reliable and appropriate to the rural community on the other hand animal dung is fully utilized directly with saving money to be spend on fuels.

The above table shows that the main reasons of installation of biogas plants by the surveyed households reported are : easy and smokeless cooking and get rid from firewood collection 46.88 percent, followed by easy and smokeless cooking and time saving 21.88 percent, easily get fuel 12.50 percent, environment protection 12.50 percent, for fertilizer 3.13 percent and due to all of the above 3.13 percent reasons. Thus easy and smokeless cooking and getting rid from firewood collection is main factor for biogas installation.

All the 32 households have installed biogas with the government subsidy. The plant owners said that without subsidy they would not been able to install a plant. About financing process plant owners are found satisfied, but they pointed out that sanction of money for plant installation was unnecessary delayed.

Among the sampled plant owners, 80 percent were satisfied with the construction techniques adopted by the GGC, while 20 percent were dissatisfied. The supervision and monitoring by the GGC was found satisfactory 85 percent. However, 15 percent of the respondents complained that mason was responsible to construct more than one plant simultaneously plant owners complained that whereas they lodged complain about certain problem, for example, leakage in pipe, insufficient gas an newly installed biogas plant, mason not visiting the plant after construction, etc.

5.5 Size of Plant

Various sized biogas plants are installed in the study areas for example $4m^3$, $6m^3$, $8m^3$ and $10m^3$. Majority (22 households) of biogas plants are $6m^3$ among 32 households sampled sizes which is shown in table 5.4 below.

Table 5.4

Sizes of Sample Biogas Plant

S.N.	Plant Size	Number of HHs	Percentage
1	$4m^3$	6	18
2	$6m^3$	22	68
3	$8m^3$	3	9.38
4	$10m^3$	1	3.13
	Total	32	100

Source : Field Survey, 2008

The table 5.5 shows that 6 households had $4m^3$ plant size, 21 households $6m^3$, 3 households $8m^3$ plant size and 1 household had $10m^3$ plant size. It was experienced that the farmers have a tendency of adopting a plant of $6m^3$ size considering other aspects which as family size and availability of dung.

5.6 Livestock Dung Availability

Livestock dung is the main input for operation of biogas plant. So its availability in sufficient quantity is a must. An 80 percent of sample biogas users have connected their toilet to operate biogas plants to ensure gas production. The per capital dung production of a sample households is 15 kg per day. Minimum quantity of dung produced is 10 kg per day while maximum dong produced is 32 kg.

Another interesting thing about the city people is that they keep the rental people in their house. All the people used the toilet which is connected to the plant. The rental people used other energy i.e. kerosene, LPG and so on. The plant owner of the house produces the gas out of this plant without

additing the animal dung. For this reasons, helps to available produced the gas of 4 to 6 members family to makes cooking meal, tea and so on. They no more need animal for the dung. And the residue of the toilet does not need frequent. At the some time another profit is that they didn't need the frequently deaning of the toilet residues.

5.7 The Operator of Biogas Plant

It is observed that female members of the family generally do the operation of biogas plants and few male members do the operation or plants. The observation shows that only female members are involved in operation of biogas plants followed by female and children and both male and female. The main reason behind female's involvement in operation is that they mostly involve in kitchen based activities themselves.

5.8 Impact of Biogas Installation

This section discusses about the saving of firewood, change in the use of kerosene/LPG, money saved in suing biogas plant etc. Almost all households felt that their economic conditions were uplifted by these of biogas plant, although if did not fetch a direct earning to them. In the beginning, users have to spend more money to install the biogas but after installation of the biogas they did not have to spend more money.

5.9 Reduction in Workloads and Time Savings

After the installation of biogas plant workload of mainly female persons is reduced. Therefore, the respondents said that introduction of biogas has a positive effect on the workload of family members. Time saving in cooking, cleaning utensils, firewood collection due to smokeless stove is the direct benefit to the female members.

Table 5.5

Reduction in Workloads and Time Saving in Owners

S.N.	Activity	Before (In minutes/day)	After (Minutes/ day)	Different (Minutes/day)
1	Firewood collection from Jungle	115	53	62
2	Cooking Activities	90	50	40
3	Washing utensils	50	32	18
	Total	125	135	120

Source : Field Survey, 2008

Table 5.5 shows that saving in time is considerable. It shows that the biogas user families used to spend more time in collecting firewood from the jungle. All most all households used to collect firewood from the jungle because firewood is easily accessible from them. On an average, 62 minutes time has been saved after the installation of biogas plant and biogas user family used to spend to 115 minutes per day for firewood collection before the installation. After installation of the biogas plant, average time spending for firewood collection has been decreased to 2 hours per day. All of the biogas users who collect firewood from own land and market has not been dealt in this analysis.

Actually this data shows that, after installation of biogas plant, the workload of women was reduced. All above activities took more time before installation of biogas plant compared to after installation.

Thus, workload of women was further reduced after installation of biogas. Responsibility of household works is handled by both men and women. It helps to reduce gender differences to some extent.

5.10 Specific Benefits from the Saving

The respondents have asked about the specific achievement they made by investing the money from the saving of firewood. Following answers were obtained by the biogas users.

Table 5.6

Specific Benefits made from Saving

S.N.	Specific Benefits	Number of HHs	Percentage
1	Educate children	8	25
2	Income generating activity	5	156.63
3	Read newspaper	3	9.38
4	General expenses	2	6.25
5	Invest in Agriculture	10	31.25
6	Households work	4	12.50
	Total	32	100

Source : Field Survey, 2008

The table 5.6 shows that biogas has good contribution towards the field of education as well as invest in agriculture. 25 percent and 31.25 percent of the households have invested their saving for the purpose of educating their children. Similarly 15.63 percent households invested for the income generating activities such as in small business.

5.11 Impact of Biogas on Health and Sanitation

The study shows that biogas positive impacts towards health had sanitation of the respondents. Uses of latrin, connection of latrine to the biogas plant, reduction in diseases and change in the prevalence of flies and mosquitoes have been dealt in this section.

5.12 Use of Latrine

Among the surveyed households, 80 percent of the households have built latrine and 20 percent households are devoid of latrine.

Table 5.7

Use of Latrine

S.N.	Have Latrine	Number of HHs	Percentage
1	Yes	30	93.75
2	No	2	6.25
	Total	32	100

Source : Field Survey, 2008

The table 5.7 shows that, out of 32 households, 30 households have latrine and 2 households have no latrine. Out of 30 households having latrine, 16 households built their latrines only after the installation of biogas plant. Similarly 6.25 percent of the households have no latrine and they use their agriculture field instead of latrine. This indicates that after installation of biogas, people were encouraged to use latrine for better sanitation practice.

5.13 Connection of Latrine to Biogas Plant

Table 5.8

Latrine Connected to the Biogas Plant

S.N.	Connection of Latrine to Biogas Plant	Number of HHs	Percentage
1	Latrine Connected	26	81.25
2	Not Connected	6	18.75
	Total	32	100

Source : Field Survey, 2008

The table 5.8 shows that, out of 32 households, the 81.25 percent of the households have connected their latrines to the biogas plants i.e. they have used human excreta to produced biogas. The reasons for connecting latrine to the biogas plant are :

- Human excreta can be utilized as fertilizer and sufficient gas production.
- Sanitation due to the establishment and connection of latrine to the gas plant.
- The remaining 18.15 percent of households have not connected the latrine. The reasons for not connecting to the plant are, because gas is sufficient and there is no need to connect.
- Because of traditional and cultural view it is felt unholy and felt dirty.

5.14 Improve in the Health Condition of Women and Children

Biogas had a positive impact on the personal health of family members specially women and children. While using the biogas for households purpose, it does not produce the smoke which is harmful for human being. That is why, the biogas has played the vital role to maintain the proper health condition for them. It is known that biogas is specially used in kitchen. Generally, the women and children are engaging in kitchen based works. Cooking in traditional fuel i.e. firewood produced smoke which caused many types of disease like eye illness. Headache burning cases coughing and respiratory problems but cooking in biogas has reduced such problems. So biogas projects have positive health impact on women and children.

Table 5.9

Improve in Health Condition of Women and Children

S.N.	Diseases	Number of HHs	Percentage
1	Respiratory	10	31.25
2	Eye illness	8	25
3	Headache	6	18.75
4	Coughing	5	15.63
5	Other	3	9.38
	Total	32	100

Source : Field Survey, 2008

Table 5.9 shows that improvement of health condition of women and children is considerable. From this study, it has been observed that about 31.25 percent of the households respiratory problems have improved after installation of the biogas plants. Similarly 18.75 percent of the sample households headache problems, 25 percent of the sample households eye illness problem and 15.63 percent of the sample households coughing problems have improved after installation of the biogas plants. Only 9.38 percent of the sample households other health problem have improved.

5.15 Reduction in Disease

It is found that there is significant improvement in the smoke. Born diseases such as eye illness, coughing, burning cases and headache due to installation of biogas. Following important information has also been revealed from this impact study :

- About 60 percent respondents told that they have built toilet to attach to the plant. This has helped in personal health and environmental sanitation.

- All respondent said that biogas facility enable to reduce the number of burning cases and eye illness and

- Around 90 percent reported that the house population covered by smoke of firewood has been reduced.

5.16 Degree of Reduction in Smoke After Biogas Plan

Before biogas installation, the people in the rural communities were mostly dependent upon biomass such as firewood, agricultural residues, dung cake etc. for their domestic in poorly ventilated kitchens, the amount of smoke inhaled by women and children increase. The health problem, leading to respiratory and heart disease.

Table 5.10

Reduction in Smoke After Biogas Plant

S.N.	Decrease in Smoke	After Biogas Plant	
		Number of HHs	Percentage
1	No smoke	2	6.25
2	To some extent	6	18.75
3	Very much	24	75
	Total	32	100

Source : Field Survey, 2008

Table 5.10 shows that the very large proportion of the households with biogas plant perceived a remarkable decrease in kitchen smoke after they have the biogas installation. However 18.75 percent respondents still realized the decrease in smoke to some extend, while the rest 6.7 did not find reduction in the amount of smoke even after biogas installation. This finding may be

attributed to either some technical defects in the plans or insufficiency of gas produced due to which they were compelled to use other sources of smoke producing fuels such as firewood, other agriculture residue etc.

5.17 Respiratory Disease

Table 7.9 illustrate the responses of the respiratory diseases of the households under examination with biogas plant.

Table 5.11

Respiratory Disease

S.N.	Status of Infection	Number of HHs	Percentage
1	Presence of Respiratory	10	31.25
2	Absence of Respiratory	22	68.75
	Total	32	100

Source : Field Survey, 2008

Table 5.11 shows that 68.75 of the households have not reported the respiratory disease. This is one of the positive impacts of biogas installation. Households reporting the presence of respiratory problem may be attributed to the use of firewood even after the biogas plant to prepare khole, dud rataune (heat milk) and other activities which uses the firewood that emits smoke in the kitchen.

5.18 Insects Prevalence

Fly and mosquito has been taken into account for the study of change in prevalence of insets. Majority of the households have reported the change in prevalence of insets.

5.19 Fly

The study reported that 53 percent of the households have felt either increase nor decrease in the fly population, where 25 percent households reported that the fly population has decreased. Other remaining households reported that the there is increase or decrease in the population of flies after the installation of the biogas plants.

Table 5.12

Effect on Prevalence of Fly

S.N.	Fly Prevalence	Number of HHs	Percentage
1	Increase	7	21.88
2	Decrease	8	25
3	No change	17	53.13
	Total	32	100

Source : Field Survey, 2008

5.20 Mosquito

The status of mosquito breeding after the introduction of biogas plants have been revealed in table 5.13.

Table 5.13

Breeding of Mosquito after Biogas Plants Installation

S.N.	Status	Number of HHs	Percentage
1	Increased mosquito	25	78.13
2	Remained the same	4	12.50
3	Decreased mosquito	3	9.38
	Total	32	100

Source : Field Survey, 2008

Annual 78 percent of biogas households reported that mosquito breeding has increased after the installation of biogas whereas 12.50 percent are of the opinion that mosquito breeding remain the same and only 9 percent perceive its decrease after biogas plant. The principle reasons for mosquito proliferation may be attributed to the followings :

- Observation indicates that the problem cause of mosquito breeding in biogas plant may be due to the availability of moist space in the outlet and the slurry ditch of the biogas plant, and
- If firewood is burnt inside the kitchen, the smoke produced from 17 drivers out mosquitoes. But biogas stoves are smokeless so there is no chance of driving out mosquito from the kitchen.

5.21 Impacts of Slurry in Agriculture Production

One of the most encouraging factors to establish biogas plant is the production of slurry, very valuable organic manure for crop farming. Multiple advantages accurr with these of biogas slurry. It increases agricultural production because of its high content of soil nutrients. When the digested slurry is placed into the food chain of crops and animals it leads to a sustainable increase in form income.

As per norms established by the Gobar Gas Company, the slurry produced from the biogas plant contains 1.6 percent nitrogen, 1.2 percent phosphorous and 1.0 percent potash against 0.05 percent phosphorous and 0.6 percent potash in livestock dung (GG, 2001). The higher percent of nutrients in slurry is due to saving of nutrient from getting lost. Biogas slurry is considered to be high quality organic manure. The organic contain of the digested slurry improves the soil texture, stabilizes its humid content, intensifies its rate of nutrient depot formation and increase its water hording capacity. Compare to form yard manure (FYM) biogas slurry has more

nutrients than FYM because in FYM, nutrients are loss by volatilization (especially nitrogen) due to exposure to sun head and as well as by teaching.

5.22 Methods of Using Slurry on Form

Information on the application of the bio-slurry in different forms as reported by the respondents are presented in table 5.14.

Table 5.14

Method of Bio-Slurry Applied

S.N.	Method of Application	Number of HHs	Percentage
1	In liquid form	6	18.75
2	In dried form	10	31.25
3	In composted form	16	50
	Total	32	100

Source : Field Survey, 2008

The data presented in table 5.14 clearly shows that about 50 percent of the biogas formers have preformed using the slurry in composted forms, while 31.25 percent used it in dried form. Only 18.75 percent of the respondents reported using liquid slurry directly to fertilizer their crops. It is worth nothing that using the slurry in liquid form is the best practice form the point of view of conservation of plant nutrients, but this practice has a limitation for wider adaptability due to the difficulty of transporting it to the fields. For this reason, the extension workers and biogas companies have encouraged the farmers to conserve plant nutrients. Thereby augmenting the quality of organic fertilizer. Application of slurry in dried form is not normally recommended, as the nutrients (especially nitrogen) contained in it are lost, when dried in the sun.

5.23 Production Increment After Using Slurry

The digested slurry can be used as manure in the fields. All of the households have used slurry as fertilizer for increasing crop production. Though exact collections are not possible, use of slurry has certainly saved money, which might have been otherwise we to buy chemical fertilizer.

Regarding the production increment 22 households reported that there is an increase in their agricultural production, 8 households have not felt any change in production and 2 households have felt the decrease in the production even after the application of bio-slurry on the form.

Table 5.15

Production Increment after Using Slurry

S.N.	Agricultural Production	Number of HHs	Percentage
1	Production Increased	22	68.75
2	Production Decreased	2	6.25
3	Remained the same	8	25
	Total	32	100

Source : Field Survey, 2008

The slurry is mainly used in maize, vegetables and paddy production. The production relationship of using and not using slurry is very significant. The data analysis recommends that the production of these crops has increased after the use of slurry. So there is positive relationship between using slurry and agriculture productivity. Thus, slurry is better than chemical fertilizer in agricultural farming.

5.24 Social Impacts

Social impacts of biogas are mostly intangible and need to be assessed from user's percent. The outcome of the study showed that there are some

positive impacts of biogas that influenced the social aspects of beneficiary household directly. They are :

- The installation of biogas plants has a matter of social prestige in the community.
- Quicker servicing of food and tea to the incoming guests.
- Firewood collection time and working load of women and children decreased (120 minute per day). Due to which children got free time to study whereas women were found more active in social and political activities.
- All most of all the total plants owners under study felt a rise in their social status in the village after the installation of biogas plants.
- Some of the plant owners involved in social organizations such as Mahila Bachat Sanstha, Amma Samuha, Krishi Sahakari etc.
- The plant owners engaged to informal education based programme.

5.25 Environmental Impact

All the households have agreed that the biogas installation has reduced forest depletion. However, the major reason of construction of biogas was not to save the forest. The plant was installed as they faced difficulties in procuring firewood in the surroundings. The users felt that if everybody installs biogas plant, the forest will be saved completely from depletion. From the macro perspective biogas has checked the ecological imbalance and climatic change due to lessening the problem of deforestation. Similarly, use of biogas has reduced the smoke and so made the clean environment in the kitchen. Due to the attachment of toilet to the plants, the surroundings have become clean and absence of bad smell. It helps in reduction of the emission of CO_2.

The environmental impact of biogas plants can be viewed from the following perspectives :

- Biogas, when for cooking saves firewood, dung cakes and agricultural wastes. The organic matter and nutrients of agricultural wastes and the dung cakes which are otherwise burnt are available to sustain the fertility of soil.
- It helps in reduction of emission of carbon dioxide in the environment.

Hence, the impact of biogas use on environment must be viewed form a number of perspectives, most of which related to the conservation of biomass. Benefits of biogas could be seen in areas where living trees and low dung as dried patties, are used as primary cooking fuels. The introduction of biogas as substitute of these traditional sources allows the forests to remain intact and the dung be used for two purposes; as gas for cooking and slurry a replacement of inorganic fertilizer in agricultural production.

5.26 Conservation of Forest

The information regarding the conservation of forest has also been obtained from the community level discussion. In the community, when the biogas is used by maximum level, then they do not go for cutting trees in the forest. This task helps to preserve and increase the area of the forests in the community. The biogas is the complimentary of the firewood. When the biogas is used then the forests are automatically protected and increased.

In the case of the preservation of the forest, the considerable amount of the firewood has been saved after installation of biogas plant. In this study area, average amount of firewood saved per household is 6.4 Bharis per month.

One Bhari is equivalent to about 40 kg. After the installation of biogas plant, the majority of the plant owners have failed the reduction of use of firewood.

5.27 Clean Development Mechanism (CDM) in Nepal

Nepal is a rich country in forest resources. Around 39 percent of land is covered by the forest which is contributing towards reducing green house effects and absorbing carbon dioxide. Forest is being destroyed due to the overdependence of people on it for the fuel which has contributed to the deforestation resulting global warming a serious problem for all the inhabitancy on the earth. Though, Nepal has a significant contribution to the reduction of CO_2 more than its share to the world community because of which gets subsidiary from world community.

In Nepal, Government, Donors and other programme partners together with the World Bank decided to develop CDM project in BSP during 2001. Two CDM projects on BSP (with a total of 19,396 systems) were allowed to register with the Executive Board of the CDM and they god registered and approved on December, 2005. A final negotiation with the World Bank for rate of carbon trading took place on March, 2006. The negotiated rate was US$ 7 per ton of carbon of Certified Emission Reduction (CEF). Implementation agreement was signed between AEPC and BSP Nepal on April, 2006 for Implementation of CDM project under BSP. Emission Reduction Purchase Agreement (ERPA) was signed between AEPC and World Bank on May 2006 for 7 years. The two project are likely to bring Nepal annual revenue up to US $ 677,500 for next several years (BSP 2007:79). In 2007 Nepal got the total amount of Rs. 3.68 million on from carbon trade. In 2008 Nepal will get Rs. 17 million for CDM.

Out of that

From biogas plants	$ 10 lakhs
From Micro-hydropower	$ 3.8 lakhs
From solar Energy	$ 4 lakhs
From Improved Stoves	$5 lakhs and,
From Improved Ghatta	Euro 3 lakhs

Source : Kantipur, 17 August, 2008.

According to the recent studies the available carbon reduction per year per system from the displacement of fuel wood, agricultural wastes, dung and kerosene is nearly 4.6 tons of carbon equivalent, this computation excludes green house gas saving from forest use according to the data published by BSP in December 2007 the number of biogas plants installed in Nepal is 172,858. According for the above data, a net reduction of approximately 795146.8 tons of CO_2 equivalent is annually derived from the displacement of the use of fuel wood and from the reduced consumption of kerosene. If we involved all the plants in CDM, assuming the value equivalent to US$ 4.5 per ton CO_2 will result in a national economic value of US$ 5.3 million per year for the green house gas displaced by the biogas units in Nepal (BSP, 2008).

As in the context of study area out of total areas is covered by forest 80 percent. This forest area itself is very important for CDM. This total number of biogas plants installed in the study area is 216. As we compute the total reduction of CO_2 in the shady area made by biogas plants is 993.6 (216 × 4.6) tons annually. It has further healped in CDM programme. If we involve all these plants in CDM Nepal, we will earn US $ 6955.20 (993.6×7) per year from carbon trade. (Field Survey, 2008).

From the study above, we come to the conclusion that the study area has significant amount of forest area which has remarkable contribution to the reduction of CO_2. It has directly helped CDM in itself. So, it is necessary to preserve the forest. On the other hand, installation of biogas plants has helped CDM by reducing dependency of people in forest for fuel wood which emitted smoke on the one side, and the other side it itself is smokeless. Thus biogas CDM programme.

5.28 Problems of Biogas Users

Although the biogas has several benefits, the researcher finds several problems from the respondents. Biogas user have listed out problems that have been observed on field survey were discussed below :

a) Unnecessary Tension

Some of the plant owners complained that the loans taken for installation of biogas plant create unnecessary tensions as they did not have such practice of taking loan before. As biogas plants did not fetch direct cash income and they were not able to express the saved time and efforts.

b) Time Consuming

Some of the families complained that they had to spend more time to collect additional water for plant feeding. Hence, in areas with longer water fetching time, biogas plant installation has increased workload to users specially women members because they engaged daily in kitchen room. As it requires daily feeding of cow dung mixed with water for the smooth operation users consider it as a extra burden.

c) Less Tasty Food

A few respondents reported that food cooked in biogas is less tasty as compared to the food cooked in firewood.

d) More Water to Collect

Feeding of biogas requires mixing of dung and water in equal proportion. Larger the biogas plant, greater the amount of dung as well as the water required. Collecting water is a main problem because there is not available sources of water nearby.

e) Damaged of Wooden Ceiling

In traditional rural households, the ceiling of the room is made with woods that are protected against insects due to deposition of soot production from firewood burning. As biogas produces smoke free flame, the wooden ceiling are liable to be damaged by insects such as ants, termite etc.

f) Increase in Mosquito Breeding

In biogas households survey, it is found that there is an increase in the population of mosquito due to the installation of biogas plants.

g) No Direct Income

Although biogas has several benefits, it doesn't generate cash income. Farmers prefer direct income to enable them to pay back the principal and the interest on loan. they have very little income generating opportunity to utilize the time saved from the installation of biogas and therefore hesitate to invest the loan money.

h) Higher Maintenance and Repair Cost

The users consider high establishment cost, high interest rate and inefficiency of biogas in space heating as the greatest advantages of biogas plant while high repair cost and difficulty of maintenance, not available of GGC staffs are considered important disadvantages of biogas plant. For the most highly rated disadvantage i.e. the high establishment cost diversity in responses has been observed.

CHAPTER - SIX

SUMMARY, CONCLUSION AND RECOMMENDATION

6.1 Summary and Conclusion

Biogas plants, one of the best options for meeting the growing need of fuel in the rural as well as in the urban areas, is being popular in the recent years in Nepal. Since, Nepal is an agricultural country, each and every household rear cattle and cattle dung is the best source of rqw material for biogas plants. It is clean energy used especially for cooking and in some extent, for lightening. Since, it uses the locally available resources, it is gaining high popularity. Thus, installation of biogas plants has been increasing rapidly. Realizing the existing problem of energy, Government of Nepal, Different NGOs and INGOs have been incorporating in the installation of the biogas plants.

Socio-economic impact of biogas in phidim VDC is chosen as a special topic to address the problem of energy in the study area and to provide the scope for the dissemination of the biogas technology which seems to offer potential for future development. Providing relevant and reliable information can surface the real implementation of the programme and may also make understand the deficiencies in the existing problem, in the policy level. Raising concern over ecology and the impact in the environment of the use of firewood as a fuel has led to the installation of biogas in the study area. Nepal is heavily based on agriculture and it is suffering from the low productivity. So its productivity has to be maintained for overall development. An immediate solution of this problem is to maintain the soil fertility which is possible by the application of bio-slurry on the farm instead of chemical fertilizer. As biogas technology does not require procurement of raw material from outside and the rural people of study area can set up utilizing their own resources and it might be helpful to improve the economy and keep clean environment as well, biogas

is seen as the topmost effective energy technology for the upliftment of the economy. Due to the higher productivity, lesser drudgery for women and reduced pressure in the natural resources, this technology may provide the scope for maintaining the ecological balance in the study area as well as in the nation as whole.

Phidim VDC headquarter Panchthar district has been taken as the study area. Out of total 216 biogas household, 32 households have been taken as the sample households using the same above.

Before selecting topic, a brief review of the literature related to the impact study of biogas on users has been studied. Primary as well as secondary data have been used in this study.

The main objective of this study is to evaluate the role of biogas plant in energy contribution, mostly in terms of fuel wood saving, saving of time and its utilization, impact on economic activities and impacts of slurry on production. Interview and field observation have been taken as a method of data collection and collected data has been analyzed using simple statistical tools such as average, percentage, table and diagrams. Biogas stoves seem to have succeeded in substituting the traditional biogas and fossil fuels. However, it has not completely substituted the traditional energy uses. Even now people are using chemical fertilizer in the field and firewood in the kitchen. The use of biogas has brought the significant improvement in the quality of life of the family members and reduction on the workload of women who are the sole manager in kitchen and take the responsibility of cooking.

While talking about the plant ownership Brahmans are ahead in the installing the plant and most of the plant owners have the occupation of agriculture. The average family size of the plant owner is medium size. The literacy rate of the plant owner has found more than average literacy rate of the

nations. Majority of the users are of medium income level families. Vary poor people with small size of land and lower income is found unable to construct the biogas plant.

Agriculture is one of the basic occupations of almost all plant owners. However, as found in the study, in addition to agriculture, many households have secondary occupations. The number of households, completely based on agriculture is 21 i.e. about 41.2 percent of sampled households. Many people sampled plant owners are also involving of in other occupations such as services in government offices and private sector, teaching, foreign employment, business etc.

Marginal group who fall in the category of less than 6 Ropani land has the highest ratio out of total biogas plant owners. After the study, it is found that the average size of land holding of the biogas users is 5-7 Ropani which varied from minimum 2 Ropani to maximum 45 Ropani. Every family has some livestock. The number of livestock above 4 is about 82.5 percent where keeping cow is found to be in most of the households. Most of the biogas users have been holding less number of livestock then recommended numbers of specific sizes.

Toilet conceted biogas plant is seen in most of the households. However, those who have toilet attached plant are found to maintain the clean and healthy environment and supplemented the bio-digester to run smoothly at ful capacity. Most of the households reported that after installation of biogas plants time has been saved in cooking, cleaning and firewood collection, which they could use other productive and social work. After is installation, all most of all households use biogas to reduce the smoke, eye problems and clean and healthy atmosphere. Most of users reported the decrease of respiratory, cough, headache, burning cases and chest pain after the construction of biogas plant and is use in their households.

Before installation of biogas plant, majority of the households had been using firewood and agricultural residue for cooking. However, the large portion of using these fuels has declined after the installation of the biogas plant. It is remarkable to note that the biogas households reported a remarkable decrease in smoke and there by reduction of indoor air population to some extent.

The entire sampled households have used the digested slurry in their field in different forms such as compost, liquid and dried. Users prepared compost manure with other waste products like straw, fodders, other agricultural residue etc. which helps the fast decaying and drying of slurry. Some households applied dried and liquid slurry especially in vegetables, other cash crops and fruits. Majority of the users 76.5 percent felt that use of slurry increased the production. However, remaining household felt most significant change in the production. Most of the biogas user, felling increase in production, said that they accounted higher growth in daal maze and other vegetable due to use of slurry. However, because of appropriate account of production exact amount of increase in production has not been stated in this report. It shows that there is positive relationship between slurry and agricultural productivity.

Some bad effects of the biogas plant have also been accounted in the study. Some people have felt in dirty business to collect dung, to mix dung, to use of manure etc and it has produced smell and insects. Since the large amount of money is required in the time of installation people have felt economic problems. These are the few problems arises due to the installation of biogas plant but these are insignificant by applying the better technique of management.

At last it can be said the introduction of biogas technology in the study area has been felt successful and one of the effective renewable energy source so far because of number of reasons namely in terms of production increment,

protecting environment from population, checking the rate of deforestation, providing ease to the women in the study area. Observation from the present study has shown that there is an increasing trend to depend on biogas which seems to be good indicator for forest resource conservation.

6.2 Recommendations

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

- The installation of biogas plants has helped saving times. But such leisure time is wasted idle. Some income generating programme should be implemented to address such leisure time the government with the installation of the biogas plants.

- Most of the plants owners have complained about the subsidy. Equal subsidy to all the people is not reasonable. The poor and downtrodden people should be given more subsidies, so that such people can install plants.

- The government should bring attractive programme on the installation of biogas regarding subsidy, long term loan facilities with minimum interest rate and mechanical aspect of the plants.

- Most of the plants owners have suggested that the construction materials of the service provide company should be specified. The government should publish the market value of such materials annually and subsidy should be given to those materials.

- Women should be encouraged in operation and maintain trainings. Such trainings enable them to maintenance plants themselves.

- Since the biogas plants save lessened the use of firewood and hence reduced the pressure in forest resource, the government should come up with a long term vision about the biogas technology.

- The regular monitoring sector of biogas companies is very weak. Due to which different problems regarding plants have not been addressed on time. So, monitoring sector should be strengthened.

- Importance and benefits of the biogas plant should be broadcasted by radio, TV and moreover through FM channels (most of the people in the study area listen FM radio nowadays).

Most of the villagers produce vegetables foe household purpose. Information should be given to them to apply bio-slurry on high valued cereal crops instead of chemical fertilizers. It may help to increase the production of the concerned people.

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APPENDIX

TRIBHUVAN UNIVERSITY

CENTRAL DEPARTMENT OF RURAL DEVELOPMENT

KIRTIPUR, KATHMANDU

BIOGAS PLANT SURVEY IN PHIDIM VDC, PANCHTHAR

2008

HOUSEHOLD SURVEY QUESTIONNAIRE

A. General Information:

Name of Plant Owner/Respondent:.....:

District: VDC: Ward No.:

Age/Sex: Caste/Ethnicity:

Education completed:

Family size: Plant size: m^3

1. What is your family occupation?
   a) Agriculture ☐ b) Business ☐ c) Service ☐
   d) Agri.+Business ☐ c) Agri.+Service ☐
2. How much agricultural land do you have (in)?
   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) Neighbours ☐
   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. When did you install this plant?

Year: …… Month: ……

5 Have you attached toilet with this plant?

a) Yes ☐ b) No ☐

6. If not, why?

a) Due to the concept of unholy ☐ b) Dirty ☐

c) Separate toilet ☐ d) Sufficiency of gas ☐

e) Others (specify) ……

7. If yes, why?

a) Due to lack of toilet b) To increase gas

d) Lack of sufficient dung d) Others(specify) ……

8. How much do you feed of plant (in kgs)?

……

9. How much water do you used for mixing the dung (in liters)?

……

10. What is the source of water to mix dung?

a) Pipe tap ☐ b) well ☐ c) Electric motor ☐

d) Others (specify) ……

11. 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. 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 kgs) ?

   .....

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 kgs)					
2.	Kerosene (in litre)					
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	Time allocated		Time saved per day (in hr)
		Before installation	After Installation	
1.	Firewood collection			
2.	Cooking			
3.	Washing utensils			

5. In which activity, do you utilize this saved time?

a) Farm activities ☐ b) Child care ☐

c) Gardening ☐ d) Physical labour for wages ☐

e) Income generating activity ☐

6. Which is the source for firewood collection before installation of biogas plant?

a) Own land (Private forest) ☐ b) Govt. forest ☐

c) Marke☐ d) Others (specify) .....

F. Loan:

1. Did you take loan for installing the biogas plant?

   a) Yes ☐ b) No ☐

2. If yes, what is the source of loan?

   a) Moneylender ☐ b) Rural Development Bank) ☐

   c) ADB/N ☐ d) Other ☐

3. What is the interest rate ?

   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 ☐

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 ☐

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 availabil☐ ☐ 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) Remained same ☐

c) Worse ☐ d) Don't know ☐

Thank You!