CHAPTER I

INTRODUCTION

1.1 Background

Nepal is an agricultural country which 85.80 percent population resides in rural area and 78 percent people are highly dependent on agriculture (CBS 2001). Nepalese rural economy, predominated by subsistence agriculture, is based on combination of crop production and animal husbandry. The average size of small-scale farm is about 0.96 hectare per holding. Livestock is an integral component of farming system, which has multiple benefits to rural people.

Animal husbandry makes up vital part of agricultural production system of Nepal. It has always been complementary to the crop production in the traditional agriculture in Nepal. In rural area, average farmer holds cattle and buffaloes for dairy products, for draught purpose and as a main source of fertilizer. Dung is used to make compost for the field and usually under condition of resources stress, as a raw material for fuel. The number of cattle and buffaloes is also increasing along with households. Nepal produces about 41.1 million MT of livestock manure. It is estimated that about 81000 Mt of dry dung cake, alternative to fire wood which is equivalent to 20,000 Mt of oil. If we compare the electricity with energy generated from existing biogas plants it would approximately 30 M.W. The estimate biogas potential of Nepal is sufficient to operate 1.9 millions of biogas plants. Thus the potentiality of biogas technology is very wide in Nepal (Singh and et al, 1996).

Fuel wood, which is used as the primary source of household energy, comes from forest. Fuel wood has been and still is the major source of fuel daily used by rural mass in Nepal. On one hand, Nepal has an estimated area of 9.2 million hectares of productive forest of which only 3.4 million hectors are considered as to be accessible for fuel wood collection. On the other hand, sustainable yield

form this accessible area is estimated to be about 7.5 million tons, while total fuel wood consumption were about 11 million tons in 1992/93. These figures indicate a non- sustainable wood harvesting of about 30 percent. Such type of serious threat over forest leads the country towards grip of natural disaster. Experts in this field have forecasted that if this trend continues for a decade or two, there is absolute danger of turning several paths of fertile strips into desert.

Due to lack of fire wood for cooking purpose, many people in rural area are burning livestock dung and other agricultural wastes. The use of agricultural residues animal dung for cooking purpose rather than being used as fertilizer reduces the crop yield in the rural areas LPG, kerosene and electricity as source of cooking are accessible for few people and especially in urban area. They are very expensive and out of the affordability of normal rural family. Thus, in rural areas traditional energy sources will remain the main supplier of energy in the foreseeable future. Considering the energy scenario of Nepalese society, the strong and immediate need of alternative source of energy was realized. In search of finding alternative source of energy, a promising sustainable source of energy that was biogas. (Bajgain 2003)

1.2 Historical Development of Biogas in world and Nepalese Context

Biogas technology has been gaining popularity now a days as a good alternative source of domestic energy. The origin and development of such popular biogas was used for heating bath water in Persia during the 6th century Macro polo mentions the use of covered sewage tanks. It probably goes back 2000-3000 years ago in ancient Chinese literatures. In 1808, H. Davy made experiments with straw manure in a retort in a vacuum and collected biogas. He was not interested in the gas but rather rotten or not rotten manure. However, he determined that methane was present in the gases produced during the anaerobic digestion of cattle manure (CES, 2001)

Jan Baptita van Helmont first determined in the 17th century that flammable gases could evolve from decaying organic matter. An Italian National, count

Alessandro Volta concluded in 1776 that there was direct correlation between the amounts of decaying organic matter an amount of inflammable gas produced. He wrote to a friend about combustible air. He wrote that submerged plant materials in the ponds and lakes continuously give off such gas. Later Volta's gas was shown to identical with methane gas.

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

In the developing countries like Nepal, the history of biogas is not very old. First of all, the credit for introducing biogas technology in Nepal goes to late father B.R. Saubol. He established a model biogas plant in St-Xavier school in Godavary in 1995. There after the interest in biogas rose slowly and kept on process of installation of biogas plants in the different parts of the country. Fortunately, initial successes encouraged the department of Agriculture (DOA) And Agriculture Development Bank to install 250 biogas plants in the Agriculture year (1975/76).

During this year, Agriculture Development Bank canalized interest free loans throughout the country. Then to promote biogas technology, Gobar Gas Tatha Krishi Yantra Shala Vikash PVT Ltd was established in 1977 with the capital finance from UMN, ADB/N and dissemination of biogas technology in Nepal was initiated mainly after the establishment of G.G.C.

With the establishment of biogas support program (BSP) in 1992 as a joint venture of ADB/N, GGC and SNV Nepal the pace of biogas development and number of household size biogas plants has increased rapidly. Alternative energy promotion centre (AEPC) was formed as a recognized governmental body under the umbrella of ministry of science Technology for the promotion of

alternative energy in Nepal. A Part from this organization other national and international agencies notably UNICEF, Save the children fund / USA, New Era, Dev-part consult, East Consult, CMS/ Nepal (Pvt) Ltd etc have also mode Significant contribution in the promotion and development of biogas technology in Nepal.

1.3 Introduction of Biogas

1.3.1 Biogas

Biogas, popularly known as Gobargas in Nepal is a combustible gas provided by an anaerobic fermentation of organic materials by the action of Methanogen bacteria with in a temperature of 25^0c to 35^0c for certain period of time. This gas is composed of 60-70 percent methane 30-40 percent Co_2 and some other gases. The Methane gas is odorless and burns with clear blue flame with out smoke. It produces more heat than kerosene, fuel wood, charcoal and dung cakes. Biogas can be used for cooking, lighting, running engines and generate electricity. However, the use of biogas in Nepal is limited to cooking and lighting only till now.

1.3.2 Benefits and use of Biogas Technology

Biogas plants provide direct benefits especially to rural women as a result of the reduction of the workload when shifting form cooking on fuel wood to using biogas. Several studies document and average time saving of three hours per day mainly due to reduction in time used for collecting fuel wood, cooking and cleaning of utensils. Reduction in work load provides more time to the housewives for doing remunerative and productive works.

A big problem for the rural people especially to the house wives is indoor air pollution and smoke exposure inside the kitchen while cooking. Poor indoor air quality is one of the major risks factors for acute respiratory infection, coughing, headache and eye ailment s with housewives, infants and children. The use of biogas significantly improves the air quality by banishing smoke and soot from rural home thereby improving health of rural wives and children by preventing

these disease caused by conventional cooking. Not only that anaerobic digestion destroys harmful enteric bacteria viruses and intestinal parasites due to connection of toilets and makes rural people free from flies and mosquitoes. Thus biogas results in better rural sanitation there by contributing to public health.

Biogas reduces indiscriminate deforestation. Another environmental benefit of biogas is maintenance of ecological balance by reduction of about 3,80,000 tones of Co_2 annually. One biogas plant saves about 2.3 tons of fuel wood per year. It roughly saves about 0.03 hectors of forest land per year Thus with 1,00,000 biogas plant installed in Nepal, the biogas would save approximately 3000 hectors of forest every year.

Similarly, studies indicate that one plant produces approximately 30 tones of bio compost per year. About (90%) percent farmers use the bio fertilizer in Nepal. The three million tons of bio-fertilizer if treated and applied properly can have higher fertilizer values, improves soil structure and contributes to maintain the content of organic matter in the soil. More over, high quality biogas manure, which is rich in nitrogen and humus, contributes in yield of crops and vegetables land eventually helps for generating income to biogas house holds. (Bajgain 2003)

At individual perspectives, the primary impact of biogas plants is on poverty alleviation by reducing expenses on fuel for cooking and to some extent lighting. At the national level, it helps in reducing import bills of the country in chemical fertilizer a petroleum products. Not only that, installation of biogas plants also helps in creating job opportunity for skilled and semi-skilled human resources as the construction work requires considerable number of such main power and contributes in rural poverty alleviation. (Gopalan: 1990)

There might be several other indirect benefits of biogas in terms of social, educational and recreational but it is clear that with the growing demand of biogas, this technology has been gaining popularity day by day with in Nepalese rural communities.

Till the end of July 2007, 1,57,675 biogas plants have been installed. Of the total, about 51.36 percent biogas plants are installed in hill region where as 48.18 percent are in Terai and 0.45 percent are installed in remote hilly area. About 8,58,267 person are directly benefited from the biogas plants. The program has so far covered 67 districts out of 75 districts. (BSP. 2007)

1.4 Statement of Problem

Many developing countries are facing the energy related problem such as rising price of fossil fuel, depleting forest resources etc and Nepal is no exception to this. Firewood has been the most common and traditional source of energy for Nepal. Fire wood represents about three forth (75.78 percent) of the total energy consumption which is mainly consumed in rural Nepal. A great part of this is consumed in residential sector for cooking purpose.

Nepal has a theoretical potential of 85,000 MW and commercial Potential of 4, 2000 MW of hydroelectricity. But till to date, only 548 MW of hydro electricity has been harvested. It contributes about 1.3 percent of total commercial potential and shares 1.47 percent of total energy consumption of the country. (RETRUD: 2003) Despite this potential of hydropower, majority of the rural population in Nepal is deprived from electricity facility due to geographical, technological as well as potential instability and bad governance. Moreover, because of the rugged terrain and other geographical disparities, these rural areas are very costly to reach by extending the already overburden electric grid. Installation of mini and micro hydropower too is not feasible in many areas due to unavailability of perennial water resources. Other alternative source of energy such as solar power and wind energy are in negligible in use because of high cost of installation. Hence, in order to solve the energy problem of remote area of Nepal, a fast, easily implemented, Cost efficient, small scale, completely decentralized renewable alternative, which is technically feasible and economically viable has to be promoted. Biogas, in this context is well realized to be most alternative and useful energy source.

Various facts and figures indicated that biogas is a sustainable source of energy in rural Nepal and it needs to be promoted and extended effectively. Unfortunately, we have been able to install only about 8 percent biogas plant of total technical potential. (BSP 2004) some of the reasons for slow progress in adoption of biogas technology in the country side are absorbed to be:

- Ignorance of the farmers as regards the usefulness of the technology.
- Easy access to forest in some areas to collect firewood.
- Non-cooperative attitude of the plant owners to convey and motivate other neighbors as regards the usefulness of biogas technology.
- Unhealthy competition between recognized biogas plants construction companies.
- Unavailability of easy loans to poor farmers due to lack of collateral needed by the bank.
- Difficult and lengthy process of loan sanctioning.
- Unavailability of water to feed into biogas digesters.
- Attitude of farmers not to use gas generated from cattle dung and human excreta (cultural and religious taboos).

Thus there may be one or more reasons as mentioned above in specific area for slow adoption of technology. Realizing the facts the study was carried out to collect answer to the following question.

- What is the socio-economic characteristics of biogas users ?
- What is the situation of biogas in relation to workload of women, Health and sanitation, saving of firewood/ kerosene /L.P.G ?
- What is the effect of biogas plant in relation to use of digested slurry as a fertilizer for agriculture?

1.5 Objectives of the Study

The overall objective of the study is to assess the socio-economic impact of biogas technology on its users. However the specific objectives of the study are:

- To find out the socio economic characteristics of biogas users.
- To study the impact of biogas in relation to workload of women member of family, Health and sanitation, saving of firewood / kerosene / LPG.
- To assess the effect of biogas plant in relation to use of digested slurry as fertilizer for agriculture.

1.6 Significance of the Study

Biogas technology has no doubt a good contribution in the energy sector of Nepal. This simple technology contributes a lot in lessening the burden on the forest resources. Promotion of biogas technology helps greatly in preventing deforestation. Deforestation is the main cause of many natural calamities such as landslides, flood, soil erosion etc.

It is well realized that biogas technology is very much suitable for Nepalese context. Because of high cost of installation of micro hydropower plants and sophisticated technology involved in exploitation of solar and wind energies, these options are not affordable to rural population. Biogas is cost effective, simple user- friendly technology. Thus this is regarded as sustainable energy in Nepalese context. The biogas further help in saving money and time in collecting fire wood and cooking activities. It provides the smokeless environment in the kitchen. More over, installation of biogas plant would help towards agricultural production. The digested slurry contains more nutrients and contributes in increasing agricultural production.

As a very little information about the socio-economic condition and impacts of biogas technology on biogas house holds in Ghorahi Municipality, collection of answer to the questions as mentioned in clues 1.4 above is of vital importance.

The in traction with the biogas user on various aspect of biogas use and observation of biogas plants would help in getting real picture of adoption of biogas plants would help in getting real picture of adoption of biogas technology in the study area. This will provide an understanding of various pertinent questions which will undoubtedly help in addressing problems formulating realistic policies and programs there by bringing about environmental balance, social justice and rural poverty reduction by providing appropriate feed back to concerned agencies.

As a result of the above important considerations, the researcher initiated an impact study to acquire useful information and observation with regards to adoption of biogas technology characteristics of biogas users. Usefulness as well as it's effect on farm production and daily lives of farm families in Ghorahi Municipality of Dang district region. Thus findings and recommendations of the present study are likely to contribute to an endeavor to bring sustainable development of Nepal.

1.7 Organization of the Study

The entire report has been divided in to 7 chapters. The first chapter gives introduction of the study. It contains background of the study, historical development of biogas in world and Nepalese context, objectives of the study, Significance and justification of the study and introduction to biogas technology.

The second chapter consists of the reviews of literature. Third chapter describes the methodology of the study. The chapter four provides the description of study site pertaining to geographical and socio-economic situation.

The chapter five describes about socio-economic condition of biogas user house hold and information on biogas plants. The chapter six consists of impact of biogas technology and major findings of the study.

And lastly, chapter seven contains conclusion and recommendations.

CHAPTER II

LITERATURE REVIEW

In the past decades, several research studies and investigation 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 to 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 work done on the field of biogas energy sector thereby providing a solid feed back to the researcher. The review is specially focused on impact of biogas. The summaries of outcomes of some of these studies have been illustrated here after.

The workshop on "Biogas technology and Utilization of Asia and pacific region" held at Manila in 1975 was organized by ESCAP. There were altogether 20 participants from 12 different countries. Every participant analyzed about working strategies, problems faced and proposed programs on biogas energy sector. The contribution of the biogas plants especially to rural people and the prospective expansion of biogas technology were also discussed in each nation’s context. (ESCAP. 1975)

Proceeding of the workshop on biogas and other related energy held Suva and the seminar on "Rural energy development" held at Bangkok, Manila, Tehran and Djakarta under the "Energy development series" deal on the biogas and integrated farming systems and lay emphasis therefore on the biogas plants, especially on possible effects on the rural life thereby analyzing direct benefits and indirect social benefits as well. As analysis, these plants supply an efficient and clean fuel for cooking and free the rural women from smoke and disease caused by traditional fuels like firewood dung cake etc. Furthermore, it provides

extra time for these women, providing them opportunity to earn extra income. Moreover, the manure from these plants is superior as compared to farm ward manure. There is almost double amount as much humans in biogas slurry as contained in farmyard manure. This manure doesn't contain terminative weed seeds, the cost of weeding in the field is lessened and the production increased by 25 to 50 percent depending on the crop. The indirect social benefits include the advantages of residues from the plants and not attracting the mosquito's and flies. Besides this, biogas technology provides means of hygienic disposal of night soil. (UN, 1979)

Agriculture Development Bank had conducted a study entitled "Impact study of biogas Installation in Nepal in 1986. The study had a survey of 60 biogas plants in total 15 plant owner each from Kavre and Kaski (hills) and Rupandehi and Jhapa (Terai). The report provides a complete literature on almost all every aspects of the biogas plants and further every field that receives the impacts of installation is covered. This report has also covered the general information on plant owners, plant establishment, plant operation gas production, slurry use and impact on production extent of use of chemical fertilizer, repair and maintenance of plant, economy of plant support service as well as other invisible benefits.

The study report depicted that:

- At individual perspective, a plant owner had saved 55 and 41 quintals fire wood (65 percent of the requirement) in terai and hill respectively. Likewise 102 lit. And 83 lit of kerosene contributing to reduction in deforestation and import of petroleum products. (eg. kerosene, L PG etc)
- The totals crop area per plant owner in terai and hill was increased by 7 percent and 9 percent respectively after the biogas installation. Similarly, the average annual increment in crop production per hac. In Terai and hill was 0.31 and 0.64 respectively thereby contributing to increment in self consumption of commodities by 13 percent and 20 percent in hill and Terai respectively due to biogas installation?

- As far as a gender issue is concerned, the use of biogas had saved 1.8 hrs and 0.6 hrs in Terai and hills respectively. The gained time was utilized in productive activities. Likewise, increment in working during evening hours was observed by 1.5 and 1.3 hrs in terai and hills respectively. (ADB/N, 1986)

- Sigdel and Das had done a study entitled "Biogas Development in Kaski district in rural context" They had surveyed 13 biogas plants in Lekhnath VDC. The report reveled that there was a growing awareness in this technology as forest saver. People felt that it would be applicable in semi urban area where people were richer since majority the village people suffered from problem of searching capital to repay loan and installation cast was found to be high. Realization of subsidy could be observed. (Sigdel and Das ,1990)

- Pokheral and yadav in their report entitled "Application of biogas technology problem and prospects" state that biogas technology has shown favorable impact on rural area of Kaski district. In average, 82.5 percent reduction is attained in fuel wood while 63.1 percent saving in kerosene consumption. Moreover, increasing awareness in health and sanitation among the rural and sub-urban population are considered as the social contribution of the biogas technology. The attachment of more 75 percent biogas with their toilet reflects it by no doubt (Pokheral and Yadav, 1992)

The result of survey entitled "Preliminary Results of research on women using Biogas" reveals that with biogas installation the time for fuel wood collection was reduced from 6.6 hr to almost hour on an average per day further more the average cooking time was reduced by 50 percent ie. 4.3 hrs to 2.1 hrs per day. (Vliet and van 1992)

Vliet had carried out another study in Madan Pokhara VDC of palpa district to examine the impact of biogas on drudgery of women in 21 biogas households. According to her, biogas technology had provided various positive impacts such

as time saving relief from firewood collection from dangerous jungles, easy to prepare food. A total of 1-2 hrs of time per day was saved by which was utilized in other creative and income generating activities. (Vliet 1993)

Centre for Rural Technology has carried out a study entitled "Biogas Latrine project Assessment" for UNICEF. According to the report, attachment of toilet to biogas has helped in creating better sanitation around the household and improved health of users. The adoption of biogas technology has resulted in saving of 12.9 metric ton of fuel wood and it has helped in protecting 108 hectare of forest area. Like wise agriculture production has been increased up to 20-25 percent after the use of biogas slurry. (CRT 1995)

Britt had conducted a research study entitled "The effect of Biogas on women's workload in Nepal" The studies were done intentionally focusing in gender and workload in Palpa, Rupendehi, Nuwakot, Chitwan and Mahottari districts for the biogas supper program. The out come of the study states that given the overwhelming work load for women in most part of Nepal, the saving in time is quite significant. But it also remarks that introduction of biogas technology doesn't appear to fundamentally alter the position of women. So-called traditional or unequal patterns in the division of labour are sustained with women working for long hours only substantiating one labor activity for another. (Britt 1994)

Adhikari carried out an impact study entitled "Effects of biogas on family Health and sanitation and Nutrition" in lamjung district. In this study both positive and Negative impacts have been evaluated. The positive impacts were improvement in environmental as well as personal health and sanitation reduction in firewood consumption after biogas plants installation were as negative impacts were increased prevalence of mosquito and loss of warmth in house in winter. (Adhikari, 1996)

Biogas user's survey conducted by Dev. part consult (PVT) Ltd (1998) reported the following findings:

- Unlike the findings of the previous survey, the users also consisted of a few small and marginal households.

- Literacy among plant owners was 77 percent.
- In all, 36 percent of biogas plants were attached with latrines.
- The O and M services provided by the construction on companies were considered as to be satisfactory in most of the case.
- Altogether 68 percent borrowed from bank, 64 percent from ADB/N and 4 percent from RBB and rest constructed on cash down payment.
- Compared to other type of loans the repayment of biogas loan was good.
- Saving of fuel wood and kerosene was reported to be 16 mt and 24 it per respectively.

Likewise Recommendations made by this survey were

- Social awareness program is necessary to maximize the social benefits from the plants. Efforts to down size the plant should be continued so that cases of under feeding are minimized.
- Problems of after-sales of service could be minimized by companies through involvement of local NGOs.
- The BSP/N should consider inducting the staff of government and line agencies that participate in the activity.

The Biogas user's survey of CMS (1999) reported the following findings.

- The literacy rate of sample households was about 75 percent
- Altogether 69 percent of the plant owner used dung as the primary feeding material for bio digester and 27 percent of the plants were attached with latrines.
- In all 77 percent of the plants were installed for cooking conveniences due to short fall of fuel wood.
- A total of 86 percent of the users reported sufficiency of gas for cooking and lighting.

- Quality control was found to be satisfactory by about 95 percent of the plant owner.
- Altogether 48 percent were found to be using slurry in compost form.

A decrease in respiratory disease by 53 percent was reported.

GGC had prepared a profile in 2001 entitled Gobar Gyas Tatha Krisi Yantra Shala Vikas Company Ltd profile. "Thus profile depicts that biogas, the clean energy technology has also improved sanitation of local environment. However poorest of poor couldn't be benefited from the program directly. After installation of biogas, the gained time was utilized in goat raising, poultry farming, childcare and agricultural production. Thus it has improved the living conditions of the rural people. It is believed that proper use of slurry from the plant would increase agriculture production for about 10-15 percent. (GGC 2001)

NEPECON had carried out a survey in 2001 entitled "Biogas User's Survey 200/2001 for AEPC." A total of 200 biogas households were selected for the survey. The survey suggested the following findings:-

- On the average a biogas households survey 990 kg fire wood and 6 liters of kerosene per annum as a result of biogas installation.
- Average time saving of the sampled biogas households for performing various biogas related activities amount to be about 1.31 hour/day or 1 hour 18 minute. With this calculation in saving a daily wage labour can earn around Rs 4,180 per year.
- About 41 percent of the respondents utilized slurry in composting form white 28 percent applied it in dried form.
- Biogas households perceive from 12 to 23 percent increment yield of crops and vegetables due to slurry application.
- Around 67 percent of plant owners practice stall feeding, 30 percent do practice postal stall-feeding and per its grazing while 3 percent leave their animal for grazing.

- 47 percent respondent s perceived a decrease in visit of hospital/ medical clinic after biogas plant installation.
- All respondents have perceived an increase in mosquito breeding after biogas installation (NEPECON 2001) similarly East Consult had conducted a survey entitled "Biogas user survey 2003/2004 for AEPC. A total 118 biogas households were chosen for the survey. The report suggested the following findings.
- A Combined figure of Brahmins and Chhetri were found 74 percent.
- Literacy among the plant owners was 75.24 percent in hill and 86.35 percent in terai.
- The majority of biogas users increase yield response in paddy (39.83 percent), maize (48.3 percent), potato (62.71) and vegetables (57.63 percent)
- Livestock feeding practice was found to be 77 percent complete stall - feeding followed by 37 percent partial stall- feeding and 7.6 percent complete free grazing.
- Cattle shed were improved by 1.6 times after the biogas installation.
- The decrease in consumption of kerosene per households per annum in hill was 17.83 lit. While figures for terai are 64 lit. and 70.77 lit in summer and winter respectively.

It recommended

- AEPC/BSP-N Should carry out effective monitoring and evaluation to maintain the sustainability of biogas plants.
- Effective Training to be end-users especially females as well as to the technicians should be carried out.
- It is recommended to conduct the precise research preferably in collaboration with Department of Agriculture and or Nepal Agriculture

Research council to study the influence of slurry on insect pest and crop diseases.

Thus from all the findings it can be safely concluded that biogas has been a very useful technology that has impacted the life of its and users in a positive way.

CHAPTER III

METHODOLOGY

3.1 Research Design

For this study a descriptive research design was followed. The descriptive research was applied for the qualitative data obtained and derived during the study. The data, which were not quantifiable, was explained literally. Analysis of data was made by generating the tables of average and percentage.

3.2 Rationality of the Site Selection

Ghorahi Municipality 3 in Dang district, Most of the families whose income is low can't use LPG, Kerosene and electric heater. They use dung cake, fire wood for fuel. So forest has been decreasing day by day and environment is although being populated about 30 percent people have installed biogas plant about 90 percent people have involved in agriculture. They are using dung, wood using traditional oven. Although people are interested to install the biogas plant but are not getting real information and advantages of biogas plant. Therefore propose of this study is to install biogas plant in this municipality.

3.3 Sampling Procedure and Sample Size

Till the end of year 2064, 80 biogas plants have been installed in various parts of Ghorahi Municipality 3. It was rather not possible to interview all the biogas house holds of Ghorahi Municipality 3 in limited time. So out of them only 30 biogas plants were selected for the study lottery sampling method was followed for the selection of samples.

3.4 Sources of Data

Both primary and secondary data and information were used to receive in depth socio-economic status biogas technology. Major emphasis was given to primary

data .The house hold survey questionnaire was used to collect the primary data to get first hand information on the impact of biogas to its users.

As extensive library consultation was made for the collection of secondary data regarding biogas technology. The library consultation contributed a lot in -depth understanding the depth of the issues under the study. Eventually the understanding helped tremendously in designing of tools and field data collection method as well. The library research involved a wide range of materials such as book study report, information bulletining, booklets etc published by various instructions and personal working in the field.

3.5 Techniques of Data Collection

The following techniques and tools were used to collect data and relevant information during the course of study.

3.5.1 Household Survey

Keeping in view of objectives a detail structured Questionnaire was developed. The questionnaire was finalized after consulting with supervisor. It was pretested in adjoining Municipality and after then administered among sample biogas households to get in-depth information and data pertaining to socio-economic characteristics of biogas households, impact of biogas in health and sanitation, utilization of slurry in agriculture. The interview was conducted by visiting door to door by the researcher. If in case any sample household was found missing, there the neighboring biogas sample household was applied for interview.

3.5.2 Informal Meeting

The researcher also met village leaders, key informants government officials, biogas companies, non biogas households of Agriculture Development Bank and held informal discussions with them. The informal meeting was particularly useful for matching the information collected through personal interview with the respondents.

3.5.3 Focus Group Discussion

The researcher also organized a focus group discussion with the potential key informants and other local people including women. (Both respondent and non-respondent) were invited to participate in the discussion. They all participated actively in discussion and provided valuable information regarding the impact of biogas on health and sanitation, agriculture production and pertinent issues regarding the status of biogas plant.

To collect further data and information than covered by questionnaire, the researcher visited some biogas plant and observed directly to have better idea about the biogas plant. Observation included on followings.

- Biogas plant under construction.
- Working condition of biogas plant.
- Working condition of cooking gas stoves.
- Site of slurry out put and its utilization in cultivated field.
- Sanitary condition around the households.
- Cleanliness of kitchen.

3.6 Data Processing and Analysis

The data obtained from both primary and secondary source was coded and cast in appropriate format in table of average and percentage. Data analysis was done on the basic of figures, percentage and mean. After this, previous information as output has been documented in this report.

3.7 Limitations of Study

Each and every study has its own limitation, no study can claim to be free from constrains of resource time and so on as a social science research, the present study is not free from same errors associated with quality of data and their interpretation despite sincere efforts was made to minimize the likely errors due

to design and methodology of this study. However the present study may have following limitations.

- The present study is one, which has tried to access the socio-economic impact on sample biogas households of only Ghorahi Municipality. 3. It has not covered the whole biogas households of all Ghorahi Municipality 3 of dang district due to various constraints. Therefore findings and conclusion may not be generalized and implemented at national level. However out come will represent the area with similar geographical and socio-economic conditions.
- The study was completed with in a short period. Due to this direct observation of biogas plants and dragging information in all season was not possible- So recall technique was used to get data and information in the past.
- It was not possible in dragging the actual information especially in the landholding and income level. They had general tendency of hiding exact information due to various reasons. Hence the basis of researcher and respondents could not be ignored.

There for the findings of the research may not be generalized to wider scale. However despite above mentioned limitations, the present study provides a comprehensive understanding of general impact of biogas technology of the study site.

CHAPTER IV

INTRODUCTION OF THE STUDY AREA

4.1 District Background

Dang, well known for the largest valley of South Asia, is one of the 5 Districts of Rapti Zone of mid western Development Region and Ghorahi is the headquarter of this district.

Dang district shares its boarder with Kapilbastu, Arghakhachi in east, Surkhet, Banke in the west, Salyan, Rolpa and Puthan in North and India in South. The district has total area of 2955 sq. Km. It lies between 27^0 36' to 28^0 29' north latitude and $82^0$2' to $82^0$5' east longitude. The elevation of this district from mean sea level ranges from 213m to 2058m. It has 39 VDCs and Two municipalities. Politically the district is divided into 13 Ilakas and 5 election constituencies and one town development committee.

The general climate of this district is neither too hot nor too cold i.e tropical Manson climate. The maximum and minimum temperature is 39.9^0c and 25.0^0c. Average rainfall is 170.6 mm.

According to CBS 2058 B.S. total population of this district is 4,62,380 having male 228958 (49.56) percent and female 2,33,422 (58.42) percent. The total number of households in this district is 82, 495. Average house hold size is 5.60 which is more than national average 5.44. The average life expectancy at birth of the population is estimated at 58 years. The demographic composition of this district shows that there are as many as 25 ethnic/ cast group in this district Among them Tharu are the most dominant ethnic groups in this district 31.86 percent population followed by Brahimin (10.82), percent, Chhetris (22.74 percent), Magar (12.04 percent), Newar (0.85 percent), Mualim (1.00 percent) Kami (5.26 percent), yadab (1.46 percent) Gurung (0.30 percent), Damai (2.67 percent), Thakuri (1.17 percent), Sarki (1.77 percent), Sanayasi (2.17), Sharpa

(0.76 percent), Baniya (0.36 percent) Kumal (1.44 percent), Dhobi (0.008 percent), Majhi (0.029 percent) Bota (0.07 percent), Gaina (0.13 percent), Badi (0.13 percent) Aadibasi ethnicity (0.48), Rauta (0.003 percent), Other (2.36 percent).

Agriculture farming is the main occupation for the majority of households in this district. The major crops grown in this district are paddy, maize wheat and potato. Agriculture in this district is still based on traditional skill of the farmers. Limited modern technologies of farming practices have been reached in this district. As a consequence forming in this district is of subsistence type rather than commercial.

Live stock is an integral part of farming system in the district and most of the house holds are keeping one or more types of livestock on their house. Cattle buffalo, goat, and poultry are commonly raised by all ethnic cast groups where a few specific casts / ethnic group raise sheep and pigs.

The literacy rate of this district is 58.00 percent comprising male 69.3 percent and female 46.9 percent. The district has 286 primary school 54 lower secondary school, 86 secondary school 10 higher secondary school 1 A.N.M campus and three CMA campuses at private level and 4 government campuses are there in this district.

The district has one district hospital, where 50 beds are available for the patient and there are 4 primary health centers, 10 health posts, 26 sub health posts, 1 eye hospital and 1 Ayurbedic hospital in this district.

4.2 Institutions Related to Biogas Promotion

Biogas support program (BSP), Nepal biogas promotion group (NBPG), and Alternative energy promotion center (AECP) are the prominent institutions related with biogas sector. These are working for the promotion and development of biogas in Nepal. A brief description of these institutions is as follows:

4.2.1 Biogas Support Program (BSP)

BSP- Nepal is a legally autonomous not –for profit organization with executive board comprising of 7 independent professional members 30 professional staffs.

Since 1992, BSP- Nepal has been promoting biogas sustainable energy source in the rural areas of Nepal through the development of commercial viable and market oriented biogas industry. BSP- Nepal has successfully built and strengthened the instructional framework to support wide-scale commercialization of biogas system through the country. BSP has been playing a vital role in the promotion of biogas system it has been certified with ISO-9001-2000 certification (BSP, 2007).

For the first two phases of the program, BSP 1st and 2nd program support was provided by His Majesty's Government of Nepal, the Netherlands Development Agency (NEDA). With the start of the third phases of the Program (BSP 3rd: 1997 to 2002), the German Government, through KFW, enforced the programmer's support with financial assistance to the subsidy and credit component.

Implementation of BSP 3rd is done jointly with three banks (Agricultural Development Bank of Nepal, National Commercial Bank and Nepal Bank Limited) and 50 recognized private biogas companies.

Biogas sector Partnership Nepal (BSP-Nepal) is the implementing agency of Biogas Support Program (BSP) Phase-IV the implementation responsibility of BSP, which formerly was managed directly by the Netherlands Development Organization (SNV).

BSP-Nepal has also articulated its vision, mission objectives and strategy as given below (which are not yet quite final).

Vision

An organization that is capable and successful in improving livelihood of communities through promotion of different environment-friendly solutions.

Mission

To promote environment-friendly and sustainable solutions to people in partnership with other players in the sector(s) for improved livelihood and environment protection

Objectives

- To further development and disseminate biogas plants as mainstream renewable energy solution in rural Nepal, while better addressing poverty, social inclusion and regional balance issues and at the same time ensuring enhanced commercialization and sustainability of the sector (Objective of BSP Phase-IV)
- To develop and strengthen innovative fund raising measures such as CDM for continued service delivery.
- To initiate and implement projects in biogas plants for institutional and community uses.
- To facilitate the process of developing new solutions that complement the promotion of biogas and integrate it with solutions on water, sanitation, etc.

4.2.2 Nepal Biogas Promotion Group (NBPG)

NBPG is an association of Biogas Company. It was established in 1995 and consisted of representatives from the Biogas Companies. It was established for the promotion of Bio-gas technology and at the same time promoting common interest of its members. Some of the activities of NBPG include:

- Facilitate import of Biogas appliances
- Facilitate bio-gas users in processing loan from Banks
- Helps avoids unhealthy competition among the member Biogas companies

- Gradually take over the activities of the promotion of biogas training and extension activities combined out by BSP

4.2.3 Alternative Energy Promotion Center (AEPC)

An apex institution was felt needed for the development of biogas. As a consequence, Ministry of Science and Technology established the Alternative Energy Promotion Center (AEPC) in November 1996. The AECP's function includes:

- Analysis of policy issues and advice on policy matters
- Coordination with other sectors and ministries
- Preparation of sector wise plans and target
- Elaboration of regulatory frameworks: selling of standard and guidelines, criteria for registration and licensing of companies.
- Mobilization of funds and liaison with donors
- Review/approval of annual work plan in respect of donor funded projects in alternative energy.
- Monitoring of development in the alternative energy sector as a whole
- Organize and/or participate in program and project evaluation

4.3 Energy Situation in Dang district

In urban and semi areas of Dang district, majority of people use liquefied petroleum gas, kerosene and electricity for cooking purpose. But in rural areas, people use fire wood, animal dung, agriculture residues for cooking purpose thus fire wood has been chief energy sources in the district.

Among 39 VDCs, 2 municipalities in Dang district, 75 percent have got electricity facility. The electricity is used mainly for lighting and running cottage industries. Due to frequent rise in price of petroleum oil and costly electricity, biogas installation has gained momentum in these days. According to BSP, there is

technical potential of 60,676 biogas plants of which only 4,443 plants have been installed, till end of July 2007.

4.4 Energy Situation in Ghorahi Municipality

Fuel wood, crop residues, biogas kerosene, rice husk, animal dung and electricity are the major resources of energy used for cooking food, preparing lives tock feed, space heating and lightning house in Ghorahi Municipality. Among these resources, biogas, LPG and kerosene are the most important sources of energy for cooking used virtually by the house holds residing in ridges and tars of this municipality while electricity and kerosene are the main sources of energy for lightning in this municipality. Till the end of 2064 total 829 biogas plant has been installed.

Fuel wood, biogas, LPG, kerosene, animal dung, crop residues and husk are major energy source of cooking in Ghorahi Municipality. There share is presented in following table.

Table 4.1 - Source of energy for cooking Ghorahi Municipality

S.N	Source of energy	No of HHs	Percent
1	Fuel wood	4245	47.00
2	L.P.G	2162	23.94
3	Kerosene	612	6.77
4	Biogas	829	9.18
5	Other (crop residues animal dung)	1182	13.08
	Total	9030	100.00

Source: field survey 2008

Above table shows that majority of households about 47 percent use fuel wood followed by 23.94 percent LPG, kerosene 6.77 percent, biogas 9.18 percent other crops residues, animal dung and rice husk 13.08 percent.

4.5 History of Biogas in Ghorahi Municipality

Looking back, the history of biogas in Ghorahi Municipality started in fical year 2035/036, 19 biogas plants were installed by “Gobar Gas Tatha Kirshi Yantra Vikash Pvt. Ltd.” The installation of biogas plant got momentum. Moreover, the pace of installation of biogas plant got further momentum due to establishment of branch office of Rastriy Gobar Gas Nirman Tatha Sewa company during 2052/053, public Gobar gas private Ltd. company 2052/2053, Gharelu Gobar Gas private Ltd. Company 2053, Biogas Pvt. Ltd. Company in 2057 established in dang district. (Ghorahi Municipality). As a consequence there are 829 biogas plants installed and presently these five biogas companies are actively engaged in installation of plants in this municipality.

4.6 Energy situation in Ghorahi Municipality 3

Fuel wood, crop residues, biogas, kerosene, rice husk and electricity are the major source of energy used for cooking food preparing livestock feed space heating and lighting houses in Ghorahi Municipality 3. Among these resources, biogas, kerosene LPG is the most important source of energy for cooking and electricity and kerosene are the main source of energy for lighting in this ward.

4.7 Source of Energy for Cooking in Ghorahi Municipality 3

Fuel wood, biogas, kerosene, crop residues and husk are major energy source of cooking in Ghorahi Municipality 3. Their share is presented in following:

Table 4.2 - Source of energy for cooking

S.N.	Source of Energy	No. of Households	Percentage
1	Fuel wood	272	59.78
2	Biogas	80	17.55
3	L.P.G	20	4.39
4	Kerosene	53	11.48
5	Other (crop residues)	30	6.59
Total		455	100.00

Source: Field survey 2008

4.8 Source of Energy for Lighting in Ghorahi Municipality3

Mainly electricity and kerosene are major energy source for lighting in Ghorahi Municipality 3. There share presented in following table.

Table 4.3 - Source of energy for lightning

S.N	Source of Energy	No of House holds	Percentage
1	Electricity	324	72.81
2	Kerosene	121	27.19
Total		445	100.00

Source: Field Survey, 2008

CHAPTER V

SOCIO-ECONOMIC CHARACTERISTICS OF THE BIOGAS USERS

5.1 Ethnicity/ Caste

Ethnic/caste composition of the respondents shows half of the respondents were Brahmans, about one quarters were Tharu, Chhetri 10 percent Gurung 10 percent, Newar and Bishwokarma together composed only 7 percent.

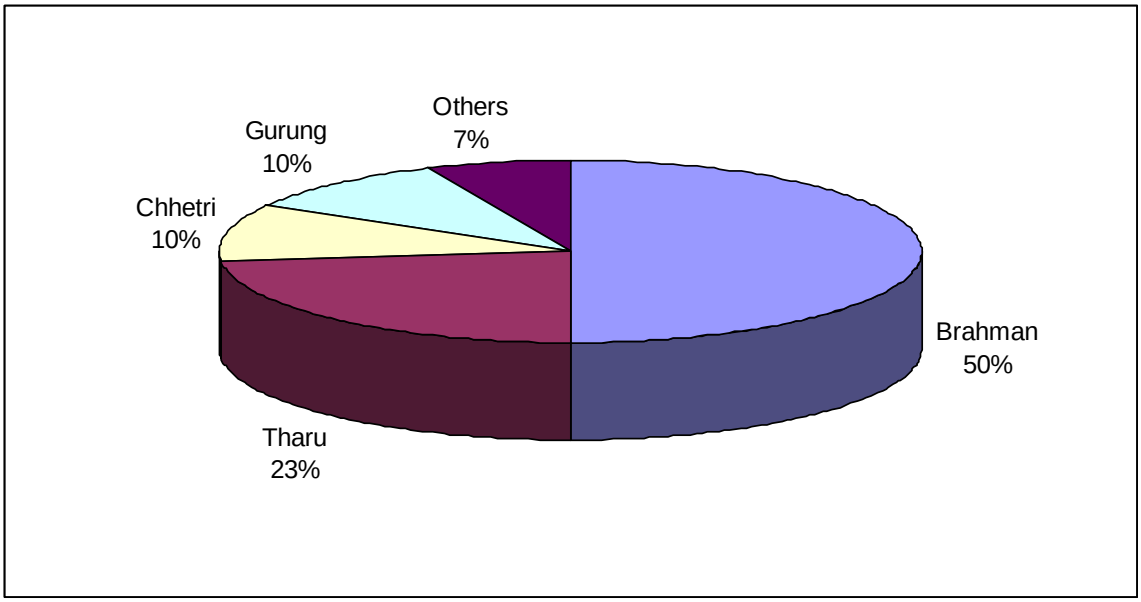
Table 5.1 - Ethnicity/ cast of households

S.N	Ethnicity /caste	No of Households	percentage
1	Brahman	15	50
2	Tharu	7	23.33
3	Chhetri	3	10
4	Gurung	3	10
5	Others	2	6.67
Total		30	100.00

Source: Field surrey, 2008

Others consists Newar and Bishwokarma Castes. The above table shows that majority of biogas users were Brahmin (50 percent) Gurung (10 percent) and so on this reveals that Brahmin who are considered as high class have adopted this technology high level.

Figure 5.1 – Ethnicity/Cast of households



5.2 Household Size of Biogas Owners

The average family size of the amp0led households was 7 persons per family. About 47% of the household have family size on and above the average. Distribution of the households according to the family size is shown in the table given below.

Table 5.2 - Distribution of Household Size

Family Size	Households	
	Number	percentage
Small (up to 4 persons)	3	10.00
Medium (5 to 7 persons)	19	63.00
Large (above 8)	8	27.00
Total	30	100.00

Source : Field Survey, 2008

The table shows that maximum number of respondents had medium size family with 5 to 7 persons. Minimum family size was 4 persons whereas maximum family size was 8.

5.3 Cost of Plant Establishment

The data owners hadn't maintained up to date data records with regard to biogas installment cost. The cost of installation can be observed through three parameters: total cost of installation, subsidy provided by institutions and self-investment of the users.

Table 5.3 - Cost of Plant Establishment (Amount in Rs)

Plant's size	Average cost	Minimum cost	Maximum cost
$4m^3$	11,692	8,000	15,000
$6m^3$	19,240	15,000	27,000
$8m^3$	23,600	18,000	30,000
$10m^3$	26,000	21,000	34,000

Source : Field Survey 2008.

The average cost for installation of 8 m^3 biogas plant was Rs. 23,600; minimum cost per installation was Rs. 18,000 and maximum cost was Rs. 30,000.

The reason for the apparent variation in cost may be the personal contribution made by the respondent during the construction work in the form of labor and construction materials.

5.4 Subsidy

BSP provide the subsidy for Biogas Installer through Biogas Company. Its provide rate is different in Terai, Hill and Remote Hill. Which, we can see better in Table 5.4 given below.

Table 5.4 - Subsidy Rate in Rs.

Plant Size	Terai districts	Hill districts	Remote hill districts
4 m^3 to 6 m^3	6,500	9,500	12,500
8 m^3 to 10 m^3	6,000	9,000	12,000

Source : BSPN, 2008.

The above the table shows that the subsidy rate is different in Terai, Hill and Remote Hill. BSPN provided high subsidy rate in Remote Hill and Hill districts than Terai. Because in Terai there are different facilities likes electricity, solar and they are rich than Hilly people. So, the BSPN provided high subsidy rate for Hilly and remote Hilly people because they are poor and no knowledge of renewable Energy Source.

5.5 Occupation

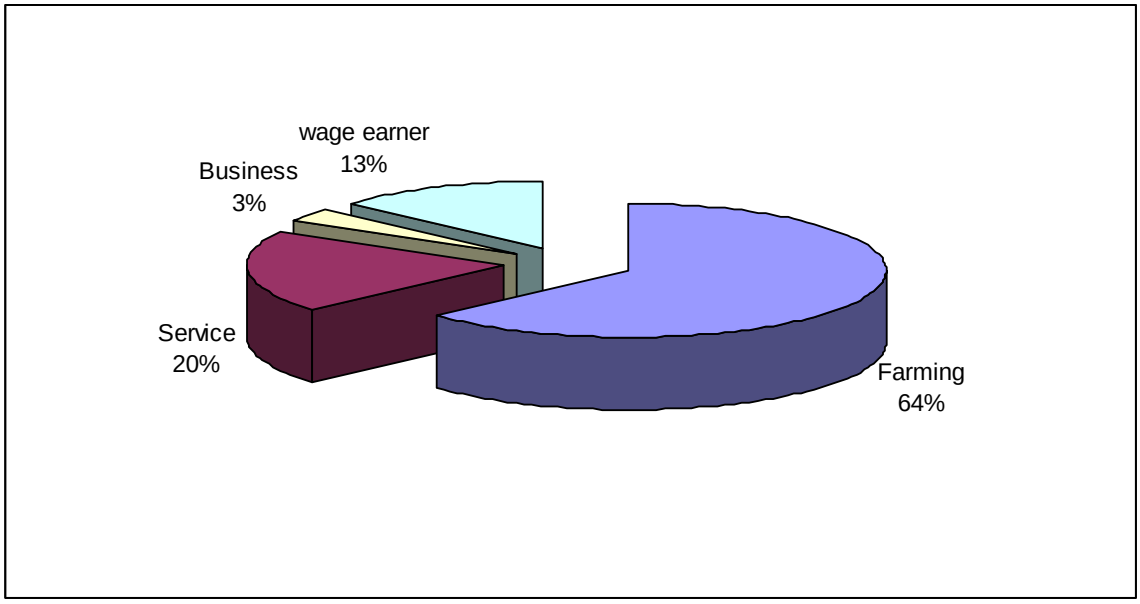
Field survey should that majority of households (63.33 percent) are self employed in agriculture. Beside agriculture other occupations were service (20 percent), wage earning (13.33 percent) and business (3.33 percent).

Table 5.5 - Occupation of the Respondents

S.N	Occupation	No of respondent	percentage
1	Farming	19	63.33
2	Service	6	20
3	Business	1	3.33
4	wage earner	4	13.33
Total		30	100.00

Source : Field survey,2008

Figure 5.2 - Occupation of the Respondents



5.6 Source of Energy for Lighting Ghorahi Municipality

Mainly electricity and kerosene are major energy sources for lighting in Ghorahi Municipality.

Table 5.6 - Source of Energy for Lighting Ghorahi Municipality

Source of Energy	No of household	Percent
Electricity	8212	91.81
Kerosene	733	8.19
Total	8945	100.00

Source: Field survey, 2008

5.7 The land holding status of biogas households

The land holding status of biogas house hold has been presented in table 5.7. It shows that about 40.00 Percent biogas households owned 11-20 ropanies of land. Similarly 30.00 percent biogas households owned less than 10 ropanies of

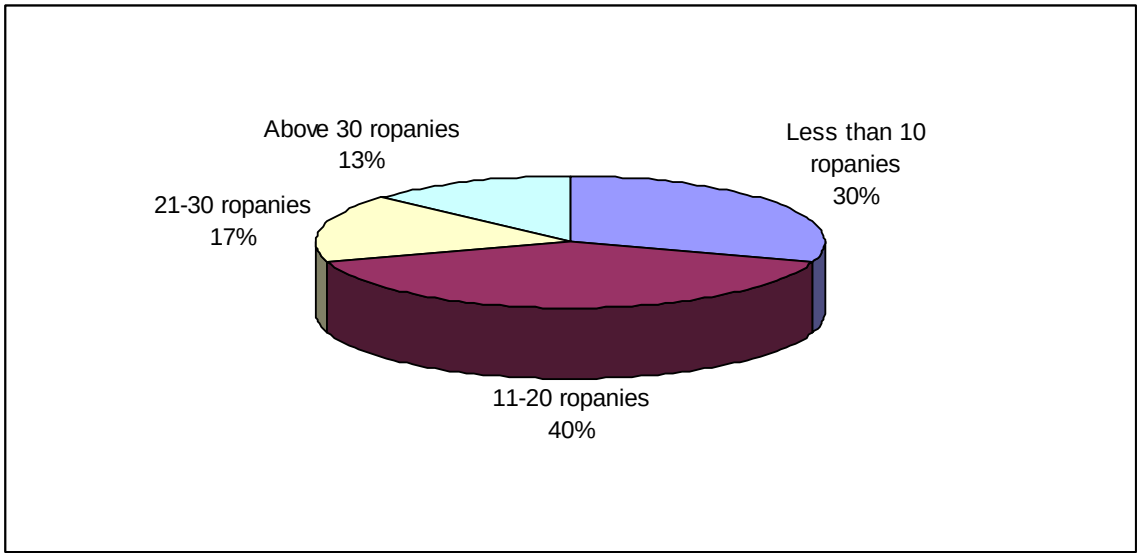
land. This indicates the small and medium landholding were associated with sample households. Only a few households owned above 30 ropanies land (13.33 percent). No landless had been reported.

Table 5.7 - Land Holding Status of Biogas Households

S.N	Land Holding in Ropanies	No of Households	Percent
1	Less than 10	9	30.00
2	11-20	12	40.00
3	21-30	5	16.67
4	Above 30	4	13.3
	Total	30	100.00

Source: Field survey, 2008

Figure 5.3 – Land Holding Status of Biogas Households



5.8 Livestock Population

Livestock farming is the main source of dung for biogas plants. They are the source of raw materials (dung) need to run biogas plants. Only cattle buffalo

were considered in the livestock population because, dung for only cattle were used for biogas. Waste produced by goat, pig and poultry but it is not used for biogas.

The average number of livestock (cattle and buffalo) per house hold was 3.7, Average number of cattle was 1.5 and average number of buffalo was 2.2 Buffaloes were admired by the respondents**.**

Table 5.8 - Livestock Population

S.N	Livestock	Number	Percent
1	Cattle	44	39.29
2	Buffalo	68	60.71
	Total	112	100.00

Source: Field survey 2008

5.9 Economic Status

Income level is the major indicators of assessing economics status in the society. The research study indicated that economically medium level households have adopted biogas technology at widespread level.

Table 5.9 - Income level of sampled Biogas

S.N	Income level (Annual)	No of Households	Percent
1	Below Rs 20,000	2	6.67
2	Rs 20,000-60,000	19	63.33
3	Rs 60,000-80,000	5	16.66
4	Above Rs 80,000	4	13.33
	Total	30	100.00

Source: Field survey, 2008

Above table shows that majority of households (63.33 percent) had annual income of Rs 20,000-60,000 followed by 16.66 percent households with Rs 60,000-80,000 income. This depict that medium level of biogas households from economic point of view are associated with wide scale adoption of biogas technology.

5.10 Dung Produced

Livestock dung is the main source for the operation of biogas plant. So, its availability in sufficient quantity is importance. Average dung product per household was 49 kgs. Minimum dung produced was 15 kgs and maximum dung produced was 95 kgs.

5.11 Dung Feeding

It has been observed that quantity of dung feeding par plant various with the size of plant. Bigger the size of plant more quantity of dung is needed to be fed. Average dung feeding per day for different size of plant i.e. $4m^3$, $6m^3$, $8m^3$ and $10m^3$ were 20kg, 25kg, 32kg and 42kg. As average livestock population is less in the study area, dung feeding hasn't met with the norms established by the Gobar Gas Company. As a mentioned above, insufficient is fulfilled from human excreta and livestock urine. Which, we can clearly from table given below.

Table 5.10 - Daily Dung Feeding Rate (Quantity in Kg)

Size of Biogas Plant	Required	Existing
$4m^3$	24	20
$6m^3$	36	25
$8m^3$	48	32
$10m^3$	60	42

Source : Field Survey, 2008.

5.12 Ratio of Mixing

Dung has to be mixed with water at the time of feeding of the biogas plant. The recommended amount of water is equal part to the dung according to the norms of biogas companies. Production of biogas will be affected if the amount of water is too less or high.

Table 5.11 - Ratio of Mixing

Water to dung ratio	Households	
	Number	Percentage
1 (normal slurry)	18	60.00
<1 (thicker slurry)	8	27.00
>1 (diluted slurry)	4	13.00
Total	30	100.00

Source : Field Survey, 2008.

The table 5.11 shows that 60% of the households used equal amount of dung and water, 27% used less than recommended and 13% used more than recommended amount of water.

5.13 House type

Dwelling status is also indicator of wealth among biogas households (53.33%) of sample biogas households are living in Ardha pakki house, 33.33 percent reside in kachhi house and (13.33 percent) live in Pakki house.

Table 5.12 - Nature of House of Sampling Biogas households

S.N	Type of House	No of HHs	Percent
1	Kachhi	10	33.33
2	Ardha Pakki	16	53.33
3	Pakki	4	13.33
	Total	30	100.00

Source: Field survey, 2008

5.14 Drinking Water Availability and Sanitation Status

The facilities for drinking water and toilets in rural area are the important indicator of development. The source of drinking water and nature of toilet are presented in table 5.13 and 5.14.

Table 5.13 - Source of Drinking water

S.N	Source of Drinking water	No of HHs	Percent
1	Tube well	15	50.00
2	Sand well	8	26.67
3	Stream	7	20.00
	Total	30	100.00

Source: Field survey, 2008

Above table shows that 50.00 percent of the sample biogas households are dependent on tube well followed by 26.67 percent on sand well and 20.00 on stream sources.

5.15 Toilet Attachment with Biogas plant

Out of total toilets constructed by sample biogas households, 86.67% toilets are attached.

Table 5.14 - Toilet attachment with biogas plant

S.N	Types of toilet	No of HHs	Percent
1	Connected with Biogas	26	86.67
2	Not connected with biogas	4	13.33
	Total	30	100.00

Source: Field survey, 2008

With biogas plant while only 13.33 percent toilets are no attached with biogas plants which we can see in above table 5.14.

5.16 Size of biogas plant

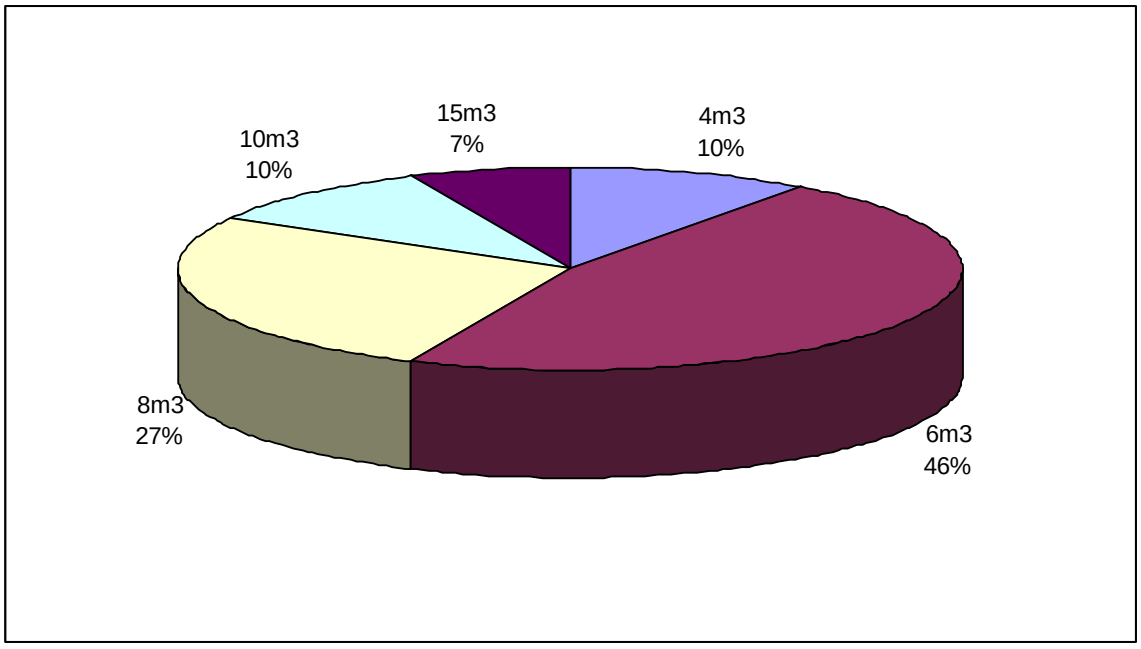
Majority of the biogas plants were of the size $6m^3$ (46.67 percent) followed by $8m^3$ (26.66%), $4m^3$ (10 percent), $10m^3$ (10 percent), $15m^3$ (6.67percent).

Table 5.15 - Size of Sample Biogas plants

S.N	Size	Number of plants	Percent
1	$4m^3$	3	10.00
2	$6\ m^3$	14	46.67
3	$8\ m^3$	8	26.66
4	$10\ m^3$	3	10.00
5	$15\ m^3$	2	6.67
	Total	30	100.00

Source: Field survey, 2008

Figure 5.4 – Size of Sample Biogas plants



5.17 Reason for Biogas Installation

About 63 percent sample biogas house holds reported that the main reason for the installation of biogas was easy and smokeless cooking while 20 percent biogas household reported due to saving in time and getting rid from firewood collection and remaining 16 percent due to all the above reason.

Thus smokeless and comfort cooking was main guiding and pushing factor for biogas installation

Table 5.16 - Reason for Biogas installation

S.N	Reason For Biogas Installation	Number of plants	Percent
1	Easy and smoke less cooking	19	63.33
2	Time saving and to get rid from firewood collection.	6	20.00
3	All the above reasons	5	16.67
	Total	30	100.00

Source: Field survey, 2008

5.18 Source of Information for Installation Biogas Plants

Majority of biogas households reported that respective biogas companies were the main source of communication regarding the biogas plant prior to installation. Neighbor served as the second important source of communication for biogas households while five biogas house holds obtained information from friends and three biogas households (10 percent) obtained information from Radio /T.V.

Table 5.17 - Source of information for Installation of Biogas plants

S.N	Source of Communication	Number of plants	Percent
1	Biogas company	16	53.33
2	Neighbor	6	20.00
3	Friends	5	16.67
4	Radio/T.V.	3	10.00
	Total	30	100.00

Source: Field survey, 2008

CHAPTER VI

IMPACT OF BIOGAS TECHNOLOGY ON USERS

In general the research study confirms the very positive impact of biogas technology at the household level covering gender issues, health and sanitation, agriculture and management land use.

6.1 Reduction in workload of Women

After the installation of biogas, there was a considerable reduction in workload of the members of family. The reduction in workload was measured was made on 3 categories of works i.e. firewood collection, cooking, washing utensils.

Table 6.1 - Reduction in workload of female members of sample House holds

S.N	Category of works	Time allocation hr/day		Time saved hr/day
		Before installation	After installation	
1	Firewood Collection	2.56	1.25	1.31
2	Cooking	2.80	1.20	1.60
	Washing utensil	1.40	0.60	0.80
	Total	6.76 hr	3.05hr	3.7 hr

Source: Field survey, 2008

Table shows that saving in time was considerable in general a household saved an average of 3.71 hrs a day. This revels that about half of workload of women was reduced. However, in operation of biogas plants mostly female were involving compare to male family members.

6.2 Use of Gained Time

All the biogas users experienced significant time due to adoption of biogas technology. Utilization of gained time in several activities is presented in table 6.2.

Table 6.2 - Utilization of Gained time In various Activities

S.N	Activities	No of HHs	Percent
1	Farm Activities	18	60
2	Kitchen Gardening	8	26.67
3	Business	2	6.67
4	Take rest	2	6.67
	Total	30	100.00

Source: Field survey, 2008

The table shows that (60%)of biogas house holds utilized the gained time after the installation of the biogas plants in farm activates, (26.67%) spent the time saved in kitchen gardening, (6.67%) in business activities and remaining about (6.67%) in taking rest.

6.3 Women participation in Social Organization

The study reveals that women have got opportunity to take part in several social organizations (community forest user groups, saving and credit group, mother group etc).

The study shows that participation of women in those organization was increased by (32.22%) due to gained time after the installation of biogas plant.

6.4 Impact on health

Though the significant impact was not quantifiable, biogas had a positive impact on the personal health of family members especially women. Though the relation

of biogas was not clear and other factors were not over locked, the users were of opinion that the major cause of the health improvement was use of biogas.

Table 6.3 - Medical Health care cost (Rs.) per year per House holds

S.N	Disease/ Health Problem	Before installation	After installation	Saving Money
1	Eye illness/burning	1820	980	840
2	Acute respiratory	3200	1510	1690
3	Headache	1730	903	827
4	Others	5020	3003	2017

Source: Field survey, 2008

The table shows that the sampled biogas households has spent Rs 1820 in eye illness, Rs 3200 in acute respiratory, Rs 1730 in headache, Rs 5020 in others per year of their family before the installation of biogas plant. They spend Rs 980 in eye illness, Rs 1510 in acute respiratory, Rs 903 in headache, Rs 3003 in others, after the installation of biogas plants. Economically it is very beneficial, it means the health status of member of households have improved after the installation of biogas plant.

6.5 Impact on Environment, Health and Sanitation

About 92 percent of sample biogas household had constructed toilet. Among them 86 percent toilets were built due to the encouragement of biogas companies majority of households (73 percent) perceived improvement in door as well as surrounding environment, According to above situation we can say environment, health and sanitation is improved after the installation of biogas plants.

6.6 Insect Prevalence

Fly and mosquito were taken into account for the study of change in prevalence of insects.

6.7 Flies

Reduction from the prevalence of fly, was reported from the study no one was reported the increased prevalence of fly. Majoring of the households reported the change in prevalence of insects. And about 23.33% of the households reported did not fell change.

Table 6.4 - Effect on Prevalence of Fly

Fly Prevalence	No. of HHs	HHs %
Decreased	23	77
Remained Same	7	23
Increased	-	-
Total	30	100

Source : Field Survey, 2008.

The table shows tat no one was reported increased the prevalence of fly from the study 77% households reported that decrease in fly population. While about 23% whose did not feel no change in prevalence fly.

6.8 Mosquito

Reduction in the prevalence of mosquito was reported from the study of 20 households reported that mosquito had increased after installation the biogas. While 67% households reported decreased in mosquito and 4 households were found different who did not feed any change.

Table 6.5 - Effect on prevalence of Mosquito

Mosquito prevalence	No. HHs	Percentage of HHs
Increased	20	67
Decreased	6	20
Remained Same	4	13
Total	30	100

Source : Field Survey, 2008.

Table shows that 67% of the households reported the increase in mosquito population and 20% households felt decrease in mosquito population. But 13% found different, who did not feel any change.

6.9 Saving on fire wood, kerosene, L.P.G.

However, extent of saving differs from family to family. Due to various reasons, considerable amount of firewood, kerosene, L.P.G. was saved after the installation of biogas plant.

Table 6.6 - Saving Energy with Respect to Quantity and Price

S.N	Source of Energy	Consumption per month (kg)		Saving Money	
		Before installation	After installation	Quantity (kg)	Price (Rs)
1	Firewood	150	60	90	210
2	Kerosene	1.50	1	0.5	40
3	L.P.G.	5.20	-	5.20	346
	Total	156.70	61.00	95.70	669.00

Source: Field survey, 2008

The above table shows that the use of fire wood, kerosene L.P.G was 150 kg, 1.50 kg, 5.20kg per month per family before the installation of biogas plant. They used 60 kg firewood, 1 kg kerosene and No body reported the use of L.P.G after the installation of biogas plant. Thus from saving of 90 kg firewood, 0.5 kg kerosene, 5.20 kg L.P.G per month Rs 669 at current price has been saved.

6.10 Saving time to schooling children

From the focus group discussion with school children, it was found that after biogas plant installation, reading time of the school children at home had increased. Because of the biogas, the work load of school children has reduced and they investing the saving time in reading and writing tasks. They explained that around half and hour of time per day has increased in reading time.

Remarkable school girl children were benefited more from biogas because it had reduced the time in collecting firewood and cleaning utensils which are the tasks especially assigned to girls in Nepalese society. They said that, their reading time has increased by about 45 minutes per day and their education and health condition had improved.

6.11 Impact on slurry use pattern

All the biogas households had used slurry as fertilizer in their field. Slurry use pattern of biogas households is presented in table 6.7.

Table 6.7 - Slurry use pattern of biogas households

S.N	Form of slurry	No of households	Percentage
1	Composting	24	80.00
2	Solid	5	16.66
3	Irrigation channel	1	3.33
	Total	30	100.00

Source: Field survey, 2008

The table shows that majority of plant owner, (80 %) used slurry in compost form while (16.66 %) household used it in solid (sub dried) from and remaining (3.33 %) used it through irrigation channel.

6.12 Status of Agriculture Production

The user's surveys and impact studies carried out by different intuitions biogas companies, NGO/INGOs, consultancies and individuals have reported that agriculture production is increased after the adoption of biogas technology. However the present study indicated quite different scenario in cases of production status of which is presented in following table.

Table 6.8 - Slurry use and production status of sample Biogas House holds

S.N	Production status	No of households	Percentage
1	Increased	20	66.66
2	Remained same	6	16.66
3	Decreased	4	13.33
	Total	30	100.00

Source: Field survey, 2008

The table shows that(66.66 percent) felt I*n*crease in production, (13.33 %) experienced decrease in production while(16.66 percent) said that production remained same due to composting and inorganic fertilize. The increase in production was observed in vegetable crops (cauliflower, cabbage and potato) and paddy. Maximum increment in production reported was 25 percent in paddy and 95 percent in potato and cauliflower while minimum was 9 percent in paddy and 35 percent in vegetable crops. Like wise maximum 50 percent while by 10 percent in vegetable.

6.13 Operation and Maintenance

Problems

The study has shown that 77% of the households had no problems in running their biogas plants. 20% of the households had the problem of occasional leakage of slurry from the burner of gas stove. 3% of the households experienced problems of dung availability.

Sufficiency of Gas

A majority of households had experienced the problem of gas insufficiency in the cold season.

Alternatives for the Insufficiency

Sixty three percentage households used firewood when gas was insufficient. A 13% of households used kerosene oil while 23% households used nothing for the insufficiency.

6.14 User's Perception and Suggestions

Perceptions

Except three households all of the respondents were of positive opinion about biogas installation. They felt improvement in the quality of livelihood after installing the biogas plant. The people felt marked differences in saving in time. Reduction in work burden, cleanliness of the environment and better crop production too.

Suggestions

All of them had given the suggestion that "Every biogas company regularly checking biogas plant for their respondents after warranty period". Out of the total, 18 households i.e. 60% of the respondents had given the suggestion that "Everyone should install the biogas plant".

- Subsidy for the biogas installation should be provided directly by GON instead of through biogas companies
- There should be provision of paying money in installment
- Biogas installation should be made completely free for the very poor people who can not afford
- One house suggested that the use of urine of livestock and water together for mixing with dung increased the amount of gas production
- One household suggested using stone instead of brick in the masonry works for biogas plant construction.

6.15 Major Findings

The present study carried out to find the socio-economic implication of biogas technology in rural Nepal, the key findings revealed from the study conducted in Ghorahi Municipality of Dang district are summarized as below.

- The total population of Ghorahi Municipality is 43126.
- The total households of Ghorahi Municipality is 8945.The house hold size is 4.8
- The present of biogas household of Ghorahi Municipality is 9.18%
- The total Biogas user households are 829 in Ghorahi Municipality.
- In the research area, word-3, 80 households are the biogas users, which is (9.65%) among them 30 households (37.86%) was selected as sampled size.
- Energy source in Ghorahi Municipality is fuel wood, crop residue, biogas, kerosene, husk, animal dung and electricity are major sources.
- In urban and semi urban area major energy source are LPG, kerosene, electricity and in rural areas firewood, animal dung, biogas agriculture residue are the main energy resources supplied.

- The biogas comprised of 6 caste groups dominated by Brahmin 15 house holds (50%), Tharu 7 households (23.33%), chhetrin3 households (10%), Gurung 3households (10%), Newar and Dalit are 2 house holds (6.67%). This reveals that Brahmin who are considered as high class have adopted this technology at high level.
- Majority of biogas households (19) were engaged in agriculture Which is (63.33%) while remaining 11house holds (36.66 percent) was engaged in other occupation like service, business and wage earning.
- Majority of households (19) were medium from income point of view. (63.33%) biogas user household annual income is medium 20,000-60,000.
- Field survey shows 26 households (87%) of sample biogas households have connected their toilet to biogas plants and 4households (13.33%) have not connected.
- Size of 6m3, 8m3 biogas plant was more popular in this municipality as compared to 4m3, 10m3, 15m3 and 20m3.
- Public Gobar Gas Pvt. Ltd. Company was leading in the construction of biogas plant in study area. It had installed 16biogas plant (53 %) of total sample biogas plant.
- Biogas user had installed biogas plant as a substitute to firewood and due to clean and comfort able cooking.
- Biogas Companies 16 households (53.33) were major sources of communication to install the biogas plant followed by Neighbors, friends 11 households (37.67%) through advertisement of T.V. and Radio 3 households (10%).
- Biogas energy was used only cooking purpose. No user was found to use in lightning purpose.

- The study reveled that women were benefited after the adoption of biogas technology.
- The study shows that significant (3.7hours) was saved per day after the installation of biogas.
- Farm activities 18 households (60%), Kitchen gardening 8 households (26.67%), and income generating activities 2 households (6.67%) were increased after the installation of biogas plant.
- Majority of biogas user's 15 households (50%) percent consumed tube well,8 households (26.67%) sand well and 6 households (20%) consumed stream water.
- The cleanliness of household as well as environment was improved and intestinal diseases have been reduced after the installation of biogas plants.
- The expenditure on firewood, kerosene LPG has been reduced due to saving of 90 kg fire wood, 0.5 kg kerosene, 5.20 kg LPG per month after the installation of biogas plant. On average households saved about Rs 696 per month at current price.
- The field survey shows that 20 households (66.66%) perceived increment in production and it was observed by more respondents as good fertilizer for vegetable production.

CHAPTER VII

CONCLUSION AND RECOMMENDATIONS

7.1 Conclusion

Energy is undoubtedly a fundamental means for meeting the needs of life support systems and developmental efforts. Nepal's energy supply is primarily based on three types of fuel sectors traditional, commercial and renewable. Traditional energy sources are the primary sources of energy in the rural area. The use of renewable energy is very insignificance as presents.

Nepal has better options and resources potential for the development of renewable energy. It can be developed without destroying the environmental condition. Biogas energy is emerging as the major contributor in the current renewable energy resources development.

The development of the biogas energy can significantly cut down the use of firewood, animal dung, agricultural residue kerosene, LPG. In the study area, biogas was mainly used for cooking foods. Biogas technology has primarily reduced the use of fuel wood. About 85 Bhari of fuel wood has been found to be saved by each biogas plant in one year.

Most of the biogas users belong to the economically medium in the village. The poor socially deprived and vulnerable people are unable to install the biogas plants. So it is obvious that upper class and so called upper caste people are enjoying the government subsides at large. Of course, the subsidy policy adopted by the government is a hall mark for biogas energy development. But it has failed to reach to the majority of poor people. The strong cultural taboos still existing in the society, it is a good sign to find all the biogas plants with toilet attachment.

No sample biogas households were found using biogas energy except for cooking domestic foods. Even below optimum amount of production of biogas

was found sufficient for them. If people feed biogas plants properly and use biogas energy for other activities along with cooking domestic food the quantity of saving of firewood consumption would increase considerably.

Based on the general findings of this study, it can be concluded that biogas technology is gender friendly. The subordinated women of the study area were benefited from biogas energy. It has made cooking easy on the one hand and on the other, it has reduced their workload and improved their health condition.

Biogas energy has provided more time for the schooling children, mainly the girls. The schooling children in the study area were found using the saved time in reading and writing. This certainly has improved their educational status.

Thus, the development of biogas technology would be a milestone in the overall development of rural areas, it can be produced from locally available biodegradable materials. It can cut down the use of both imported and traditional energy sources therefore; government, I/NGOs, some community forest group social" organizations and private sector organizations and private sector should join hands and come up with better plan; policies and strategies for extending biogas energy to the poorer section of people in the rural background.

7. 2. Recommendations

Based on the general findings of the study, the following recommendations have been proposed for the further development of biogas technology in the rural area in particular and through out the country in general.

- Concerned biogas companies should carry out supervision and evaluation more elaborately.
- Operation, repaired maintenance training should be provided to the users regularly particularly females.
- Biogas appliances and spare parts should be made easily available to the costumer at reasonable cost.

- Research should be carried out of lower the cost of biogas plant to the increase efficiency of gas production in winter and control the breeding of mosquito.
- Training or proper management of biogas slurry should be done to ensure agricultural production.
- Dissemination of information should be done massively through the media like newspaper, radio and television.
- Concerned agencies should conduct social awareness program among rural people to maximize the adoption of biogas.
- Timeframe for subsidy should be fixed in order to exploit the potentiality of biogas so that is would motivate the potential owners to install the biogas plants.
- A consistent policy should be introduced to penetrate the small marginal and poorest of the poor.
- The concerned biogas companies should mobilize local NGOs to promote technology so that they can act as bridge between users and the companies.

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