SOCIO-ECONOMIC AND ENVIRONMENTAL IMPACT OF BIO-GAS PLANT

(A case study of Ghorahi Municipality-2 of Dang District)

A Thesis
Submitted to the Central Department of Rural Development
in partial Fulfillment of the Requirements for the
Degree of Master of Arts in
Rural Development

Submitted By
PRADEEP MAJGAIYAN
Exam Roll No.281010
T.U. Regd.No.:6-2-54-823-2004

Central Department of Rural Development
Faculty of Humanities and Social Science
Tribhuvan University
Kirtipur, Kathmandu, Nepal
June, 2011

LETTER OF RECOMMENDATION

This is to certify that this thesis entitled **"Socio-Economic and Environmental Impact of Biogas Plant: A Case Study of Ghorahi Municipality-2, Dang District".** It has been prepared by **Mr. Pradeep Majgaiyan** under my supervision as a partial fulfillment of the requirement for the degree of Master of Arts in Rural Development.

To the best of my knowledge the study is original and carries useful information in the field of study of Ghorahi Municipality-2, Dang. I recommend it for evaluation to the Thesis committee.

……..…….

Suman Baskota

Thesis Supervisor

Central Department of Rural Development

T.U, Kirtipur

APPROVAL SHEET

We certify that project report entitled "Socio-economic and Environmental impact of Bio-gas plant". A case study of Ghorahi Municipality-2,Dang district" Submitted by Mr. Pradeep Majgaiyan in partial fulfillment for the requirements of the degree of master of Arts in Rural Development has been approved by this department.

The Evaluation Committee

……..
Prof. Dr. Pradeep Kumar Khadka
Head of the Department

……..
Mr. Suman Baskota
Supervisor

……..
Mr. Umesh Prasad Acharya
External Examiner

ACKNOWLEDGEMENTS

I would like to express my deep gratitude to the Central Department of Rural Development of Tribhuvan University for allowing me to carry out this thesis for partial fulfillment of the requirements for the degree of Masters of Arts in Rural Development.

I am infinitely indebted to my research supervisor, **lecturer Mr. Suman Baskota** Central Department of Rural Development, TU, Kirtipur for his cooperation and continuous guideline in the course of study from very beginning to the last. And **Prof. Dr. Pradeep Kumar Khadka** the Head of Central Department of Rural Development goes grateful thanks for his valuable suggestion.

I'm very much grateful to various organizations related to biogas for providing me with the supporting materials for the analysis of my thesis. In this regard, I also would like to thanks the staffs of Central Library of T.U., Library of R.D. Department, BSPN, AEPC of Lalitpur, Public Gobar Gas Pvt. Ltd., National Gobar Gas construction and service, Gobar Gas and Agriculture goods development company, Gharelu Gobar Gas Company of Dang district.

I express my deep gratitude to my father, mother and my family member for their kind cooperation, encouragement and financial support during my study.

At last but not the least I also would like to thank everyone who helped me to complete my thesis and the staff of Ghorahi Municipality, Secretary of the Ward. I am also thankful to the respondents as well as local people of the study area, who provided necessary and valuable information to accomplish this thesis.

Pradeep Majgaiyan

Pradeep_majgaiyan@yahoo.com

ABSTRACT

Nepal is one of the lowest energy consuming countries in the world. More than 85 percent of its total energy comes from traditional biomass energy such as from forests, agricultural residues, and by-products from crops which lead to environmental degradation and ecological imbalance and adverse human health impacts too. Beside the carbon revenue, other quantifiable tangible benefits are also associated with the technology. The main objective of the study was to study about the socio-economic and environmental impacts of biogas.

The present study was based mainly on primary data. They were used to estimate and analyze the socio-economic and environmental impact of biogas on the surveyed households. The household survey, informal meeting, focus group discussion, key informant interview and observations. The study entailed biogas was used only for cooking purpose whereas almost all the Non-Biogas Households dependent on fuel wood for regular cooking purpose. Each biogas. Biogas contributed in improved sanitation, reduction in smoke and significant reduction in respiratory and eye related disease.

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 buffaloes, cattle and dung of them is the best source of raw 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.

The major advantage the bio-gas plant brought is the reduction of smoke free environment smoke in kitchen are other advantage is that the prevalence of insect has become very low than it was before installation of plant. This smoke free environment in the kitchen improves air quality ultimately leading to improvement in health condition of women because they have to always work in kitchen. Adversely, the installation of biogas plant has significantly increased the problem of mosquitoes. 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.

ACRONYMS AND ABBREVIATIONS

ADBN	: Agriculture Development Bank of Nepal
AEPC	: Alternative Energy Pregame Centre
BSP	:Biogas Support Program
CBS	:Central Bureau of Statistics
CDM	:Clean Development Mechanism
CFCs	:Chlorofluoro Carbon
DDC	:District Development Committee
GJ	:Giga Joule
INGO	:International Non Governmental Organization
KG	: Kilogram
LPG	: Liquefied Petroleum Gas
MOF	:Ministry of Finance
MOF	:Ministry of Finance
MT	: Mega Tonne
MT	:Metric Ton
MW	:Mega Watt
NGO	:Non Governmental Organization
No	:Number
UN	:United Nation
VDC	:Village Development Committee

CHAPTER-ONE

Introduction

1.1 Background

Biogas has been gaining popularity nowadays as a reliable alternative source of renewable energy especially in domestic sector. As Nepal has scarce of resources for huge investments for hydropower generation, rural people mostly rely on firewood for their energy needs. Most of such firewood is collected from natural forests which causes environmental degradation and its scarcity. Due to these reasons, the authorities have tightened the entry of villagers to the forest areas for collection of firewood. In such circumstances, biogas has emerged an alternative source of sustainable energy to these people. Still, a small part of rural population is using biogas for energy.

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 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 in 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 farming, 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 are 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 MW. 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 from 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 dangerous 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).

Kerosene and other oil based sources of fuel are scarce and costly to be easily available for small marginal and medium farmers residing in rural areas. Furthermore, frequent alarming hike in prices of imported oil and chemical fertilizer have serious economic threat to the rural poor. In this context, to reach the self-sufficiency in energy and fertilizer and to minimize the pressure on traditional biomass fuel, biogas technology has been the best alternative energy solution, which could be achieved through the active mobilization and economic utilization of local indigenous resources available in the country. Biogas is comparatively advantageous than other renewable energy sources like hydropower, solar, wind in rural village. It improves the health condition of children and women more due to the reduction of Carbon dioxide. It has wide scope in socio economic and environmental benefits for the prosperity and quality of life of rural people.

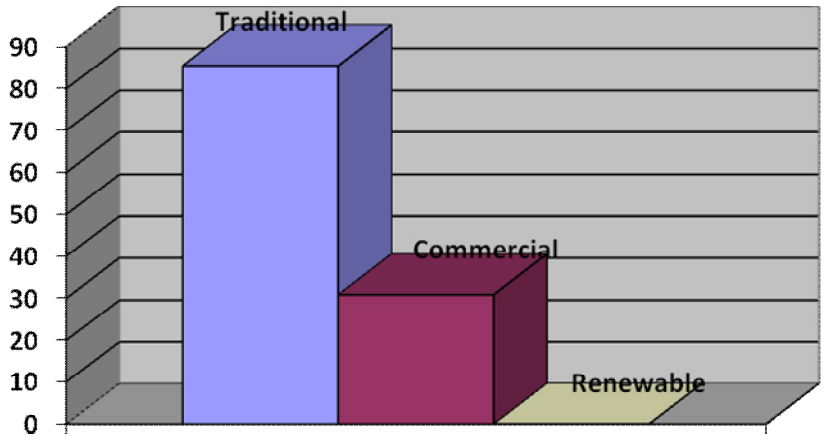
Biogas, popularly known as Gobargas in Nepal is a combustible gas provided by an anaerobic fermentation of organic materials by the action of Methanogen bacteria

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 Carbon dioxide (Co_2) and some other gases. The Methane gas is odorless and burns with clear blue flame without 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.

1.1.1 Energy Situation in Nepal:

Energy is a basic tool for development. Developing countries like Nepal face added dilemmas regarding environmental protection due to their heavy dependency on biomass and fossil fuel. Per capita consumption of primary energy in Nepal is estimated to be fifteen gigajoules (GJ) in 2006 (MOF 2007).Out of this, traditional sources (fuel wood, agricultural residues and dung cake) make up about 85.5 percent while share of alternative energy is 0.6 percent. Out of the total amount of traditional energy used, share of fuel wood consumption was 88.68 percent.

Figure no.1 Energy Situation in Nepal



1.1.2 Importance of Biogas Energy:

The main challenge of present world is to harness the energy source which is environment friendly and ecologically balanced. This need has forced to search for other alternate source of energy. But unfortunately the new alternative energy sources like the solar, hydro, wind etc. require huge economical value and technical power to operate, which seem to be very difficult for the developing countries like Nepal. In the present moment biogas energy can be one and only reliable, easily available and economically feasible source of alternative and renewable source which can be managed by locally available sources and simple technology for these rural villages.

1.1.3 History of Biogas:

Although biogas was first discovered by Alessandro Volta in 1776 and the presence of combustible gas methane in the farmyard manure was pronounced by the Humphery Davy in the early 1800s, yet it was only the oil crisis of 1973 which led to the active promotion of biogas technology. While international interests in these uses have been most noticeable in the technical and developing communities in the last 15-20 years, serious development efforts in this field began about 50 years ago in Asia.

1.1.4 History of Biogas Development in Nepal:

Nepal has a history of over 50 years of biogas technology development. The first historical biogas system was introduced by Father B.R Saubolle in 1955 at St. Xavier's School at Godavari Lalitpur as his personal initiatives. It was in the Agriculture Year 1974/75 that the government of Nepal launched special program to promote biogas technology and installed as many as 250 units of biogas plants (KVIC) in different parts of the country under the supervision of government and non government organizations. Since then, the technology has proved its worth in Nepal to draw interest and involvement of various private and public sector institutions including the donor agencies.

1.1.5 Potentiality 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 was estimated to be 2.7 million in 2001. Based upon the study of technical biogas potential of Nepal, it is estimated that a total of 1.9 million can be installed in Nepal out of

which 57 percent in plains, 37 percent in hills and rest 6 percent in remote hills or in mountain region. According to BSP Year Book (2008), a total of 172,858 plants have been constructed under BSP and 1,733 biogas plants under GSP. It is reported that as of March 2009, a total of 201,247 biogas plants had already been installed in about 71 districts of Nepal (BSP 2009).

1.1.6 Environmental Benefits of Biogas:

Biogas, a sustainable renewable energy, has positive environmental impacts at local, national and global levels. Below are some environmental benefits associated with the use of biogas technology.

1.1.7 Local Environmental Benefits:

Replacing biomass energy with biogas could help to solve a lot of problems that are typically found with biomass fuels. The indoor air quality of homes will be dramatically improved as a result of employing biogas stoves instead of burning fuel wood, straw and dung cakes. This would mean that a lot of the problems with hazardous smoke particles would be avoided. In addition, installation of biogas systems has resulted in better management and disposal of animal dung and night soil. The slurry that has been digested is a high grade fertilizer.

1.1.8 National Environmental Benefits:

From a national perspective, biogas systems have helped reduce the pressure on forests. This in turn has important implications for watershed management and soil erosion. In addition, use of bio-slurry have reduced the depletion of soil nutrients by providing organically rich nutrients resulting increased crop yield and hence reduces the pressure to expand cropland, the principal cause of deforestation in Nepal.

1.1.9 Global Environmental Benefits:

Biogas fuel helps to reduce greenhouse gas emissions by displacing the consumption of fuelwood, agricultural residues and kerosene. The biogas used in a sustainable basis assures the CO2, associated with biogas combustion will be reabsorbed in the process of the growth of fodder and food for animals. All the CH4 and CO2 emissions that are associated with the combustion of fuelwood can be accounted as being replaced by a biogas system.

1.1.10 Greenhouse Gas and Climate Change:

Most of the GHG emissions which is causing the world's current climate change can be traced to human activities particularly in industrialized countries resulted in high concentration of some of these gases specifically CO2, CH4, and N2O.The major source of GHG emission in the context of Nepal is through the unsustainable use of traditional biomass resources like fuelwood, agricultural residues, animal dung etc. as well as uncontrolled use of the imported commercial fuels like (coal, petrol, kerosene, diesel etc.) in different sectors. Besides, the GHG emitted from inefficient combustion of biomass fuel contributes to global warming, the possible cause of world climate change. The earth's average global temperature has risen by about 0.710 Celsius and by about 0.640 Celsius over the Southern Hemisphere (IPCC 2007).The outcome of the recent Copenhagen Conference from December 7 to 18 has set a commitment to limit global warming to two degrees Celsius but is not legally binding.

1.1.11 Status of CDM Projects in Biogas:

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. In the context of CDM project of biogas in Nepal, it has been realized that the quality of the biogas and overall positive impact of biogas be assured. In order to obtain necessary feedbacks about the technology, it is essential to monitor both the technology and its impact on user satisfaction by conducting appropriate and detailed surveys at regular intervals.

1.2 Statement of Problem

Energy is a critical component of the development process. It is needed in all sphere of life which are directly connected with mans survival progress as in cooking, lighting, heating etc. Many developing countries are facing the 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 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 lack of good 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 10 percent biogas plant of total technical potential (BSP 2008) .Some of the reasons for slow progress in adoption of biogas technology in the country side are absorbed to be:

1 Ignorance of the farmers as regards the usefulness of the technology.

2 Easy access to forest in some areas to collect firewood and low knowledge of environmental consciousness.

3 Non-cooperative attitude of the plant owners to convey and motivate other neighbors as regards the usefulness of biogas technology.

4 Unhealthy competition between recognized biogas plants construction companies.

5 Unavailability of easy loans to poor farmers due to lack of collateral needed by the bank.

6 Difficult and lengthy process of loan sanctioning.

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.

1 What is the socio-economic characteristic of biogas users?

2 What is the situation of biogas in relation to workload of women, health and sanitation, saving of firewood/ kerosene /L.P.G?

3 What is the effect of biogas plant in relation to use of digested slurry as a fertilizer for agriculture?

4 How the knowledge of environmental consciousness is provided?

1.3 Objectives of the Study

In any research work, determination of objectives is most important. so, I have determined the following objectives of this study, The overall objective of the study is to assess the socio- economic impact of biogas on its users. However the specific objectives of the study are:

1 To assess the economic, social and environmental impacts of biogas.

2 To study the impact of biogas in relation to workload of women member of family, Health and sanitation, saving of firewood / kerosene / LPG.

3 To assess the effect of biogas plant in relation to use of digested slurry as fertilizer for agriculture.

1.4 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.

Biogas technology simply reduces the workload of women and children in family for collecting firewood and washing utensils. Time and money saved after the installation of biogas plant, can be utilized on income generating activities. Biogas technology also helps to improve the health and sanitation of rural people and creates smokeless

and healthy environment in the kitchen. Biogas also reduces the prevalence of insects in higher rate than that of earlier due to the neat and clean environment.

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. Moreover, installation of biogas plant would help towards agricultural production. The digested slurry contains more nutrients and contributes in increasing agricultural production. The bio-gas plant benefited the people to increase agriculture productivity reduces the emission of smoke and improving the quality of life of the people in this area.

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

This study will help to addressing problems formulating realistic policies and programmers there by bringing about environmental balance. Social justice and rural poverty reduction by providing appropriate feedback to concerned agencies. This study will also help to bring sustainable development of Ghorahi -2 of Dang.

1.5 Organization of the Study

The study has been organized into five chapters. Chapter one deals with the introduction which included background, statement of the problem, objectives of the study, significance of the study and organization of the study.

Chapter Two is related with the literature review, which includes conceptual review and thesis reviewed.

Chapter three deals with the research methodology which comprises research design, rationale for the selection of the study area, introduction of the study area, district background, nature and sources of data, sample size, tools and techniques of data collection, data processing and analysis and limitation of the study.

Chapter four consist data presentation and analysis which includes Socio-economic characteristics of biogas users, socio-economic impacts of biogas, impact of biogas in health and sanitation, Environmental impact of biogas, impacts of slurry in the agriculture production and operation and maintenance. These all title have own sub title too. Chapter Five deals with Findings, Conclusion and Recommendation.

CHAPTER-TWO

Literature Review

2.1 Conceptual 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 is 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:

1 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. (e.g. kerosene, L PG etc)

2 The total 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 H. 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?

3 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).

4 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).

Biogas is the mixture of gas produced by methanogenic bacteria while acting upon hide gradable materials in an anaerobic condition. It is mainly compassed of 60-70 percent methane, 30-40 percent carbon dioxide, and some other gases. It burns with clear blue flame similar to that of LPG(BSP 2005).

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 egg (GGC profile 2001:7).

Ghimire (2001) has shown the biogas in relation to forestry. He has estimated that installation of 1.3 million biogas plants (total potentiality of Nepal) would save about 4 million total of firewood per year.

Devpart-Nepal (2001) has carried out the study of the impact of biogas on users and also taken non-biogas household for the study. Syngja,

Dr. Poornakanta Adhikari (1996) in report entitled effects of bio-gas on family health, sanitation and nutrition: has evaluated both positive and negative impacts of bio-gas. The positive impacts on health were most significantly reduction on eye diseases, headache, coughing and throat ache. The negative impacts of bio-gas were increased prevalence of mosquito and loss of warmth in house in winter, sanitation conditions and practices were improved and the study reported 62 percent reduction in firewood collection.

According to bio-gas support program (Phase III). The bio-gas technology is one of the viable devices among alternative energy source in the country Nepal. 1,23,395 number of plants are built by BSP – Nepal in the end of fiscal year 2003/004. If this capacity could be utilized in an effective manner. It can fulfill about 10 percent of the country's total energy requirement without adversely effecting the production of the agriculture. Based on the estimated that a total number of 1.9 million domestic bio-gas systems can be installed in Nepal.

According to the final report of bio-gas use survey 2000/001. A Bio-gas user household saves 990kg of firewood & 6 liter of kerosene oil per year. The gas production was insufficient of in the winter as reported by majority of the respondents one third of the household are attached their latrines to the bio-gas plants. Above half of the respondents used the slurry in the cultivated land and other uses in gardens. The decrease in occurrence of disease was the positive benefit of bio-gas plant installation. However negative part of installation was increased prevalence of mosquito and some even reported occurrence of typhoid. Most of the household were in the value of male. The major problem in the bio-gas plant in the value problems, high rate of interests, high cost and non-availability of spares, increased prevalence of mosquito.

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

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

Final evaluation of Nepal India conservation (NICE-1994)The report states that, NICE program was run in five villages of Bardiya district as an around Royal Bardiya National Wild Life Camp with as goal of conservation of environment through bio-gas technology.

It was a follow-up programme after introduction of 10 Deenbandhu model bio-gas in 1991. NICE successfully adopted this new Indian model. There were altogether 8o Deen bandhu model plants of size 2,3,4 m^3 installed. In their report a comparison has been given between Deenbandhu model and convention GGC model bio-gas plant. Deenbandhu model is shown to be at least 20 percent cost effective with hydraulic retention time. Performance of the plant was good. The finding were improvement in health and sanitation of the families and lesser load on the nearby forest for firewood.

2.2 Thesis Reviewed

The literature is reviewed from the thesis presented by former students is listed in the concerned topic. A brief review of literature made is as of:

Bista (1981) has focused that biogas is considered as one of the most reliable alternative energy resource replacing fire 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 of Bhaktapur district for Hill site and Phoolabari village of Chitwan district for Terai site were chosen for the study. A total of 30 samples were chosen, each site consisting of 15 samples.

This study has taken economic approach and the analysis is focused on the various types of benefits obtained and savings made through the installation of biogas plants.

Energy situation 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 Rolpa, 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 woman. So called traditional or unequal patterns in the division of labors are sustained, with working women for long hours simply substituting one labor activity for another.

It was found from the study that estimated time saving for women in Rupendehi was 4 hours and 30 minutes (on an average) in Nuwakot however, in a village based research, the estimated time saving was found to be 1 hour and 55 minutes. In Madanpokhara, 3 hours and 14 minutes.

Adhikari (1996) has shown the impact of biogas plant on family health, sanitation and nutrition. This study has considered the negative and positive impacts of biogas. This report is based upon the survey of 25 samples households of Ishaneshowr village of Lamjung district.

The positive impacts on health were most significant, reduction in eye disease; headache, coughing and throat ache whereas the negative impacts were increased prevalence of mosquito and loss of warmth in house in winter. Sanitation condition and practices were improved and the study reported 62% reduction in firewood consumption after biogas plant installation.

The report recommends for further in depth study in

- Prevalence of mosquito
- Digested slurry
- Short, medium and long term effects on health.

This review provided an idea about the impacts of biogas on health and sanitation.

BSP (1996) has assessed the operation and maintenance of the plants. Most of the plants were underfed and there was high water to dung ratio. Gas production was considerably low in winter. However, 82% of users were satisfied with working of plants.

The benefits of biogas plant installation were saving in time. Visible implication of personal health and general sanitary condition having in firewood and kerosene. One hundred such plants were estimated to save 2.8 hectares of forest. The study noticed that user's percept no significant effects of digested slurry.

In the concluding part, role of GGC and BSP in the promotion of biogas has been highlighted. The main benefit of biogas has been stated as cooking and lightening facilities, which saved considerable amount of money.

The other important benefits included were time saving, convenient cooking and elimination of indoor air pollution resulting in improvement in health.

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 very 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 implemented the research program to study the influence of bio-slurry application on maize and cabbage in Lalitpur district. The result of the experiment has revealed the supremacy of organic manure in all forms viz. FYM (Farm Yard Manures), slurry compost and liquid slurry over the inorganic manure. The increment in the production of cabbage and maize was realized after the application of digested slurry.

Ghimire (2001) has shown the biogas in relation to forestry. He has estimated that installation of 1.3 million biogas plants (total potentiality of Nepal) would save about 4 million total of firewood per year.

Dev. Part-Nepal (2001) has carried out the study of the impact of biogas on users and also taken non-biogas household for the study. Syngja, Nuwakot, Chitwan and Morang districts were taken as the study area representing high Hills, mid Hills and Terai region of the country.

The outcome of this study has shown that the whole quantity of dung produced is not collected by the biogas users and collected amount is also not entirely fed into the plant which reduced the plant efficiency.

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 outcome of this study shows that 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, uses of other types of renewable energy technology (RET) did not report an increase in crop production as experienced by the biogas users. The biogas user 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.

B.Subedi(2006) has focused the study in Kaski district regarding the Scoio- Economic Impact of Bio-Gas plant. The main objective of this study is to find out socio-economic impact of biogas plant on users, impacts of slurry on production and to study the impact of forest resources.

P.Nepal (2008) has shown Socio-Economic Impact of Biogas Energy on Rural Women in Chandragadi VDC in Jhapa District.she arises the assess of the economic activities performed by the women after getting the facility of biogas energy.

CHAPTER- THREE

Research Methodology

This chapter deals about sets of methods which were employed during the conduct research. The whole study was carried out using primary as well as secondary data. So, the relevant and reliable data made possible only by applying scientific method. This research is mainly devoted to achieve the objective of the study.

3.1 Research Design

This research adopted exploratory and descriptive research design. It was exploratory in the sense that in contrast to deductive approach, it tried to explore and explain the phenomenon by accumulating primary data and building casual relationship between the variables. It was descriptive as it described different causes for and against the significance of the technology. Hence it was important that various conditions prevailing in the respective households selected for the study after the installation of biogas plants was also know to compare them with the conditions. The historical and other references were also taken for assistance of the micro level. In order to fulfill the objectives, information has been collected from the Household survey, informal meeting, focus group discussion, key informant interview and observations which were the main techniques that have been used to obtain the information from the biogas users.

3.2 Introduction to the Study Area

Ghorahi Municipality, ward no-2 in Dang district was selected as the universe of the study, most of the families whose income are low and could not 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 being polluted, about 40 percent people have installed biogas plant about 90 percent people are 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 purpose of this study is to find out the situation of biogas plant in this ward.

3.2.1 Rationale for the Selection of the Study Area

The present study has been carried out in Tribhuvan Nagar-2 Dang district which is the part of mid western development region. The reason for selecting Tribhuvan Nagar-2 as the study area is that the researcher is a native villager of this study area. Secondly, the researcher is familiar with the local biogas companies and the local people and local language. Therefore, by selecting of this area, it is believed that more accurate information could be collected during the study at area.

3.2.2 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 border with Kapilbastu, Arghakhachi in east, Banke and Salyan 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 213 m. to 2058 m. It has 39 VDCs and Two municipalities. Politically the district is divided into 13 Elakas 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 5.0^0c respectively. Average rainfall is 170.6 mm.

According to Population Census 2058 B.S. total population of this district is 4,62,380 having male 2,28,958 (49.56%) and female 2,33,422 (50.44%). 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% population followed by Chhetris 22.74%, Magar 12.04%, Brahimin 10.82%, Kami 5.26%, Damai 2.67%, Sanayasi 2.17%, Sarki 1.77%, Yadab 1.46%, Kumal 1.44%, Thakuri 1.17%, Muslim 1.00%, Newar 0.85%, Sharpa 0.76%, Baniya 0.36%, Gurung 0.30%, Badi 0.13%, Gaine 0.13%, Bote 0.07%, Majhi 0.029%, Dhobi 0.008%, Raute 0.003%, Aadibasi ethnicity 0.48% and Other consists of 2.36% (Population Census 2058).

Agriculture 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 used in this district. As a consequence farming in this district is of subsistence type rather than commercial.

Livestock is an integral part of farming system in this district and most of the households 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 as 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 and one University are there in this district.

The district has one zone hospital, where more than 50 beds are available for the patient and one district hospital. There are 4 primary health centers, 10 health posts, 26 sub health posts, 1 eye hospital and 1 Ayurbedic hospital in this district (Tribhuvan Nagar Municipality Profile- 2008).

3.3 Nature and Source of Data

Both primary and secondary information sources have been used for the accomplishment of the objectives of the study. The study was basically based on field survey where as secondary sources of information have used from the relevant sources.

3.3.1 Primary Data

This study was mainly based on primary data collection in Ghorahi Municipality, ward no-2 in Dang district. Sampled households in the ward were asked to respond to a brief structured questionnaire to collect information on the socio-economic impact of biogas plant installation upon its users.

The primary information was collected during the field survey with the help of questionnaire. The questionnaire included the various aspects of biogas plant

installation with the respondents such as information on biogas, cattle numbers, saving of time and money, energy consumption habit before and after installation of biogas plant and problems of biogas plant installation including health and sanitation situation, environmental impact of biogas etc.

Interview method was used to collect the quantitative information from biogas plant owner or households. Thus the study was primarily based on questionnaire with 25 sample informants who gave their opinion on different topic of general concern.

3.3.2 Secondary Data

This study was primarily based on primary sources of data but some secondary data were also used for background purpose. Secondary information were collected from all the materials concerning to the biogas plants such as books, journals, newspaper, published and unpublished articles and other reports etc.

3.4 Sample Size

Till the end of year 2067, 98 biogas plants have been installed in various parts of Ghorahi Municipality 2. It was not possible to interview all the biogas households of the study area in limited time. So out of them, only 25 biogas plant users were selected for the study. Random Sampling method was followed for the selection of samples. Name of all 98 households were listed on 90 pieces of paper. Those papers were folded properly and kept in a box and mixed well. Out of 98, only 25 papers were drawn randomly and they were selected as the sample respondent. If in case any sample household was found missing, there the neighboring biogas sample household was interviewed.

3.5 Techniques and Tools of Data Collection

The data used in this study have collected from field survey conducted in Ghorahi Municipality, ward no-2 in Dang district. The present study was based mainly on primary data. They were used to estimate and analyze the socio-economic and environmental impact of biogas on the surveyed households. The survey was conducted through the formal method of interview in a structured questionnaire, household survey, informal meeting, focus group discussion, key informant interview and observations Following tools and techniques have been used for data collection.

3.5.1 Household Survey (Interview)

Keeping in view of objectives a structured questionnaire was developed. It was pre-tested in adjoining Municipality and after that 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 interviewed (Four cases).

3.5.2 Informal Meeting

The researcher also met village leaders, key informants government officials, biogas companies, non biogas households 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

Researcher also organized focus group discussions with the potential key informants and other local people including women 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. This researcher invited ten persons from different household for focus group discussion where the discussion was held with the help of a check list which comprised the similar questions so as know their group view and compare with the individual responses. Only one focus group discussion was conducted.

3.5.4 Observation

Observation method was also used to cross-check the information. Some 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.

3.5.5 Key Informant Interview

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

- Government and NGO officials.
- DDC
- Staffs of biogas companies
- Laborers
- Owners of biogas plants
- Households without biogas plants.

3.6 Data Processing and Analysis

The data obtained from both primary and secondary source was coded and cast in appropriate format in tables of average and percentage. Data analysis was done on the basic of figures, percentage and charts. After this, various 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 and time and so on as a social science research. The present study was also 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 was one, which has tried to access the socio-economic impact on sample biogas households of only Ghorahi Municipality-2. It has not covered the whole biogas households of all Ghorahi Municipality of Dang district. Therefore findings and conclusion may not be generalized and

implemented at national level. However outcome will represent the area with similar geographical and socio-economic conditions.

- The study was completed within 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 to conclude the actual information especially in the landholding and income level. Respondent had general tendency of hiding exact information due to various reasons. Hence the bias 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 FOUR

Data presentation and Analysis

4.1 Socio-Economic Characteristics of the Biogas Users

4.1.1 Ethnicity/Caste

Ethnicity and cast was taken to examine the pattern of biogas user by cast. It would help to find the socio characteristic in the study area. It is related to question no. one in the structured questioner

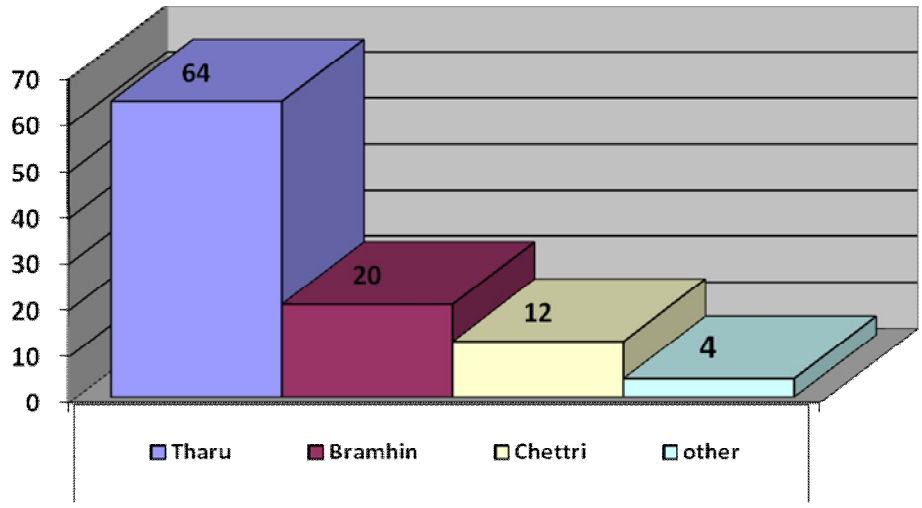
Table no.1 Ethnicity/ cast of households

S.N	Ethnicity /caste	No of Households	Percentage
1	Tharu	16	64
2	Brahman	5	20
3	Chhetri	3	12
5	Others	1	4
Total		25	100.00

Source: Field surrey, 2011

Table shows that the majority of the sampled households under study area are Tharu (64 percent),Brahmin (20 percent),Chettri (12 percent), Other(4 percent).

Figure no. 2 Ethnicity/Cast of households



4.1.2 Occupation

Occupation focuses man for increasing life standard. The main occupation of plant owners was agriculture. Beside agriculture, government service, private service and business are the second main occupation of plant owners occupation of sampled household is given in the table 2.

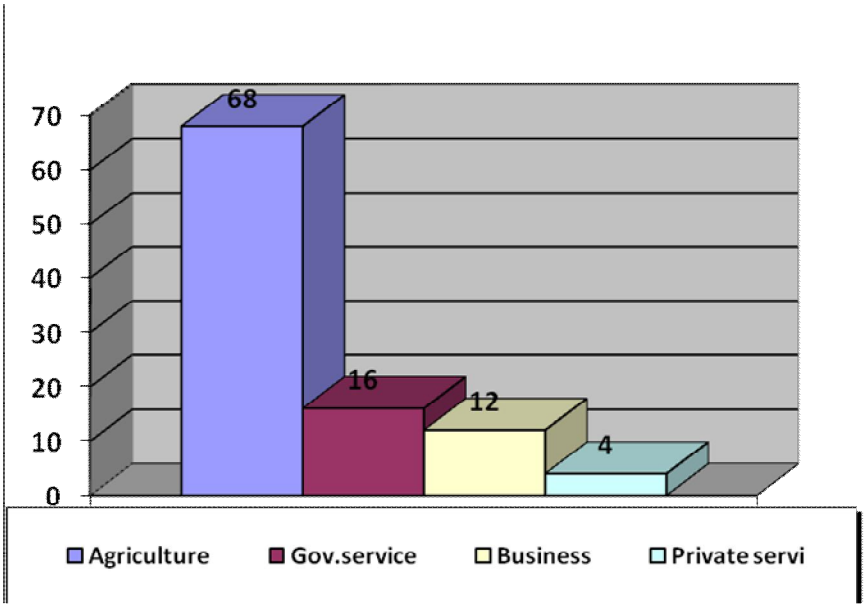
Table no.2 Occupation distribution of Plant owners

S.No	Occupation	No. of Household	Percent
1	Agriculture	17	68
2	Gov. Service	4	16
3	Business	3	12
4	Private Service	1	4
	Total	25	100

Table shows that the higher percent of the plant owners are engaged in agriculture sector. About 68 percent of the plant owners are involved in agriculture, 16 percent in Government service, 12 percent in business and 4 percent private service. 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.

Figure no.3 Occupation distribution of Plant owners



4.1.3 Family Size

Family size shows about the number of father, mother and children. Small size of family is indicator of happiness life. Distribution of sampled household by family size is given in Table 3.

Table no.3 Distribution of Households by Family Size

S.N.	Family Size	No. of Households	Percentage
1.	1-3	2	8
2.	4-6	17	64
3.	7 and above	6	24
	Total	25	100

Source: Field Survey, 2011

Table, shows that among all 25 plant owners, 17 households (64 percent) have 4 to 6 members. Only 6 households (24 percent) have 7 and above members. 2 households (8 percent) have 1 to 3 members.

4.1.4 Land holding

The main occupation of plant owners were agriculture, all of them have their own land to cultivate. Only operational land holding had taken into account. It was found that most of the cases, land was cultivated by owners themselves. In the research area, the landless households were not found. All the plant owners had their own little land. Land distribution is given in the table 4.

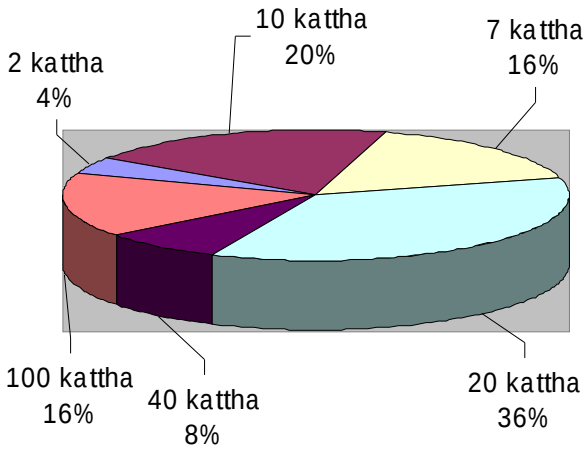
Table no. 4 Distribution of Land holding among sample household

S.N	Land Holding in Kattha	No of Households	Percent
1	2 kattha	1	4
2	7 kattha	4	16
3	10 kattha	5	20
4	20 kattha	9	36
5	40 kattha	2	8
6	100 kattha	4	16
	Total	25	100.00

Source: Field survey, 2011

The land holding status of biogas house hold has been presented in table 4. It shows that about 36 Percent biogas households are owned up to 20 Katthas of land. Similarly 20 percent biogas households have 10 Kattha of land and 16 percent households have 100 kattha. This indicates that small and medium landholding are associated with sample households. Only a few household (4 percent) is owned 2 kattha.

Figure no. 4 Distribution of Land holding among sample household



4.1.5 Annual income

Income level is the major indicators of assessing economics status in the society. Economically medium level households would adopt biogas technology at widespread level. Economically low level house hold would not be able to pay for it and rich people would adopt a better option as LPG. This is related to the structured questioner no. 1.

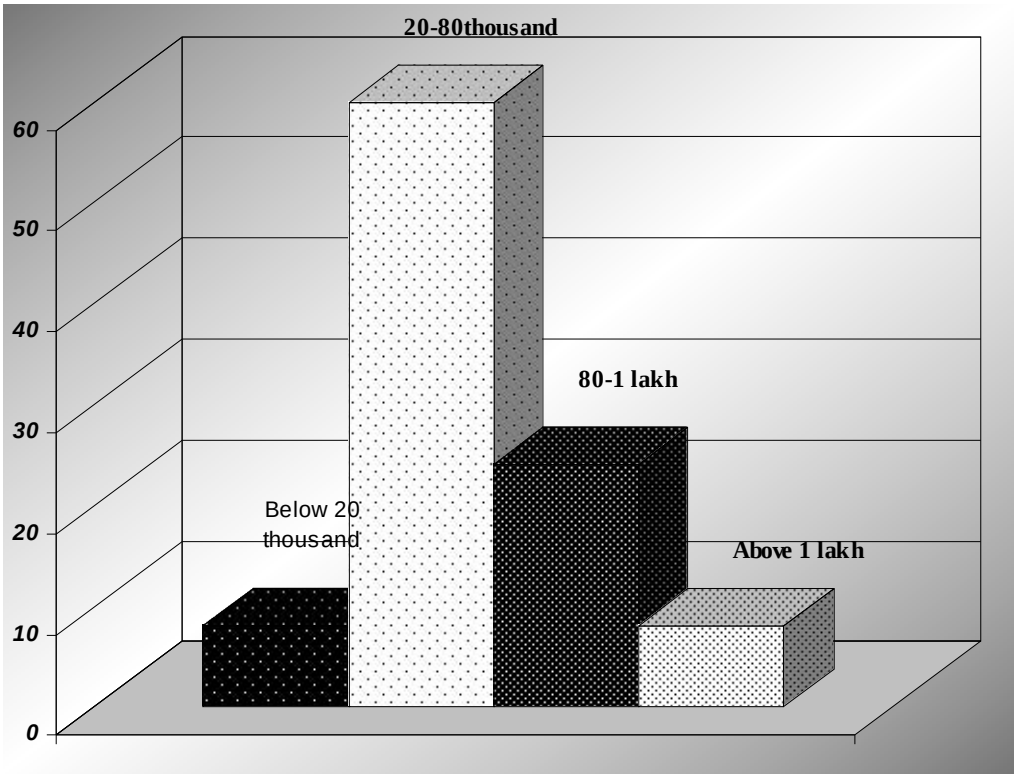
Table no. 5 Income level of Households

S.N	Income level (Annual)	No of Households	Percent
1	Below Rs. 20,000	2	8
2	Rs. 20,000-80,000	15	60
3	Rs. 80,000-1,00000	6	24
4	Above Rs. 1,00000	2	8
	Total	25	100.00

Source: Field survey, 2011

Above table shows that majority of households (60 percent) have annual income of 20-80 thousand, followed by 24 percent households with Rs 80 thousand to 1 Lakh income per year. This depict that medium level of biogas households from economic point of view are associated with wide scale adoption of biogas technology.

Figure no.5 income level of sampled biogas



4.1.6 Size of biogas plant

There are many types of the size of the plants prescribed by the Gobar Gas companies. Manly there are five types of popular size. They are 4, 6, 8, 10 and 15 m^3. Size of the plant varies because of the size of the family and the population of the livestock.

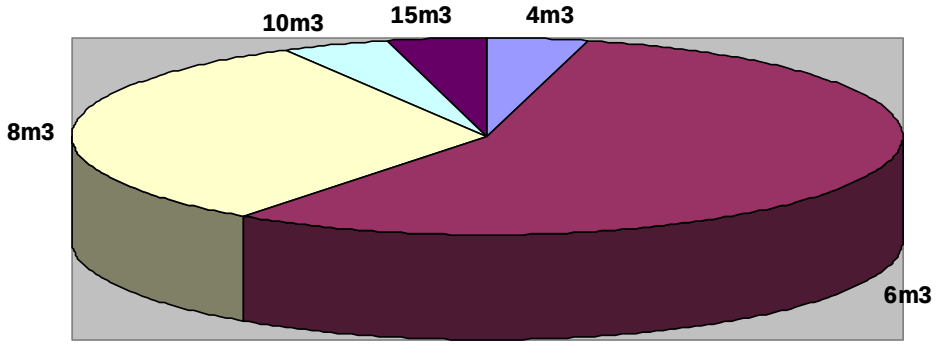
Table no. 6 - Size of Sample Biogas plants

S.N	Size	Number of plants	Percent
1	$4m^3$	1	4
2	$6\ m^3$	14	56
3	$8\ m^3$	8	32
4	$10\ m^3$	1	4
5	$15\ m^3$	1	4
	Total	25	100

Source: Field survey, 2011

The table shows the majority of the biogas plants are of the size $6m^3$ (56 percent) followed by $8m^3$ (3 percent2), $4m^3$ (4 percent), $10m^3$ (4 percent), $15m^3$ (4 percent) respectively.

Figure no. 6– Size of Sample Biogas plants



4.1.7 Owners of Biogas Plants

This research shows that maximum number (22 households) of sample biogas plant owner's households head was male. Among 25 households, 22 households and 3 households were male and female as plant owner respectively.

Table no.7 Owners of Biogas Plants of Sample Households

S.N.	Plant Owners	Number of HHs	Percentage
1	Male	22	88
2	Female	3	12

Source : Field Survey, 2011

This table shows that more than 88 percent of owner are male household head. However, as regard the sex-wise distribution of sampled biogas owners male covers 88 percent and female covers 12 percent.

4.1.8 Educational Status

Education has played the vital role in the development of people. Most of the family members of the plant owners were educated. They have admitted to their children to school.

Table no.8 Educational Status of Sampled Family Members

S.N.	Literacy Level	No.of persons	Percent
1	5 pass	3	12
2	8 pass	9	36
3	SLC	7	28
4	I.A.	2	8
5	B.A.	2	8
6	Master	2	8
	Total	25	100

Source : Field Survey, 2011

From the table 8 shows that majority of the family members belong to 5 pass 12 percent, 8 pass 36 percent, SLC 28 percent, I.A. 8 percent, B.A. 8 percent and Master 8 percent. So, the education status of this study area is satisfactory.

4.2 Socio-economic impact of Biogas

4.2.1 Source of Information for Installation Biogas Plants

This section would let us know how the households get information about the biogas technology. This section is related with question no. 2.a in structured questioner.

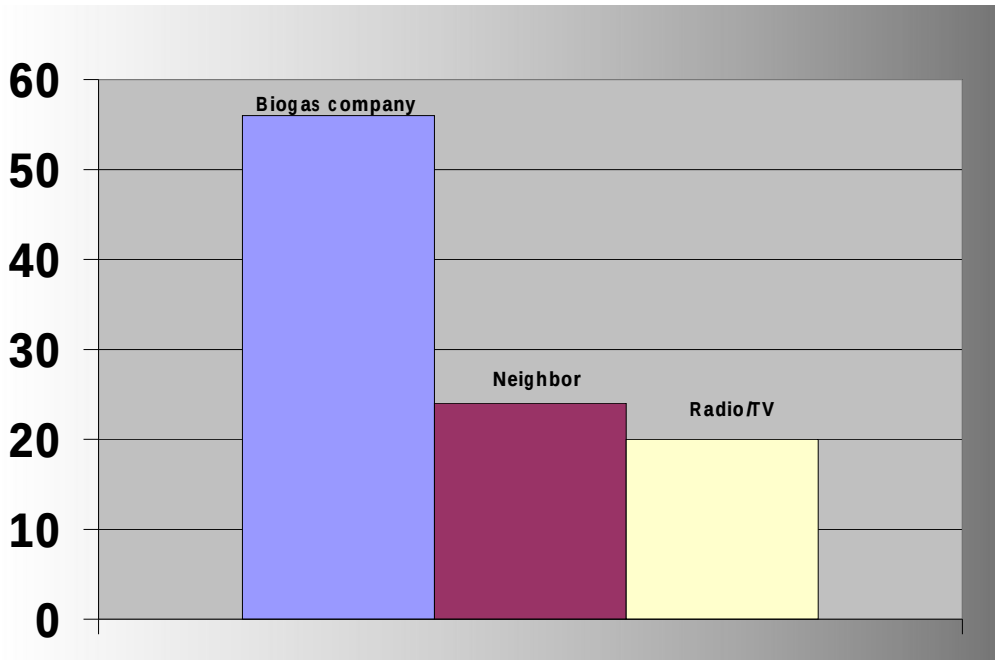
Table no. 9 Source of information for Installation of Biogas plants

S.N	Source of Communication	Number of plants	Percent
1	Biogas company	14	56
2	Neighbor	6	24
4	Radio/T.V.	5	20
	Total	25	100.00

Source: Field survey, 2011

Majority of biogas households (56 percent) reported that respective biogas companies were the main source of communication regarding the biogas plant prior to installation. Neighbor (24 percent) served as the second important source of communication for biogas households while five biogas households obtained information from Radio /T.V.

Figure no.7 Source of information for installation of biogas plants



4.2.2 Reason for Biogas Installation

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

This section wants to know the reason for the adoption of the biogas plant. About 80 percent sample biogas households reported that the main reason for the installation of biogas was easy and smokeless cooking while 8 percent biogas household reported increase crop in production and remaining 12 present sample biogas households reported that to saving in time and getting rid from firewood collection. This section is related with the question no. 2.c in the structured questioner.

Table no.10 Reason for Biogas installation

S.N	Reason For Biogas Installation	Number of plants	Percent
1	Easy and smoke less cooking	20	80
2	Time saving and to get rid from firewood collection.	3	12
3	Increase crope production	2	8
	Total	25	100.00

Source: Field survey, 2011

From above table we can get 80 percent of people install biogas for Easy and smokeless cooking, while 8 percent biogas household reports increase crop in production and remaining 12 percent sample biogas households reports that to saving in time and getting rid from firewood collection.

4.2.3 Cost of Plant Establishment

The cost of plant establishment is inversely related to the adoption of the biogas, as the cost increases the adoption rate may decrease because of the lack of the resource. This is related to the question no 2.d in structured questioner. This question was asked to find out what is the amount that a family has to bear while establishing a biogas plant.

Table no.11 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 2011.

The data owners hadn't maintained up to date data records with regard to biogas installment cost.

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.

4.2.4 Subsidy

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

Table no. 12 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, 2010

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.

4.2.5 Source of Energy for Lighting Ghorahi Municipality

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

Table no. 13 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: Tribhuvan Nagar Municipality Profile - 2010

4.2.6 Livestock Population

Livestock farming is the main source of dung for biogas plants. They are the source of raw materials (dung) needed to run biogas plants. Population of livestock is directly proportional to the dung production and the adoption of the biogas plant. Only cattle and buffalo were considered in the livestock population because, dung for only cattle were used for biogas. Waste produced by goat, pig is not used for biogas.

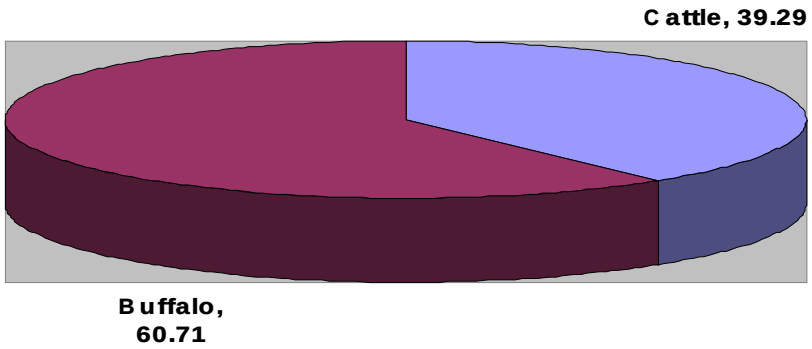
Table no. 14 Livestock Population

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

Source: Field survey 2011

The table shows that among livestock population, it gets 60.71 percent Buffalo and 39.29 percent cattle.

Figure no.8 Livestock Population



4.2.7 Dung Produced

Livestock dung is the main source for the operation of biogas plant. Availability of dung for the adoption and the running the biogas plant is very important, so question no 2.e was asked to know the availability of the dung in the study area.

Average dung product per household per day was 25 kg. Minimum dung produced was 10 kg and maximum dung produced was 40kg, which is not sufficient as prescribed as Gobar Gas Company.

4.2.8 Ratio of Mixing Dung and Water

Dung has to be mixed with water at the time of feeding of the biogas plant. The recommended amount of water is equal 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.

Here the mixture (slurry) is categorized into three groups as Normal slurry, Thicker and Diluted slurry, where normal stands for the equal amount of dung and water, less amount of water than dung and less amount of dung than water are thicker and diluted respectively.

Table no.15 Ratio of Mixing Dung and Water

Water to dung ratio	Households	
	Number	Percentage
Normal slurry	15	60
Thicker slurry	8	32
Diluted slurry	2	8
Total	25	100

Source: Field Survey, 2011

The table shows that 60 percent of the households used equal amount of dung and water, 32 percent used less water than recommended and 8 percent used more than recommended amount of water.

4.2.9 Purpose of Biogas uses

Most of the households used biogas for cooking purpose. So, the finding shows that most of the sampled households had used two burners in their kitchen. hile few household used biogas for lighting purpose.

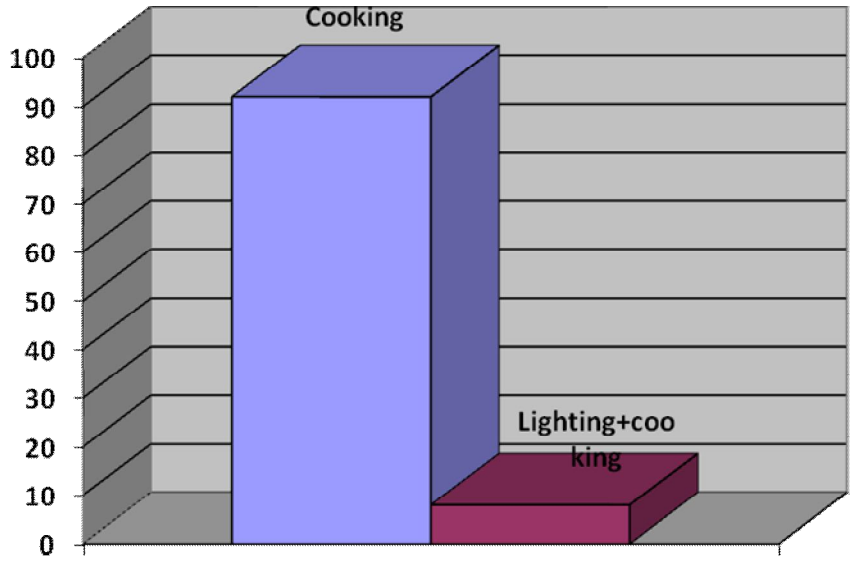
Table no. 16 Purpose of Biogas uses

S.N.	Purpose	No. of users	Percent
1	Cooking	23	92
2	Lighting+cooking	2	8
	Total	25	100

Source: Field Survey, 2011

From above table shows that 92 percent households use biogas for cooking and remaining 8 percent households use biogas for lighting + cooking.

Figure no.9 Purpose of Biogas uses



4.2.10 Saving of firewood, 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 no. 17 - 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	450
2	Kerosene	1.50	0.5	1	83
3	L.P.G.	7	1	6	567
	Total	158.5	61.5	97	1100

Source: Field survey, 2011

The above table shows that the use of fire wood, kerosene L.P.G was 150 kg, 1.50 kg, 7 kg per month per family before the installation of biogas plant. They use 60 kg firewood, 0.5 kg kerosene and 1kg L.P.G. after the installation of biogas plant. Thus from saving of 90 kg firewood, 1 kg kerosene and 6 kg L.P.G per month Rs.1100 at current price has been saved.

4.2.11 Specific Benefits from the Saving

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

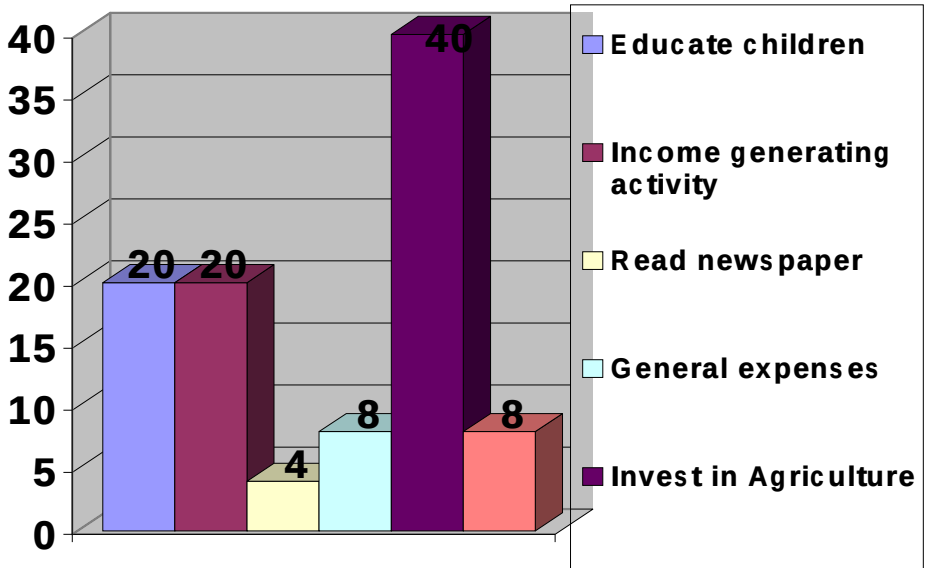
Table no.18 Specific Benefits made for Saving

S.N.	Specific Benefits	Number of HHs	Percentage
1	Educate children	5	20
2	Income generating activity	5	20
3	Read newspaper	1	4
4	General expenses	2	8
5	Invest in Agriculture	10	40
6	Households work	2	8
	Total	25	100

Source: Field Survey, 2011

The table shows that biogas has good contribution towards the field of education as well as invest in agriculture. 20 percent and 40 percent of the households have invested their saving for the purpose of educating their children and agriculture similarly 20 percent households invested for the income generating activities such as in small cottage industry.

Figure no.10 Specific Benefits made for saving



4.2.12 Reduction of 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 no. 19 Reduction in Workloads and Time Saving in Owners

S.N.	Activity	Before (In minutes/day)	After (Minutes/ day)	Different (Minutes/day)
1	Fuel manage	120	40	80
2	Cooking Activities	90	50	40
3	Washing utensils	40	25	15
	Total	250	115	135

Source: Field Survey, 2011

Table 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. Before installation it took 120 minute for fuel manage, 90 minute for cooking activities and 40 minute for washing utensils, and after installation of biogas it took 40 minute for fuel manage, 50 min. for cooking and 25 min. for washing utensils. Meanwhile it shows in total 135 minute times was saved.

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, especially 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.

4.2.13 Use of Gained Time

All the biogas users experienced significant time saving due to adoption of biogas technology. They utilized gained time in different activities which is presented in table. This refers question no. 3.c in structured questioner.

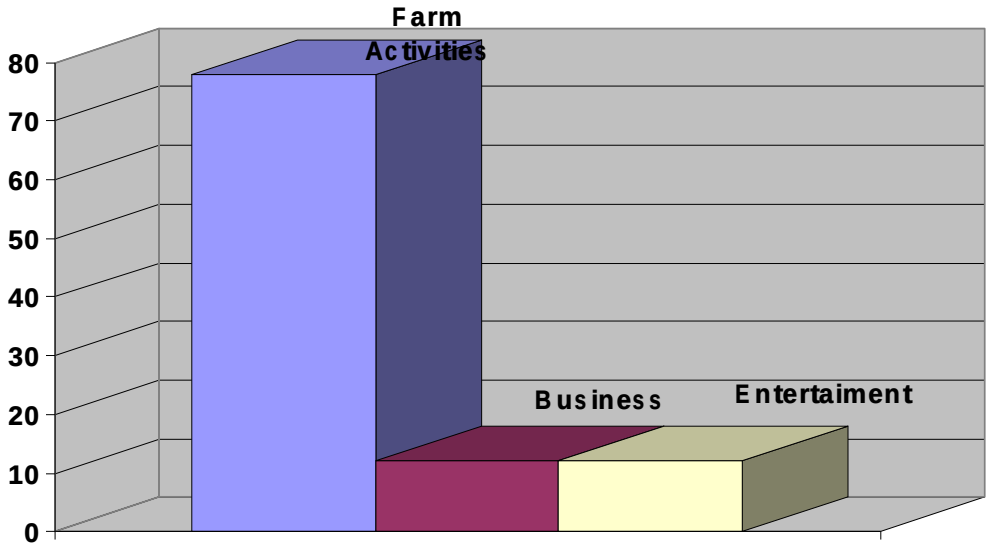
Table no. 20 Utilization of Gained Time

S.N	Activities	No of HHs	Percent
1	Farm Activities	18	78
3	Business	3	12
4	Entertainment	3	12
	Total	25	100.00

Source: Field survey, 2011

The table shows that 78 percent of biogas households utilized the gained time after the installation of the biogas plants in farm activates, 12 percent in business activities and remaining about 12 percent in entertainment.

Figure no. 11 Utilization of gained time



4.2.14 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) due to gained time after the installation of biogas plant.

4.3 Impact of Biogas on Health and Sanitation Status

This topic is relevant to find out the health and the sanitation status of the households which is very important to study the impact of biogas in relation to the health and sanitation as already mentioned in the objectives of the study. Previous studies have shown that, after the adoption of the biogas plant the sanitation around the house has been improved significantly.

4.3.1 Source of drinking water

The facilities for drinking water and toilets in rural area are the important indicator of sanitation. The source of drinking water and nature of toilet are presented in tables.

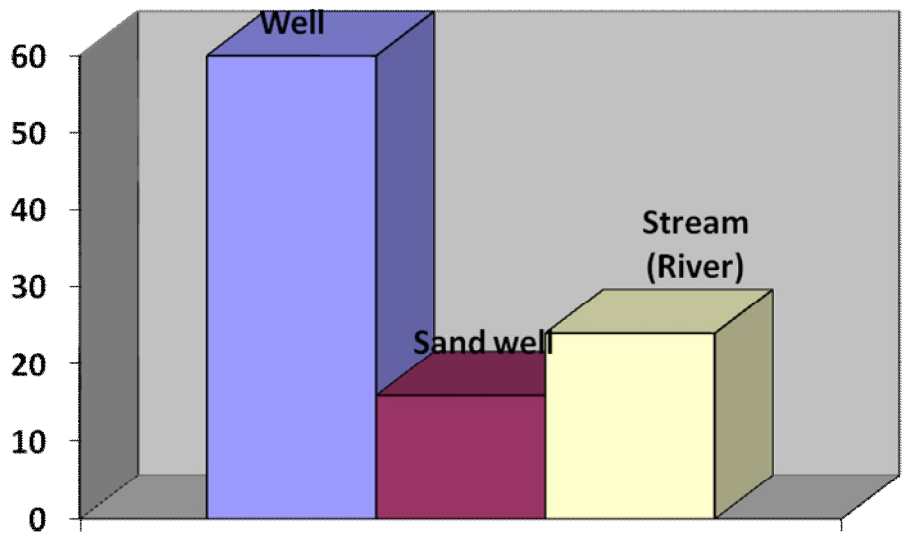
Table no. 21 Source of Drinking water

S.N	Source of Drinking water	No of HHs	Percent
1	Well	15	60
2	Sand well	4	16
3	Stream (River)	6	24
	Total	25	100.00

Source: Field survey, 2011

Above table shows that 60 percent of the sample biogas households are dependent on tube well followed by 16 percent on sand well and 24 on stream sources.

Figure no. 12 source of drinking water



4.3.2 Use of Toilet

During the research it was found that among the surveyed households, most of households had a toilet. Out of 25 households, 24 households had toilet and 1 household had no toilet

Table no.22 Use of Toilet

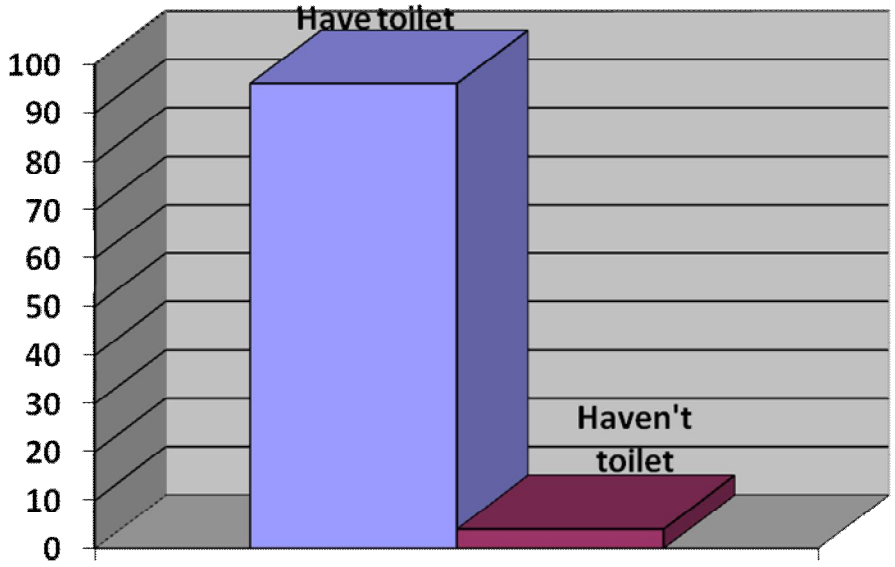
S.N.	Have Toilet	Number of HHs	Percentage

1	Yes	24	96
2	No	1	4
	Total	25	100

Source: Field Survey, 2011

The table shows that, 96 percent households have used toilet and remaining only 4 percent households have no toilet.

Figure no. 13 Use of Toilet



4.3.3 Toilet Attachment with Biogas plant

Attachment of the toilet with biogas plant improves the sanitation and the health of the people. As before mentioned that, there is insufficient dung for the biogas plant, the insufficiency is fulfilled by the human excreta and livestock urine.

Table no.23 - Toilet attachment with biogas plant

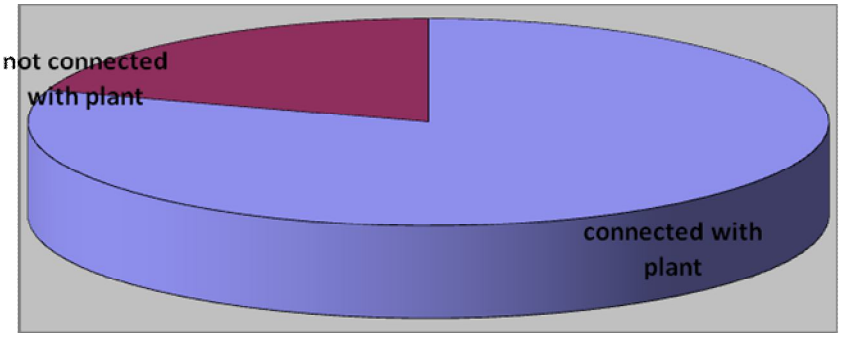
S.N	Types of toilet	No of HHs	Percent
1	Connected with Biogas	20	80
2	Not connected with biogas	5	20

	Total	25	100.00

Source: Field survey, 2011

Out of total toilets constructed by sample biogas households, 80 toilets are attached with biogas plant while only 20 toilets are no attached with biogas plants which we can see in above table most of households connected biogas with the toilet because they had not to make another safety tank and as a result toilet is becoming cheaper as well as it will increase the availability of sufficiency of gas. And 20 percent households don't connect biogas with the toilet because of concept of unholy.

Figure no. 14 Toilet attachment with biogas plant.



4.3.4 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 no.24 Improve in Health Condition of Women and Children

S.N.	Diseases	Number of HHs	Percentage
1	Respiratory	10	40
2	Eye illness	6	24
3	Headache	5	20
4	Coughing	3	12
5	Other	1	4
	Total	25	100

Source: Field Survey, 2011

The table shows that improvement of health condition of women and children is considerable. From this study, it has been observed that about 40 percent of the households respiratory problems have improved after installation of the biogas plants. Similarly 20 percent of the sample households headache problems, 24 percent of the sample households eye illness problem and 12 percent of the sample households coughing problems have improved after installation of the biogas plants. Only 4 percent of the sample households other health problem have improved.

4.3.5 Saving medical health care cost after installation of biogas

Biogas had a positive impact on the personal health of family members especially women and children. During the research, it was found that after installation of biogas, health problem had decreased as a result the cost of medical health care was also saved. This section is related with question no.4 of structured questioner.

Table no. 25 - Medical Health care cost (Rs.) per year per Households

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	1000	450	550
4	Others	1500	800	700

Source: Field survey, 2011

The table shows that the sampled biogas households has spent Rs 1820 in eye illness, Rs 3200 in acute respiratory, Rs 1000 in headache and Rs 1500 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 450 in headache, Rs 800 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.

Meanwhile, after installation of biogas the cost of medical health care was saved and that saved money was used for other relevant activities like education, income generative activities, farming and general expenses.

4.3.6 Insect Prevalence

During the research, Flies and mosquitoes were taken into account for the study of change in prevalence of insects.

4.3.7 Flies

Reduction from the prevalence of fly was reported from the study. Some households reported that the no. of flies were increased too. This section is related with question no. 4.b in the structured questioner

Table no.26 Effect on Prevalence of Fly

Fly Prevalence	No. of HHs	HHs %
Decreased	15	60
Remained Same	8	32
Increased	2	8
Total	25	100

Source: Field Survey, 2011

The table shows that, 60 percent households reported that decrease in fly population. While about 32 percent whose did not feel no change and only 8 percent household reported increase in no. of flies.

4.3.8 Mosquito

The prevalence of mosquito was reported increase from the study after installation the biogas. This section can be reveled from question no. 4.b in the structured questioner.

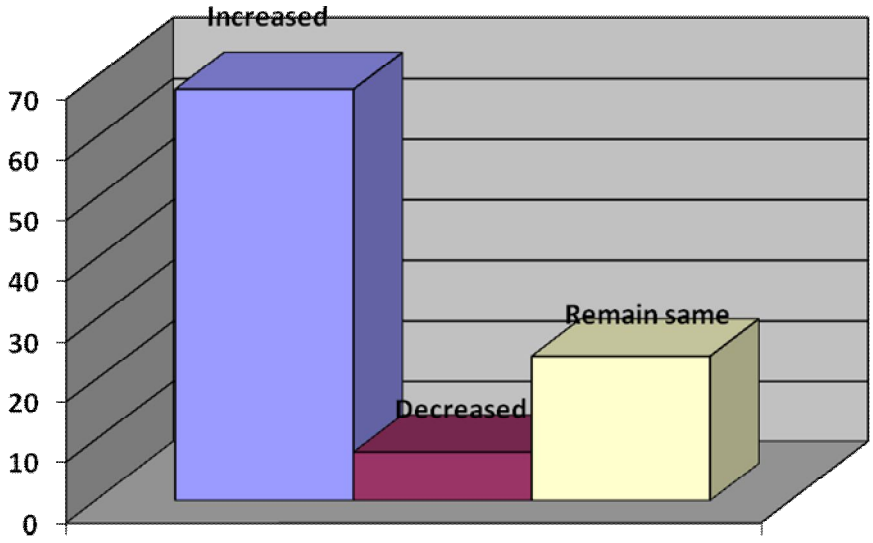
Table no.27 Effect on prevalence of Mosquito

Mosquito prevalence	No. HHs	Percentage of HHs
Increased	17	68
Decreased	2	8
Remained Same	6	24
Total	25	100

Source: Field Survey, 2011

Table shows that 68 percent of the households reported the increase in mosquito population and 8 percent households felt decrease while 24 percent found no difference on the prevalence of the mosquito. The main reason behind the increasing the no. of mosquitoes was lack of smoke because; from using of biogas stove it doesn't produce smoke.

Figure no.15 Effect of prevalence of mosquito



4.3.9 Visible change in kitchen surrounding

During the research, most of the kitchen of biogas users was found so clean and systematic after using the biogas. This section can be reveled from question no. 4.c in the structured questioner.

Table no.28 Visible change in kitchen surrounding

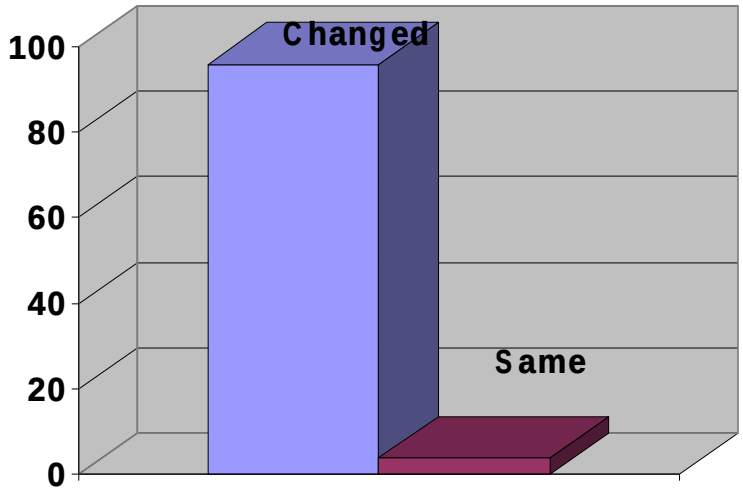
S.N.	Situation	No. of households	Percentage
1	Changed	24	96
2	Same	1	4
	Total	25	100

Source: Field Survey, 2011

From the above table, it is found 96 percent kitchen surrounding is changed after using biogas and only 4 percent is same.

From the observation and FGD during the research, it was found most of kitchen surroundings were more clean and systematic of biogas users than use of traditional fuel, like firewood, dung cake, agriculture residues.

Figure no.16 Visible change in kitchen surrounding



4.4 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.

4.4.1 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. After the installation of biogas plant, the majority of the plant owners have failed the reduction of use of firewood.

4.4.2 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 program 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 got 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 projects 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 got 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 50 percent. This forest area itself is very important for CDM. This total number of biogas plants installed in the study area is 98. As we compute the total reduction of CO_2 in the shady area made by biogas plants is 450.8 (98 × 4.6) tons annually. It has further helped in CDM program. If we involve all these plants in CDM Nepal, we will earn US $ 3155.6 (450.8×7) per year from carbon trade (Field Survey, 2011).

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. So we can say that biogas is very useful and suitable technology for developing country like Nepal.

4.5 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 accrue 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 farm 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.

4.5.1 Using biogas slurry on the farm by the users

Biogas slurry is very significance for farm which can help to increase production. During the research it was found that most of households used biogas slurry on the farm.

Table no. 29 Using biogas slurry on the farm by users

S.N.	Using slurry on farm	No. of Households	Percentage
1	Use	23	92
2	Not use	2	8
	Total	25	100

Source: Field Survey, 2011

From the above table shows that 92 percent households use the biogas slurry on the Farm and only 8 percent households don't use slurry on the farm.

4.5.2 Methods of Using Slurry on Farm

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

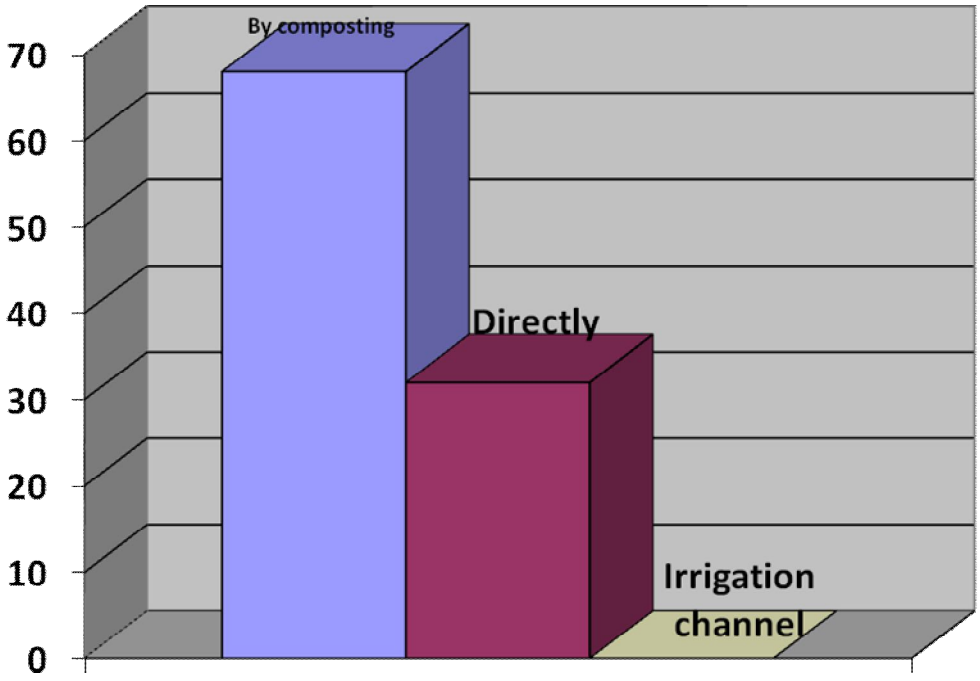
Table no. 30 Methods of Using Slurry on Farm

S.N.	Method of Application	Number of HHs	Percentage
1	By composting	17	68
2	Directly	8	32
3	Irrigation channel	-	-
	Total	25	100

Source: Field Survey, 2008

The data presented in table clearly shows that about 68 percent of the biogas formers have performed using the slurry in composted forms, while 32 percent use it in directly form. No one households report using liquid slurry directly to fertilizer their crops.

Figure no. 17 Methods of Using Slurry on Farm



4.5.3 Production Increment After Using Slurry

Level of production and productivity plays great role in economic development. Increase in production is the base of Gross Domestic Product (GDP) growth. Hence, increase in production increases level of employment and reduces poverty and hunger. Biogas slurry is useful for agricultural production increment.

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 20 households reported that there is an increase in their agricultural production, 3 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 no. 31 Production Increment after Using Slurry

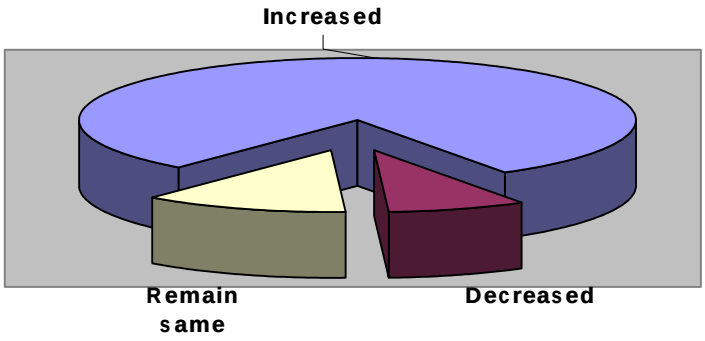
S.N.	Agricultural Production	Number of HHs	Percentage
1	Production Increased	20	80
2	Production Decreased	2	8
3	Remained the same	3	12
	Total	25	100

Source: Field Survey, 2011

Table shows that 80 percent households feel that biogas slurry have improved their production. However, 8 percent households respondent that it decreased their production and 12 percent respondent remain same.

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.

Figure no.18 Production Increment after Using Slurry



4.6 Operation and Maintenance

4.6.1 Problems

Biogas energy is an alternative source of energy. It has no all plus point some of there are problems for users .During the research, it found that through using biogas it created problem too not only benefit like it created problems in operation, maintenance, dung availability and others.

From the Observation and FGD, It was got the households had the problem of occasional leakage of slurry from the burner of gas stove.

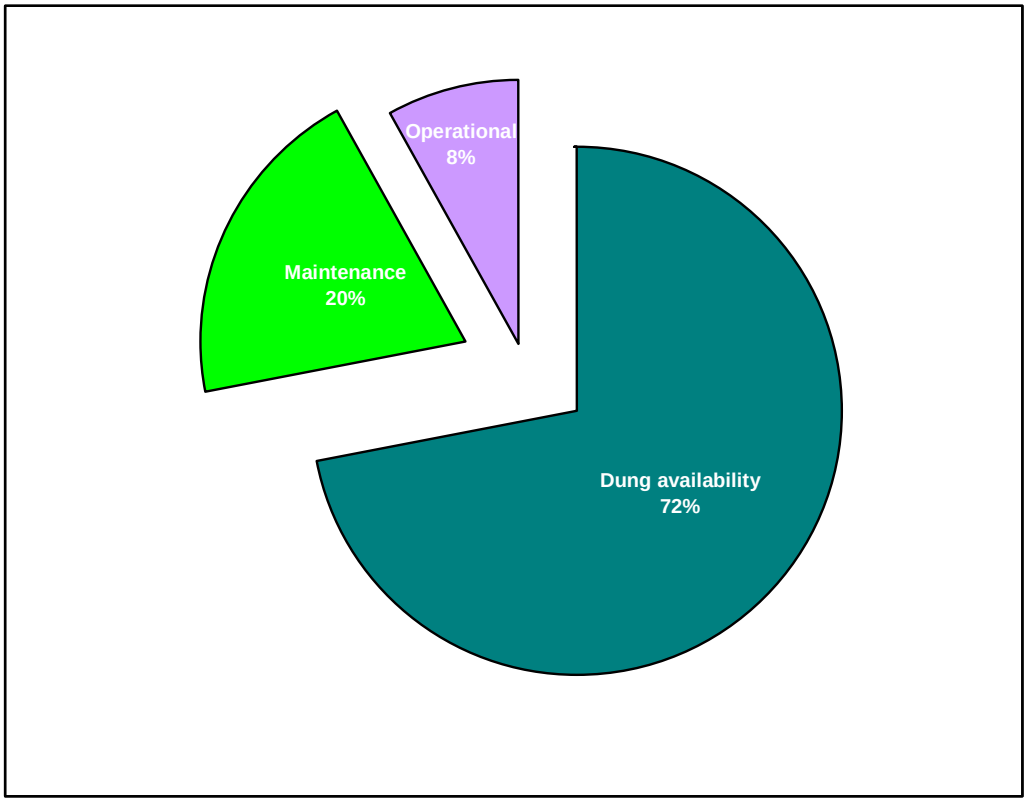
Table no. 32 Problems of bio-gas plant

S. No	Problems	No of household	Percent
1	Dung availability	18	72
2	Maintenance	5	20
3	Operational	2	8
	Total	25	100.00

Source: Field Survey 2011

This study shows that 72 percent of the households have problem of dung availability, 20 percent of the households have problem of maintenance and rest 8 percent households have a problem of operational.

Figure no. 19 Problems of bio-gas plant



4.6.2 Problem regarding insufficiency of gas

During the research, it found that after the installation of biogas, households faced problem regarding insufficiency of gas. A majority of households had experienced the problem of gas insufficiency in the cold season.

Table no. 33 Problem regarding insufficiency of gas

S.N.	Problem of gas	No. of households	Percentage
1	Insufficiency	19	76
2	Sufficiency	6	24
	Total	25	100

Source: Field Survey, 2011

Above table shows that 76 percent households have a problem regarding insufficiency of gas and 24 percent households haven't problem insufficiency of gas.

4.6.3 Alternative for the insufficiency

To reduce the problem regarding insufficiency of gas most of households had used alternative form of energy like firewood, LPG, Kerosene, electricity etc.

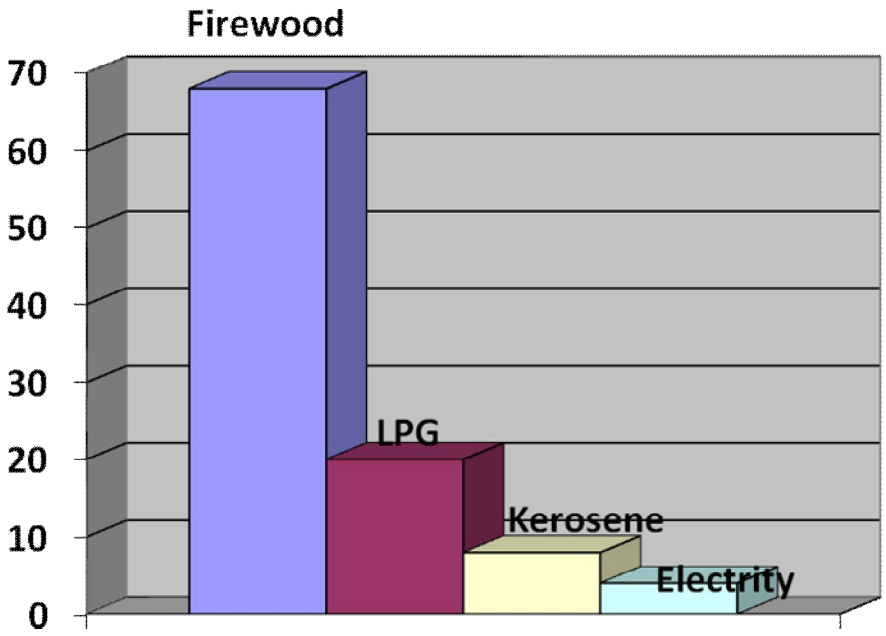
Table no. 34 Alternative for the insufficiency of gas

S.N.	Alternative energy	No. of households	Percentage
1	Firewood	17	68
2	LPG	5	20
3	Kerosene	2	8
4	Electricity	1	4
	Total	25	100

Source: Field Survey, 2011

The table shows that households use the alternative forms of energy for reducing the insufficiency of gas. Out of total 68 percent households use firewood as a alternative energy, 20 percent households use LPG,8 percent households use kerosene and only 4 percent households use electricity as a alternative energy.

Figure no.20 Alternative for the insufficiency of gas



4.6.4 Maintenance service

In the study area, it was found there were many biogas companies like Public Gobar Gas Pvt. Ltd., National Gobar Gas construction and service, Gobar Gas and Agriculture goods development company, Gharelu Gobar gas etc. Only minor maintenance and repair was needed for the biogas plant. So, the users had to experience no regular expenses for the maintenance and repair. Most of the biogas users were satisfied from Biogas Company.

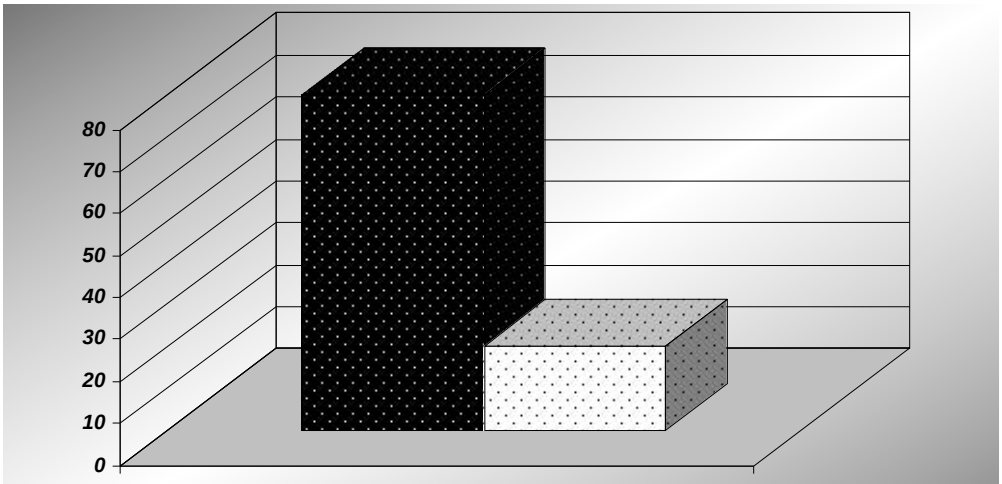
Table no. 35 Maintenance service

S.N.	Maintenance	No. of households	Percentage
1	Satisfied	20	80
2	Not satisfied	5	20
	Total	25	100

Source: Field Survey, 2011

The table shows that 80 percent households are satisfied and 20 percent households aren't satisfied by maintenance.

Figure no.21 Maintenance service



Satisfied	80
Not Satisfied	20

CHAPTER FIVE

Findings, Conclusion and Recommendation

5.1 Major findings

This study was mainly focused on the socio-economic and environmental impact of biogas in Ghorahi Municipality -2.During the research different research methodologies like the formal method of interview in a structured questionnaire, household survey, informal meeting, focus group discussion, key informant interview and observation were used for assessing in the socio-economic and environmental impacts among the biogas users. After conducting the research, the following key findings are summarized below.

- Size of $6m^3$ biogas plants were more popular in this area as compared to other size of plants ($8m^3$, $10m^3$, $15m^3$).
- This study found out that there were also the size of $10m^3$ biogas plants (4 percent) and $15m^3$ biogas plants (4 percent) installed. But these sizes of plants were installed before 10 years.
- 98 biogas plants were installed in the study area.
- 88 percent male were the Owner of biogas plant.
- Biogas Companies were major sources of information to install the biogas plants.
- For easy and smokeless cooking most of (80 percent) households installed the biogas plants.
- Most of households used of biogas is only for cooking nowadays but before the availability of electricity biogas was also used for lighting purpose.
- There was a considerable reduction in the workload of the family member, children and women were highly benefited by the biogas plant installation.
- Majority of time has been saved and the saved time has been used mostly in farm activities (40percent) followed by income generation activities (20percent) (and 20 percent)educated their children and others.

- Average amount of dung feeding was lesser than the capacity of plant.
- 96 percent household had a Toilet.
- Majority of the households had connected toilet (80percent) with the biogas plant.
- Public Gobar Gas Pvt. Ltd. Company was leading in the construction of biogas plant in study area.
- Medical expenses also have been reduced after the installation of biogas plants.
- Average dung product per household per day was 25 k.
- Because of low temperature in winter season, majority of households had experienced the problem of gas insufficiency mainly in the cold season.
- In sampled household the users of biogas felt the reduction of smoke in the kitchen.
- During the research, it was found most of kitchen(96 percent)surroundings were more clean and systematic.
- Majority of sampled households (60 percent) have felt the decrease in fly prevalence because of clean environment at the surrounding.
- Breeding of Mosquitoes had increased significantly in 68 percent of the sampled households and it was one of the negative impacts of bio-gas plant.
- The users felt reduction in health related problems such as eye burning, headache, and respiratory problems such as asthma.
- Almost of all plant owners (92percent) used slurry on farm and agricultural production which has been increased.
- It was found that 68 percent of the biogas farmers had performed using the slurry in composted forms, while 32 percent used it directly . No one household reported using liquid slurry directly to fertilizer their crops.
- It was found that, If we involve all biogas plants of study area in CDM, we will earn US $ 3155.6 (450.8×7) per year from carbon trade.

- Majority of households reported that the overall socio- economic and environmental conditions has been improved.

5.2 CONCLUSION

This study was conducted in Ghorahi municipality-2 of Dang district. Out of Ninety eight households regarding the installation of biogas only Twenty five household had been taken as sampled households. This study was confined only in ward no. 2 of this municipality.

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 buffaloes, cattle and dung of them is the best source of raw 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.

The major advantage the bio-gas plant brought is the reduction of smoke free environment smoke in kitchen are other advantage is that the prevalence of insect has become very low than it was before installation of plant. This smoke free environment in the kitchen improves air quality ultimately leading to improvement in health condition of women because they have to always work in kitchen. Adversely, the installation of biogas plant has significantly increased the problem of mosquitoes. 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.

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.

Biogas technology has also improved the health and sanitation situation. It has helped to reduce the prevalence of smoke borne disease such as respiratory problem,

headache and eye burning etc. This technology has also improved the overall energy, environment and economic condition of the plant owners.

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

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

In a nutshell, biogas technology has been proved as an appropriate alternative source of energy to fulfill the increasing demand of energy requirement.

Thus, the development of biogas technology would be a milestone in the overall development of rural areas as well as urban too. 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 should have join hands and come up with better plan; policies and strategies for extending biogas energy to potential areas.

5.3 Recommendations:

Based on the general findings of the study, the following recommendations have been proposed for the further development of biogas technology. On the basis of analysis of this study, the following recommendations are drawn to formulate and adopt the policy by the concerned authorities to develop and promote biogas technology.

- A great deal of time and money of households has been saved after installation of biogas plant. Therefore, women members should have chance to work in income generation activities. Concerned authorities should pay attention to this.

- It is found that all the plant owners have used the gas only for cooking purpose. Thus it is necessary to conduct further studies about the uses of gas to other income generation activities.
- Connection of the toilets to the biogas plants should be promoted. This would help further improving the health and sanitation.
- Insufficiency of the gas in cold season has been the major problem for the biogas users. So proper alternative design of biogas plant is becoming a need.
- Provision of easy loan and cheap interest rate on loan should be made including higher percentage of subsidy.
- Importance and benefits of the biogas plant should be demonstrated.
- Application of bio slurry on farm should be studied systematically, qualitatively and quantitatively.
- Slurry utilization prospects and use of biogas for lighting should be promoted to enhance benefits of biogas and reduce payback period of biogas installation.
- Women are the main user of biogas, special emphasis such as operation, maintenance and installation training has to be given directly to women.
- Importance and benefits of the biogas plant should be broad casted regularly by medium of communication. like local FM, newspaper, radio, T.V. etc.
- With several direct benefits and indirect benefits of biogas in terms of social, health and environmental sector, biogas installation should be given priority.
- Public support is very important in the promotion of biogas. If the rural communities don't have confidence in investing in biogas they will continue to use fuel wood that is already available. Spreading information about biogas and its positive effects should be promoted.
- Lack of financial capabilities to invest in biogas plants among poor farmers in rural areas is one of the biggest challenges. Possible solutions to this should be explored.
- The Clean Development Mechanism (CDM) can help finance further biogas growth in developing countries. More research should be made in biogas and related aspects of CDM to obtain supportive data and information.

References

ADB/N (1986), Impact Study of Biogas Installation in Nepal, Kathmandu.

Adhikari, P.K. (1996), Effects of biogas Plants on Family Health Sanitation and Nutrition, BSP-Nepal, Kathmandu

Baskota, Suman (2004). Research Methodology. Kirtipur : New Hira Books Enterprises.

AEPC (2001), Final Report of Biogas User's Survey, MOST, HMG/N. Kathmandu.

Bajagain, S.Sunder (2003), Biogas: A Mine of Energy, In Sustainability- The Lasting Fuel, Forum For Sustainable Development, Kathmandu.

Bajgain, Sundar (2003), Biogas in Nepal-Development, Apprortunities and Challenges, RETRUD 03. (eds) Shrestha et.al. IOE, TU, Lalitpur, Nepal.

BPS (2001). Gobargas EK Janakari, Kathmandu.

BPS (2003),Integrated Environment Impact Assessment of biogas Support Program, Kathmandu.

BPS (2004), Biogas Nepal 2003,Kathmandu.

Britt, C. (1994), The Effects of biogas on Women's Workload in Nepal: An Overview of Studies Conducted for the biogas Support Program, BSP-Nepal Kathmandu.

BSP (2010), BSE Year Book 2010, April 2010.

BSP-Nepal (2004), Final Report on Biogas Support Program Phase III Kathmandu.

CMS (2001), Advance Course in biogas Technology for Rural Development,Kathmandu.

CBS (2001), National Population Census of Nepal, Kathmandu.

CBS (2003), Renewable Energy Technology for Rural Development, Kathmandu.

CMS (1994), Biogas Latrine Project Assessment Kathmandu, UNICEF.

CMS (1999), Biogas user Survey 1998/1999, BSP-Nepal, Kathmandu.

CMS (2003), Renewable Energy Technology for Rural Development, Kathmandu.

Development Part. Nepal (1998), Biogas User's Survey 1998, BSP-Nepal.

CBS (2002). Population Census 2001 National Report. Central Bureau of Statistics.

Kathmandu : Central Bureau of Statistics.

East Consult (P) Ltd. (2004), Final Report of biogas User's Survey, 2003/2004. AEPC, Kathmandu.

MoF (2007), Economic Survey Fiscal Year 2006/07, GON Ministry of Finance.

ESCAP (1975), Biogas Technology and Utilization of Asia and Pacific Region, Manila.

GGC (2001), Gobar Gas Tatha Krishi Yantra Vikas (P) Ltd. Profile, Kathmandu.

Ghimre, S. (2000), Social Impact of Biogas on Users, MA Thesis in Anthropology. Kathmandu.

Gopalkrishnan, C. A. & Lal, G.M.M. (1990), Livestock and Poultry Enterprises for Rural Development, Vikash Publishing House PVT Ltd., India. New Delhi.

Karmachary, R (1992), An Analysis of the Socio-Economics Impact of Biogas Plant in Nepal, M.A. Dissertation, Kirtipur.

NBPG (2004), Renewable Energy, Kathmandu.

NEPECON (2001), Final Report of biogas User's Survey 2000/2001, AEPC/MOST, Kathmandu.

New Era (1985), Biogas Plants in Nepal, UNICEF Kathmandu.

Pokhrel, R.K. & Yadav R.P. (1992), Application of Biogas Technology in Nepal Problems & Prospects, ICIMOD, Kathmandu.

Shrestha, L.K. (2002), Socio-Economic Impact of biogas Installation in Rural Nepal, MA Thesis in Anthropology. Kathmandu.

Sigdel S.K. & Das A.K., Biogas Development in Kaski District, Pokhara.

Silwal, B.B. (1999), A Review of the biogas Programs in Nepal, Winrock International Kathmandu.

Singh, S.B. and N.P. Ghimire. (1996), Animals, Environment, Prosperity and Healthy Citizens, Proceedings of fifth National Veterinary Conference, Kathmandu.

UN (1979), Proceedings of the Workshop on biogas and other Related Energy, Suva.

Van Vliet, M. (1993), Effects of biogas on the Workload of Women in the Village of Madan Pokhara in Palpa District in Nepal, BSP, Kathmandu.

Vliel, M. Van Marieke and NEs., Mim J. Van 1992/1993, Effect of bio-gas on the Workload of women in Rupandehi District of Nepal, Published on : bio-gas Bulletin, eleventh Anniversary issue, BAED Head office, Nepal.

WECS (1994), A Study of Alternative Technology Assessment, Kathmandu.

Web Sites Visited:

http://www.baspnepal.org.np/

http://www.mof.Gov.np/

http://www.Clean development mechanism.ent

http://www.cgap.org/

http://www.cmfnepal.com/

http://www.undp.org/

http://www.mowcsw.gov.np/

http://www.nepalnews.com.np/

http://go.worldbank.org/

http://www.gorkhapatra.org.np/

http://news.mongabay.com/

http://www.kantipuronline.com/

http://www.renewableenergyworld.com/

ANNEX I

HOUSEHOLD SURVEY QUESTIONNAIRE

Socio- Economic and Environment Impact of Bio-Gas Plant

(A case study of Ghorahi Municipality-2 of Dang District)

Date _____

1. GENERAL INFORMATION

Name (HHH) :	Village/Tole:
Sex (M/F) :	Type of House:
Age : No	Plant size (m^3):
Cast/Ethnicity:	Education:
Land holding:	Occupation:
Annual Income (Rs):	

2. INFORMATION ON BIOGAS

a. How did you know about biogas

Biogas company [ ] Neighbors [ ]

Radio/TV [ ] Others [ ]

b. What is the name of your biogas company?

.....

c. Reason for installation

Easy and smokeless cooking [ ] Increase crop production [ ]

Save time [ ] All the above [ ]

d. How much cost in Rs you paid for gas plant installation?

Total cost of installation(_____)Subsidy amount(_____)

e. Livestock and dung production per day.

Animal	Number	Dung Produced/day
Cattle		
Buffalo		
Total (kg)		

f. What is the purpose of biogas production?

Cooking [ ] Lighting [ ]

Both [ ] Other [ ]

g. Have you attached toilet with this plant?

a) Yes b) No

If not, why?

a) Due to the concept of unholy b) Dirty

c) Separate toilet d) Sufficiency of gas

e) Others (specify) _____

If yes, why?

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

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

h. How much dung is necessary for this size of plant (in kgs)?

_____

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

_____

j. What is the source of water?

Well [ ] River [ ]

Tap water [ ] Other [ ]

3. SAVING

a. Consumption and saving fuel before and after installation (per month):

		Consumption per month		Saving/month	
		Before installation	After installation	Quantity	Amount (Rs)
1	Fire wood				
2	Ag. residue				
3	Dung Cake				
5	LPG				
4	Kerosene				

b. Saving in time (workload)

SN	Works	Time allocation		Time saved (Hrs)/day
		Before installation	After installation	
1.	Fuel manage			
2.	Cooking			
3	Washing utensils			

c. How did you utilize the time saved?

Farm activity [ ] Business [ ]

Kitchen gardening [ ] Entertainment [ ]

4. HEALTH, ENVIRONMENT AND SANITATION

a. What change you feel after installation of bio-gas regarding your health and environment?

Disease/health problem	Increased	Decreased	No change
Eye illness/burning			
Acute respiratory disease			
Asthma			
Headache			
Other specify			

b. Changes in insect prevalence of flies and mosquitoes

Decreased [ ] Remained same [ ] Increased [ ]

c. Do you feel any visible change in sanitation of your kitchen surroundings.

Yes [ ] No [ ]

d. How much did you spend in medical health (per year)

Before installation: _____ After installation: _____

5. ECONOMY

a. Do you use biogas slurry on the field?

Yes [ ] No [ ]

b. How do you use it?

Directly [ ] By composting [ ]

Irrigation channel [ ] Other (specify)

c. If used in farms, does digested slurry have any impact on the production of crops? If so in what way?

Production increased significantly [ ] Production remained same [ ]

Production increased some what [ ] Decreased [ ]

d. If production increased, how?

Crop	Crop yield		Increment
	Before slurry use	After slurry use	
Paddy			
Wheat			
Maize			
Oil seed			
Vegetables			

6. PERCEPTIONS TOWARDS BIOGAS

a. Do you think biogas technology is affordable in rural area?

Yes [ ] No [ ]

b. Are you satisfied with biogas cooking?

Yes [ ] No [ ]

7. PROBLEMS

a. What problems are you facing after installation

Operational [ ] Maintenance [ ]

Dung availability [ ] Other (specify)

b. Is there any problem regarding insufficiency of gas?

Yes [ ] No [ ]

c. If yes, why and when?

d. How do you manage for the insufficiency?

Fire wood [ ] Electricity [ ]

LPG [ ] Kerosene [ ]

e. Are you satisfied with the service of your gas company?

Yes [ ] No [ ]

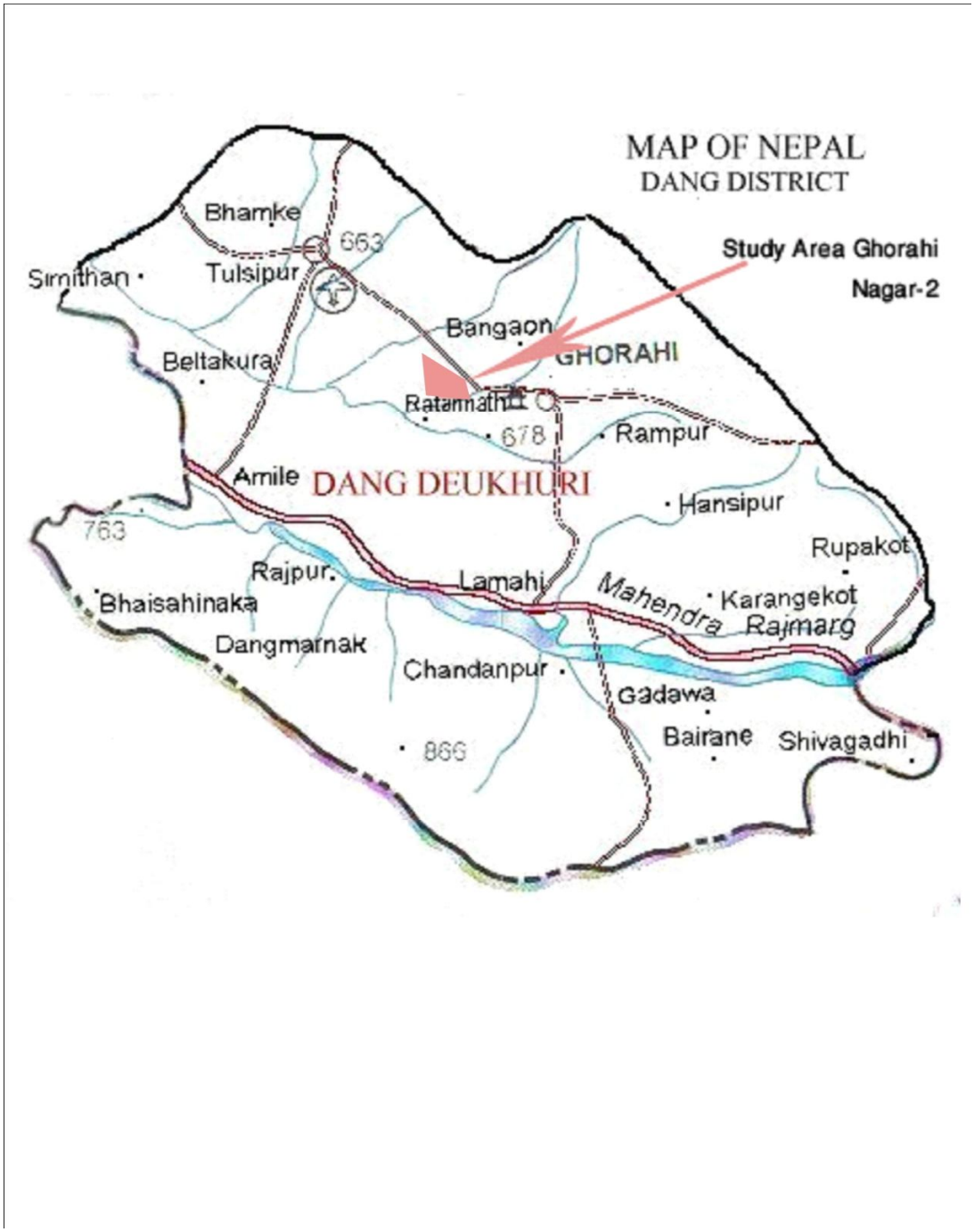
f. If no, what are the drawbacks?

8. DO YOU HAVE ANY SUGGESTIONS?

_____

_____

ANNEX II: MAPS AND PHOTOS



1. During the data collection

2.Mixing dung

3.Biogas plant attached with toilet

4.Researcher with biogas users while collecting data

5.Mixing dung in biogas plant by users

6.Researcher observing the plant with the help of users

7.with the biogas user who didn’t use biogas slurry on the farm

8.Composting slurry

9. Using slurry in the field

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES