CHAPTER I

INTRODUCTION

1.1 Background of the Study

The per-capita energy consumption of any country indicates the level of development of that country. Per-capita energy consumption in Nepal is very low (14 b Gj) and most of the energy is being used for domestic purpose (WECS, 2002). In Nepal, the sources of energy are primarily conventional. The energy consumption in 2002, by percentage is 75.78% fuel wood, 9.23% petroleum, 1.47% electricity, 5.74% animal waste, 3.75% agricultural residue, 3.53% coal and 0.48% renewable energy (WECS, 2003). The figure indicates that the dependency on forest for energy in Nepal is very high.

Nepal an agricultural country, where livestock farming is an important component of agricultural system. The number of households with cattle or buffaloes in Nepal was estimated to be 2.7 million in 2001 (BSP, 2004). The technical potentiality of biogas pants installation is assumed to be 1937015. By the end of July, 2005, a total number of 140457 plants were installed under BSP. (BSP, 2005).

Biogas is 20% lighter than air, colour less, orderless and smokeless (environmentally friendly) gas that burns with clear blue flame similar to LPG. Its calorific value is about 20 mj/m^3 and 60% efficient in a conventional biogas stove, (AEPC, 2000)

Biogas has been gaining popularity now a day as a good alternative source of domestic energy. The history of biogas in Nepal goes back to 1955 when the pioneer of biogas in Nepal, B.R. Sauboll, a Belgium teacher at Godavari St. Xavier's School built a demonstration plant.

Only a few farmers were interested in biogas technology and they installed a few biogas plants after 1967 under the design of Khadi and Village Industry Commission (KVIC) model of India. In Nepal Biogas Development Committee (BDC) was formed as a part of Energy Research and Development Group (ERDG), under Tribhuvan University in 1995 (New Era, 1985) Gobar Gas and Agriculture Equipment Development Company P. Ltd. GGC was formed in 1977 with joint investment of United Mission to Nepal (UMN). Agricultural Development Bank Nepal (ADB/N) and Nepal Fuel Corporation (NFC) to initiate concrete programs and popularize biogas technology (Ghimire, 2000). In the beginning, the government did not take interest to support activities of GGC; however biogas was given priority as an alternative energy sector during the seventh five year plan. (BSP, 1994).

In 1992, Biogas Support Program (BSP) was initiated as a joint venture of ADB/N, GGC and SNV, Nepal. And BSP was introduced at three different stages for massive dissemination of technology in the country with the long term objectives of: reducing deforestation and environmental deterioration, improving health and sanitation of rural population especially women, and increasing the agricultural productivity by promoting the use of digested slurry. It has successfully completed its third phase in June 2003 and have started fourth phase from July 2004.

BSP has still providing a flat rate subsidy in Terai Rs 5,000/plant, Hill Rs, 8000/plant and Remote Hill districts Rs 11,000 upto the size of $10m^3$.In the case of $4m^3$ and $6m^3$ plants Rs 500 is also added. The "Biogas Nepal 2004" reports that the total numbers of 123,395 plants have been installed by the end of 2004 and the total number of 140457 plants have been constructed by the end of July 2005 (BPS). It also states that 97% of Constructed plants are in operation, 88000 toilets

are connected with biogas plants 80% of bio-slurry is utilized as an organic compost fertilizer, 860,000 persons are directly benefited and 11,000 persons got employment by the end of 2004. Biogas programe is environment friendly and can implement clear development mechanism in Nepal.

His Majesty's Government of Nepal has set up an Alternative Energy Promotion Center under the Ministry of Science and Technology in 1996, for networking at the central level policy making and promoting the alternative energy technology. At present, there are several private companies working for the extension of biogas technology under BSP, SNV/N. There are 64 recognized biogas companies, 104 micro finance institutions 14 biogas appliances workshops working in different districts for fiscal year 2061/62. In Nepal it is aiming to cover at least 70 districts with high quality biogas plants, 66 districts have already been covered with biogas and in future other 4 districts are planned to be covered (BSP, 2005).

1.2 Statement of the Problem

Many developing countries are facing the energy related problems such as rising prices of fossil fuels, depleting forest resources etc, and Nepal is no exception to this. Nepal, with a percapita energy consumption of about 15 G.J, is one of the five least energy consuming countries in the world. The demand for energy is increasing day by day in the country and major share of energy consumption is met through traditional sources. The traditional biomass sources of energy share a large quantity of about 85.27% of total energy where as commercial and renewable sources of energy are limited to 14.24% and 0.48% respectively (WECS, 2003). Around it 89.05% of the energy is consumed in residential sector. The rural household energy end use in 1995 was: 65% in cooking, 8% in space heating, 2% in water boiling, 3% in agro

procuring, 1% in lighting and 21% in others (Shrestha and Bajracharya, 2003).The share of traditional energy sources has decreased from 96% in 1990 to 85.27% in 2002, how ever; the use of fuel wood is beyond its sustainability. The sustainable supply of fuel wood was estimate to be 6.5 million tons where as the consumption was 15.4 million tons in 2000/01, (WECS, 2001). It has caused a severe pressure in the forest resources and led to deforestation and environmental degradation. The problem, therefore, arises due to over consumption of fuel wood. To struggle for improving this condition, the renewable energy sources are to be developed and biogas promotion will be a significant one, which will cut both traditional and commercial sources.

When we compare biogas to other renewable energy sources like; hydropower, solar and wind energy, it is cheaper and advantageous in rural areas. Reducing the indoor pollution and improving the health condition of users is the strength of biogas technology. For the development and promotion of biogas technology, this study will be good manure in rural Nepal.

1.3 Objectives of the Study

To find out the various uses of biogas energy and its relation to environmental conservation and rural development is the general objective of this study, where as the specific objectives are as of:

a. To find out the economic impact of biogas on users.
b. To analyse the impact of biogas technology in environmental conservation.
c. To study impacts of biogas on the workload health situation of women.

d. To formulate relevant recommendations based on the study findings.

1.4 Importance of the Study

Rural populations are not able to afford for sophisticated technologies such as hydropower, solar and wind energies. Thus biogas technology is very much suitable for Nepalese context. Biogas technology involves simple and user friendly technology. More over, the potential of this technology in Nepal is very high. However the progress achieved till date in exploiting the vast potential is not too encouraging. The reason for such slackness may be numerous. Very little information exists at present regarding the positive and negative impacts of biogas on the users which indicates that there is need to carry out more studies in this sector.

Many studies done on impact of biogas on users have drawn the positive impacts on women health and their socio-economic activities. The changes on women status and activities of biogas user household in the study area will be the investigating part of this study. It is expected that everybody interested in this sector would be benefited from the outcome of this study, which address in detail the positive and negative impacts of biogas on users. Moreover, interactions with the biogas users on various aspects of biogas use and observations of biogas plants and its components would help in getting real picture of biogas use in the study area. This would further help in addressing problems and formulate recommendation accordingly.

CHAPTER II

LITERATURE REVIEW

To gain useful and background information about the problem over the study literature review is essential. It is one of the most important parts of any research work. The development of literature in this field has been enriched by many researchers by their contribution in theoretical concepts.

2.1 Theoretical Review

The first person to report the existence of biogas was A. Volta. He was Italian national. In 1776, he wrote to a friend about "combustible air". Volta wrote that the submerged plant materials in the ponds and lakes continuously give off such gas. He demonstrated the presence of methane in marsh gas. This marsh gas is also known as biogas or "Gobar gas". There are other names such as Klar-gas refused derived fuel will of the –wisp given to biogas. It is odorless, smokeless and burns with a blue flame. Biogas production occurs in many microbial ecosystems, such as organic sediments of aquatic ecosystems, marshes and soil in the rumen and large intestines especially in herbivorous animals. It involves a complex mixture of anaerobic bacteria which converts up to 90 percent of the combustible energy of the degradable organic matter to methane and carbon dioxide (Trehan, 1991).

The gas which comes out of a biogas plant contains 65 to 85 percent methane, 15 to 35 percent carbon dioxide, some hydrogen, nitrogen and sometimes traces of hydrogen sulphide or other gases. A typical biogas sample containing 68 percent methane, 31 percent carbon dioxide, and1 percent nitrogen gives a calorific value of around 5871kcal/m^3. (Trehan, 1991).

Biogas is a gaseous matter produced from the organic wastes such as animal dung, human excreta and plant residues by the action of bacteria in anaerobic condition i.e. in absence of oxygen. The biogas is composed of mixture of different gases, the chief component being methane gas. The biogas is colorless, odorless and burns with a clear blue flame (Karmacharya, 1992).

'Karki, A.B; Gautam, K.M and Karki Ajoy: 1994' mentioned that theoretically, all biodegradable materials can be used to produce biogas through anaerobic decomposition. However, in practice, it is only the animal dung (especially cow dung) that has been primarily used as feedstock for methane generation. The technology of using other plant materials as feedstock is not developed fully to be commonly practiced at the field level, mainly because of inadequate research.

Biogas was first introduced in Nepal by late Father B.R. Saubolle of St. Xavier's School at Gdavari in 1955. It was then popularized in 1974/75 by the government of Nepal. Presently, it is becoming more and more popular and relevant to rural population. Thus, many agencies like NGOs, NGOs, GOs, Consultancy Firms, etc are gradually involved in the expansion of biogas. Commercial banks like Rastria Banijya Bank (RBB), ADB/N, and Nepal Bank Limited (NBL) provide loan at low rate of interest with repayment in five years. Furthermore, other agencies are supporting financially to promote biogas in Nepal. For advancing loans, various criteria such as site, family size, number of livestock and economic condition of the household are observed by the bank personal.

"Biogas Field book" written by Amrit Bahaduur Karki and Kunda Dixit has analyzed the benefits of biogas plants in Nepal as well as in other countries. Many countries had utilized on methane gas before Second World War. Working in practical aspects of biogas in Algiers, Ducellier

and Isman published the first work on methane gas from animal dung in1938. Methane gas is the main component of biogas produced from anaerobic digestion of the biodegradable waste. Just after the Second World War, when the Germans faced an energy crisis due to the shortage of firewood, coal and petroleum, biogas plants were successfully introduced. According to a report, French scientists have installed about 1000biogas plants in France and in some French African colonies from 1940 to 1945. Biogas became more reliable fuel to those farmers who possessed animals (Karki and Dixit, 1984).

During nineteen fifty's India had developed different models of biogas called Gram Laxmi I, Gram Laxmi II, and Gram Laxmi III. Likewise due to energy crisis, various countries off the world have taken necessary step to develop renewable energy resources. China has made remarkable progress in the field of organic recycling and biogas since 1875. Many countries like; Afghanistan, Bhutan, Fiji, Indonesia, Laos and other countries have taken interest in developing biogas technology in view of producing gas and manure (Karki and Dixit,1984).

Biogas provides excellent fuel for cooking and lighting and thereby reduces the pressure on the existing forest and import of kerosene from aboard. In most of the developing countries, chemical fertilizer has to be imported from aboard. It is costly. Use of biogas not only produces an excellent fuel but also an excellent quality of organic fertilizer. Generally, 20-30 percent increase in yield of various crops has been reported by the use of biogas effluent. Biogas saves time in cooking and provides the housewife leisure time. Moreover, they are relived from toxic smokes produced form wood burning. It reduces suffering from eye and lung disease caused by smokes. Cleaning the pots becomes easier and life span of utensils increases. In conclusion, it helps to create a healthier environment in the surroundings. The poorer section

of society can benefit from a community biogas programme (Karki and Dixit, 1984).

2.2 Review of Impact of Biogas

Poorna Kanta Adhakari in his study entitled," Impacts of Biogas plants on Family health, sanitation and nutrition",-February, 1996, has suggested that most of the owners do not feed cow dung to the biogas plant every day because of various reasons. They used to collect and deposit the cow dung in the plant inlet for 2-3 days. This practice might be favourable for disease causing organisms. It is suspected that deposition of dung in the inlet for longer period (2-3 days) could be one of the reasons for increased prevalence of Mosquitoes (Adhakari, 1996).

There has been a remarkable impact of the biogas plant on the life of its users. Surveys have revealed that the tangible impact in terms of savings in firewood, kerosene and savings in time that would be required in the absence of biogas plant and thee intangible benefits such as the reduction in the respiratory disease plus other benefits all are perceived to be quite significant by the users (Silwal,1999).

Bista, on his book 'Development of the Himalayan Resources for Regional Co-operation and National Development' writes that, biogas is considered as the most reliable alternative energy resource replacing fuel wood of which the greatest part is used for cooking specially in rural area of Nepal. It means that this is the urgent need for substituting rural energy through non-conventional energy sources (Bista, 1981).

Huston, writes that suitable technology could give some ease for the highly rises in fuel consumption but only if this technology gives are in really suitable for local use. In this case renewable sources can be

utilized by biogas with great care in any part of the earth (Huston, 1980).

Another study carried out by Department Consult for BSP entitled, 'Impacts of Biogas on Users -1996' suggested that 82%of the total users were satisfied with the working of their plants while the remaining 18% were not satisfied because of the lesser gas production then the expected by them. On being interviewed if they were getting what they expected prior to the installation of biogas plant, 13% of the respondents told that the amount of gas they were receiving is more than their prior exception, 63% said it is to be as expected and the remaining 24% expressed the quality to be less than what they had expected (BSP, 1996).

WECS studied the work load of rural women, and found that a large number of children, mostly girls, have to allocate 20% of their work time for fuel wood collection (WECS, 1995). Comprehensive studies on women's workload in different parts of Nepal conclude that a day's work consist of time to 11 hours. A study by BSP conducted in 1992 estimates that almost 75% of household spent more time collecting firewood in 1988 than in 1983. Two third of them spent about six hours a day (Britt, 1994). Van Vliet and Van Nes (1993) studied the effect of biogas on the work load of women in Rupandehi district of Nepal. They concluded that the reduction in work load of women as a result of installing biogas plants accounts to minimum of two hours and maximum of seven hours per family per day. When pressed with the labour shortage for such works in a family, it is the female children who have to forego their schooling.

Cooking with traditional fuel such firewood and waste from agriculture and livestock produce obnoxious and odorous smoke that pollutes the kitchen. A long hour of exposure in such smoke polluted environment

is known to cause various coronary and respiratory diseases (Hurt and Barnet, 1990). Use of biogas helps relieve women from such diseases. Studies have shown that women cough less and have fewer eye problems once they switch to biogas from firewood. Cases have been reported abut older women who could no longer cook on open fire, being able to cook with biogas. Many studies have reported the substantial improvement in in-house pollution and the sanitary condition of homestead after installation of biogas plant.

As biogas helps to do away with the need to collect fuel wood, it indirectly helps women in s many different ways such as opportunity for income generation, education and improvement in health by providing some leisure time.

"Effect of biogas on the work load of women in the village of Madan Pokhara in Palpa district in Nepal" written by Marieke Van Vliet (1993) highlights on the rural women in Nepal confronted with a high work load. They do most of the households' domestic and agricultural works. Depletion of natural forest resource like forest will even worsen their situation. Biogas is considered as a promising renewable energy source probably to reduce the work load of women. Biogas influenced positively to all the families with regard to the time spent on collection of firewood and cooking fuel. She further explains that collection of water to feed the plant took extra time for a few families who had to go to a public tap. Other households had a tap on their yard. Mixing of water and dung required little time by all households. In general, due to utilization of biogas, women saved minimum one hour and maximum two and half hours a day. Besides these workloads, biogas had some other positive effects related to cooking and lighting of the household.

"The effects of biogas on women's work loads in Nepal: An overview of Studies Conducted for the Biogas Support Programme" written by

Charla Britt in 1994 holds different views on biogas. He mentions that cooking; the collection of water and fuelwood, and the cleaning of pots are dramatically affected by the introduction of biogas. Particularly, in areas where wood is in short and household members are forced to spend substantial periods of time collecting fuel wood, the time saving aspects of biogas are emphasized. The water source at a great distance from the plant, the time saving impact of biogas is less noticeable. Nevertheless, in most cases the time saving effects related to the case of and /or quicker food cooking and pots cleaning still allows for a saving of labour for women in the majority of the households. Of course, when the biogas plants provide sufficient energy to eliminate or minimize the use of fuel wood, the health effects as well as environmental benefits are also quite significant.

"Biogas Users Survey 1992-93" written by East Consult (P).Ltd. has also focused on effects, impacts, benefits, advantages, disadvantages of the biogas user in Nepal. Overall, the impact of the biogas plant was found to be positive. It has explained that biogas is much useful to rich and medium farmers, but not to the poor farmers who are not capable enough to install it due to their disability to pay for such plants. They are still in a difficult position to solve their basic needs and have survival problems. Since a majority of the plant owners have either a secondary occupation or surplus agricultural production to generate financial income, repayment of loans was not found to be a serious problem. All the plant owners were happy that they have invested properly and they were quite sure that their investment would benefit them for a longer duration (East Consult, 1994).

"Mid-Term Evaluation of the Biogas Support Prgramme" written by De Castro, Dhussa, Opdam, and Silwal have focused on effectiveness and follow-up strategies. As regards to the follow-up, they have

concentrated on quality of construction, training of masons, repair and maintenance services, training of users and information dissemination to prospective users. The authors point out that installation of biogas plants are not only the responsibility of the support organizations (De Castro, Dhussa, Opdam and Silwal, 1994).

Karki, Shrestha and Bajgain cited on Renewable Source of Energy in Nepal: Theory and Development that, as a consequence of the substitution of traditional fuels such as fuel wood, crop residue and dung, and commercial fuels such as kerosene, LPG to some extant by the biogas plants has a great potential of reducing carbon emission into the atmosphere. Such reduction when seen at the nation wide perspective can be very significant even though at the household level it might seen not so significant.

Carbon emission saved from the decrease in use of fuelwood because of their poor combustion, the traditional stoves using fuelwood are thermally inefficient and thus divert a significant portion of the fuel carbon into products of incomplete combustion, which generally have a greater impact on climate than co_2 . A study done by Smith et-al (2000) indicates that: - a kilogram of wood burned in a traditional mud stove generates 418 gram carbon (g-c) equivalent of carbon emission, a kilogram of agricultural residue, namely rice straw burned in a traditional mud stove generates 381 gram carbon (g-c) equivalent of carbon emission, a kilogram of dung burned in a traditional mud stove generates 334 gram carbon (g-c) equivalent of carbon emission, a kilogram of kerosene burned in a pressure stove generates 843 gram carbon (g-c) equivalent of carbon emission (Karki, Shrestha and Bajgain,2005).

CHAPTER III

RESEARCH METHODOLOGY

3.1 Research Design

For this study, a descriptive research design was followed. The descriptive research was utilized for the qualitative data obtained and derived during the study. The data was made by generating the tables of averages and percentages.

3.2 Rational of the Selection of Study Area

Chhoprak VDC was chosen for the study. Chhoprak lies in Gorkha district of the Gandaki zone. The reason to select Chhoprak VDC as a study site is: it is one of such VDC's where biogas programme is successfully running and this VDC represents the rural VDC's of entire country. Therefore by selection of this area it was believed that more information could be collected during study and the result obtained can be generalized.

3.3 Sampling Procedure

Out of the total 117 biogas owning households a sample of 25 households was sampled for the study. The total 117 biogas households were taken as the universe and simple random sampling technique (lottery method) was followed for the selection of samples.

3.4 Sources of Data Collection

This study aims to explore the status and activities changed through the impact of biogas on users. So, the primary data was collected from the selected universe and the secondary data was also used for the

study, which was collected from individuals, experts, organizations, published and unpublished written documents concerned to biogas.

3.5 Data collection Tools and Techniques

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

3.5.1 Structured Questionnaire

A structured question schedule was developed to generate the realistic and accurate data from household survey of the biogas users. The respondents were requested to fill up the questionnaire. The questions were asked to the respondents and answer was filled up for those who cannot fill up it, to collect required information.

3.5.2 Focus Group Discussion

The key informant persons in the VDC were consulted for focus group discussion. One such discussion meeting was organized. The number of participants in the discussion was up to 10 members. Information related to the impacts of biogas on environment, social life, health and sanitation and other relevant issues were collected during that discussion.

3.5.3 Field Visit and Observation

Each and every biogas household selected in sampling was visited and biogas plants were observed to collect primary information. The data were recorded while observing the biogas household environment, functions of biogas and its impact.

3.6 Data Analysis

Simple statistical tools like tables' graphs, diagrams etc were used for data analysis for the qualitative data logical method were also used.

3.7 Limitation of the Study

This study was limited to the biogas user of Chhoprak VDC of Gorkha district and is very specific like case study. Hence, the outcome of this study may not represent the whole country. However, the outcome was representing the areas with similar geographical, social, economic and ecological conditions.

3.8 Organization of the study

This study has been divided into six chapters. Chapter one is related with introduction and it includes background of the study, statement of the problem, objectives of the study and importance of the study. Chapter two is related with review of the literature and it includes the theoretical review of the biogas energy and the review of the impacts of biogas energy. Chapter three is related with research methodology and it includes research design, rational of the selection of the study area, sampling procedure, source of data collection, data collection tools and techniques, data analysis, limitation of the study and organization of the study.

Chapter four is related with general introduction of the study area and it deals an overview of Gorkha district and Chhoprak VDC respectively. Chapter five is related with analysis of the collected data. It deals with major characteristics of the biogas plant owners: caste/ ethnic composition; family size; educational status; economic status; land holding situation; livestock ownership and information on biogas plants: size; reason for installation; and cost. And this chapter is also related with impact of biogas on users it deals with introduction,

impact on saving of firewood, saving of time, impact on women workload and time use, impact on general health and sanitation, impact on environment, and other positive and negative impacts. Chapter six is related with summary, conclusion and recommendation.

CHAPTER IV

General Introduction of the Study Area

4.1 Gorkha: District an Overview:

Gorkha District lies in the western hill and one of the historical places of Nepal. It is one of the six districts of Gandaki zone. The district is bounded on the North by Tibet, South by Chitwan, Tanahun and Dhadin, East by Dhading and West by Lamjung and Manang district.
Geographically Gorkha district lies between $27^0$15' to 28^0 45' North Latitude and 84^0 27' to 84^0 45' East Longitude. The total area covered by the district is 33610 km^2, total population are 272382 among them 130868 are male and 141514are female. The average household size is 5.1 (CBS, 2001).

Most of the people in the district are engaged in agricultural farming as their main occupation. The other economic activities include livestock raising, trade, wage labor, employment in organized sector. (Government and non Government officers), industries and they like (District Profile, 2001).

4.2 Chhoprak VDC: an overview:

Chhoprak VDC is one of the 66 VDCs of Gorkha district. It is situated in mid-eastern part of the district. Total number of population of this VDC was 6829 within 1441 households. Among them2266 were male and 2559 were female (CBS, 2002). Where the total number of biogas installation was 117 (BSP, 2005).
Total area of VDC is divided in to 9 wards. Settlements in this steeply hill area are scattered here and there. Lacking of infrastructure, no more opportunities favor to local people. Some people have suggested that working youths are gradually decreasing in the village. The reason was reported that they are in search of employment in their own

country and others. Some of the youth hands have been found playing with the gun/rifles of Nepal Army; some are engaged in public services, very few are in Indian labour and farming activities. Agriculture was in the state of subsistence production. Both male and females were activity involved in traditional agricultural production. Whatever, females have been found relatively busy than that of males mainly because of higher load of household activities. Majority of the villagers were land owners and very few were landowner cum tenants. The system of tenancy was sharecropping.

Chapter-V: Analysis

Socio-Economic Situation of Plant Owners

5.1 Characteristics of Plant Owner Households.

The Users Surveys and Impact Studies carried out by different biogas companies, NGOs, INGOs, consultancies and individuals reported that most of individual biogas plant owners are well off by rural Nepali standards, as characterized by plenty of land, plenty of live stock and many educated family members. However, the present study indicated quite different scenario in the case of land holdings. The findings on socio-economic characteristics of the plant owners under study are described below:

5.1.1 Caste/Ethnic Composition of Plant Owners.

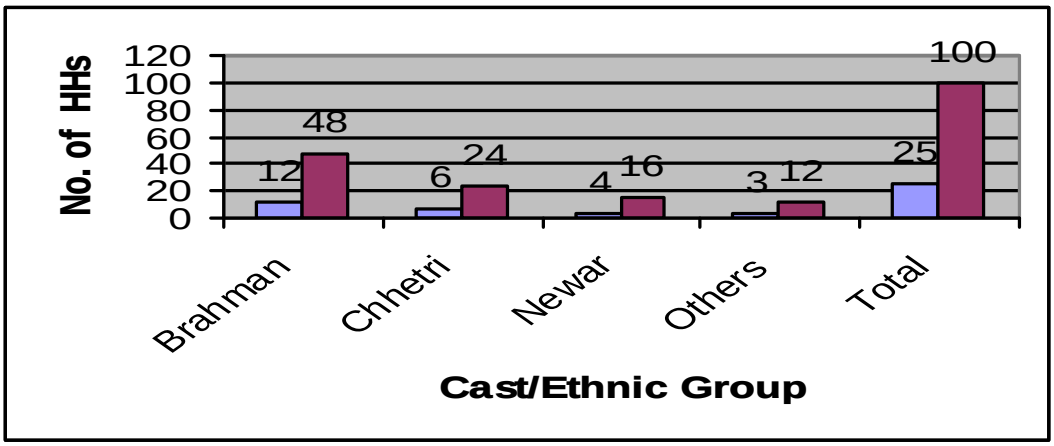
The majority of the households under study were Brahmins 48% followed by Chhetries 24%, Newars16 and others 12%.

Table 5.1.1: Caste /Ethnic Composition of plant owners:

Caste/Ethnic group	Households	
	No.	percentage
Brahman	12	48
Chhetri	6	24
Newar	4	16
Others	3	12
Total	25	100

Source: Field Survey 2006

The figure indicates that the majority of the biogas plant owners are Brahman and Chhetri where as minority are Newar and others. But one of the positive aspect of development in this area is that two of the sampled biogas plant owners are Nepali (so called Sarki) and one of the sampled biogas plant owner is B.K(so called Kami). Who are so called Dalit and second class people in the society.



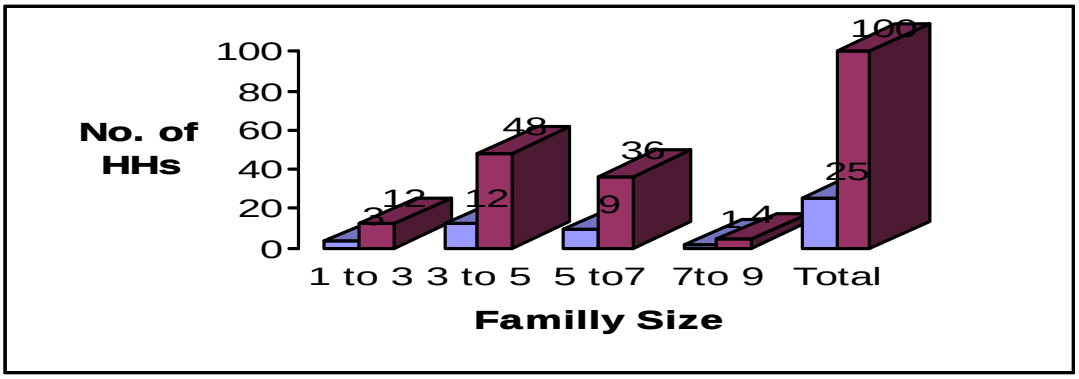
5.1.2 Family Size of Plant Owners.

The family size plays an important role in the social structure of Nepal. Agriculture being the main source of income and livelihood in Nepal, majority of the respondents are found to be engaged in agriculture activities in the study areas. The family size of the plant owners are presented hereunder:

Table 5.1.2: Distribution of Family Members in Surveyed households.

Family Size	Mid value (x)	No. of HHs(N/F)	FX	Percentage
1-3	2	3	6	12
3-5	4	12	48	48
5-7	6	9	54	36
7-9	8	1	8	4
Total	__	25	Σ FX=116	100

Source: Field survey 2006



The total population of the 25 sampled households was found to be 129 among which 66 were females. It can be noted that the average family size of 4.64 persons per household, is lower than the national average of 5.44 recorded in the census of 2001. Households with maximum number of family member was 9 whereas, the minimum number was 2.

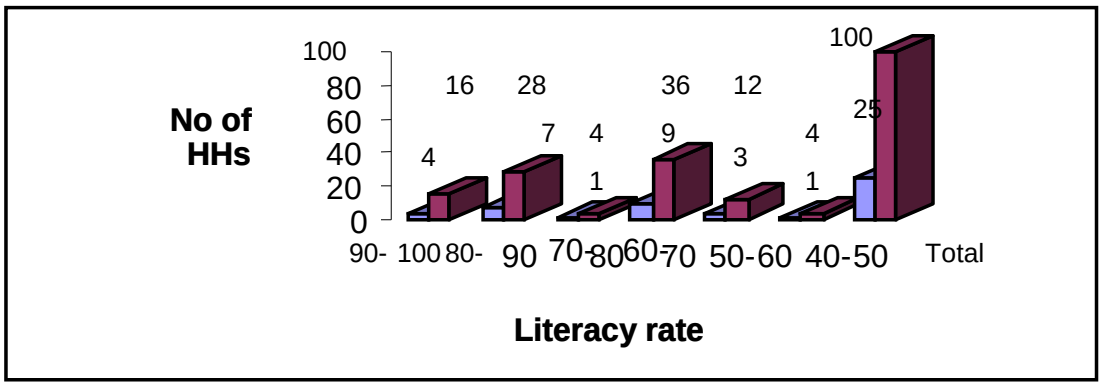
5.1.3 Educational Status of Plant Owners.

The literacy rate of the selected household was found to be 73.64% which was very much higher than the national average (39.69). The male and female literacy rates, excluding the children of schooling age, were calculated to be 84.12% and 62.12% respectively. The literacy pattern of the households can be seen on table 3.

Table5.1.3: Literacy Pattern of the Households

Literacy rate	Mid value(x)	No of HHs (N/F)	F X	Percentage
90-100	95	4	376	16
80-90	85	7	595	28
70-80	75	1	75	4
60-70	65	9	585	36
50-60	55	3	165	12
40-50	45	1	45	4
Total	__	25	Σ FX=1841	100

Source: Field survey 2006



Study shows that sent percent children of the sampled households were schooling, out of infants (below 4 years).

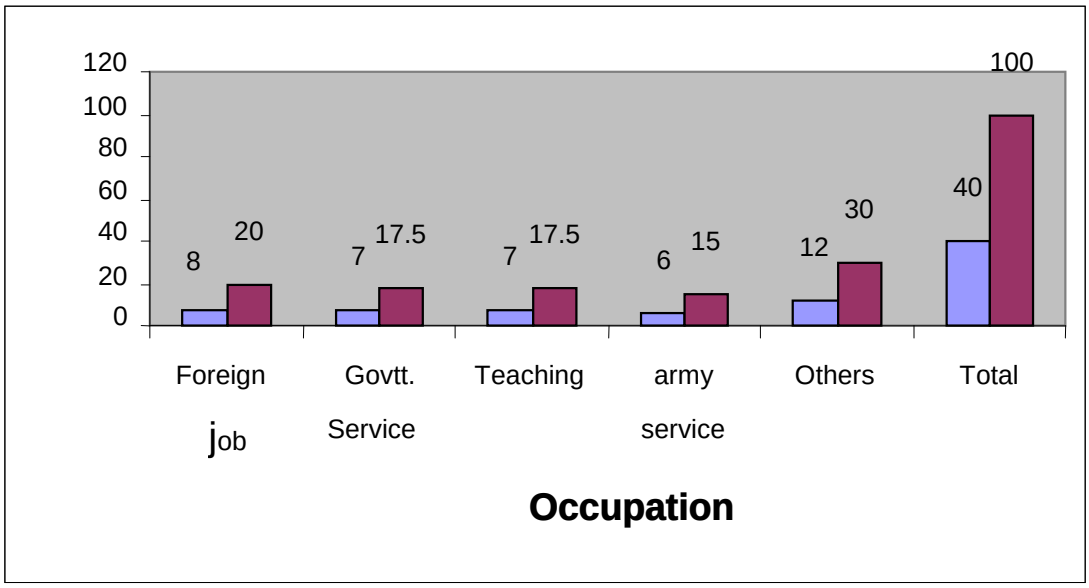
5.1.4 Economic Status of the plant owners:
Occupation

The research study indicates that all most all of the families (100%) had agriculture as the main source of income. And majority of the households (76%) had at least one person involved in cash earning from their jobs. The following table illustrates the occupation of the family members in the sampled households.

Table5.1. 4: Occupation of the Household Members

Occupation	No. of Persons	Percentage
Foreign job	8	20
Govt.service	7	17.5
Teaching	7	17.5
Army service	6	15
Others	12	30
Total	40	100

Source: Field survey 2006



Source: Field survey 2006

Table 5.1.4 indicates that out of the total population of surveyed households (129 persons) 40 persons or 31 percent population is engaged in different cash earning jobs; 8 persons in foreign job, 7 persons in government services, 7 in teaching, 6 in army service and 12 persons are engaged in other types of cash earning jobs. The scenario shows that the study area is very forward in economic sense.

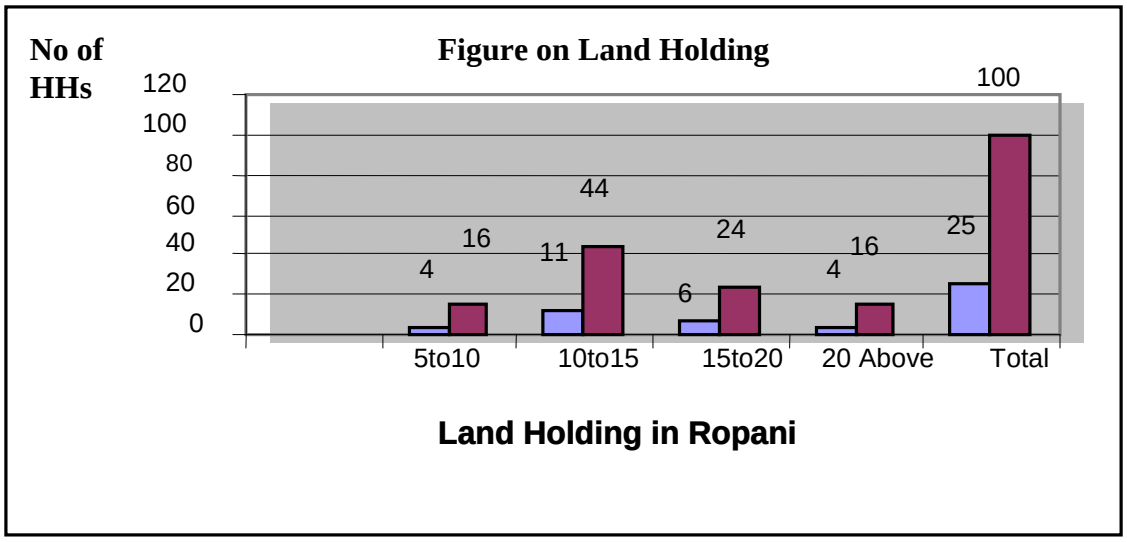
5.1.5 Land Holding of Plant Owners.

During field investigation, attempts were made to assess amount of land holding of sampled families as the amount of land holding is the main indicator to assess the economic condition of any family. In this case, while calculating the land holding, only operational land holdings were taken into account. The land use and cultivation patterns were observed to be very similar to that of the traditional Nepalese practice. It was found in most of the cases that the lands were cultivated by the owners themselves. There were very few instances of land being rented .The average land holding size per family being 14.50 ropani, the national land holding size per family being 19.2 ropani (CBS, 2001). The figure on land holdings are shown in table 5 below. The maximum land holding of the sampled household was 109 ropani and the minimum was 06 ropani. It illustrates that marginal to small landholdings are associated with most of the plant owners. This finding is different from the findings of previous studies which reported that medium to large land holdings were associated with most of the owners. This is the positive indication of the effectiveness of biogas programme in the country to reach the poorer section of the population.

Table5.1.5: Figures on Land holdings

Land Holding in Ropani	Mid value (X)	No. of HHs(N/F)	FX	Percentage
5-10	7.5	4	30	14
10-15	12.5	11	137.50	44
15-20	17.5	6	105.	24
20-25	22.5	4	90.	16
Total	__	25	Σ FX=362.5	100

Source: Field survey 2006



The table shows that 14 percent sampled households had 5-10 ropani of cultivated land, 44 percent sampled households had 10-15 ropani of cultivated land, 24 percent sampled households had 15-20 ropani of cultivated land and 16 percent sampled households had more than 20 ropani of cultivated land. It can be concluded that the average landholding (14.50 ropani) of the sampled households is lesser than the national land holding size 19.20 ropani (CBS, 2001).

5.1.6 Livestock Ownership

The sampled biogas owners owned a total of 77 livestock (buffaloes, cows and oxen excepts others such as goats, pigs etc.) at an average of 3.12 cattle per household. The name of owners, plant sizes and number of livestock have illustrated in the following table. It can be noted in most of the cases that the number of livestock and family size are the governing factors of the plant size.

5.2 Information on Biogas Plants

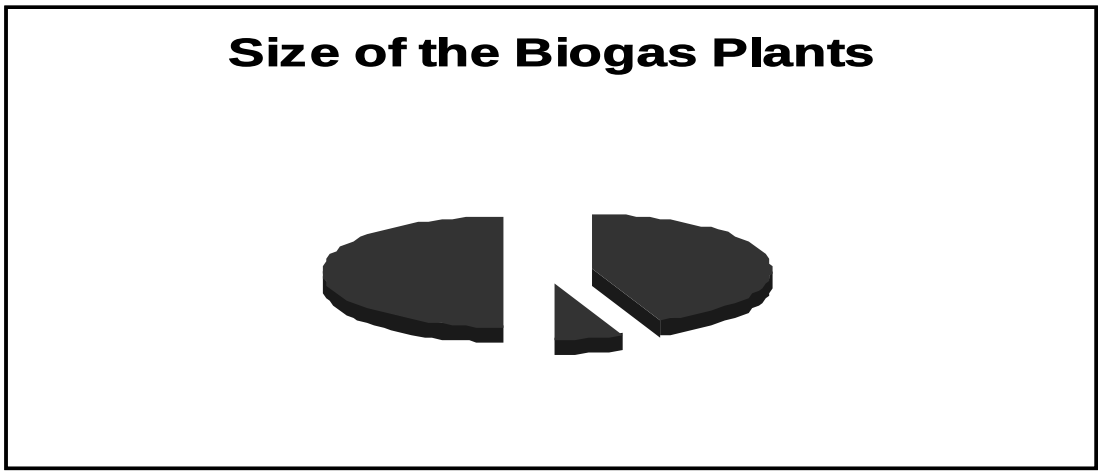
5.2.1 Size of the Biogas Plants

Among the studied 25 biogas plants, 3 plants were found with the capacity of 10m^3 and other 22 plants were found the capacity of 6m^3. These plants were established during the period of 2048 to 2060. It is reported that all biogas plants were toilet connected. It was reported by the respondents during the field survey that 20 of them had taken loan from ADB to install biogas plant and the remaining 5 households use their own money to construct their plants.

Table 5.2.1 Size of the Biogas Plants

Size	Number of biogas plalnts	Percentage
6m^3	22	88
10 m^3	3	12
Total	25	100

Source: Field survey 2006



5.2.2 Sources of Information on Biogas

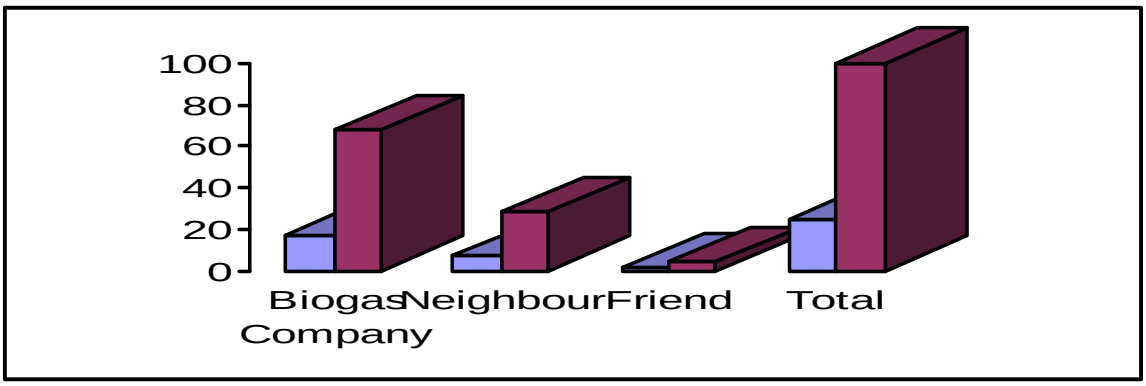
Before establishing the biogas plant, the chief source of information was the respective biogas companies of the respondents. Neighbour served as the second important source. One respondent obtain information from his friend.

Table 5.2.2: Source of Information on Biogas.

S No	Source of Information	No of HHs	Percentage
1	Biogas Company	17	68
2	Neighbour	7	28
3	Friend	1	4
	Total	25	100

Source: Field survey 2006

Diagrammatical presentation of the above table is hereunder



The figure implies that primary source of information was the biogas companies. This is because they reach more to the people for the sake of their business. Whereas the neighbour in the second position implies that, people are convinced and satisfied with the advantages of biogas in the area that thereby encouraged their neighbours for the installation.

5.2.3 Reason for Biogas Installation

The main reason for the installation of biogas was to get rid of the firewood collection and to have easy and smokeless cooking. About 80% of the total respondents installed biogas to get rid of firewood collection. While rest of the respondents replied that the installed for easy and smokeless coking as well as to get rid of firewood collection.

5.2.4 Cost

The cost of installation can be observed through three parameters: total cost of installation; subsidy provided by institutions and; self investment of the users.

5.2.4.1 Total cost

The respondents were asked about the cost of installation. The total cost consisted of two factors:

- Subsidy from BSP
- Self-investment

The average cost of installation of biogas plant was Rs 29700 .The minimum cost of installation was Rs 20,000 .While the maximum cost was Rs 40,000.

Table-5.2.4.1: Total cost invested in biogas plant installation by sampled households.

Cost in Rs	Mid value (X)	No of HHs (N/F)	FX	Percentage
20,000 – 25,000	22500	8	180000	32
25,000 – 30,000	27500	4	110000	16
30,000 – 35,000	32500	7	227500	28
35,000 – 40,000	37500	6	225000	24
Total	-	25	Σ FX=742500	100

Source: Field survey 2006.

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 labours and construction materials.

The cost of plant establishment included two factors: subsidy and investment by the owner himself.

5.2.4.2 Subsidy

Every biogas plant gets a subsidy of Rs Rs, 8000/plant upto $10m^3$ from the BSP through the biogas company. Thus each biogas plant received Rs 8,000 as total subsidy.

5.2.4.3 Self investment of the users

Besides of the subsidy, the respondents had to bear rest of the costs by themselves. Provision of loan was also available for this purpose

through Agricultural Development Bank. And the interest rate of the loan is 18 percent.

Among 25 household, 20 had received the loan from ADB/N and 5 had their own source for the self-investment part. Besides loan and self-investment, all of them received subsidy equally.

5.3 Impacts of biogas

5.3.1 Introduction

The main cause of utilization of biogas is its positive impacts including its quantifiable and non quantifiable benefits. For example saving of time and firewood is quantifiable parameter, while improvement on environment, health and sanitation is non–quantifiable. The impact produced by biogas has been explained below.

5.3.2 Saving of Firewood

Before the installation of biogas plant, almost all plant owners used firewood for the cooking purpose. Therefore, the installation of biogas saved firewood. Saving of firewood produces positive impact on forest. Due to the biogas plant installation the forest is protected and the situation of environment degradation is improved.

Table-5.3.2.1: Sources of Firewood Collection before Biogas Installation

Sources	No of HHs	Percentage
Own land	7	28
To buy	8	32
From both	10	40
Total	25	100

Source: Field survey 2006.

The diagrammatical presentation of the above table is hereunder,

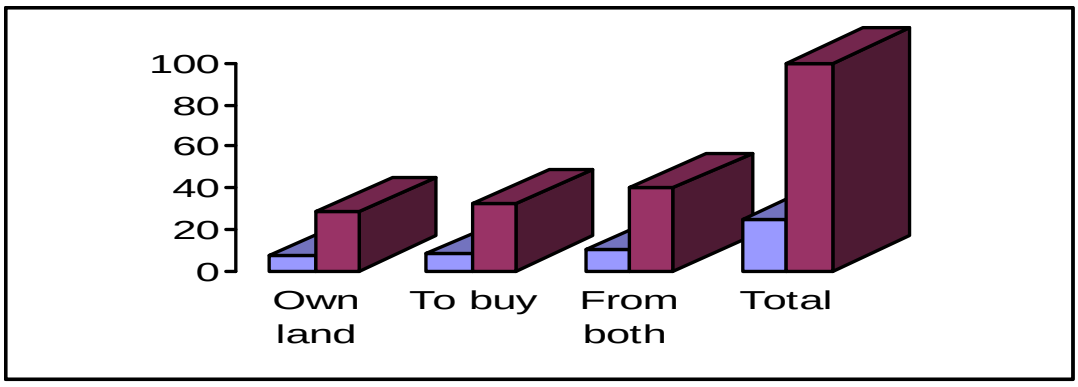


Figure shows that, before installation of biogas plant, 28% plant owners had collected firewood from their own land, 32% plant owners had bought and 40% got from both above mentioned sources. However, the main source of fuel wood is the jungle. Thus, utilization of biogas is directly proportional to the saving of forest.

Quantity of firewood consumed by households in a week before the installation of biogas plant is given in table:-

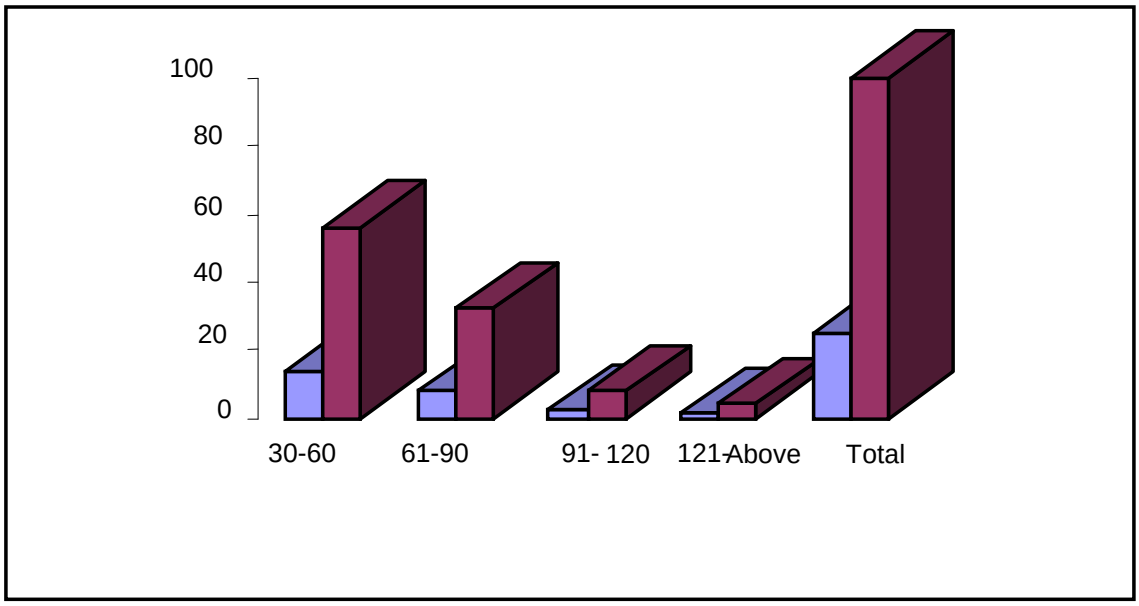
Table-5.3.2.2: Use of Firewood before the Installation of Biogas Plant

Quantity of firewood (kg*/week)	Households	
	Number	Percentage
30-60	14	56
61-90	8	32
91-120	2	8
121-above	1	4
Total	25	100

*30 kg =1 Bhari firewood

Source: Field survey 2006

The diagrammatical presentation of the above table is hereunder,



Most of the households had used firewood up to60 kg in a week. Likewise, 4% used 121kg firewood in a week. The firewood consumed according to their family size and availability of agricultural products. The firewood had been obtained from either government forest or from private forest. Before the installation of biogas, the only source of fuel for cooking in this area is firewood.

Following the installation of biogas plant, all respondents are using gas for cooking purposes. If gas is not sufficient or there is any problem, they revert to the use of traditional *chulo*. They have not spent money for the firewood because after installation of biogas they collected it from their own land. The collection of firewood is done mainly by the female members of the family like daughter or daughter- in- law.

The cost of fuels is higher than installation of the biogas plants. After the installation of biogas plant, on an average, all the households have saved up 1.5 bhari of firewood per week. Saving of firewood by number of households is given in the following table.

Table-5.3.2.3: Saving of Firewood after Installation of Biogas Plants

Quantity of Firewood saved (bhari/year)	Quantity of Firewood saved (kg/week)*	Saved amount of money per year in Rs **	Households	
			Number	Percentage
Below 60	Below-37.5	Below 3000	2	8
60-79	37.5-49.37	3000-3950	7	28
80-99	50-61.87	4000-4950	8	32
100-119	62.5-74.37	5000-5950	3	12
120-above	75 Above	6000Above	5	20
Total			25	100

(*48 weeks =1 Year, **1 bhari of firewood is worth to Rs 50)
Source: Field survey 2006

After the installation of the biogas plant it was found that a large amount of firewood is saved for cooking food. According to the study; 8 percent of the total sampled households saved about 37.5 kg firewood per week, 28 percent households saved about 49.37 kg firewood per week, 32 percent households saved about 61.87 kg firewood per week, 12 percent households saved about 74.37 kg firewood per week and 20 percent households saved about 75 kg firewood per week.

5.3.3 Saving of time after installation of biogas plants

5.3.3.1 Time Saved in Cleaning Utensils

Saving of time is one of the most important benefit or positive impact of biogas programme. All the respondents have positive view on time saved in various activities. Almost all female member of the family, who were solely responsible for cleaning cooking utensils, said that using biogas for cleaning utensils are very easy and quick because pots were not affected by smoke and do not become black. Before installation of biogas plant, cleaning utensils took around 2hrs/day, but after its installation it took only 30minutes /day. It shows that in a day each family saved about one and half hours in cleaning utensils. They can use this spare time in other earning or social activities.

5.3.3.2 Time Saved in Collection of Firewood

According to the respondents, to collect one bhari firewood requires 4-6 hours or the average time to collect one bhari of firewood is five hours. Time saved in collection of firewood after the installation of bias plant is tabulated hereunder.

Table-5.3.3.2: Saving of time in collection of firewood

Time Saved After installation of biogas plant(hrs/year)	Time Saved After installation of biogas plant(hrs/week)	Households	
		Number	Percentage
Below-300	Below-6.25	2	8
300-395	6.25-8.23	7	28
400-495	8.33-10.31	8	32
500-595	10.41-12.39	3	12
600- Above	12.5- Above	5	20
Total		25	100

Source: Field survey 2006

The above table indicates that, after the installation of biogas plant 8%of the total sampled households saved more than 6 hrs; 28% of the total sampled households saved 6.25 to 8.23 hrs; 32% of the total sampled households saved 8.33 to10.31 hrs; 12% of the total sampled households saved 10.41 to12.39hrs and 20% of the total sampled households saved more than 12.5 hrs per week due to the reduction in firewood consumption.

5.3.3.3 Time Saved in Cooking

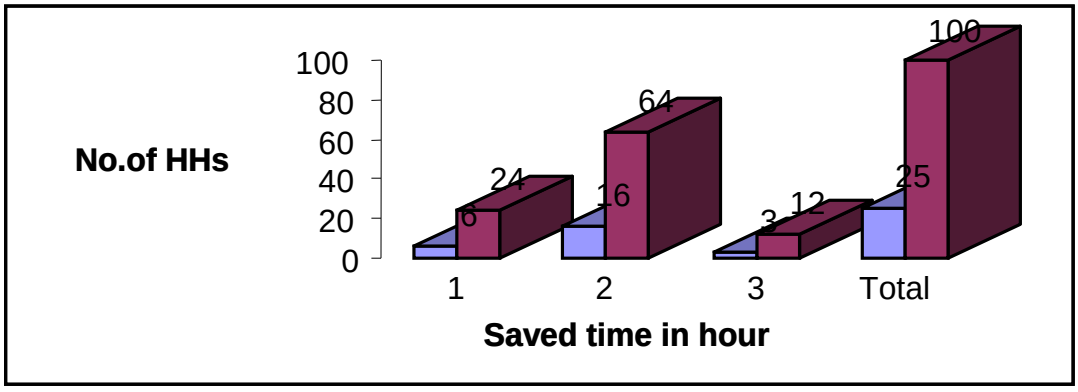
As reported by the respondents/users and key informants, the produced gas is being used only for cooking. The focus on cooking indicates that the end use of biogas is mainly cooking. Almost all users feel that cooking on biogas stove consumed less time than firewood. Time saved in cooking after the installation of biogas plants is shown in the following table.

Table-5.3.3.3: Saving of time after installation of biogas plants in cooking

Saving Time(in hour/day)	No. of HHs	Percentage
1	6	24
2	16	64
3	3	12
Total	25	100

Source: Field survey 2006

The diagrammatical presentation of the above table is hereunder,



The above table indicates that 24% of the total respondents saved 1hour/day; 64% of the total respondents saved 2hours/day and 12% of the total respondents saved 3 hours/day while cooking with biogas. It shows that the average time saved in coking is 2 hours/day in each household.

5.3.4 Impacts on Women Workload and Time use

The introduction of biogas has a positive impact on the work load of family members especially women. Less time required for acquiring cooking fuel, time saving in cooking and cleaning cooking utensils directly resulted in time saving. This time saving has been quantified as presented in the table given hereafter. Besides this, less time needed to wash cloths (without smoke), time reduction in cleaning the household (without black soot) and reduced time to clean the surroundings (toilet connected plants) are some of benefits that helped in time saving. The

amount of time saved differs from household to household due to several reasons and it is not always easy to determine the exact duration of time saved largely because of unclear responses.

Table-5.3.4: Average time allocation

Activity	Time saved after plant installation (hours/day)		
	Before	After	Time Saved
Cattle care	-	-	0
Collection of water	30 minutes	45 minutes	-15 minutes
Collection of dung	45 minutes	50 minutes	-5 minutes
Mixing of dung	-	30 minutes	-30 minutes
Cooking	180 minutes	120 minutes	+60 minutes
Cleaning Utensil	120 minutes	30 minutes	+90 minutes
Collection of firewood	90 minutes	30 minutes	+60 minutes
Total time	465 minutes (= 7.75 hrs)	305 minutes (= 5.08 hrs)	160 minutes (= 2.66 hrs)

Source: Field survey 2006

The study revealed that, in general, a family saved an average 2.66 hrsper day. When being interviewed if they experienced any saving of time due to installation of biogas, all respondents answered that they did experience significant time saving.

Utilization of Saved time in Different sectors

Sector	No of respondents	Percentage
Social work	20	80
Vegetable farming	17	68
Child caring	10	40
Income generating	8	32

Source: Field survey 2006

Those who experienced time saving replied that the time saved was used in number of ways such as, (80%) social work; (68%) vegetable farming; (40%) child caring; (32%) income generating and all to all households experienced that saved time for household activities.

The study suggests that rural women rarely have an opportunity to decide themselves what to do with the saved time. In substance agricultural economies, time was found to be reallocated to activities that benefited the family unit and it is with in this unit that those choices were made. Whether biogas saved the women from drudgery, therefore, is debatable. What is done is that they substituted the drudgery of firewood collection and cooking for an activity that help in producing economic gain for the family. Even though most of the respondents agreed that there was considerable time saving from biogas plant installation, none of them was in a position to say exactly how much additional financial earnings they made out of that. It was difficult to quantify in deed.

5.3.5 Impact on General Health and Sanitation

It is well accepted that biogas installation substantially helps to improve general health condition of the recipient family members by eliminating indoor air pollution due to smoke containing carbon monoxide, formaldehyde and other respirable suspended particles. However, such benefits are rather difficult to quantify because of baseline data. The benefits of biogas can easily be understood when a publication of WHO on 1994 is referred. The publication stated that the amount and toxicity of the smoke inhaled by a person on traditional system of using firewood, crop residue, dung patties etc, was found to be equivalent to smoking 40 cigarettes per day if the person continuously remains in the place of cooking. It should be noted that biogas may not eliminate all smoke from the kitchen as even those recipients whose plant produces enough gas report that they still use traditional fuels for cooking cattle food, milk- boiling, and roasting pop-corns (responded by 92%) etc, because of various reasons. Nevertheless, the elimination of even half of the smoke previously inhaled is a very significant health benefit.

5.3.5.1 Insect Prevalence

Fly and mosquito were taken into account for the study of change in prevalence of insects. Reduction in the prevalence of fly was reported from the study. Twenty- one households reported the decrease in fly population. While rest 4 households neither felt increase nor decrease. One the other hand all (100%) households reported that mosquito had increased after biogas installation.

5.3.6 Environmental Impacts

The immediate environmental impact of biogas is very difficult to assess in household level. This should be seen in a wider context. But one single biogas plant saves 4.99 tons of CO_2 per year (Gorkhapatra, 2005). Checking the production of such amount of CO_2 can be seen as the positive environmental impact of biogas. Burning of firewood or agricultural waste is not sustainable when the use of fuel-wood exceeds production, resulting in deforestation and, secondly, when organic matters including nutrients, is destroyed in the process. Burning of dung cakes as a fuel was not found in the study area. Biogas is a sustainable and renewable source of energy because it is part of a closed cycle (Wim Van Nes and Jan Lam). The organic materials that are fed in to the plants are used without being destroyed. The nutrient and organic matters (apart from some carbon and hydrogen) will still be available in the slurry and can be returned to the soil. Biogas, when used for cooking, saves fuel-wood, and agriculture wastes. The organic matters and nutrients of agricultural wastes, which are otherwise burnt, are available to sustain the fertility of soil. Saving the living plants, which contributes oxygen is another positive environmental impact of biogas.

5.3.7 Other Positive Impacts

Besides above mention impacts, some other major and indirect positive impacts of biogas on users have been presented below:

5.3.7.1 Impact on household activities

The household activities in relation to biogas have already been defined in some detail. Thus, it is discussed here in brief. The main direct positive impact is less time required for cooking food. It is easier and faster to cook than firewood. it was realize by 95% plant owners that one could leave the coking place for sort time and do some other activities. More time was saved due to biogas which otherwise would be spent for collection of firewood. The leisure time so gained can be utilized for useful purpose by the family members. Before installation of biogas more storage space was needed to firewood. But now there is a space saving. Women's time was saved due to less time needed for cleaning utensils and collecting firewood.

5.3.7.2 Health impact

The sampled household realized that using biogas has reduced eye, lung and respiratory disease. Before the installation of biogas, most of the users were having difficulties in using firewood. Almost all respondents said that there was no adverse effect of biogas on health.

Before the installation of biogas in the survey area, 24 percent of the total households were suffered by such problems. But after the installation of biogas plant, these types of problems were reduced.

Regarding the incidence of flies and mosquitoes in and around the house after the storage of digested slurry in the pits, sent percent of the respondents replied negatively. Most of the households agreed that biogas has reduced the number of burning cases. They felt comfort and convenient to cook on biogas. One the other side, house and other

belongings remained clean due to the absence of smoke. Thus, it reflects on improved general hygiene of the family members.

5.3.7.3 Economic impact

Almost all households felt that their economic conditions were uplifted by the use of biogas plant, although it did not fetch a direct earning to them. In the beginning, users have to spend money to install the biogas but after installation of the biogas they do not have t o spend money.

Most of the respondents said that they have to spend less money on firewood after the instillation of biogas. They had to travel very far distance to collect firewood and fodder before installation of biogas plant. But they do not need to go now far because of the installation of biogas plant. So they have much more time to do other useful activities. They can use their saved time for some extra activities, e.g.: agricultural, household, child caring etc. About 90 percent households said that they used their saved time in social work, about 80 percent used in household works, about 60 percent used in vegetable farming, and a few 24 percent used their saved time in income generating activities.

After the installation of the biogas plant it was found that a large amount of money is saved due to the cut off of firewood for coking food. According to the study; 8 percent of the total sampled households saved firewood worth of Rs 3000/year, 28 percent households saved firewood worth of Rs 4000/year, 32 percent households saved firewood worth of Rs 5000/year, 12 percent households saved firewood worth of Rs 6000/year and 20 percent households saved firewood worth of more than Rs 6000/year.

CHAPTER-VI

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

6.1 SUMMAY

Biogas is becoming popular in the villages as an alternative source of energy for daily life. In this contest, the present study n the socio-economic impact of biogas was made.

This study was conducted in Chhoprak VDC of Gorkha district. Gorkha lies in the Western part of Nepal. The study is based on a sample of 25 households who were selected by using simple random sampling technique.

Before preceding the study, a brief review on existing literature was made. The review focused mainly on the impact studies. For the reviews, Central library of Tribhuwan University, BSP office and biogas experts were consulted.

The main objective of the study was to assess the socio-economic impact due to biogas installation. This included both positive as well as negative impacts.

Analysis of the data was made through simple statistical tools like tables', graphs, diagrams etc. Data showed how the biogas plants helped to save firewood, reduced workload, saved time and improvement on the health and sanitation. Use of slurry in regard to agriculture production was also been dealt. Following were some of the highlights of key findings.

1. Size of $6m^3$ biogas plants was more popular in the region compared to other sizes.

2. Biogas companies were reported as the main source of information regarding biogas by the households.

3. People installed biogas as a substitute to fire wood and to have ease in cooking.
4. Subsidies provided by the BSP were very encouraging factor for the installation of biogas.

5. Sent percent of the sampled households connected their latrine to the biogas plant so; cattle/buffalo dung and human waste were used in biogas plant.

6. Average amount of dung feeding was as per recommendation by the majority of the households.

7. Biogas was used only for cooking purpose. No lighting use was reported.

8. On an average, one household saved firewood worth of Rs 400 per month. The time to collect firewood was also saved. Time saving had contributed in preserving the scarce forest in Chhoprak VDC.

9. The saving made was mostly used for the education of the children and in social activities.

10. After the installation, there was sufficient time saved in firewood collection, coking and washing the dishes. The workloads of the women were reduced. But the extra time was devoted mainly in other household works and in agriculture. Some of them used their time in social work and child caring.

11. The users felt reduction in health related problems such as eye burning, headache, coughing, diarrhoea and fever.

12. Cleanliness of household environment improved. The prevalence of fly was reduced.

13. One of the negative impacts of biogas plant was increased prevalence of mosquito.

14. Most of the users had no maintenance problems. A few had the problem of slurry leakage from the burner of cooking stove.

15. Most of the respondents reported that the supervision from constructing companies were not satisfactory. They supervise one time per year for three years only.

All the surveyed biogas plants were in good running condition. The biogas company provided short trainings to the households. Therefore, the users could do minor repair works by themselves whenever needed.

6.2 Conclusion

Following conclusions were drawn from the study.

1. Biogas has been proved very useful for the women members of the family.

2. The workloads of the women have been greatly reduced. Biogas has cut the firewood need of the house. So maximum labour and time was saved in firewood collection. Food could be cooked in lesser time. Since no smoke was produced, the cooking job was easy and could be done in relatively short time. The utensils were not

blackened (unlike in 'chulhas'). So, half f the time was saved in washing the utensils. Hence, much time was saved.

3. Therefore, majority of the house wives time was saved after biogas installation. However, most of the women had to involve in other household activities and agriculture. Only a few had used the gained time in social work and child caring. Only 32 % of the total respondents used their saved time in income generating activities.

4. The chance of occurrence of health problems such as burning of eyes, headache, diarrhea and fever were reduced.

5. The prevalence of fly was reduced.

6. One of the negative impacts of biogas was the increased prevalence of mosquitoes. It seems that the slurry output pit served as the site for mosquito breeding.

7. Biogas has promoted good sanitation. Sent percent of the surveyed households are using latrines.

8. Considerable amount of firewood has been saved after installation of biogas. With this, a good amount of money was saved. Most people used it in social work and vegetable farming. Only a few people used it in income generating purposes. Some spent it for child caring and others.
9. Subsidy has been the main promoting factor for biogas installation. And the respected biogas constructing companies are the key informants of biogas programme in the selected area.

10. Most of the biogas plants are functioning well. Some are facing some minor problems such as scullery leakage from burner and gas leakage from pipe junction.

6.3 Recommendations

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

2. The cause of increased prevalence of mosquito should be studied. It seems that proper compositing of slurry would reduce the chance of breading of mosquito and reduce their prevalence.

3. The cause of leakage of slurry from the burner should be studied and prevented. Precaution should be made in new constructions t avoid the problem. For the better management f the biogas, training should be provided to the users.

4. 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.

5. The aspect of 'biogas development in Chhoprak VDC in Gorkha district is noteworthy. This is recommended to be followed in other places too.

References

AEPC. (2000). *An Introduction to Alternative Energy Technology in Nepal*: HMG/N, Ministry of Science and Technology.

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

Baskota, S. (2004). *Research Methodology*, Kathmandu: New Hira Books Enterprises.

BAEDC (P) Ltd. (1994). *Biogas Bulletin,* March.

Bista, N K. (1980). *Development of the Himalayan Resources for Regional Co-operation and National Development,* Nepal: CEDA.

Britt, C. (1994). *The Effects of Biogas on Women's Workload in Nepal: An overview of studies conducted for the Biogas Supported Program, a Compilation of Research Findings*. Jawalakhel: BSP.

BSP. (2002). *Abstracts of Biogas Related Publication*, 1992-2002, Kathmandu: Biogas Support Programme.

_____. (2004). *Biogas Nepal 2003*, Kathmandu: Biogas Support Programme.

_____. (2005). *Biogas Nepal 2004*, Kathmandu: Biogas Support Programme.

Castro De JFM., Dhussa A K., Opdam JHM., and Silwal B B. (1994) *Mid Term Evaluation of the Biogas Support Program*- Final Report. Jawalakhel: BSP.

CBS. (1995). *Population Monograph of Nepal*, Thapathali: His Majesty's Government, National Planning Commission Secretariat.

CBS. (2001). *Population Census of Nepal*, Thapathali: His Majesty's Government, National Planning Commission Secretariat.

CES, (2001). *Advanced course in Biogas Technology*, Institute of Engineering, T.U.

East Consult (P) Ltd. (1994). *Final Report of BSP Biogas Users Survey 1992-93*, Lazimpat.

Ghimire, S. (2002). *Social Impacts on Biogas Users: A Case Study of Nuwakot District*: A Dissertation Submitted for Master's Degree in Sociology.

Karki, A B., & Dixit, K. (1984). *Biogas Field Book:* Kathmandu, Sahayogi Press.

Karki, A B., Gautam, K M., & Joshi, S R. (1993). *Present Structure of Biogas Sector in Nepal*: Lazimpat, CMS.

Karki, A B., Shrestha, J N., & Bajgain, S. (2005). *Biogas as Renewable Source of Energy in Nepal, Theory & Development*: Kathmandu, BSP.

New Era. (1995). *Biogas plants in Nepal*: An Evaluative Study.

NPC. Seventh Five Year Plan to Tenth Five Year Plan.

Huston, P. (1980). "*Is Bio-gas New Technology*", published on: Energy for World Development, VITA News Paper.

Shrestha, L. K. (2002). *Socio- economic Impact of Biogas Installation in Rural Nepal*: A Dissertation Submitted for Master's Degree in Sociology.

Sigdel, P. (2004). *Social Science Research Methods in Practical Use*: Kshitiz Publication, Kathmandu

Silwal, B B. (1999). *A Review of the Biogas Programme in Nepal*, Kathmandu: Winrock International.

Van Vliet, M. (1993). *Effect of Biogas on the Workload of Women in the Village of Madan Pokhara in Palpa District in Nepal*, Jawalkhel: BSP, SNV-Nepal.

W E C S. *Abstracts of Biogas Related Various Reports*, Kathmandu: HMG/Nepal.

Wolff, H. K., and Pant, P. R. (2002). *A Hand Book for Social Science Research and Thesis writing*. Kathmandu: Buddha Academic Publishers and Distributors.

Annex-One

Observation Sheet/Questionnaire for Key Informants

1. Environmental impact of biogas

2. Impact on health and sanitation

3. Impact on workload reduction

4. Problems on the biogas plants /on gas production

5. Problems on the operation of the gas stove

6. Prevalence of mosquito and fly

7. Installation cost, Government's Subsidy and Bank's loan

8. Interest rate of the loan

9. Supervision of the construction company's member

10. Prestige of beneficiaries on the community

11. Awareness towards the vary energy 'Gobargas'

12. Role of biogas energy in the development of the study area

Annex-Two

Household Questionnaire

Name of Household: .....

1) Personal Description Date: .....

Name of the Respondent ..... Address: Chhoprak

Age..... Sex.....

Occupation, main.....Assistance.....

2) Family Description

Sex/ Age	1-10	10-20	20-30	30-40	40-50	50-60	60- and above	Literate	Illiterate
Male									
Female									
Total									

3) Economic Description

a) Land Ownership of a family (in ropani)

Land Ownership	Cultivate land	Land	
		Irrigated land	Unirrigated land
Own land			
own land cultivated by others			
other's land			

b) How many cattle do you have?

.....cow, ...Goat, ...buffaloes,

.....bulls/bullocks, ...other's

c) Have you increased the number of cattle after installation of biogas plant?

.....yes, ...No, if yes (specify number).....

4) Biogas Plant Description

a) Plant size .....,

b) Installed data.....

c) Who encouraged you to install the biogas plant?

ADB/N [ ], Staff of Biogas Company [ ],

Biogas plant owner [ ], Govt, agencies/office [ ],

Other's [ ].

d) Did you obtain any support for the construction?

.....yes, ...No, If yes,

e) Who support you?

.....

f) What type of support is it?

[ ] Free installation

[ ] Subsidy

[ ] Loan

[ ] Technical Support, If loan

g) What is the interest rate on the loan?

..... Percent.

h) What advantage of biogas program attracted you most?

[ ] Environment, [ ] Health,

[ ] Saving of time, [ ] Less expenditure,

[ ] Other's [ ] above all

i) Who fixed the plant size?

.....

j) On what basis plant size was fixed.

[ ] Cattle/buffalo, [ ] Family size

[ ] Wealth

k) What are the uses of biogas?

[ ] Only Cooking, [ ] Only lighting,

[ ] Both, [ ] Other's (specify).....

l) Total burning hours of stoves and lights

Stove ..... hrs/day (average) Winter

Stove ..... hrs/day (average) Summer

Light ..... hrs/day (average) Winter

Light ..... hrs/day (average) Summer

m) Who selected the location of biogas plant?

[ ] Yourself, [ ] GGC person,[ ] Other's,

[ ] If others (Specify) .....

n) Who construct the plant?

[ ] GGC, [ ] Other's (Specify) .....

o) Was supervision of the funding agency enough?

[ ] yes, [ ] No, if no (specify)

p) How much dung and water do you feed the plant?

	Dung (kg)	Water (Lit)
Daily		
Once in two days		
Twice in a week		

q) Has the gas being produced effectively?

[ ] yes, [ ] No, if no (specify) .....

r) What is the total investment cost of the plant?

Rs. .....

5) Description related to environment, health and sanitation.

a) How much fuel did you require per week before the installation of biogas plant?

Firewood ..... Bhari/Rs. .....

Dung ..... Bhari/Rs. .....

Agricultural product ..... Bhari/Rs. .....

b) Where did you collect the firewood before the installation of the biogas plant?

[ ] Have to collect, [ ] Bought, [ ] Both

c) Where did you collect the firewood before the installation of biogas plant?

[ ] Own land/field/private farm/Garden

[ ] Jungle, [ ] Other's (specify) if others

d) Has the gas facilitated in cooking ?

[ ] yes, [ ] No

e) Has it reduced cooking time?

[ ] Yes, [ ] No

f) Do you think that because of biogas the Kitchen remains clean and smoke free?

[ ] Yes very much, [ ] Yes some extent

[ ] Not at all

g) Do you think the storing of digested slurry in pits has reduced the menace of flies/mosquitoes in and around your house?

[ ] Yes some extent, [ ] Yes very much not at all

[ ] Not at all

h) Had any cases of eye/lung disease occur among your family member before the installation?

[ ] Yes, considerably, [ ] yes, some extent,

[ ] Not, at all [ ] Can not say

i). In your opinion are there any adverse effects of biogas on the health?

[ ] Yes, [ ] No, if yes, specify

j) Has it improved the household environment and sanitation?

[ ] yes, [ ] No

k) Has the mosquitoes increase after the plant installation?

[ ] yes, [ ] No

6) Women's workload Description

a) How much time is required to collect one bhari of firewood from the source?

.....hours, ...minutes

b) How much time does it take to collect the dung?

.....hours, ...minutes

c) Who do the work of bring dung and water more?

Dung: Male ..... Female .....

Water: Male ..... Female .....

d) Who feeds the plant more?

Male ..... Female .....

e) What is the different in the consumption of kerosene and firewood after the installation of plant?

Before		After	Difference
firewood (Bhari)			
Kerosene (Liter)			

f) After the installation of biogas plants, what impact is seen in working hours of men and women?

S.N.		Before		After		Difference	
	Particulars	Male	Female	Male	Female	Male	Female
1	Collection of five woods						
2	Fetching water						
3	Cooking						
4	Cleaning vessels						
5	Plant feeding						

g) Has it brought any difference in cooking times?

	Before	After	Difference
Time (Hour)			

7) General Description

a) Have you used the time saved in other social work?

i) Household work .....

ii) Income generation .....

iii) Social work .....

iv) Vegetable farming .....

v) Agriculture .....

vi) Child caring .....

vii) Others .....

b) Are you satisfied with the biogas plants?

.....yes, ...No (specify, if no).....

c) Has the expenditure on your health reduced after?

biogas plant installation?

.....yes, ...No

d) Has your participant in social and economic activities increased?

.....yes, ...No

e) Do you feel that biogas has increased your life standard and prestige?

.....yes, ...No (specify, if no)

f) Do you think that biogas technology will help in environmental conservation and social development?

....yes, ...No (specify, if no)

g) Do you have any suggestions about biogas plants?

.....

.....

.....

Thank You

Biogas is burning with blue flame in a single stove.

Biogas is burning with blue flame in the double stove