Evaluation Report
on
"Biogas as renewable energy source in Indian villages"





SUBMITTED BY:
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SkillPro Foundation has undertaken the evaluation preparatory of the project titled “Biogas as renewable energy source in Indian villages” being implemented in 20 villages of Dausa district, Rajasthan. 148 project beneficiaries and 65 non beneficiaries were covered under the study. 5 HPPI implementing team members were also interviewed.

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SkillPro Foundation

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LIST OF ACRONYMS

S. No	Acronyms	Expansion
1	Cum	Cubic Meter
2	FGD	Focused Group Discussion
3	OBC	Other Backward Caste
4	OC	Other Caste
5	ROI	Return On Investment
6	SC	Scheduled Caste
7	SHG	Self Help Group
8	ST	Scheduled Tribe

EXECUTIVE SUMMARY

The ***"Biogas as renewable energy source in Indian villages"*** Project (2010-2012), financed by the Finnish Ministry for Foreign Affairs (MFA) and UFF Finland, has been implemented by Humana People to People India (HPPI). The project aims at setting up 200 biogas units in 20 villages of Dausa district for the promotion of biogas as a major energy source for the beneficiary households. The biogas units will provide a cleaner and eco-friendly energy source to the beneficiaries and will reduce their dependence on firewood and cow dung for meeting their energy requirements. The biogas units will also provide a residual organic waste (slurry), after anaerobic bacterial digestion. The slurry thus produced has even better nutrient qualities compared to normal farmyard manure. The use of this slurry, which is obtained as a residue in the generation of biogas contributes significantly towards increasing the agricultural productivity of the farm. The study evaluated the above mentioned project as it is being implemented in 20 villages of Dausa district, Rajasthan. The study focused on assessing the extent to which the planned project goals and outputs have been realized.

The major study objectives were:

- The primary role of this evaluation is to find out to what extent the set goals and results have been reached.
- To analyze the goals and results in terms of strategic relevance to the various aspects of the project. The policy environment, effectiveness, efficiency, sustainability and ownership. The evaluation will also provide an estimate of the impact the project is likely to achieve in the long run.
- The information obtained from the evaluation will help UFF and HPPI to plan, implement and monitor new projects in a more effective manner.

The major study findings are provided below:

Prior to the inception of the project ***"Biogas as renewable energy source in Indian villages"***, biogas projects were implemented in the villages by the government. The respondents thus, had a fairly good idea about biogas units and their corresponding benefits. Unfortunately, the biogas units constructed under these government projects were not very successful, and most of the units became defunct. This was because the units constructed under the government projects did not take care of the needs of the beneficiaries. The units were not technically sound and there were frequent cases of biogas leakage, low production of gas, frequent problems in maintenance and so on. Hence, the respondents did not have a positive experience and their opinion of biogas projects and units was pretty low.

As a result of this, the respondents were not willing to come forward for the UFF supported biogas project due to their unfavorable experience of earlier biogas units constructed under the government projects. The HPPI team had to undertake an intensive community mobilization drive in order to convince all the members of the community about the project and the benefits they would derive from it.

However, it was only after the construction of the biogas units under the project and the visible benefits that were accrued from them, that the community was finally convinced that biogas units under the project could be successful. The community then accepted the project based on the visible results obtained from the biogas units that had been constructed and were running successfully.

The project is quite relevant to the rural context of India as there is a regular source of available dung. This is because the local population has a large number of livestock, especially cows and buffaloes. There is a high need for such a project as the local community in the rural areas requires a clean, safe, cheap and efficient energy source, and this has been met by the project. Apart from that, considering the agricultural

background of the rural areas in the province (state) and locality the project contributes towards enhancing the use of organic fertilizers as well.

The organizational capacities and technical knowledge of the people have been utilized efficiently at the project. The monitoring carried out by the team, and the success rate of the units show that the team has been successful in provided the necessary inputs. Resource management was also conducted efficiently during the project implementation phase.

On the other hand, this project has benefited the respondents in multiple ways. The respondents received a cleaner energy source in the form of biogas which succeeded in reducing indoor pollution as well. This reduction in indoor pollution has led to reduced respiratory problems and eye ailments, and the corresponding medical expenditure on such ailments was also kept in check. The reduced indoor pollution has controlled the rate of respiratory problems and eye ailments that they suffered from. The respondents thus saved on the expenses related to health related problems caused by indoor pollution. The average annual cost in savings per respondent per year was **Rs 1,405**. Though, the non beneficiary respondents still continued to face health related problems due to high indoor pollution levels. The average annual health related expenditure for respondents was **Rs 1,738**.

The women in the household now have more spare time during which they can carry out other important duties. The women are also able to devote more time towards taking care of their children. As a result, the older girl child in the household is also getting more time off from her domestic duties and is hence able to focus on her school work. All the women of the household are also able to take some much needed rest in the additional spare time that they now have, all due to the use of the biogas units.

During the pre-project period, beneficiary respondents were heavily dependent on firewood and dung cakes as their primary source of fuel and energy. The average monthly expenditure per respondent on these energy sources was **Rs 2,220**. However, currently as the beneficiaries are using biogas for most of their energy needs their post project expenditure on an energy source has dropped to **Rs 535** per month. Thus, they are now able to save **Rs 1,685** per month. The non beneficiary respondents, on the other hand, are still dependent on firewood and dung cakes for cooking and incur an average monthly expenditure of **Rs 2,578** on the same. The expenditure of non beneficiaries on their energy source currently is higher than the pre project expenditure made by beneficiaries on their energy sources, due to rising prices.

The biogas units also produce slurry as a residue. The slurry, though a residual product, contains high nutrient qualities compared to the usual organic manure, i.e. farmyard manure. The slurry is collected in the slurry pits and applied on the farm as organic manure. This slurry application has improved the nutrient and moisture content of the soil. This has led to reduction in irrigation hours for the respondents. The irrigation hours per day per season have been reduced by 20% post slurry application. The respondents are saving **Rs 1,685** due to reduced irrigation requirements. The average daily irrigation hours for the beneficiary respondents was clocked at 4.61 hours while those of the non beneficiary respondents was 6.76 hours, in the same time frame.

The total savings made by beneficiary respondents from the use of biogas are provided in the following table:

S.No	Particulars	Savings (unit wise)	Annual savings
1	Energy source	Rs 1,685 per month	Rs 20,220
2	Irrigation	Rs 1,685 per agricultural season	Rs 1,685
3	Health expenses	Rs 1,405 per year	Rs 1,405
	Total annual savings		**23,310**

The use of slurry from the biogas unit has also reduced the cost of cultivation. The cost incurred on chemical fertilizers, and irrigation has been reduced due to slurry application. The productivity of the farms has also increased, this adds to an increase in income for the respondents. Hence the overall income from agriculture has increased for beneficiary respondents. The overall RoI from agriculture for the respondents in the pre project period was 95%, which has now increased to 138% in the post project period.

The decision to buy a biogas unit was made mostly by the men of the household as it had financial implications. We had to consider the fact that men are the decision makers in the project villages in Dausa district, Rajasthan. Women were more involved in deciding on the type of biogas unit, the volume of the unit, number of burners required, location, etc., but this was only after the decision to purchase it had been made by the man in the household. The responsibility for dung collection for the biogas unit, however, was primarily the responsibility of the women of the household.

The biogas unit has helped in the saving of time of the women. 53% women in beneficiary households saved 1-2 hours daily and 44% saved 2-4 hours. 1% of the women saved 0-1 hours while the remaining 3% saved more than 4 hours daily. The time saved was considerable since the women no longer had to spend long hours in collecting firewood. Cooking time was shorter using biogas and cleaning utensils was also easier as they no longer had to labor over scrubbing utensils covered in black soot. The women have now used this spare time in carrying out other important household tasks and farm related activities. The women are able to spend more time with their family members and also take some much needed rest in their spare time. They are able to spend more time with their children and also take better care of them.

The trainings conducted under the project were also very effective. Most of the respondents have attended the trainings. The trainings have provided better understanding and orientated them on the proper functioning and maintenance of their biogas units. The trainings were mostly attended by the men of the household as women were busy in their domestic chores and since their mobility outside their home was limited. The respondents have also admitted that the trainings were very useful for them. The trainings have provided optimal understanding of the maintenance of the biogas units, which will further contribute towards the project sustainability.

The spare parts for the biogas units are also easily available. The spare parts are available within close proximity of the village. This will ensure that the biogas units are easy to maintain and incur low maintenance costs. The easy availability of spare parts will positively contribute towards the project sustainability post project completion.

The project has significantly reduced the dependency of the respondents on firewood as fuel for meeting their energy needs. The reduced dependency on firewood has also reduced the cutting of trees in the villages. This has led further to the conservation of trees and in preserving the surrounding green cover of the forests. As a result, the overall biomass has increased in the villages.

Majority of the biogas units (82%) were constructed in 2011 and 2012. Hence the full benefits of some of the units have not accrued to the respondents as yet. 89% of the biogas units were functional while 5% were not functional and 6% were yet to start up. 94% respondents said that their biogas units were functional throughout the year. Some problems were reported in the winter months when the methane content in the dung was low and there were some difficulties in gas generation.

The non-beneficiaries are now also willing to adopt biogas units under the project. It has been seen that 86% of the non beneficiaries were willing to adopt biogas units. Of these, 89% of the non beneficiaries were willing to make the required investment on establishing their own biogas units. Thus, there is high scope and potential for biogas units in the villages under the study. This shows that the project has made a tremendous impact on the minds of the people in the area. After witnessing the success of the units, now there is not only a huge demand in these villages, but in the nearby villages as well. It is high time now, that the government and other agencies upscale this model and the project in that area.

CHAPTER 1: INTRODUCTION

1.1 About the Project

The ***"Biogas as renewable energy source in Indian villages"*** Project (2010-2012), financed by the Ministry of Foreign Affairs of Finland (MFA) and UFF Finland, is implemented by Humana People to People India(HPPI).

This project seeks to provide households with an alternative, more easily available and environmentally sustainable source of energy through the use of biogas. This will increase the self-sufficiency of farmers, have a positive effect on the situation of women, reduce indoor pollution in households as well as ensure safe disposal of cow dung and household waste. The biogas plants produce a slurry, which will improve farming productivity and decrease the need of chemical fertilizers. To achieve these objectives and results, the project established 200 biogas plants in villages in the rural area. The beneficiaries will also be provided with training and support, and local communities will be sensitized on the benefits of biogas and its positive impact on environmental issues.

The project has been implemented in 20 villages in Dausa district in Rajasthan, an area which has many small villages with small-scale farming activities. Rajasthan is one of the poorest and least developed areas in India. The direct beneficiaries of the project are the local households. During the three years, the project has benefitted directly and/or indirectly approximately 2,000 households or 20,000 people. This project was granted funding for three years with a total budget of 355,174 Euros.

1.2 About the Study

The study was conducted for undertaking an evaluation of the ***"Biogas as renewable energy source in Indian villages"*** Project. The study focused on assessing the extent to which the planned project goals and outputs have been realized. The major indicators focused on during the evaluation are enlisted in the following table:

Table 1: Study Indicators

S.No	Project Aspects	Data Indicators
1	Relevance	• Coherence of project with India Country Strategy Paper and other relevant policies • Relevance of project to Indian national, provincial and local needs • Conduct of need assessment prior to project planning • Adequacy of project activities in addressing the needs and constraints of the target groups • Stakeholders' attitude towards project • Perception of UFF's contribution by HPPI • Likelihood of project duplicating other related activities undertaken in same area

2	Efficiency	• Efficiency in utilization of organizational capacities at different project stages • Adequacy, flexibility and quality of project monitoring • HPPI's rating of UFF's delivery of administrative support in project administration and management
3	Effectiveness and Impact	• Contribution of project activities towards achievement of project goals and objectives • Extent of achievement of project goals and objectives • Opinion of all stakeholders on achievement and delivery of planned benefits • Assessing if expected results were realistic and reasonable considering time and other resources
4	Sustainability and Ownership	• Planning process of project activities • Sustainability of project ownership by the community • Involvement of stakeholders in project designing, implementation and monitoring • Technical guidance provided to the community for biogas maintenance during the post project period • Availability of spare parts needed for biogas unit maintenance • Likely flow of project benefits over time • Evidence of replication of the project activities
5	Gender Relations	• Effect of project on gender relations of beneficiary households • Time availability to women in beneficiary household and utilization of spare time • Consideration of power relations in household during project planning and implementation
6	Poverty Reduction	• Effect of biogas plant on economic status of beneficiary household • Participation of beneficiary households considering the initial high cost of constructing a biogas plant
7	Environmental Issues and Climate Sustainability	• Effect of trainings and community mobilization on the awareness of the community about environmental and climate sustainability issues • Effect of the project on the environment of the project area • Estimation of project's effect on reduction of carbon emissions due to forest preservation and use of biogas

1.3 Study Objectives

The study objectives are as follows:

- The primary role of this evaluation is to find out to what extent the set goals and results have been reached (focus on those listed in the table above).
- To analyze the goals and results in terms of strategic relevance to the project. The project policy environment, effectiveness, efficiency, sustainability and ownership. The evaluation will also provide an estimate of the impact the project is likely to achieve in the long run.
- The information obtained from the evaluation will help UFF and HPPI to plan, implement and monitor new projects more effectively.
- As this project is a pilot project, the evaluation will provide valuable information for future plans to scale up similar activities in the other districts of the region.

1.4 Study Methodology

The methodology for the study involved data collection from the field from beneficiaries, non beneficiaries and the HPPI project implementing team. The data was collected through structured interview schedules and Focused Group Discussions (FGDs) in the field.

The study methodology adopted is represented with the help of flow diagrams

A brief description of the activities undertaken during the study are as follows:

Consultation with HPPI: An initial consultation was conducted with the HPPI team. The consultation helped in developing clarity on the study. It also helped in deciding on the target respondents, sample size, sampling technique and type of data collection tools to be used. The consultation also helped in finalizing a timeline for the study.

Development of study tools: The study tools were developed. The tools were a judicious blend of quantitative and qualitative techniques. The major study tools consisted of structured schedules and FGD formats. The study tools were shared with UFF and HPPI and finalized in consultation with them.

Primary data collection: The primary data was collected from the 20 project villages where the project is being implemented, from the project beneficiaries and non beneficiaries (control group). Data was also collected from the HPPI implementing team.

Fig 1.1: Study methodology

Data compilation and entry: The primary data collected from the field was entered into the data entry format. The data was then verified for completeness and accuracy. After which it was cleaned and maintained in the form of a database that could be used for future reference.

Data analysis: The data was analyzed using statistical packages. The data analysis generated data tables and graphical illustrations. The data analysis helped in assessing the overall status of project implementation and achievement of the planned project outputs.

Submission of draft report: The draft report consisting of the study findings was submitted to UFF and HPPI for their inputs and feedback. The draft report consisted of data tables and graphical representations for facilitating a better understanding.

Submission of final report: The final report will be submitted to UFF and HPPI after incorporating their inputs and feedback into the draft report.

1.5 District Profile

The study was conducted in Dausa district, Rajasthan. The brief profile of the district is as follows:

Fig 1.2: Map of Dausa district

Introduction

The Dausa District wasconstituted on 10th April 1991 by separating 4 Tehsils namely Dausa, Baswa, Sikrai and Lalsot of Jaipur district. Mahwa Tehsil of Sawai Madhopur was included as part of this district on 15th August 1992. Dausa district is located in the eastern part of the state of Rajasthan. The district of Dausa is surrounded by Alwar district in the north, Sawai Madhopur district in the south, Bharatpur district in the northeast, Karauli district in the southwest and Jaipur district in the west.

Demography

According to the 2011 census Dausa district has a population of 1,637,226. The district has a population density of 476 inhabitants per square kilometer. The population growth rate over the decade 2001-2011 was 24.31%. Dausa has a sex ratio of 904 females for every 1,000 males, and a literacy rate of 69.17%.

Key human development indicators for Dausa district are as follows:

S. No	Indicators	Details
1	Education index	0.757
2	Health index	0.591
3	Income index	0.380
4	Human development index	0.576
5	Net enrolment rate (NER- 2006-07)	99.63
6	Infant mortality rate (IMR)	81.30
7	Per capita income (Rs)	10198
8	Life expectancy at birth (years)	62.22
9	Crude birth rate (CBR)	19.25

A comparative table depicting the demographic details of Dausa district with Rajasthan and India is provided below:

S.No	Indicator	Dausa	Rajasthan	India
1	Total population	1,637,226	68,621,012	1,210,193,422
2	Population growth rate	24.31%	21.43%	17.65%
3	Population density	476/sq Km	201/sq Km	382/sq Km
4	Literacy rate	69.17%	67.06%	74.04%
5	Sex ratio	904	926	940

Soil

The soil of the district is yellowish to dark brown in color, it is dominantly fine textured, and generally suitable for all types of crops. Furthermore, the watershed scheme has been implemented in the district to avoid soil erosion.

Flora and Fauna

Dausa district falls under the Indus Plains floristic region of India. Each region has its own distinctive species of flora and fauna. This particular district is endowed with Acacia nilotica (Babool), Asenegal (Kumta), Anogeissus (Dhok), Prosopis (Khejadi), Capparis(Kair) and Caotropis (Ak). This vegetation is typically observed in tropical Throne forests. The district is endowed with a variety of habitats. The district, though not rich in dense forest growth, sustains considerable biological diversity. As far as the faunal regions are concerned, the district falls under the Oriental region. As far as the characteristic wildlife of the region goes, the wildlife that still survives in this district include the monkey, lemur (langoor), panther, black buck and the peafowl.

Sources of Irrigation

The major sources of irrigation are wells and tube wells in the district. Around 155,000 hectares in area (45% of the district area) are covered by these sources throughout the year. Besides this, a very limited area is irrigated with the help of the small rivers and ponds that exist here.

Major Crops and Cropping Pattern

The district has 219,575 hectares of arable land of which 128,169 hectares (58.92%) is under irrigation. During the Kharif season, the Groundnut crop is produced in the irrigated areas. Maize also requires irrigation. Generally other crops are sown at the commencement of the rainy season. Groundnut, Maize and Cotton are sown by broadcasting the seeds. Fertilizer is applied before the sowing of Groundnut and Cotton.

During the Rabi season, Mustard and Gram are sown between September-October, on the un-irrigated land, while on the irrigated land, Barley, Gram and Mustard are sown in October-November and Wheat in November-December. The district has 94,652 hectares of double crop area with the crop cycle, including Moong-Wheat, Moong-Mustard, Bajra-Mustard, Bajra-Gram etc. The principal crop of the district in the Kharif season is Bajra, while the most important food grain crop in the Rabi season is wheat.

CHAPTER 2: RESPONSE TO KEY TOR QUESTIONS

The key questions raised in the TOR were studied in detail during the evaluation. The summary of responses to the key questions is provided in the following table:

S.No	Particulars	Response
1	**Relevance of the project in its policy environment**	
a	Is the project coherent with the Indian Country Strategy Paper and other relevant policies?	The project is at par with the vision of renewable energy for rural households which is Decrease dependency on conventional energy sources, and reduce the Demand-Supply gap by • Promoting Renewable Energy Sources • Becoming the leader in heralding a green energy revolution aiming at energy security and reducing climate change Mitigation • Establishing green jobs and sustainability through increased reliance on renewable energy sources • Provision of green and modern energy services to all on a sustainable basis
b	How relevant is the project to the Indian national, provincial, and local needs?	The project is quite relevant to the rural context of India where there is an adequate source of available dung, as the locality has a large number of livestock, especially cows and buffaloes. There is the need for such a project in the local community and the rural people, as here, a safer, cheaper and more efficient energy source has been provided by the project. Apart from that, considering the agricultural background of the rural areas in the province (state) and locality, the project seeks to enhance the use of bio fertilizers as well.
c	Is the project likely to reinforce or duplicate other related activities undertaken in the same area?	There have been no relevant projects undertaken on renewable and safe energy sources in the locality during the past decade. Other similar projects undertaken earlier had not been effective due to various reasons.
2		
a	How well do the project activities address the needs and constraints of the target groups identified? To what extent are they in line with their aspirations?	The local people were dependent on firewood and dung cakes for fuel which they would collect either by cutting trees or making dung cakes. This project has provided a safe and efficient energy source and has helped in saving time, minimizing pollution and also protecting the environment. Aspirations of the community of accessing cheap energy from existing sources at a lower cost and sustainable for a longer period of time, have all been met by the project.
b	What is the stakeholders' attitude towards the project; has the project made sense for them?	During the initial period, the stakeholders were skeptical of the probability of the success of the project. After witnessing the failure of such projects implemented by other agencies, their feelings are understandable. Now, they are more confident about the project and are willing to upscale it. The project has been implemented successfully in most of the cases, and the stakeholders are efficiently using the gas and slurry and now understand the far-reaching consequences and realize the benefits that the project provides.

3		
a	Were the organizational capacities (human resources, available budget) utilized efficiently in the different stages of the project? How could these capacities been used more efficiently?	The organizational capacities and technical knowledge of people have been utilized efficiently in the project. The monitoring by the team and the subsequent success rate of the biogas plants provide evidence that the inputs provided by the team were adequate. The resources were also efficiently managed during the project implementation phase.
b	Has the project monitoring been accurate adequate, flexible, and of optimal quality?	The monitoring undertaken during the project has been accurate, adequate, flexible and appropriate. The implementing team also managed to develop good rapport with the community. This was due to the frequent visits and support supplied by the team right from the inception of the project (initiation of a plant) to the final stages.
c	How does HPPI rate UFF's delivery of administrative support in project administration and management? What could UFF have done better from HPPI's perspective?	The administrative support provided by UFF to the HPPI team was quite satisfactory and appreciable. An extension of the project period will help in ensuring greater sustainability of the project.
4		
a	How well have the implemented activities contributed towards the fulfillment of the goal, objectives and results of the project?	**Long term goal: Contribute towards the achievement of the Millennium Development Goals for environmental sustainability (goal 7), combat diseases (goal 6) and eradicating extreme poverty (goal 1)** The project has contributed towards the achievement of the Millennium Development Goal (MDG) goal 7 i.e. ensuring environmental sustainability. The project has promoted biogas as a major energy source in the 20 project villages in Dausa district. This has reduced the pressure on the forest and the commons to a considerable degree. The beneficiaries are not cutting trees and exploiting the commons for firewood. This has led to improvement of the tree cover in the project villages. Moreover, the enhanced tree cover has also ensured lower soil erosion and enhanced the biomass in the region. The MDG goal no 6, i.e. combating diseases has also been positively affected by the project. The biogas units installed under the project provide a clean eco-friendly and efficient energy source to the beneficiaries. The biogas units have reduced indoor pollution, which has significantly reduced the respiratory problems and eye ailments faced by the women in the household during the pre project period. Thus, the expenditure on such health problems has also been reduced for the beneficiaries using biogas for cooking. The project has contributed towards MDG goal 1, i.e. eradicating extreme poverty. The bio gas units have led to savings by the beneficiaries on expenses made on firewood during the pre project period. The irrigation requirement and expenditure has also been reduced due to the use of slurry in the field. The beneficiaries have also been able to save money on health related problems that occurred due to indoor pollution in the pre project period. The overall income from agriculture has also increased due to enhanced productivity. Hence the project has led to savings and increased income for the beneficiaries thereby contributing towards poverty eradication in the project villages.

		Direct objectives The project has also led to the fulfillment of direct objectives such as: • Households now have access to a cleaner and more eco- friendly energy source such as biogas. The biogas units are also contributing towards environmental sustainability. • Farmers have been able to save money on pre project energy sources, on health expenses that were due to indoor pollution induced diseases as well as reduce their irrigation expenses. In addition, income of farmers has increased due to the project because of increased agricultural productivity. Hence the overall economic status of farmers has improved due to cost savings and increased flow of income. • The working condition of women has improved as they do not have to travel long distances and spend hours in collecting firewood for cooking. The women now have more leisure time due to the biogas units as they save time on collecting firewood, and in the cooking and cleaning of utensils that are no longer covered in soot. They are able to rest and have more leisure time and are also able to spend more time with their families. The health status of women has also improved as the indoor pollution induced respiratory problems and eye ailments have also reduced significantly in them. • A model for the safe disposal of cow dung and household waste has also been created. The bio-degradable waste is largely produced in the form of kitchen waste, cattle dung, garden waste, and leaves of trees. • The indoor pollution has reduced significantly and the community is aware of all the benefits of the biogas units. **Results** The following results have been achieved under the project • Construction of 195 biogas units in 20 villages over 3 years • 50 SHGs have been formed in the project villages. The SHGs have also been provided trainings on savings, livelihood activities, the biogas project, etc • Improved farm productivity and better income for the beneficiaries through the usage of slurry on their farms • Trainings were conducted and basic awareness was created about biogas units and their operation. Trainings on the maintenance of these units were also held in the community.
b	How successfully has the project advanced in terms of its anticipated outcomes and results?	The project has been successful in achieving most of the targets, and the expected/anticipated outcome. A total number of 200 biogas units were planned under the project and 195 were installed successfully.
c	Do all the key stakeholders and beneficiaries feel that the planned benefits have been delivered and achieved?	The beneficiaries feel that their expectations and needs have been met by the project to a large extent and are quite satisfied. A few of the beneficiaries wanted a larger biogas plant and felt that instead of single burner stoves, double burner stoves would have been much more useful.
d	Were the expected results achievable and reasonable, considering the time, the resources, and the conditions of the project?	The results were very difficult to achieve as initially, the villagers/beneficiaries were not ready to install the biogas units. This was because of the bad experiences that some of them had heard of, from others. Thankfully, the HPPI team did a commendable job in mobilising the community, creating awareness and maintaining quality work, which helped in achieving the expected results and targets.

e	To what extent have the expected results been achieved / not achieved? Success and failure factors. Were these factors taken into account during the project planning?	The results achieved under the project are as follows: • 195 biogas units providing a clean and eco-friendly energy source have been constructed in the project villages • 30 SHGs and 20 farmer's group have been formed under the project. The SHGs have promoted savings and livelihood activities. • Farm fertility and productivity have increased and cost of cultivation has been reduced due to the use of the slurry in field, by the farmers. • Trainings have been conducted for the community on the biogas project, awareness creation on biogas and on operating and maintaining the biogas units. The project has achieved all the expected results pertaining to the construction and usage of biogas plants, SHG formation, improvement in the health condition of women, improvement in the productivity of farmers, etc. There were certain units, which were yet to commence at the final stages of the project. Such plants could have been initiated at least 3 months before the end of the project. This was due to the fact that initially, there were many issues pertaining to the acceptance of the model which hampered the pace of project implementation. More than 95% of the structures were completed by November 2012, and the remaining were planned to be completed by the end of November 2012, with a one month phase out period. The project has created a movement within the community, and more people are coming forward to install biogas plants in their homes. As the number of households interested in having biogas units is increasing it is no longer possible for a volunteer to support the project and its processes. An organization has to be involved in order to upscale the project, and it is now the ideal time for the government or any other similar agency to get involved in the project to help upscale it.
5		
a	Has the project reached its goal of establishing the 200 biogas plants? Are they functioning well? What kind of problems have come up and what kind of solutions have been found for them?	The project has almost completed 195 biogas plants in the stipulated time, and the rest of the plants will be completed soon. The team is planning to initiate more biogas plants by motivating more farmers and having them contribute a larger amount to the project. The initial delay caused in initiating the units was due to the experience of failure of the projects implemented by other agencies. Due to this, it took time to clear all the doubts held by the beneficiaries by constructing a few units free of cost and establishing them successfully.
b	The beneficiaries' perception of the project in relation to: • The success of the project and its relevance to the problems experienced by them • The level and quality of support given in the process of saving for the biogas plant, building it and maintaining it. • The quality and usefulness of the training given	The beneficiaries felt that the project has really addressed their issues on a better source of energy, better health conditions, improved productivity of crops, savings in the consumption of fertilisers, decrease in the use of firewood, and an increase in the usage of productive timing. The support given by the team was very good and this has helped them in quality construction. The masons and volunteers within the local community were equipped with the necessary skills and relevant technical knowledge and they can now go ahead to help their community in the future. The quality of the training was pretty good, and the beneficiaries were given knowhow on the regular maintenance of their biogas units, awareness of biogas in general, how to use the slurry and so on.

c	Gender relations • What has been the effect of the project on gender relations in those households that have built a biogas plant? • What has been the effect of building the biogas plants for the women in the households? Has it resulted in them having more time to do other activities as planned? If so, how have they used this time? • Were the power relations within households adequately taken into account when planning and implementing the project? Were for example, the following issues considered: who decided on the purchase of the biogas plant? Who benefits most from it and how? How is the collection of the dung organized and who is responsible for it? Who is responsible for the plant's operation and maintenance? Who has had access to the training, study tours and other relevant information and knowledge?	The capacity of women has increased in the households that have built a biogas plant. Their health has improved, and they spend less time in collecting firewood as well. Women's participation in the selection of the type of biogas unit was very high. Primarily, women made such choices in their household. Their decision was given importance and accepted by others in the family. Hence the project has provided an opportunity to the women to have their own say in household matters. The women were empowered and were using their additional free time in productive activities like agriculture, maintenance of livestock, and other household duties. It was also noted that they could now take some time out to rest, due to the time saved in cooking using biogas. The locality where the project has been implemented is primarily male dominated. However, it was found from the study and analysis that the women members also had a voice in deciding on the establishment of a biogas unit and in some cases, it was on the coercion of the women that the men were now ready to install the unit. The power and gender equations in the household were taken into account while conducting the need assessment study. The need assessment study also focused on various socio economic aspects like identifying the decision maker in the household for buying a biogas unit, benefits of the biogas unit to the household, responsibility of maintenance of units, current level of understanding of the community on biogas units and the capacity building inputs needed to make them adept at operating and maintaining the biogas units. During the construction of the biogas unit gender specific needs like number of burners, location of unit, etc., were also taken care of. The women in the house were encouraged to participate actively in the trainings to provide them adequate inputs on operating and maintaining the biogas units as they would usually be taking care of the unit due to their presence within the house, throughout the day.

d	Environmental issues • What has been the effect of the training imparted and community mobilization on the awareness level of the communities about the environmental issues facing them? • What has been the effect of the project on the environment of the project area?	The trainings have been very effective in orienting the community on the biogas units: its importance to them, benefits accruing from it, its handling, maintenance and upkeep. The community has also understood that biogas units help in saving trees and enhances the biomass in the villages. The community also understood and appreciated the fact that the biogas units have led to conservation of forest and improved the overall environment of the locality. The greenery of the area has increased due to reduced usage of firewood as fuel. Though the real impact will only be visible in the next 4 to 5 years. The cutting of trees has reduced significantly and hence the tree cover has increased. The biomass has increased in the villages as well. The trees on the farms also contribute towards improving soil fertility by providing rich compost and preventing soil erosion.
e	Poverty reduction • Have the saving schemes been successful? • Have farmers been able to participate in the project despite of the relatively high cost of the initial investment needed for building the biogas plant? • What has been the effect of the biogas plant on the economic status of households?	The SHGs were mainly consisting of women from the family of the beneficiaries, and each group had 10 members. They have undertaken the savings scheme and the average savings is Rs. 1,000 per group per month. The savings scheme has been implemented successfully, and 10 SHGs have received Rs. 4.8 lacs as loan from the bank and internal loan is provided to members for starting their own livelihood activities. Where most of them have bought buffalos or goat and the yield from these livestock's has been used to repay the loan. Initially, the farmers were reluctant to participate in the project as the initial cost of setting up a biogas unit was high. Moreover, the failure of earlier government projects on biogas was also deterring them from taking the first step. However, after seeing the success of a few units installed under the project, the farmers were convinced about the feasibility of the units and participated in the project. They were then eager to have their biogas units installed. The beneficiaries have participated equally in the project irrespective of their social category, economic status, etc. The project has led to the increase of income among the beneficiaries. Their income has increased as the cost of cultivation has been reduced due to less expenditure on chemical fertilizer and irrigation. The productivity has also increased leading to enhanced income from agriculture. Other factors which were indirectly related were the lower use of firewood resulting in reduction of firewood expenses, more productive time for the women, lowering of expenses on health issues, lower use of chemical fertilisers and so on. All these have resulted in higher income and hence reduction in the poverty level. The farmers who were ready to participate in the project have only been considered as beneficiaries of the project. The farmer's contribution was in terms of kind; mostly, in material rather than with direct cash investment. The economic conditions of the households have been visibly improved as a result.

f	How well has the project taken into account local social and cultural conditions? How have cultural issues affecting the project (e.g. customs related to dung collection) been dealt with and have they hindered the progress of the project?	The awareness provided to the farmers on the use of biogas has succeeded in overcoming all the taboos about the ill effects of biogas. As the farmers were already using dung cakes to cook food, they did not have much of an issue over this. The farmers did not face dung shortage as the biogas units were provided to the farmers having a sufficient number of cattle, and the adequate dung availability required for running a biogas unit. Initially, the farmers were reluctant as they did not believe in the quality of gas production and also what they had heard from people about the effect on taste that would have been imparted on their food, etc. But with proper awareness and the establishment of a number of units serving as models in the villages, more people to come forward for erecting biogas units.
g	How do those members of the local community who have not directly benefitted from the project view it? Has the mobilization of the community been successful? Has the community understood and accepted the benefits of biogas?	Most of the non beneficiaries are motivated towards establishing such plants, if they are provided with soft loans or some subsidy. They have seen people reaping the benefits from the units. The mobilisation drive has gone well with the community, and more people are interested in setting up their own biogas units. The non beneficiaries are now willing to make the investment required to procure a biogas unit under the project. The community members have understood the benefits of biogas and appreciate it highly. All the respondents during the study said that they would continue to use their biogas units even after the project completion period.
h	How is HPPI as an organization perceived by the community? Does it have a good reputation among the community members and the local government?	a commendable job in community mobilization and convincing the people to adopt biogas units. The communities identify and accept HPPI as a highly credible organization. The community is so convinced and satisfied with the project that they are demanding more units to be set up. The HPPI project has managed to overcome all the misinformation and misconceptions about the model and the project itself.
i	Have the local authorities been involved sufficiently in the project at all stages of the project cycle? How do they evaluate the success of the project?	Local authorities used to visit the plants and were also involved in the trainings, especially in horticulture, other agricultural practices and so on. There were no direct contributions made by the local authorities in the biogas plants.
6		
a	How were the activities planned and does their implementation secure sustainability?	The project activities were carried out in a planned and sequential manner. The project has completed the task, but the phasing out stage needs more time and a sustainability plan has to be drawn especially in areas of maintenance. More focus has to be given now on training and also developing volunteers at the village level in order to support the farmers, especially where the construction is new.
b	Have the stakeholders been actively and meaningfully involved in project design, implementation and monitoring?	Technical experts from HPPI and UFF were involved in project planning and designing. The community was actively involved in project implementation.

c	How will the project beneficiaries and/or stakeholders be able to continue the work initiated by the project? o Has the technical guidance given to the communities been good enough for the biogas plants to be sustainable even after this project ends? Are the necessary spare parts and knowledge on how to use them easily available?	The project has focused a lot in training and providing technical inputs to the beneficiaries for operating and maintenance of their biogas units. The beneficiaries have also understood their role and responsibilities in ensuring proper maintenance of their biogas units. The technical guidance and trainings given to beneficiaries under the project for biogas unit maintenance was very good. The beneficiaries are also aware of how to identify problems in the unit and how to repair them. More training has to be given and HPPI should also visit the plants at least once in 6 months to see the effectiveness of the plants and guide the farmers if anything is amiss. Spare parts for the units are easily available locally, which will contribute significantly towards project sustainability in the long run.
d	How likely are the project benefits to continue for a reasonable period of time?	The biogas units constructed under the project are of good quality and are technically sound. The beneficiaries have also been provided adequate training to ensure proper maintenance of their biogas units. The units will be operative for at least 20 years, if maintained properly. On the other hand, if they are sufficiently motivated they may benefit from them for an even longer period and can go ahead if they are ready, to construct another plant out of their own investment.
e	Is there evidence of replication or up scaling of project activities in the organization or in the communities?	There is no evidence of such an incidence but the present beneficiaries are motivated, and some are thinking of establishing a second plant to make use of the available slurry. Though the project had been started with a higher contribution made by HPPI, now the people are ready to pay more to get their biogas plants installed, this in turn may help more beneficiaries within the limited budget.

CHAPTER 3: STUDY FINDINGS

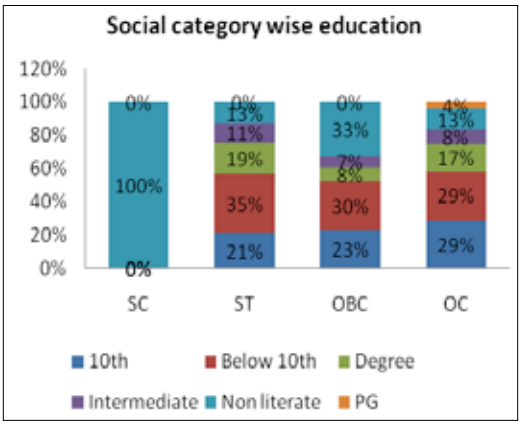
The study was conducted in 20 villages of Dausa district, Rajasthan. The study was conducted for evaluating the project entitled **"Biogas as renewable energy source in Indian villages"**, being implemented by HPPI and supported by UFF. The major study findings related to project beneficiaries are provided in this chapter.

A. Demographic Details:-Beneficiaries and Non beneficiaries

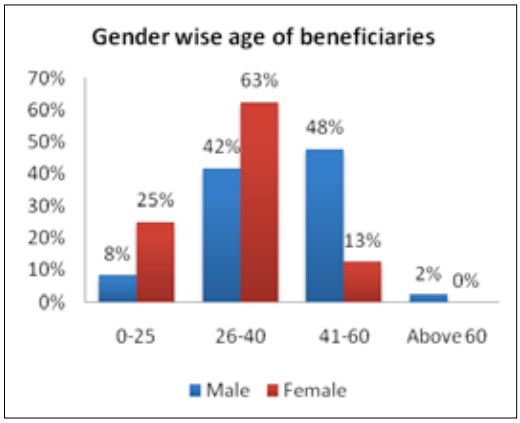
A total number of 148 beneficiaries and 65 non beneficiaries were interviewed under the study for data collection. 89% of the total respondents were male and 11% were female. Though the percentage of females involved looks low it is considerably more than what has been shown. In most of the cases, both the men and the women were present while responding to the survey, but only the name of the male beneficiary was recorded. For around 46% of the respondents, both men and women were present during the interview and responded together. While 92% of the total non beneficiaries interviewed were male.

10% of the beneficiary respondents belonged to the age group of 0-25 years and 44% each were in the age group of 26-40 years and 41-60 years. 2% of the respondents were above the age of 60 years.54% of the total non beneficiaries interviewed were in the age group of 26-40 years and 25% were between 41-60 years of age. The remaining 21% of the non beneficiaries were in the age group of 0-25 years.

41% of the beneficiary respondents belonged to the Other Backward Caste category and 42% were from Scheduled Tribe category. 1% of the respondents were Scheduled Caste and the remaining 16% respondents belonged to Other Caste, i.e. non backward category. 46% of the total non beneficiaries belonged to the Other Backward Caste category and 42% were from Scheduled Tribe category. 3% of the respondents were from Scheduled Caste category and the remaining 9% belonged to the Other Caste category.



21% of beneficiary respondents were non literate. 32% respondents were educated below the 10th standard and 23% were educated upto the 10th standard. 9% respondents were educated upto the Intermediate level. While 15% and 1% of respondents were educated upto the Degree and PG level respectively. 34% of the non beneficiaries interviewed, were non literate and 25% are educated below the 10th standard. 25% of the respondents were educated upto the 10th standard. 11% and 6% of the respondents were educated upto the Degree and Intermediate level respectively.



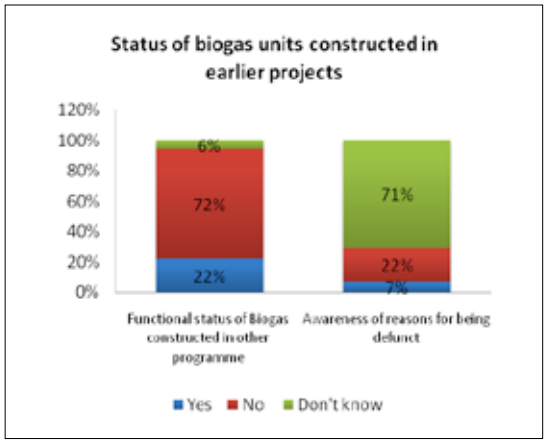
8% of male respondents interviewed were in the age group of 0-25 years and 42% were in the age group of 26-40 years. 48% and 2% of males were in the age group of 41-60 years and above 60 years respectively. 25% of female respondents were in the age group of 0-25 years and 63% were in the age group of 26-40 years. While 13% female respondents were between 41-60 years of age.

21% of ST were educated upto the10th standard, 35% were

educated below the 10th standard and 19% were educated upto the Degree level. 11% of ST respondents were educated upto the Intermediate level and 13% were non literate. 23% of OBC were educated upto the 10th and 30% below the 10th standard. 33% of OBC were non literate. 13% of OC were non literate, 29% each were educated below the 10th and upto the 10th standard and 17% were educated upto the Degree level.

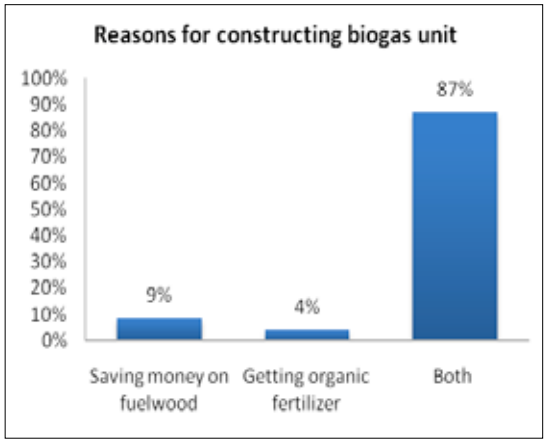
B. Project Effectiveness

77% of the beneficiary respondents had a basic awareness about biogas plants since the government had implemented the scheme in their village. However, the awareness they had acquired was negative in nature due to the failure of the plants constructed under the government schemes. HPPI had to conduct a lot of awareness generation events and only after seeing the successful operation of the biogas units implemented by HPPI did they develop sufficient confidence to come forward in constructing their own biogas units.



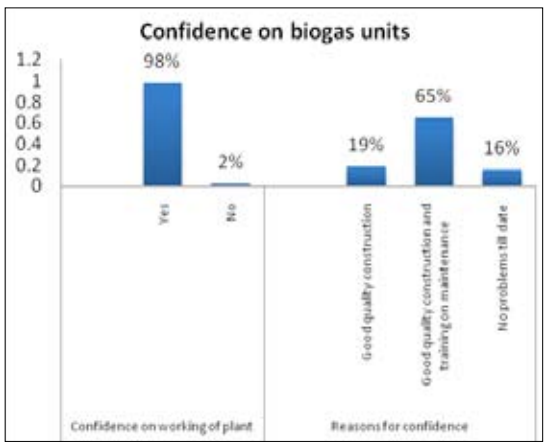
22% of the respondents said that the biogas units constructed under earlier schemes are functional while 72% said that they were not functional. 6% were not aware of the functionality of biogas units, which were constructed under the government schemes. 71% respondents were not aware of the reasons due to which the biogas units were defunct.

The study revealed that most of the biogas units constructed under the government scheme were not functional. The biogas units constructed under the government projects were not technically sound and there were frequent problems of gas leakage, very low gas production, frequent breakdowns, difficulty in the availability of spare parts, etc. The community did not assume the ownership of biogas projects implemented under government schemes. The beneficiaries of the government biogas projects were also not satisfied with the project benefits, which accrued to them.



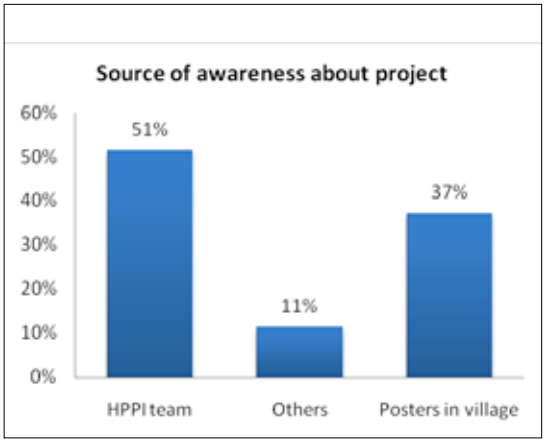
9% of respondents said they constructed biogas for saving money on firewood while 4% of the respondents had constructed biogas for acquiring organic fertlizer. Majority of the sample beneficiaries, however, i.e. 87% respondents-constructed biogas units for both of the above benefits.

98% of respondents said that they were confident about the working of the biogas plant. While 19% respondents identified good quality of construction as the reason for their confidence. 65% reported good quality of construction and training on maintenance of biogas units. 16% respondents conferred that there were no problems reported in their biogas units till date, and hence they were confident that the units would work properly.

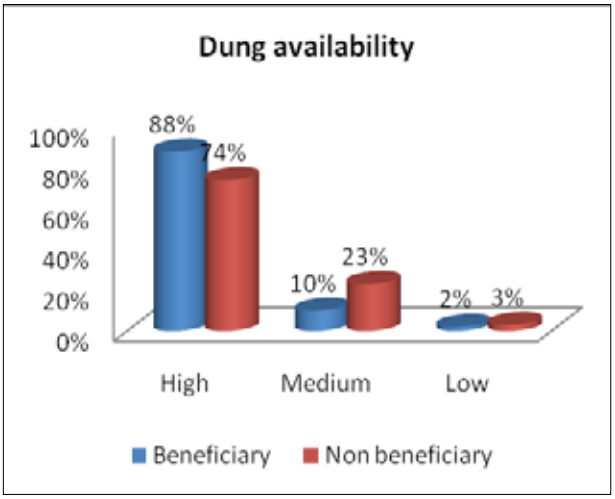


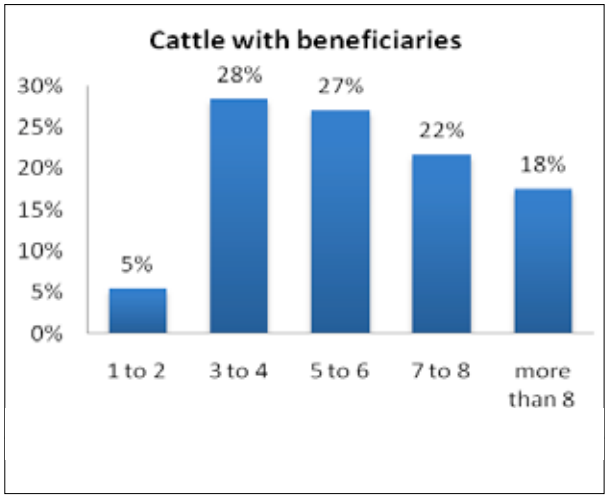
The respondents had a positive attitude towards the biogas units constructed under the project. They were confident

about the quality of construction, and the trainings imparted on biogas maintenance as well. Quality construction by the trained masons and training on maintenance and operations were the main reasons for the confidence among the beneficiaries on the functioning of the biogas unit over a long period of time. Again, many volunteers were trained in the villages, and these volunteers were ready to help out the beneficiaries whenever any issuearose. This also added to their confidence and the fact that the HPPI team was always present there and could be approached as and when required should any issue arise.



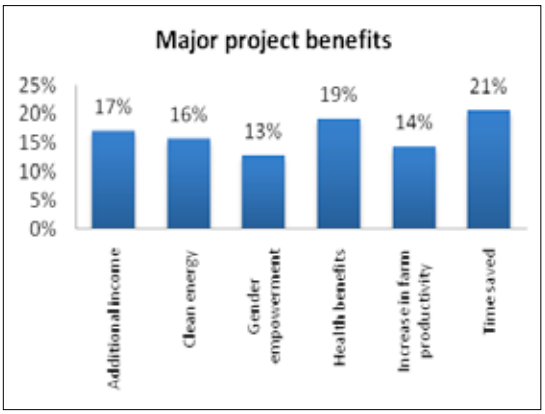
51% of the sample beneficiaries said that the HPPI team was their real source of awareness of the project. 37% beneficiaries were aware of the project from the posters displayed in the villages about the project. The remaining 11% of the beneficiaries came to know about the project from other sources.





It reflects that the visibility of the project has been good. The HPPI team and the posters put up in the villages have created awareness among the respondents about the project, its components, objectives, activities and benefits.

5% of respondents had 1-2 heads of cattle and 28% had 3-4 heads of cattle in their household. 27% respondents had 5-6 heads of cattle while 22% had 7-8 heads of cattle. The remaining 18% respondents had more than 8 heads of cattle in their household. The average number of heads of cattle per respondents is 4. 88%. Most of the beneficiary respondents said that the dung availability was high while 10% respondents said there was medium availability of dung. 2% of respondents reported low availability of dung. The average number of cattle with the non beneficiary was 4. The opinion of the non beneficiary was also taken on the dung availability. 74% of the non beneficiaries said that they had high dung availability while 23% of them said dung availability was medium. Only 3% of the non beneficiaries have reported low dung availability.



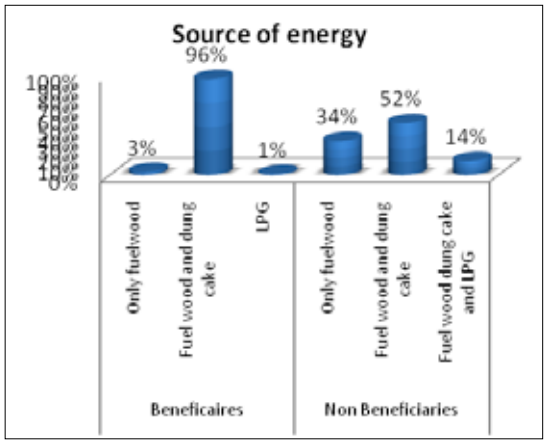
The overall dung availability with the respondents was adequate, which is essential for the functioning of the biogas units. This is also an indication of the appropriate selection of beneficiaries for the biogas project. Beneficiaries having

high dung availability were selected as dung is the major input required for the functioning of the biogas units.

17% respondents benefited from the project by acquiring additional income. The income of the respondents increased from agriculture due to the reduced cost of cultivation and the increase in productivity. 16% respondents said, clean energy was a major benefit from the project and 13% said that the project had led to gender empowerment. 19% respondents admitted that health benefits in terms of reduced indoor pollution diseases and reduced health expenditure were the major benefits of the project. 14% respondents reported an increase in agricultural productivity as the major benefit, while 21% said time saved by biogas was the major project benefit. The responses related to health benefits and increased productivity have directly led to additional income for the respondents as money is being saved on health expenses and increased agricultural productivity is providing more income to the respondents. The response related to clean energy also contributes towards savings on firewood as fuel, and encourages the use of readily available cow dung as an alternative energy source.

It is evident that the project has benefited the respondents in multiple ways. It has helped them save cost on traditional energy sources and also provided them a cleaner energy source in the form of biogas. The biogas units have also reduced health related problems faced by the women and helped in saving them a lot of time. Farm productivity has also increased due to the use of slurry from the biogas units.

Earlier, since women had the dual work of cooking for the family as well as working at the family farm, the responsibility of the smaller children fell on the older siblings. Due to this, these children would usually drop out of school or do very badly as they were unable to concentrate on their school work, and their grades would suffer. Thankfully, now women have more time, and they spend it on taking care of the children. So the education of the older siblings is not affected while the health of the younger children is also not affected by pollution from the fuel used at home. The women are also able to spend more time in agricultural activities on their farm, and in providing personal care to the crops and cattle which further helps in procuring additional income.



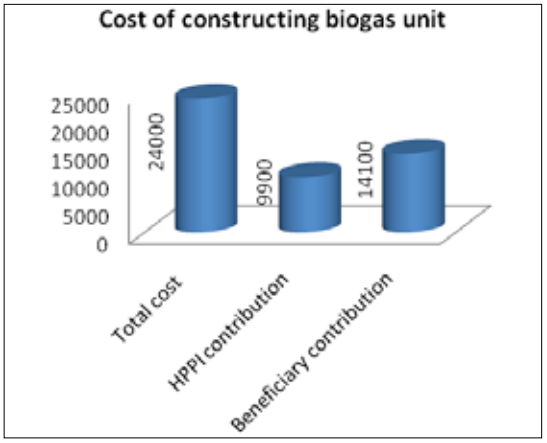
The energy source of beneficiaries was assessed for the pre project period as currently they are using biogas units for meeting their energy requirements. 3% of beneficiary respondents used only firewood as fuel in the pre project period while 96% used firewood and dung cakes and 1% used LPG. 34% of non beneficiaries used only firewood while 52% used firewood and dung cakes, while 14% used firewood, dung cakes and LPG as their energy sources.

It was noticed that the beneficiary respondents were heavily dependent on firewood and dung cakes for their energy needs in the pre project period. However, in the post project period most of their energy needs are being met by the biogas unit. This has reduced pressure on the cutting of trees and led to biomass improvement. Due to biogas the beneficiaries have stopped using LPG, and this has reduced their costs drastically considering the recent increase in the cost of LPG. Earlier, biomass was being used as fuel, and now it is made into compost and used as manure. This improves the fertility of the soil and also helps in reducing the use of chemical fertilizers. Meanwhile, the non beneficiaries still continue to be dependent on firewood and dung cakes for meeting their energy requirements.

C. Economic Impact

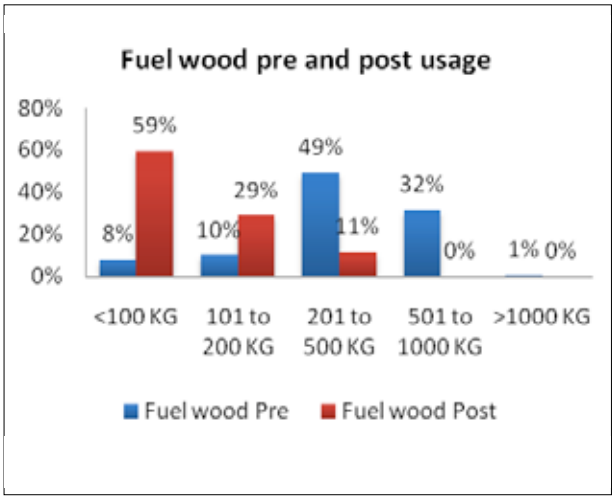
The average cost of setting up a biogas unit per beneficiary was Rs 24,000. The beneficiaries were provided

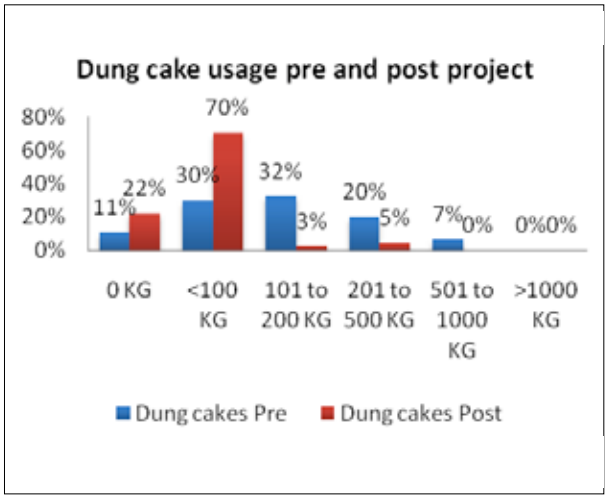
a subsidy from HPPI for biogas unit construction. The average subsidy per beneficiary was Rs 9,900. Thus, the beneficiary's contribution was only Rs 14,100 per unit.



This is a high cost that has to be borne by the respondents for establishing a biogas unit under the project. Initially, this was a limiting factor as respondents found it difficult to afford the amount and were also hesitant to invest the amount upfront. However, after seeing the success of biogas units installed under the project and the benefits it offered, the respondents were convinced and came forward to make this investment and get their own biogas units under the project. The community mobilization undertaken by the HPPI team was very commendable in this regard.

The usage of firewood and dung cakes has been reduced in the post project implementation period. As seen in the graphs above, the percentage of respondents using less than 100 Kg of firewood and 101-200 Kg of firewood per month has increased in the post project compared to the pre project period. Similarly, the

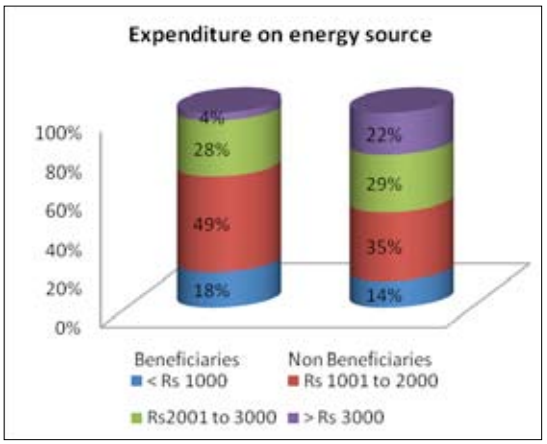




quantity of usage of dung cakes per month has also been reduced in the post project period due to the usage of biogas as the energy source.

The respondents were heavily dependent on firewood and dung cakes as their energy source in the pre project period. Their dependency on these sources has reduced as in the post project period they use biogas for meeting their energy requirements. The biomass in the villages has increased due to reduced cutting of trees for firewood. The dung is also made better use of in biogas units instead of being used as dung cakes.

In the pre project period,18% of respondents spent less than Rs 1,000 per month. 49% respondents spent Rs 1,000-2,000 per month while the monthly expenditure of 28% respondents was Rs 2,000-3,000 per month. 4% respondents spent more than Rs 3,000 per month on energy sources. The average cost of energy source in the pre project period was seen to be **Rs 2,220** per month.

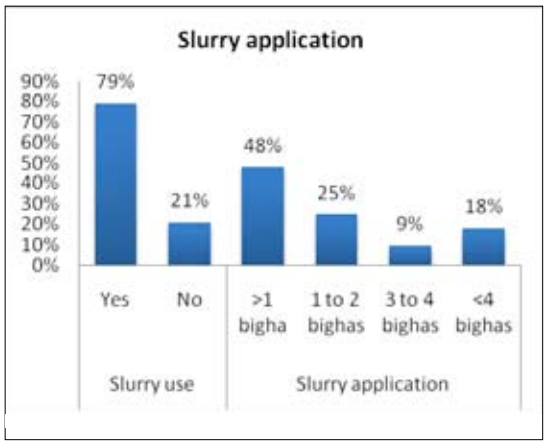


In the post project period the respondents on an average used 107 Kg of firewood and 39 Kg of dung cakes per month. Thus the average cost of energy sources used during the post project period came down to **Rs 535** per month.

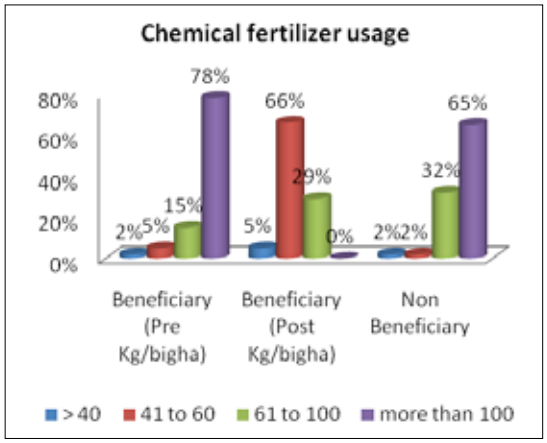
The average monthly expenditure on energy sources for the non beneficiary was less than Rs 1,000 per month for 14% of the non beneficiaries. 35% non beneficiaries spent Rs 1,001- 2,000 on their energy source. 29% non beneficiaries spent Rs 2,001- 3,000 per month on their energy source while the expenditure for 22% non beneficiary was more than Rs 3,000. The average monthly expenditure per beneficiary was **Rs 2,578**.

The above analysis shows that the beneficiaries are saving on **Rs 1,685 per month** as their energy needs are being met by the biogas unit installed under the project. The non beneficiaries though have to meet their energy requirements from other sources and have to forego **Rs 2,578** per month for the same. Hence the project has been successful in saving costs for meeting energy requirements for all the beneficiaries.

79% of the respondents interviewed, used slurry from their biogas units on the farm. 21% respondents were unable to use slurry as their biogas units had not reached the slurry production stage as yet. Hence all the respondents, whose biogas units were producing slurry, applied the slurry on their farms.
48% of the respondents used slurry in less than 1 bigha of land while 25% used it in 1-2 bighas. 9% respondents applied slurry in 3-4 bighas while the remaining 18% respondents used slurry in more than 4 bighas of land. The average area on which slurry was applied by the respondents was **2.24** bighas. The slurry from the biogas units have enhanced the productivity of the farm and also reduced the cost of purchasing chemical fertilizers.

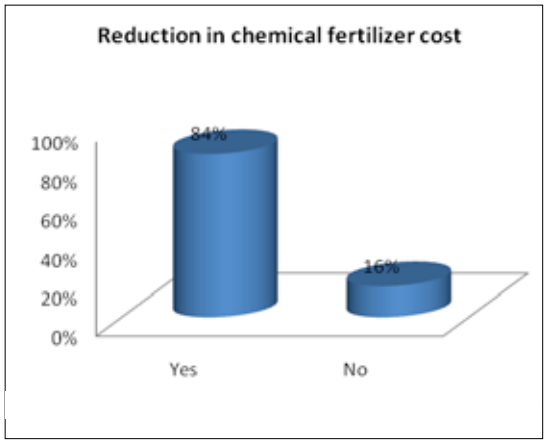


During the pre project period, 2% respondents used less than 40 Kg of chemical fertilizer per bigha and 5% respondents used 41-60 Kg fertilizer per bigha. 15% respondents used chemical fertilizers up to 61-100 Kg/bigha and the remaining 78% respondents used more than 100 Kg/bigha of chemical fertilizer. In the post project period, 5% of the respondents are using less than 40 Kg of fertilizer per bigha. Fertilizer application was found to be 41-60 Kg/bigha for 66% of respondents and 61-100 Kg/bigha for the remaining 29% of beneficiaries.



The non beneficiaries were also questioned about their usage of chemical fertilizer. Chemical fertilizer usage for 2% of the non beneficiary was less than 40 Kg/bihga. 2% non beneficiaries used 41-60 Kg/bigha while 32% non beneficiary applied 61-100 Kg/bigha. The chemical fertilizer usage for the remaining 65% of non beneficiaries was more than 100 Kg/bihga.

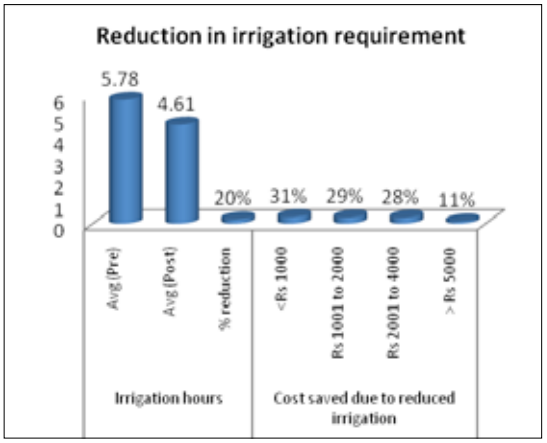
Thus, we can see that the use of chemical fertilizer has been greatly reduced by the beneficiary respondents as they now use slurry on their farms. The slurry acts as organic manure and supplements the nutrient requirement of the soil.



84% respondents said that their expenditure on chemical fertilizer has reduced. The expenditure on chemical fertilizer per agricultural season has reduced as the respondents

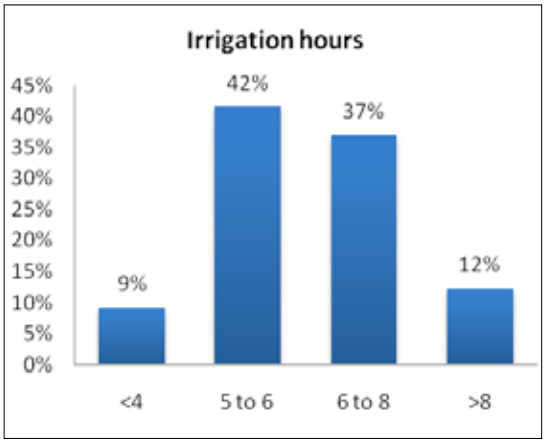
have used slurry on their farms. As the slurry supplements the nutritional requirement of the soil, a lower quantity of chemical fertilizer is needed. This lower use of chemical fertilizer has brought down the cost of cultivation to a great degree.

The hours spent on irrigation per day during the pre project period was 5.78 hours while in the post project period it was reduced to 4.61 hours. The reduction in irrigation requirement has thus been almost 20%.

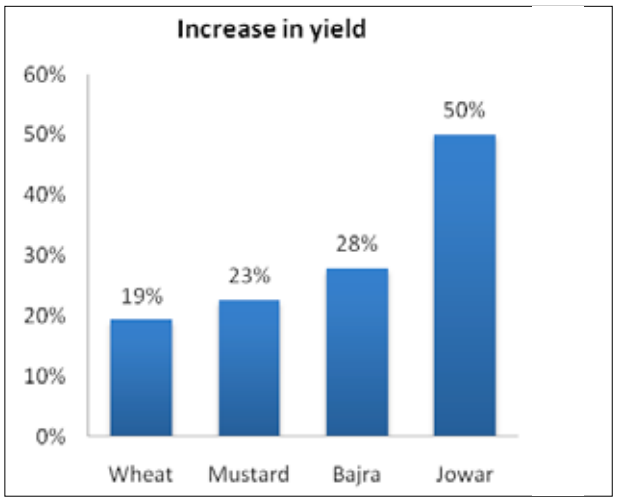


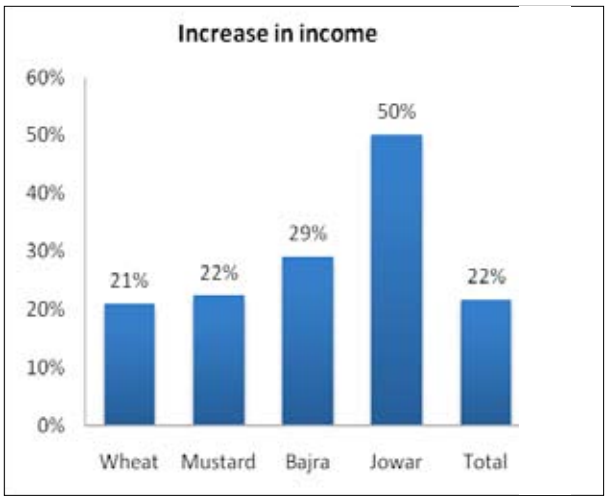
The reduced irrigation requirement has also led to reduction in irrigation cost for the respondents per agricultural season. 31% respondents said their savings was less than Rs 1,000 while 29% of respondents saved Rs 1,001-2,000. 28% of the respondents have saved Rs 2,001-4,000 while the remaining 11% of respondents saved more than Rs 5,000 from the reduction in irrigation hours. The average cost in savings per respondent was **Rs 1,685** per agriculture season from the reduced irrigation hours.

The irrigation requirement has reduced due to the application of slurry. The slurry applied ensures greater nutrient and moisture conservation in the soil and hence less irrigation is needed. The reduced cost of irrigation leads to reduction in the overall cost of cultivation for the respondents.



The irrigation hours for 9% of non beneficiaries were reported as less than 4 hours per day. 42% of non beneficiaries used irrigation facilities for 5-6 hours per day while for 37% of non beneficiaries it was 6-8 hours per day. The remaining 12% of non beneficiaries used more than 8 hours of irrigation per day. The average irrigation hours per day for non beneficiaries were **6.76 hours**.





The impact of the project on agriculture was also studied. The major crops cultivated in the region consisted of Wheat, Mustard, Bajra and Jowar. The agricultural yield of the respondents has increased post project implementation. The increase in yield of Wheat was 19%. The yield increased by 23% for Mustard and 28% for Bajra. Jowar registered an increase of 50% in yield.

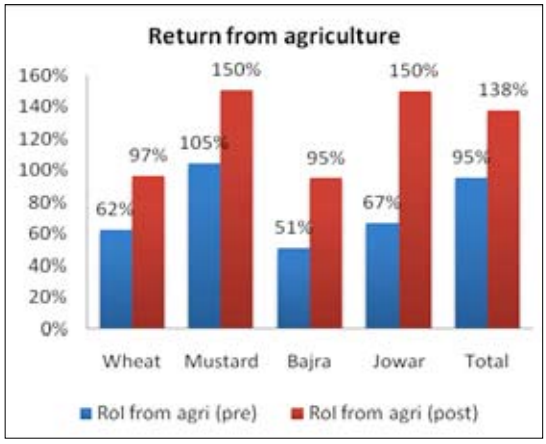
The income of the respondents from agriculture has also increased. The increase in income from the cultivation of Wheat was 21% while the income from Mustard increased by 22%. The income of the respondents from cultivation of Bajra and Jowar was also increased by 29% and 50% respectively. Thus, the overall increase in income of respondents from agriculture was 22%.

The yield has increased due to the use of slurry on the farms. Slurry acts as organic manure and is rich in nutrients needed by the crops. Slurry application has also enhanced the moisture holding capacity of the soil which also leads to increased productivity. The income from agriculture has increased both due to reduction in cost of cultivation resulting from reduced expenses on chemical fertilizer and irrigation and also due to increased productivity from the farm.

The different crops cultivated by beneficiary respondents are provided in the following table:

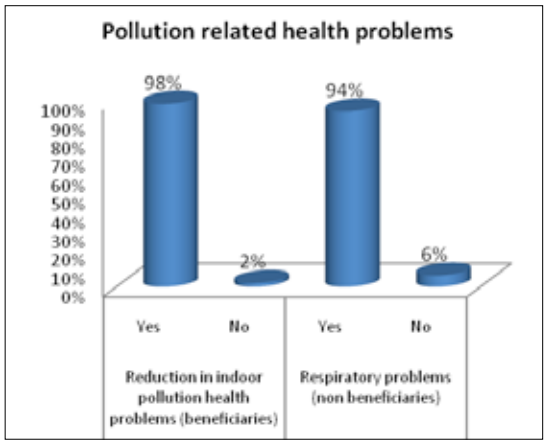
S.No	Crop 1	No of respondents cultivating	Crop 2	No of respondents cultivating
1	Wheat	100	Wheat	48
2	Mustard	46	Mustard	86
3	Bajra	12	Bajra	0
4	Jowar	2	Jowar	2

The yield and the income from agriculture have increased for the respondents. This has resulted in a positive and favorable return from agriculture. The **RoI**[1] (ROI)from Wheat cultivation increased from 62% in pre project period to 97% in the post project period. The RoI from Mustard increased from 105% to 150%. The RoI from Bajra was 51% in pre project which increased to 95% in post project, while RoI from Jowar has increased from 67% to 150% in post project period. The overall RoI from agriculture was 95% in pre project period which has increased to 138% in the post project period.



The **RoI** has increased due to reduced cost of cultivation and increased agricultural productivity due to slurry application.

98% of the beneficiary respondents said that the indoor pollution related health problems have reduced due to the use of biogas units. The incidence of indoor pollution related diseases was high for non beneficiaries as they used firewood and dung cakes for cooking, which produced significant smoke and increased pollution inside the house.

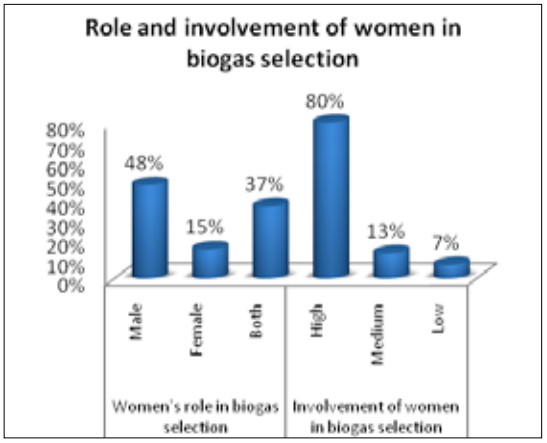


Confirming this observation, 94% of the non beneficiary respondents also said that they face respiratory problems due to high levels of indoor pollution.

Indoor pollution leads to respiratory problems affecting the lungs and also causes eye ailments. Similar cases of indoor pollution related health problems were not observed in beneficiary respondents.

[1]**RoI= (Income- expenditure)/expenditure**

56% of beneficiary respondents saved less than Rs 1,000 per year on health expenses, 28% respondents saved Rs 1,001-2,000 per year. The saving in medical costs added uptoRs 2,001-3,000 for 7% of respondents and Rs 3,001-4,000 for 2% sample respondents. The remaining 6% of sample respondents saved more than Rs 5,000 per year on health expenses. The average cost saving per respondent per year was **Rs 1,405**.



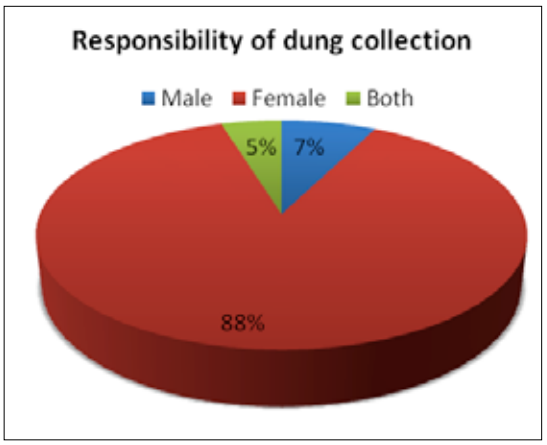
The average annual expenditure of the non beneficiary respondents on indoor pollution induced diseases was assessed. 49% of the respondents made an annual expenditure of less than Rs 1,000. 31% of respondents made an annual expenditure of Rs 1,001-2,000 on health problems due to indoor pollution. The expenditure on health for 11% of respondents was Rs 2,001-4,000 while 9% of respondents spent more than Rs 5,000 per annum on indoor pollution induced health problems. The average annual health related expenditure for respondents was **Rs 1,738**.

D. Gender Impact

48% of the respondents said that the decision to install a biogas unit was made by the senior male in the household while only 15% of respondents said that the senior female member was the decision maker in installing the biogas unit. 37% of respondents said that the decision to buy a biogas unit was taken jointly by both the main male and female member in the household. 80% of the respondents were of the opinion that women had a big role in the selection of the type of biogas unit i.e. deciding on the location of the biogas unit, the volume of biogas unit required for the household, deciding the number of burners required and so on.13% of the respondents said that women had a medium role while 7% said women had a very small role in the selection of the type of biogas unit that was to be installed.

Males in the household had the major say in the decision regarding purchasing of biogas in household due to the financial implications involved. Once the decision regarding the purchase was made women had a bigger role in deciding about the type of biogas unit needed, number of burners, volume needed for the household, etc. Though in 7% of the households women had a very small role to play as the decisions regarding specifications of the biogas unit was also taken by the men.

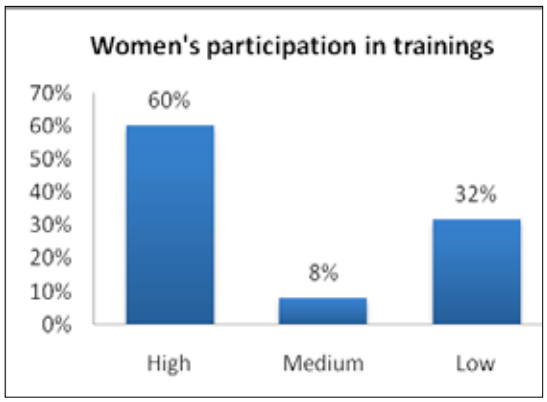
The collection of dung is an important activity in the operation of the biogas unit. The respondents were asked about the responsibility of dung collection. 88% of the respondents said that the women were responsible for dung collection in the household. 7% of the respondents said the male member was responsible for dung collection while in the remaining 5% of the household, dung was collected by both the men and the women.



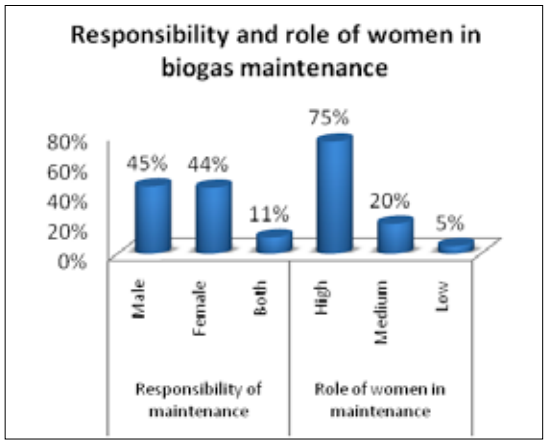
Collection of dung was seen predominantly as a woman's duty, and they were primarily responsible for this. Women had to collect and prepare the dung for use in the biogas unit.

The participation of women in the trainings that were conducted under the project was studied. 60% of the respondents opined that women's participation in the project related training was pretty high. 8% respondents said that women's participation in the training was medium while the remaining 32% of beneficiaries said that the participation of women in training was rather low.

In some households, women were not allowed to go out and attend the training hence their participation was recorded as medium and low in such instances. However, whatever training was given within the village, women participated in higher percentage than the men. Overall women's participation in the project trainings was good.

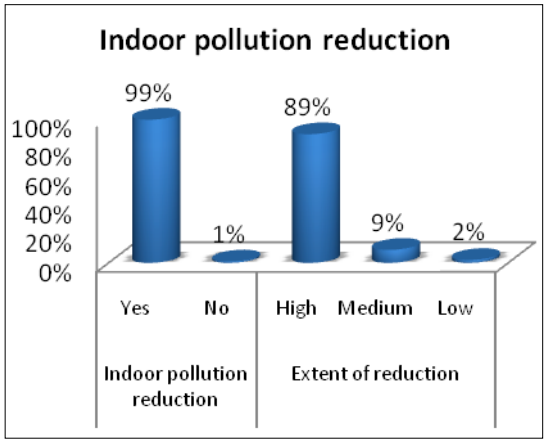


The study revealed that the responsibility of the maintenance of the biogas units was assigned to the male members in 45% of the respondents' household. In 44% of the households, women were responsible for maintenance of the biogas unit. In the remaining 11% of the households, the men and women were jointly responsible for maintenance of the biogas unit. 75% of the respondents said that women had a bigger role in biogas unit maintenance. 20% and 5% of the respondents said that women had a medium and smaller role respectively in the maintenance of the biogas units.



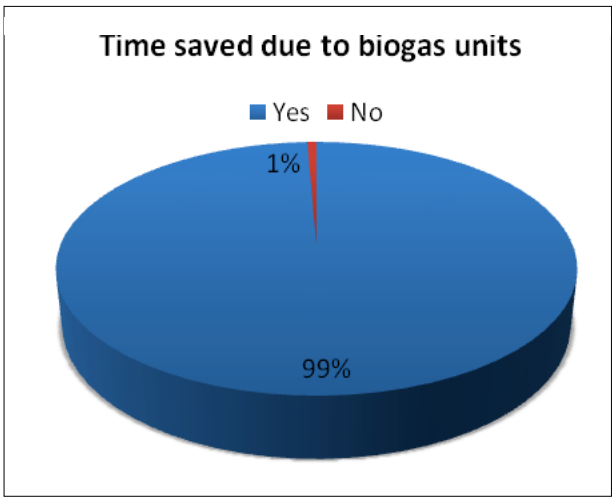
Biogas unit maintenance was seen as a joint function in which both men and women members of the household were usually involved. However, as the women spend more time in the household, they have a bigger role in the maintenance and daily upkeep of the unit as reflected in the graph above.

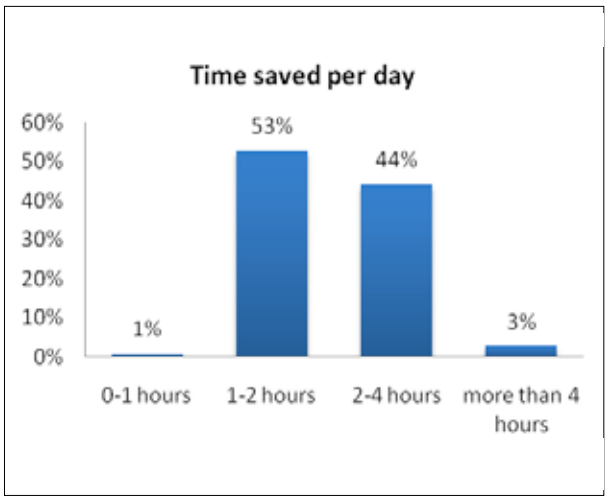
Majority of the respondents, i.e. 99% reported reduction in indoor pollution due to the use of the biogas units. The women involved in cooking face problems due to indoor pollution caused by the use of firewood and dung cakes. The smoke causes respiratory problems and eye ailments. The reduced indoor pollution has ensured healthy working conditions for women in the household and reduced incidence of respiratory problems and eye ailments, which occurred very frequently in the pre project period, when firewood and dung cakes were being used as fuel to power the ovens while cooking. As the respondents used firewood and dung cakes (during the pre project period) indoor pollution rates had been very high. This indoor pollution has reduced after using biogas. 89% of the respondents said that the reduction in indoor pollution was high while 9% and 2% respondents reported medium and low reduction in indoor pollution respectively.

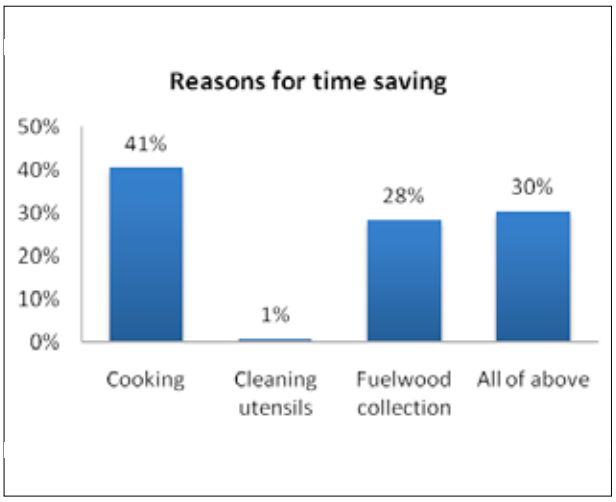


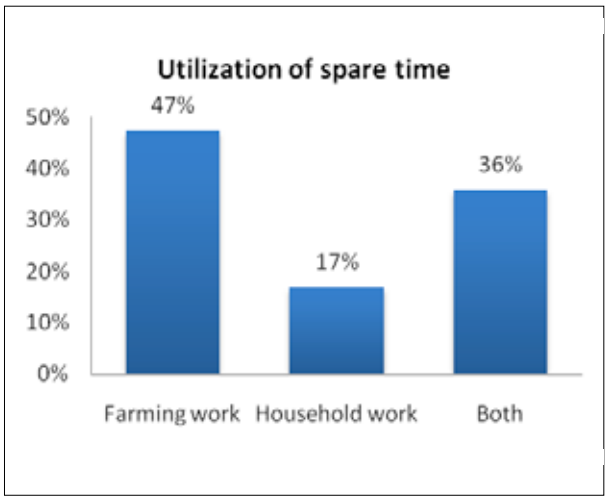
The biogas units have significantly reduced the indoor pollution caused due to cooking using traditional energy sources like firewood and dung cakes. Biogas is a cleaner energy source and hence there is no indoor pollution. The extent of reduction in indoor pollution has been quite significant.

99% of the respondents said that due to use of biogas units, time was saved by the women in the household. In 53% of the respondents' households women saved 1-2 hours of time per day while in 44% of households time saved by the women was up to 2-4 hours per day. In 1% of households women saved 0-1 hours while in 3% of households women saved more than 4 hours per day due to use of their biogas unit. Thus, we can see that the biogas units have definitely contributed in saving time for the women in the household. The time saved is being used by the women for carrying out other important duties.



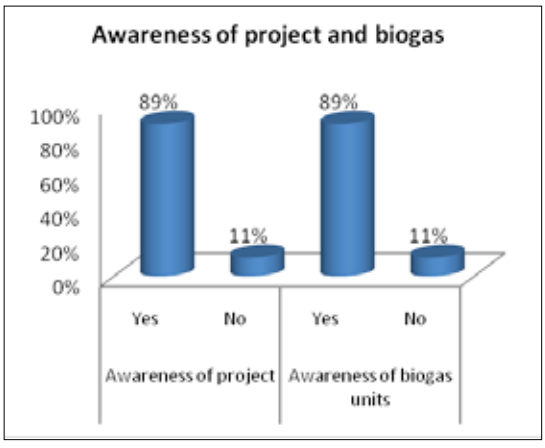






41% respondents said time was saved as a lower amount of time is taken for cooking while using biogas as compared to the traditional energy sources like firewood and dung cakes that were used earlier. 1% respondents said time was saved in cleaning utensils as there was less soot on the utensils used for cooking with biogas. 28% respondents said time was saved on the collection of firewood. 30% of respondents opined that all the above mentioned factors led to time saved by women using biogas. Women in 47% of the respondent households utilized the additional time saved by doing farm work while 17% carried out other household duties at that time. Women in 36% of respondent households carried out both farm activities and other household duties in the time saved.
Thus, the time saved is being utilized by women in doing various domestic and farm related activities.

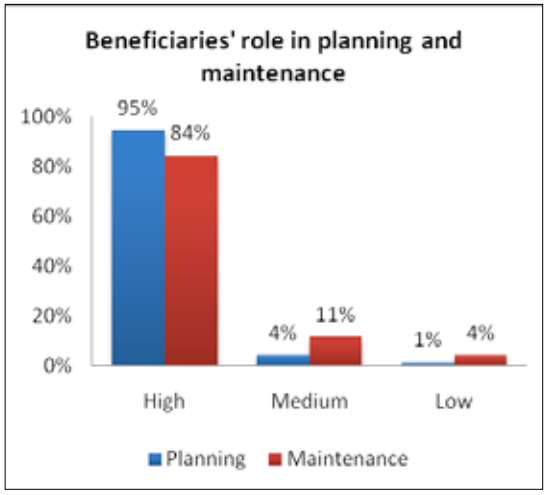
E. **Sustainability**



89% of the respondents were fully aware of the project its components, objectives and activities. The remaining 11% of respondents were partially aware of the project. Similarly, 89% of the respondents were fully aware about the biogas units and their benefits while 11% of respondents were partially aware of the same.

There was a significant level of awareness among the respondents about the project. This was due to good quality of community mobilization, use of IEC materials and efforts of the HPPI implementing team in visiting and communicating with the beneficiaries. The respondents were

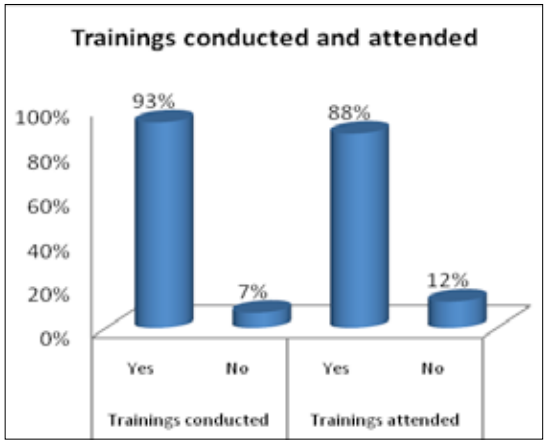
aware of the benefits of the biogas units; how they were run, how they were being benefitted and so on. This was also because in some of the villages, other biogas projects had been implemented earlier under various government schemes.



The overall role and involvement of the respondents in planning and maintenance of the biogas units under the project was assessed. 95% of the respondents said they have a big role in the planning of the individual beneficiaries' biogas unit at the household level. 4% respondents said they have a medium role while 1% said they have a small role in the planning of the individual biogas unit at the household level.

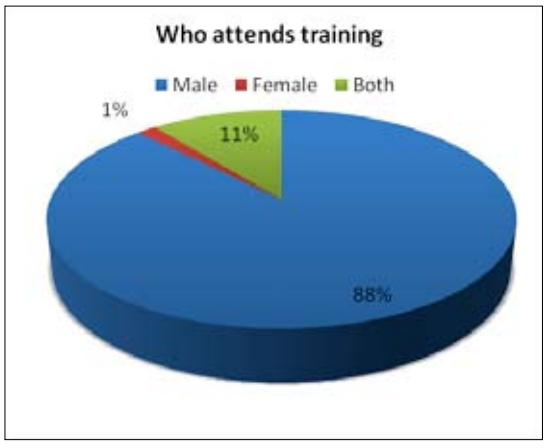
84% of respondents said their role in the maintenance of the biogas unit is high. 11% and 4% respondents reported medium and small roles in the maintenance of the biogas units constructed under the project.

The involvement of the individual beneficiary at the household level in planning was quite good. The household was involved in deciding about the type of unit needed, number of burners required, and volume of the biogas unit required and so on. The respondents have also understood their role in maintaining the biogas units after project closure, which will contribute significantly towards the project sustainability.



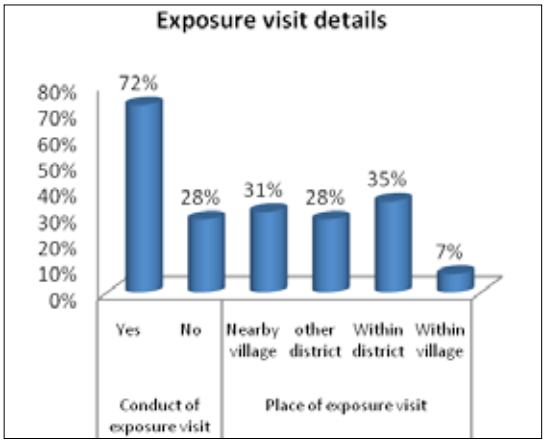
93% of respondents said that relevant biogas related trainings were conducted under the project. 88% of the respondents said they have attended the trainings conducted under the project. The remaining 12% respondents have not attended the trainings, but other members of the family have attended, on their behalf.
The overall awareness among the respondents about the trainings conducted under the project was quite good. The attendance of the respondents in the trainings and their participation was also appreciable.

88% of respondents said that their male members attended the trainings while in 1% of the households the women attended the biogas trainings. In the remaining 11% of the households, both the male and female members jointly attended all biogas related trainings. The respondents were asked about the usefulness of the trainings conducted under the project. 78% of the respondents said that the trainings were highly useful while the remaining 22% respondents said that the trainings were of medium usefulness. Though the number of



women attending the trainings is less compared to the men, the participation and involvement of the women in trainings, their keen learning attitude was higher than the men. Hence the participation level of women attending the trainings is much higher as compared to men.

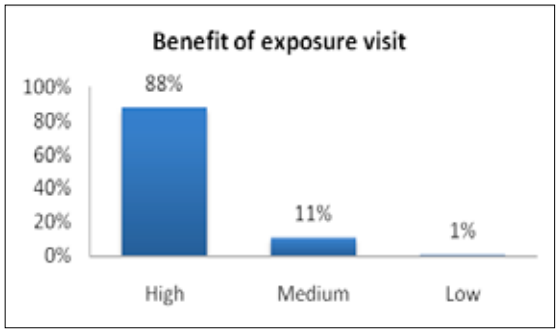
The trainings were mostly attended by the male member in the household as women's mobility, outside their home is somewhat restricted. As a result, the attendance at the trainings was quite low. Overall most of the respondents found the trainings useful. Hence the trainings have greatly fulfilled their purpose of creating awareness about the project. It has encouraged the use of biogas units among respondents and also succeeded in imparting knowledge and relevant skills for the maintenance of their biogas units.



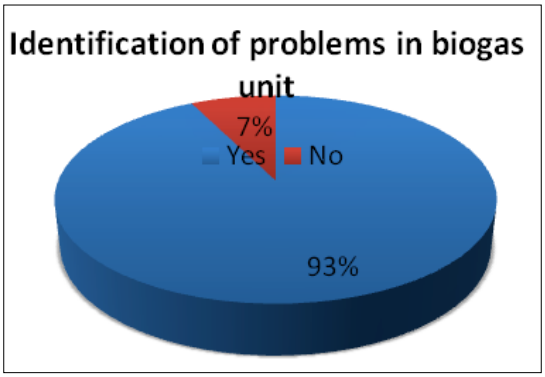
72% of the respondents said that exposure visits were conducted under the project. 31% respondents said the exposure visits were conducted in the nearby villages while 7% beneficiaries said exposure visits were conducted within the same village. 35% respondents reported that exposure visits were held within the same district while the remaining 28% said that the exposure visits were conducted in other districts as well.

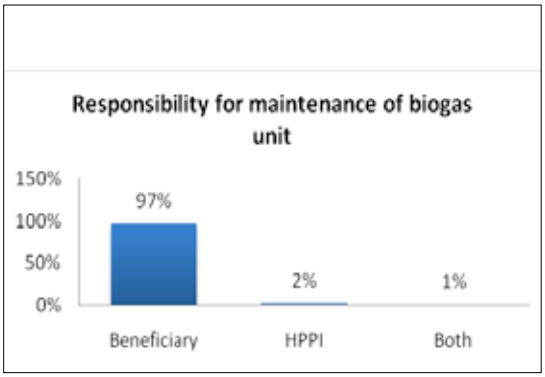
Exposure visits are important in orienting the respondents about the project and making them understand all its benefits. The exposure visits also motivate the respondents to own the project in the long run. This in turn contributes towards ensuring sustainability of the project.

88% respondents said that the exposure visits were highly useful. 11% respondents said the exposure visits were of medium use while the remaining 1% found the exposure visits conducted under the project to be of low use.

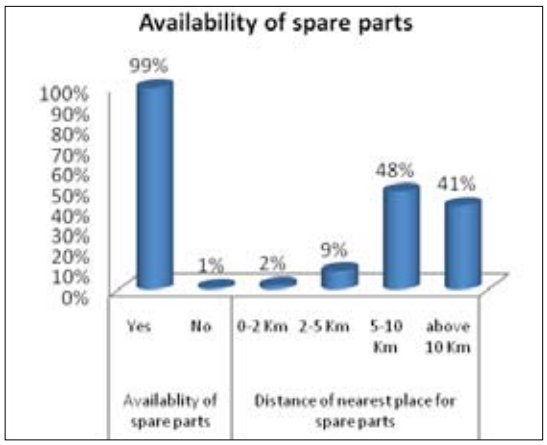


The respondents were asked if they can identify the problems arising in the biogas units. 93% of the respondents said they can identify the problems arising in the biogas units and also assess the spare parts needed for fixing the problem. This reflects the effective training imparted to the respondents under the project on maintaining their biogas units. 97% of the sample respondents said that the individual beneficiary is responsible for maintaining the biogas unit constructed under the project. 2% respondents said that HPPI was responsible for maintaining the biogas unit while 1% said that both the beneficiary and HPPI were responsible for biogas unit maintenance. The individual respondents have understood that maintaining the biogas units is their responsibility, and this will contribute significantly towards ensuring sustainability of the project.



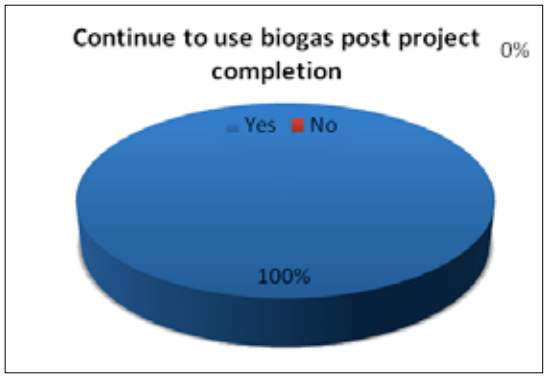


99% of the respondents said that the spare parts needed for biogas unit maintenance were easily available. On being enquired about the distance of the nearest place that supplied the spare parts, 2% respondents said they get their spare parts within 0-2 Km from their village. 9% respondents said they have to travel across 2-5 Km to find spare parts for their unit. 48% respondents said they get their spare parts within 5-10 Km, while the remaining 41% respondents said that the nearest place, they could get their spare parts is more than 10 Km from their village.



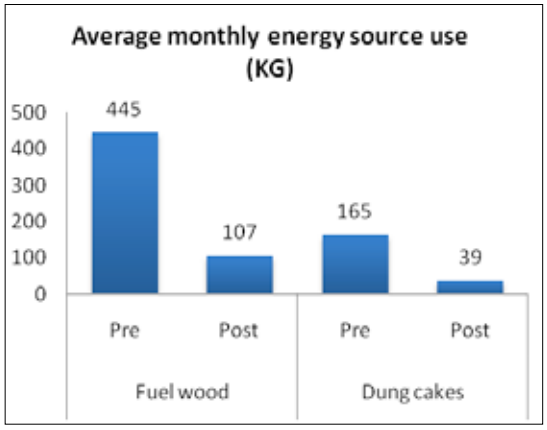
Since the spare parts are easily available, maintaining the biogas units will be relatively easier post project completion. This will contribute to the project sustainability.

All the respondents interviewed (100%) said that they would continue to use their biogas unit even in the post project period. This is an indication of the project's success in creating awareness on biogas' benefit and also convincing the respondents to continue using it after project completion. The biogas units constructed under the project have been highly effective and hence respondents said they will continue using it post project completion.



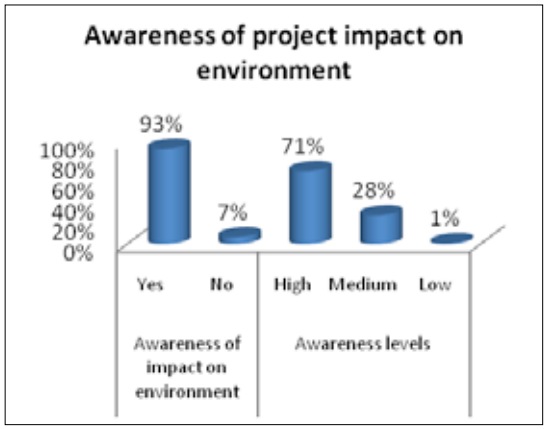
F. Environmental Impact

The biogas units have led to reduced usage of conventional energy sources like fire wood and dung cakes. The average per month firewood consumption per respondent was 445 Kg. During the post project period, the firewood consumption has reduced to 107 Kg per month per respondent. While the average dung cake consumption per month per respondent was 165 Kg, earlier, now due to the use of biogas, consumption was reduced to 39 Kg per month per respondent.



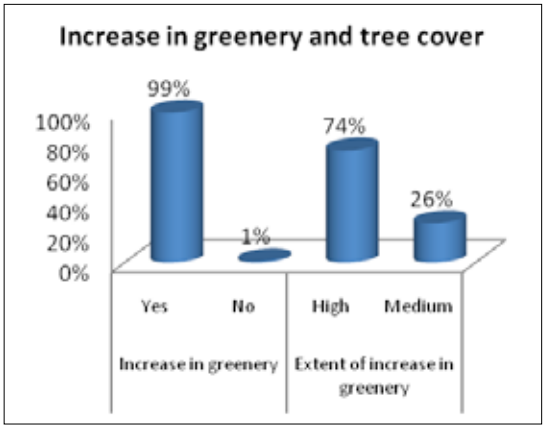
The reduced usage of firewood has ensured forest conservation and contributes to improved biomass and a greater tree cover in the region. The consumption of dung has reduced as the dung now is being used for the biogas units instead of making dung cakes.

The respondents were questioned about the impact of the project on environmental conservation. 93% of the respondents were aware of the impact the project has had on the conservation of the environment in the project villages. The extent of awareness among the respondents on the project impact on environment was also assessed. 71% of the respondents said that the impact of the project on environmental conservation is high while 28% said the project has had a medium impact on environmental conservation. The remaining 1% respondents believed the project had had a low impact on the conservation of the environment.



The respondents were well aware of the projects' impact

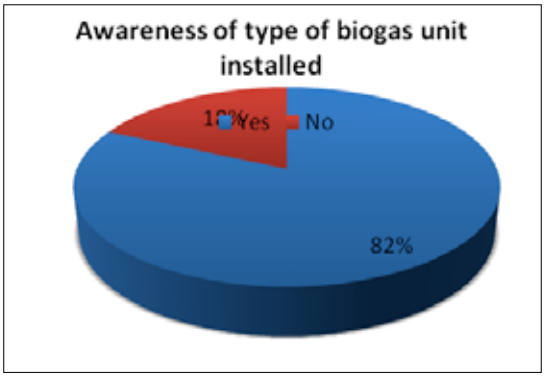
on the environment, protection and conservation of trees in the locality and the enhancement of the biomass of the region.

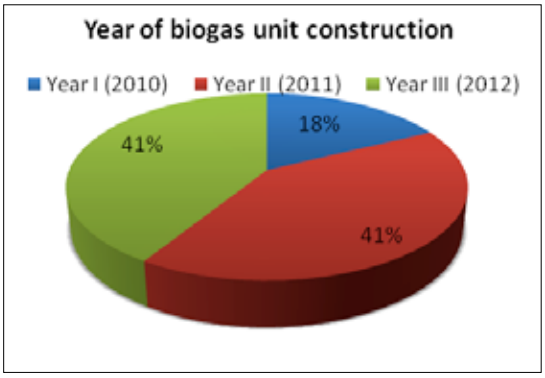


99% of the respondents said that the greenery and forest cover has increased in the post project implementation period. This has contributed as improved tree cover and increase in greenery. 74% of the respondents said that the increase in tree cover and greenery was high while 26% reported a medium increase in the same.

The use of biogas has led to lower use of firewood, which has reduced the pressure on the forests in the project villages.

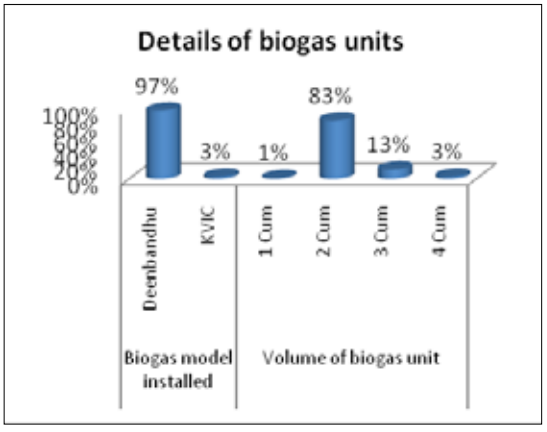
G. Biogas Model





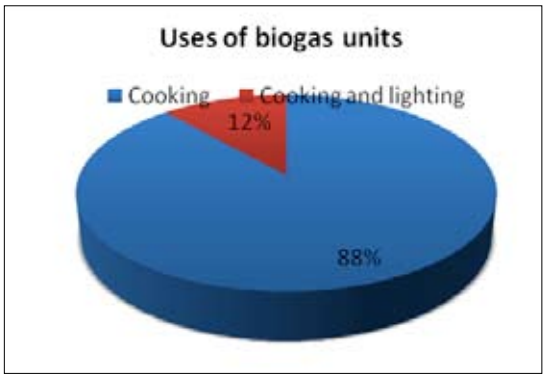
The study also focused on assessing the knowledge of the respondents on the type and model of the biogas unit installed. 82% of the respondents were aware of the model of the biogas unit installed under the project. 18% of the biogas units were constructed in 2010. 41% each of the biogas units were constructed in 2011 and 2012.

97% of the respondents said that they have the Deenbandhu[2] model of the unit installed under the project while 3% respondents had the KVIC model installed. 83% of the respondents had a 2 cubic meter (Cum) biogas unit installed under the project. 13% respondents had a 3 Cum biogas unit. 1% of the respondents had 1 Cum and the remaining 3% respondents had a 4 Cum biogas unit installed.



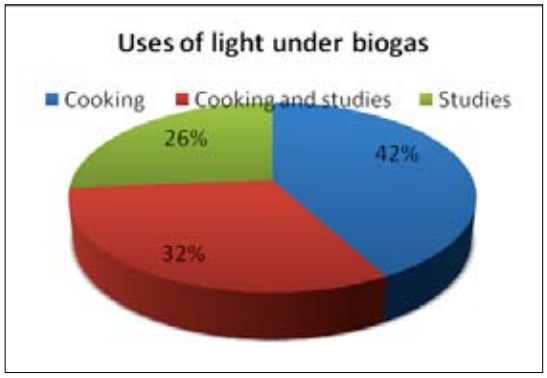
89% of the total respondents said that the biogas unit installed was functional. 5% of the total respondents said that their biogas units are non functional. While 6% respondents said that their biogas units are not operational as yet.
All the respondents in the project villages mixed the water and organic manure in the ratio of 1:1 for their biogas unit. However, some (10% of the total respondents)of the respondents were not taking proper care in mixing the dung with water, and some of the dung collected also had sand in it. This is slowly filling the digester of the biogas unit. If this practice is not contained, the digester will slowly be filled, and the plant will become dysfunctional or has to be emptied and filled frequently in due course of time.

[2]**A note on Deenbandhu and KVIC models is provided in Annexure 1**

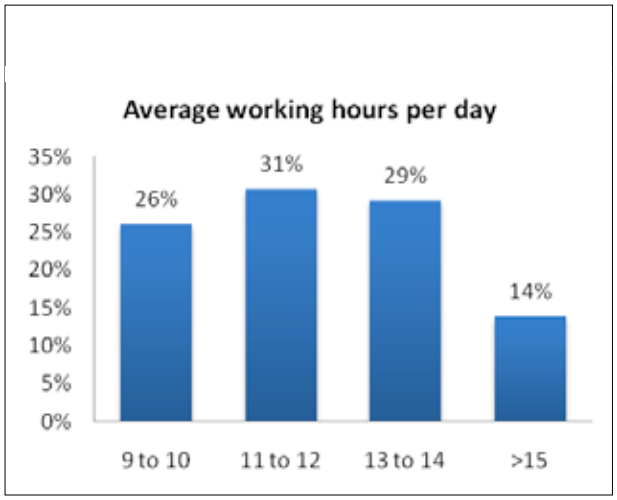


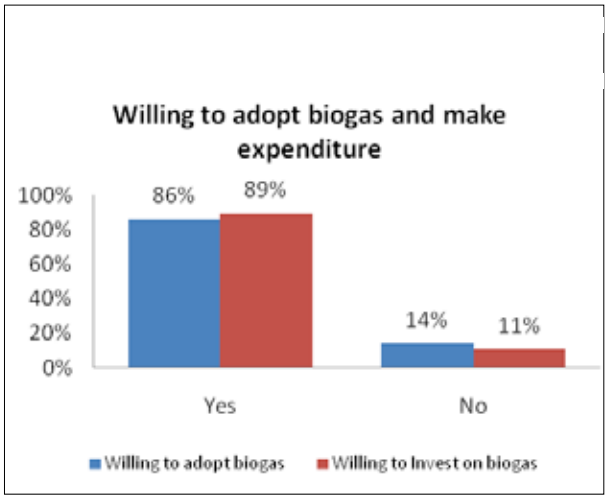
94% of the respondents said that the biogas unit installed, functions properly throughout the year. Although in 6% of the respondents' cases, the biogas unit was not working properly all through the year. The major problem being faced by the respondents was in the winter season. At this time of the year, due to lower temperatures, the dung was not providing proper energy due to the lower rate of methane production.

88% of the respondents said that their biogas unit was only used for cooking food in their household. The volume of the biogas units of these families was not sufficient to use for lighting their homes as well. The biogas production was just about sufficient to meet their cooking needs. The remaining 12% of respondents used their biogas units for cooking and lighting up their homes. Of the total respondents using biogas units for lighting up their homes, 42% respondents used the light only for cooking food.26% respondents used the light for their children who were studying inside the house. The remaining 32% of respondents used the light both for cooking and their children's studies.



Hence the biogas units are not only being used as an energy source for cooking but also for lighting up the house. The children of the household are also benefitted, as now they can study under the lights generated by the biogas unit.





The working hours for women in 26% of the non beneficiaries' households were 9-10 hours per day. 31% of non beneficiary respondents reported the daily working hours for women as 11-12. Women in 29% of the non beneficiary households worked for 13-14 hours per day while in 14% of non beneficiary households the daily working hours for women was more than 15. The average daily working hours for women in non beneficiary household was found to be 12.43 hours.
On the other hand, the average working hours for women in beneficiary households was 8-10 hours per day. Hence the working hours for women in non beneficiary households are much more than that of the women in beneficiary households.

The respondents were asked if they are willing to adopt biogas and make an investment on the same. 86%

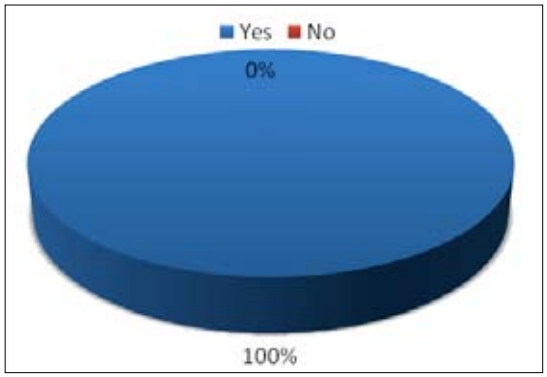
of the respondents were willing to adopt biogas units. Of these 89% of the respondents were willing to make the investment required for the biogas units. Thus, there is high scope and potential for biogas units in the study villages. This shows that the project has made a tremendous impact in the mindset of the people. After seeing the success of the units, there is a huge demand now, not only in these villages, but also in the nearby villages. It is high time for the government and other agencies to upscale this model and the project as well.

CHAPTER 4: HPPI TEAM FINDINGS

The HPPI team members involved in the implementation of the project was consulted and their opinion on the project, and its impact was taken. A total of 5 HPPI team members (field officers) were interviewed. The details of the team members are provided in annexure IV. The findings related to the project and its impacts according to the discussion with the implementation team are provided below:

The implementing team members were asked about the major benefits of the project to the beneficiaries. The benefits (not in order or importance) listed by them are as follows:

- **Conservation of forest:** The implementing team said that the project has led to reduced consumption of firewood as an energy source since the beneficiaries now use biogas as their primary source of energy. This has ensured reduced pressure on the forest and farms for the cutting of firewood. This has resulted in conservation of forest in the region.
- **Improved greenery:** The greenery in the project villages has increased as the cutting of trees for firewood has reduced. This has also improved the biomass availability in the project villages.
- **Reduction in indoor pollution:** Indoor pollution rates generated during cooking have been reduced due to the project. Biogas as an energy source is much more efficient and cleaner as compared to the use of firewood and dung cakes. It does not produce smoke while cooking and thus has reduced indoor pollution significantly.
- **Reduction in health problems:** The reduced indoor pollution has led to reduction in indoor pollution induced health problems. Earlier, the women used to have respiratory problems, eye ailments, etc., due to the smoke generated during cooking that came out of the combustion of the firewood and dung cakes. Now as indoor pollution has been reduced, all these health problems have also disappeared. As a result, the expenditure made by the beneficiaries on such diseases has been reduced as well.
- **Women have additional time:** Women in the beneficiary households have additional time as their daily working hours pertaining to cooking and meeting energy source requirements have reduced since the advent of the biogas units. The women save time on the collection of firewood and the making of dung cakes. Time is also saved on the washing of utensils as biogas does not produce soot like firewood and dung cakes hence the utensils do not get burnt and black at the bottom. The time saved by women is being utilized by them in carrying out important household duties as well as working on their farms.
- **Reduction in use of chemical fertilizers:** The use of chemical fertilizers has been reduced in the project villages. The beneficiaries are using slurry as organic manure as it supplements the nutrient requirement of the soil. Thus, the expenditure incurred by the beneficiaries on chemical fertilizer has also been reduced in the project villages.
- **Improved land productivity:** The productivity of the beneficiaries' land has improved due to slurry application. This has led to increased yield of the crops being cultivated by the beneficiaries.



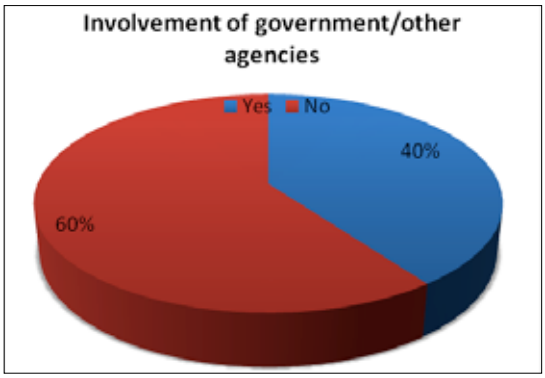
All the implementing team members admitted that a need assessment survey was conducted prior to project implementation. The major difficulty faced during the need assessment was that the farmers were unwilling to adopt biogas units as some of the earlier biogas projects implemented by other agencies had not been successful. Moreover, the initial investment to be made for setting up a biogas unit was also a major deterrent in motivating the farmers to set

up their own biogas units.

The implementing team was also asked about the major difficulties they faced during project implementation. Some of the difficulties faced by them are elaborated below:

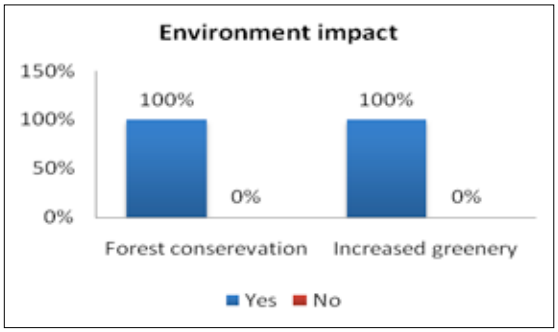
- **Unwillingness to adopt biogas:** Some of the earlier biogas projects in the region implemented by other agencies had been unsuccessful. The biogas units constructed under those projects became defunct quite quickly. Hence it was difficult to convince the people that biogas units to be constructed under the project would work. People were hesitant to adopt the technology as they were convinced that the units would not work like in the case of the earlier projects.
- **High cost of setting up units:** Most poor farmers were interested in setting up biogas units but the initial investment was a limiting factor. The poor farmers were not in a position to afford the cost.
- **Misconception among beneficiaries:** There was a wrong notion and misconception among beneficiaries that the biogas produced by the units would smell bad. Hence, initially, it was a constraint to motivate people enough to set up their biogas units.
- **Leakages in some units:** Some of the plants developed leakages due to which gas production was reduced. This deterred the beneficiaries from spreading positive information about the biogas units. However, the problem was fixed, and the plants began to function properly.

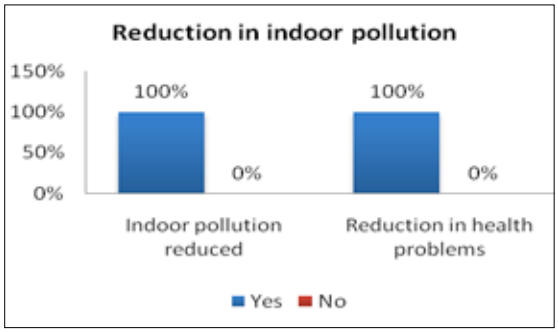
The involvement of government and other agencies in the project was assessed. 40% of the implementing team members said that the government and other agencies were involved and provided support to the project.
All the implementing team members commented that biogas units were not constructed in households, which did not have cattle. As dung is the integral input needed for biogas units, the units were only constructed for households that have cattle. 100% of the team members said that the beneficiaries were aware of how to repair and maintain their biogas units.



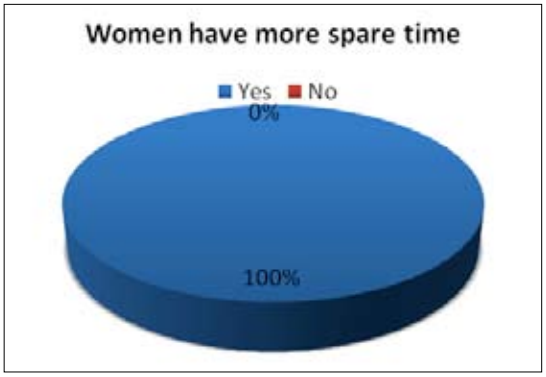
100% of the implementing team members said that the project has contributed towards forest conservation and has led to increased greenery in the project villages. The beneficiaries use biogas as their primary energy source due to which the firewood usage has reduced significantly. This has reduced the cutting of trees for firewood hence leading to forest conservation and increased greenery.

100% of the implementing team members said that the biogas units have led to reduction in indoor pollution. The reduced indoor pollution has also resulted in checking health problems that arise due to this. Consequently, the expenditure on indoor pollution induced health problems have also been reduced.
100% of the implementing team members said that the women's workload has been significantly reduced in the project villages. The daily working hours for women has also been reduced. Time is saved as they no longer have to spend time on collecting firewood, making dung cakes, washing soot covered utensils, etc. The time saved by women is being utilized by them in doing important and more productive household duties and farm related activities.

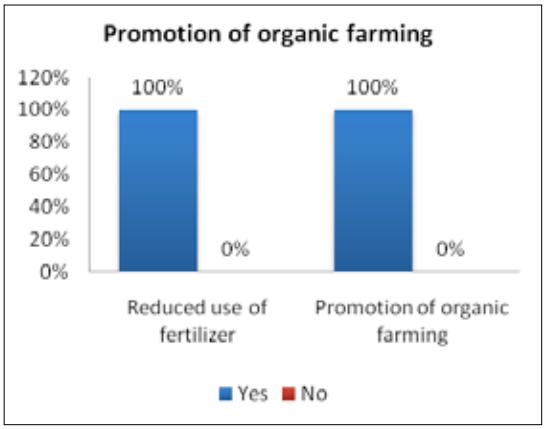




100% of the implementing team members said that the use of chemical fertilizer has also been reduced by the beneficiaries in the project villages. The beneficiaries use slurry from the biogas units as organic manure due to which their dependence on chemical fertilizer has been reduced. As a result, the expenditure incurred in purchasing the chemical fertilizer has also come down. All the implementing team members agreed that the project has been successful in motivating the beneficiaries to adopt organic farming techniques.



The HPPI team members said that UFF has provided timely and adequate technical and administrative support to HPPI for project implementation. All the implementing team members were of the opinion that the project can be replicated in other regions as well, and they were convinced that the success rate of the project would be very high there as well.



CHAPTER 5: OBSERVATIONS AND RECOMMENDATIONS

The major observations and recommendations from the study are as follows:

1. Majority of the biogas units have been constructed in the year 2011 and 2012. Hence the benefits from the project have not accrued to the beneficiaries fully as yet. As the plants have been constructed recently, major repair and maintenance issues have also not surfaced thus far.

2. The biogas units under the project had to be initially given to well off families in order to kick start the project. These families acted as inspiration for others in the community. Initially, it was risky to provide biogas units to the poor families as they were apprehensive due to the high upfront investment, and they were also not convinced about the success of the project due to the experience of failure of earlier biogas units established under government projects.

3. Slurry collection is not done properly by the beneficiaries. In about 10% of the cases (beneficiaries interviewed under the study) the slurry pits were also not dug up in the proper manner.

4. The ideal dung to water ratio is 1:1. Although the beneficiaries say they mix dung and water in the 1:1 ratio, in actual practice the ratio is not maintained by some of the beneficiaries. The dung and water should be mixed outside and then poured into the digester but some of the beneficiaries mix the dung and water right inside the chamber. This improper mixing of dung and water leads to lower methane production.

5. The dung collected should never have any sand in it. However, about 10-20% beneficiaries are not paying attention to this, and they collect dung, which has sand, and put it in the digester. Unfortunately, the sand in the dung will fill up the digester and stop it from functioning properly. The beneficiaries should be oriented on these aspects so as to ensure that they follow proper practices that will guarantee optimal functioning of their biogas units.

6. There has been an overwhelming positive response to the project. Considering the response from the community and their willingness to adopt biogas as an energy source, the project can be up scaled to benefit more farmers.

7. One more year of handholding support is required for the beneficiaries on the maintenance of their biogas units and slurry application. Withdrawal at this stage may lead to non sustainability of the biogas units and may not lead to long term benefits from the project.

8. The beneficiaries had to contribute their share of investment in the biogas unit in a single installment. Thus, the poor and financially weak farmers were not able to benefit from the project. Easy repayment options could have been provided to farmers to ensure that even poor farmers can afford the beneficiary's investment.

9. There should be female members in the HPPI implementing team. A female member would be able to better understand the needs of women in the community. She could also help in organizing the women better in the SHGs and also help plan livelihood opportunities for the group.

10. The project should aim for having better convergence with the government for tapping their resources. This will ensure better and sustained flow of benefits to the beneficiaries over a longer time period.

CHAPTER 6: CONCLUSION

Conclusion

Rajasthan is one of the states in India, which has a large number of heads of cattle. The state is drought prone and hence, cattle rearing is one of the major modes of livelihood in the rural areas of the state. Though milk, meat and other products obtained from cattle are well known and used, their dung was only being used as fuel and fertilizer. Considering the demand for fuel, especially due to the increase in cost of LPG and other forms of fuel, such as firewood, it is important to find newer sources of cheaper fuel. Biogas is one such element, which can produce clean, safe and efficient energy from cattle waste.

Humana People to People India and UFF came together to design a project and then implement it in one of the drought prone districts of Rajasthan. The project was implemented under adverse conditions where the earlier biogas units installed under the government schemes have failed considerably. While the community had lost faith on biogas, HPPI took up the project and went back to the community seeking to start new biogas units. There was lot of resistance from the community during the early stage of the project, and it took a lot of time and energy on the part of the HPPI team to convince the community to try out biogas once more. So they had to start by installing the unit with some well off farmers who were willing to spare space and dung. Initially, the entire cost was borne by HPPI and after seeing the success of 4 to 5 units, the community came forward to construct their own units. HPPI had to strive hard initially to make the farmers construct their biogas units. Considering the kind of awareness and the interest that has now been generated in the community, there can be no better time to upscale the project in the region. Moreover, there are trained masons and also volunteers. These people can help in the construction as well as, in the day to day maintenance of the units.

The dung availability with each farmer is more than what is required and hence if there is sufficient space, the size of the unit can be made a bit bigger, so that it can cover more members in the future. It is also a fact that, slurry which is produced from the unit is much more effective than the dung if it is directly applied in the field as manure. Hence, if the unit is a big one, it can serve two purposes – 1. Produce more gas,2. Produce more slurry.

It has also been seen that construction of these units have helped farmers in saving space, which was earlier used for storing dung cakes and firewood from rain and other bad weather conditions. In winter, the gas production will be lower, so a bigger biogas unit will help. Then again, traditional firewood is usually damp during the winter months and hence the smoke and pollution caused by it is much higher. There are also many cases where people have reduced their use of LPG. Considering the increase in the cost of LPG, there has been considerable saving in money because of the use of biogas.

Due to the construction of biogas units, the women also have more time on their hands. The time required for cooking has been reduced as has the time spent on collecting firewood and preparing dung cakes. They are spending the free time that they have gained either in rearing cattle, doing work on their farms or in taking better care of their children. The older children who were forced to take care of their younger siblings have now been relieved of this duty to a large extent and can now devote themselves to their school work. This has resulted in lower rates of school dropouts as well as better educational standards in the children.

The use of biogas has helped the farmers in reducing the use of firewood. This has helped in increasing the green cover of the region. The biomass from the farm was being used as fuel earlier. Now all the biomass is allowed to turn into compost and is then used as manure on the land. This has increased soil fertility and also helped in increasing the yield. Earlier, the organic matter content of the soil was quite low in this part

of the country, as this region is prone to droughts.

Slurry, which is considered to be the by-product of biogas has much more value than the gas itself. When used in the field, slurry, not only helps in increasing the yield, it also imparts other benefits as well. It increases soil fertility, improves organic matter content and also increases the moisture holding capacity of the soil. This has helped in reducing the number of hours spent on irrigation. On the whole, it has led to a reduction in the cost of cultivation and resulted in increased returns as well. Although the farmers have realized the benefits accrued in the usage of slurry to a great extent, in most of the cases it is just the initial phase. Sufficient training has to be given on the usage of slurry. Thus, handholding support for another year will surely help in reaping a lot more of the benefits. The use of slurry has helped them to reduce the need of using other chemical fertilizers to a drastic degree.

Unfortunately, the farmers who tried using slurry along with chemical fertilizers ended up losing their crop. This was because the growth during the initial stage of the crop was very high, and then they wilted due to the influx of excessive nutrients. So care needs to be taken in the use of slurry along with other chemical fertilizers. A proper ratio based on the soil fertility has to be ascertained, and the farmers have to be educated on this.

Indoor pollution has been reduced significantly due to the use of biogas. The use of firewood and dung cakes produces a lot of smoke, and this affects the lungs and eyes and creates a lot of health issues such as, asthma, breathing problems watering and itching of the eyes and so on. Now, due to the use of biogas, the women and children are relieved of inhaling all the toxic fumes within their homes. Thus, due to the positive benefits derived from biogas the women have more time and are able to take better care of their children, sleep peacefully, start a number of income generating activities, contribute more to cattle rearing, work on their farms and so on.

HPPI has gone in for the Dheenabandhu and KVIC- floating drum models of biogas plants. Majority of the units are of the Dheenabandhu model. This model is very sturdy and can produce gas even in winter where the climate is very cold. Compared to this, the KVIC model produces a smaller amount of gas during the winter months. Furthermore, the KVIC model requires frequent maintenance since the drum present in it can get damaged pretty quickly either due to rain, or rust formation. HPPI has also introduced the practice of covering the dome of the Dheenabandhu type with grass, or sand. This helps in keeping the dome intact and stops it from being exposed to the cold in winter. So, as the dome is kept warm the production of the gas is increased. The farmers are themselves prone to coming up with such innovations quite frequently, and these local innovations should be recorded so that they can be tried out elsewhere as well.

The Dheenabandhu model construction requires trained and technically experienced masons, and the project has been successful in training the masons well. Now they are available in the local district and blocks and hence will be helpful if others want to construct new units or repair the existing ones. The project has helped in developing and transferring the knowledge to the locals. There are also a number of trained volunteers in the block. These volunteers can help out with any of the maintenance issues. Spare parts can be made available at some of the local shops, or with identified vendors and the volunteers can help the beneficiaries on the replacement and repair of their biogas units.

Overall, the project has been beneficial to the community and also to the country. It has helped in procuring clean energy, protecting the environment, increasing the agriculture yield and returns, saving time, and reducing health related issues. Moreover, the project has cleared the doubts of the community regarding the earlier biogas projects. Now they are confident that this model will work and many more are willing to take it up. Government projects such as MGNREGA can be linked to this for digging the pits and other activities. Certain projects of the agriculture department can also be linked to slurry collection and application which will reduce the burden on the farmers, in having to invest directly. More than 80% of the farmers have sufficient cattle and space and encouragement from the government should be enough to motivate them to go in for their own biogas units.

The kind of confidence the community has on HPPI needs to be utilized and such projects should be up scaled in the rural areas. Considering the shortage of fuel, especially the LPG scarcity India is facing, this will help in protecting the environment and also in improving the forest cover and basic greenery around the villages. So, this certainly needs to be looked into. The project is also working on the directives of the Indian policy which has the vision of ***"…decrease dependency on conventional energy sources, reduce Demand-Supply gap by promoting Renewable Energy Sources and a leader in heralding a green energy revolution aiming at energy security, climate change mitigation, green jobs and sustainability through increased reliance on renewable energy…"***

ANNEXURE 1: NOTE ON BIOGAS MODELS

Deenbandhu model

The Deenbandhu model was developed by Action for Food Production (AFPRO), New Delhi, India, in 1984. The word 'deenbandhu' means 'friend of the poor'. Up till now, this model is the cheapest among all the available models of biogas plants. This model is designed on the basis of the principal of minimization of the surface area of a biogas plant to reduce its installation cost without sacrificing functional efficiency. The design consists of two spheres of different diameters, joined at the base. The structure thus formed acts as the digester or fermentation chamber, as well as the gas storage chamber. The digester is connected with the inlet pipe and outlet tank. The upper part above the normal slurry level of the outlet tank is designed to accommodate the slurry to be displaced from the digester with the generation and accumulation of biogas.

KVIC floating drum type plants:

This design was developed and popularized by the Khadi & Village Industry Commission (KVIC) of India and, hence, is known as the KVIC model. These were standardized in 1962 and are used widely even today. These plants have an underground well shaped digester having inlet and outlet connections through pipes located at the bottom on either side of a partition wall. An inverted drum (gas holder), made of mild steel is placed in the digester, which rests on a wedge shaped support and the guide frame at the level of the partition wall. This drum can move up and down along a guide pipe with the accumulation and disposal of gas, respectively. The weight of the drum applies pressure on the gas to make it flow through the pipeline to the point of use.

A floating-drum plant consists of a cylindrical or dome-shaped digester and a moving, floating gas-holder, or drum. The gas-holder floats either directly in the fermenting slurry or in a separate water jacket. The drum in which the biogas collects has an internal and/or external guide frame that provides stability and keeps the drum upright. If biogas is produced, the drum moves up, if gas is consumed, the gas-holder sinks back.

ANNEXURE II: DETAILS OF BENEFICIARY RESPONDENTS

The details of the beneficiaries are as follows:

Table 3: Details of beneficiaries

S.No	Beneficiary name	Village	Age	Social Status	Education	Gender	Month and Year of Biogas Unit construction	Volume of Biogas Unit (Cum)
1	Dharam Singh	Bhoparatappa	60	OBC	Degree	Male	August 2010	2
2	Maharaj Singh	Bhoparatappa	45	OBC	Below 10th	Male	July 2010	3
3	Birsingh	Bhoparatappa	22	OBC	Below 10th	Male	September 2012	2
4	Jagdish	Bhoparatappa	43	OBC	10th	Male	July 2012	3
5	Bhikam	Pali	50	ST	10th	Male	March 2012	2
6	Nathi laal Meena	Pali	37	ST	10th	Male	January 2012	2
7	Bhagwan-Meena	Pali	35	ST	Below 10th	Male	January 2012	2
8	Balram Ram-laal	Pali	55	OC	10th	Male	July 2011	2
9	Sakuntala Devi	Pali	50	OC	Non literate	Female	March 2011	2
10	Sureh Sharma	Pali	47	OC	Below 10th	Male	February 2011	2
11	Surendar Sharma	Pali	40	OC	PG	Male	May2011	2
12	Iccha Shankar	Pali	46	OC	Below 10th	Male	June 2011	2
13	Gajendra Sharma	Pali	27	OC	Intermedi-ate	Male	May 2011	2
14	Mukesh	Pali	35	OC	Below 10th	Male	April 2011	2
15	Gopal	Pali	40	OBC	Non literate	Male	May 2010	2
16	Babu laal Saini	Pali	45	OBC	Non literate	Male	June 2011	2
17	Hanuman	Pali	25	OBC	Below 10th	Female	May 2010	2
18	Nathilaal	Pali	50	OBC	10th	Male	April 2012	2
19	Devendra	Pali	36	OBC	Below 10th	Male	May 2010	2
20	Harimohan	Pali	57	OC	10th	Male	January 2012	2
21	Ramnivas Vijaysharma	Pali	32	OC	10th	Male	June 2012	2
22	Ramkishore Jatav	Pali	37	SC	Degree	Male	February 2012	2
23	Mukat Gurjar	Pali	28	OBC	Intermedi-ate	Male	August 2012	2
24	Murari	Pali	40	OC	Degree	Male	June 2012	1
25	Dheernendra	Pali	26	OC	10th	Male	April 2012	2

26	Bhagawan Sai Meena	Pali	52	OBC	10th	Male	April 2012	2
27	Jugal Kishore Sharma	Pali	42	OC	10th	Male	January 2012	2
28	Jagram Saini	Pali	38	OBC	Below 10th	Male	May 2010	2
29	Bholaram Meena	Dholkhera	35	ST	Below 10th	Male	January 2012	2
30	Bejendra Singh	Dholkhera	45	OC	Non literate	Male	August 2011	2
31	Jagram	Dholkhera	45	ST	Intermediate	Male	August 2011	2
32	Khemchand Yimaladeri	Dholkhera	35	OC	Non literate	Female	December 2011	2
33	Kailasham Meena	Dholkhera	32	ST	Intermediate	Male	January 2012	2
34	Bhagali	Dholkhera	32	OBC	Non literate	Female	September 2012	2
35	Pappuyogi	Dholkhera	35	OBC	Non literate	Female	May 2010	2
36	Hari omm	Dholkhera	23	OBC	10th	Male	January 2012	2
37	Rajesh, son of Sukhram	Dholkhera	25	ST	Intermediate	Male	May2012	2
38	Angad Meena	Dholkhera	40	ST	Degree	Male	July2010	3
39	Rambhavari	Dholkhera	32	ST	Intermediate	Male	May 2011	2
40	Shyam lal Yogi	Dholkhera	39	OBC	Intermediate	Male	February 2012	2
41	Ramkishan	Dholkhera	42	ST	10th	Male	November 2011	2
42	Shivram Meena	Dholkhera	42	ST	Below 10th	Male	December 2011	2
43	Bhagchand	Dholkhera	58	ST	Below 10th	Male	December 2011	2
44	Vishram	Dholkhera	46	ST	10th	Male	October 2011	2
45	Dharam Singh	Bhoparatappa	60	OBC	Degree	Male	July2011	2
46	Maharaj Singh	Bhoparatappa	45	OBC	Below 10th	Male	July2010	3
47	Birsingh	Bhoparatappa	22	OBC	Below 10th	Male	August 2012	2
48	Jagdish	Bhoparatappa	43	OBC	10th	Male	August 2012	3
49	Bhikam	Pali	50	ST	10th	Male	July 2012	2
50	Haskesh	Goyakabas	35	ST	10th	Male	February 2012	3
51	Dharam Singh	Goyakabas	35	ST	Intermediate	Male	February 2012	2
52	Dinesh	Goyakabas	22	ST	Below 10th	Male	December 2010	2
53	Dodi ram	Goyakabas	35	ST	Intermediate	Male	March 2012	2
54	Narsi	Goyakabas	35	ST	Non literate	Male	October 2012	2
55	Murarilal Meena	Goyakabas	50	ST	Below 10th	Male	February 2011	2

56	Hari Ram	Goyakabas	40	ST	Below 10th	Male	September 2012	2
57	Prem Bai Meena	Goyakabas	40	ST	Below 10th	Male	April 2011	2
58	Rumali w/o Ramsingh Meena	Goyakabas	38	ST	Non literate	Female	October 2012	2
59	Mohanlal	Goyakabas	45	ST	Degree	Male	April 2011	2
60	Hari Ram	Goyakabas	37	ST	Non literate	Female	January 2011	2
61	Narayan Meena	Goyakabas	40	ST	10th	Male	June2012	3
62	Naval	Goyakabas	50	ST	Non literate	Male	August 2011	3
63	Kedar	Goyakabas	60	ST	Non literate	Male	May 2012	3
64	Bhagvathi	Goyakabas	35	OBC	Non literate	Female	March 2012	3
65	Madan Saini	Goyakabas	25	OBC	Below 10th	Male	September2011	3
66	Phoochand Meena	Jatwada	40	ST	Below 10th	Male	March 2010	4
67	Srinivas Meena	Jatwada	64	ST	Below 10th	Male	March 2012	2
68	Nand Kishore Sharma	Jatwada	42	OC	Below 10th	Male	May 2012	2
69	Kailash Chand Meena	Jatwada	40	ST	Below 10th	Male	June 2012	2
70	Jagram Meena	Nangal meena	42	ST	Intermedi-ate	Male	May2011	3
71	Sasikant Sharma	Kesri	28	OC	Degree	Male	May 2012	2
72	Jagdish	Kesri	35	OC	Below 10th	Male	July 2011	2
73	Bhalaram	Kesri	50	OC	Below 10th	Male	June 2011	2
74	Bhavani Singh	Kesra	55	OC	Degree	Male	August 2010	3
75	Mast Ram	Kesra	50	OC	10th	Male	March 2011	2
76	Kailash	Bhapur	45	OBC	Non literate	Male	October 2011	2
77	Padam Singh	Bhapur	50	OBC	Below 10th	Male	July 2010	3
78	Sawriya Gujjar	Bhapur	57	OBC	Below 10th	Male	April 2010	4
79	Changalal Saini	Rashidpur	50	OBC	Non literate	Male	February 2011	2
80	Rambabu	Rashidpur	42	OBC	Degree	Male	January 2012	2
81	S. N. Rawat	Raseedpur	62	OBC	Degree	Male	May 2010	4
82	Chatar Singh	Rashidpur	45	OBC	Degree	Male	March 2012	2
83	Manohar	Nandna	42	OBC	Intermedi-ate	Male	October 2011	2
84	Rameshwar	Nandna	48	OBC	Non literate	Male	October 2011	2
85	Tuhi Ram	Nandna	60	OBC	Non literate	Male	June 2010	2
86	Amar Singh	Nandna	63	OBC	Non literate	Male	March 2012	2
87	Satya Prakash	Nandna	30	OBC	10th	Male	June 2011	2
88	Hari Ram	Nandna	30	OBC	Intermedi-ate	Male	March 2012	2

89	Maansingh	Nandna	30	OBC	Non literate	Male	July 2012	2
90	Rameshwar	Nandna	55	OBC	Non literate	Male	October 2010	2
91	Shivdayal	Nandna	52	OBC	10th	Male	July 2012	2
92	Gulab	Ramgarh	40	OBC	10th	Male	April 2012	2
93	Surendra	Ramgarh	51	OC	Degree	Male	January 2012	2
94	Ramful Meena	Ramgarh	50	ST	Degree	Male	July 2012	2
95	Jagdish	Ramgarh	35	ST	10th	Male	June2011	2
96	Ramesh Meena	Ramgarh	45	ST	Degree	Male	May 2012	2
97	Gopal Meena	Ramgarh	45	ST	Below 10th	Male	April 2012	2
98	Maharaj Singh	Tudiyana	60	OBC	10th	Male	May 2010	4
99	Kamlesh Gurjar	Tudiyana	22	OBC	Below 10th	Female	January 2012	2
100	Sahiram	Tudiyana	50	OBC	Non literate	Male	April 2012	2
101	Bachan	Tudiyana	45	OBC	10th	Male	April 2012	2
102	Babulal	Tudiyana	45	OBC	Below 10th	Male	July 2010	2
103	Balram	Tudiyana	30	ST	10th	Male	April 2012	2
104	Ram Charan	Tudiyana	45	OBC	Non literate	Male	February 2011	2
105	Kaushalya	Tudiyana	50	OBC	Non literate	Female	May 2010	2
106	Remu	Veerasana	14	ST	10th	Female	August 2012	2
107	Bhagrath Meena	Veerasana	26	ST	Degree	Male	March 2010	2
108	Dharmendra Meena	Veerasana	40	ST	Below 10th	Male	March 2012	2
109	Siya Ram Meena	Veerasana	35	ST	10th	Male	July 2012	2
110	Brij Mohan	Ukrund	28	ST	Degree	Male	July 2012	2
111	Roshanlal Meena	Ukrund	50	ST	Below 10th	Male	April 2012	2
112	Ram Swaroop	Ukrund	55	OBC	Below 10th	Male	May 2011	2
113	Ramsingh Rajput	Saravali	50	OC	10th	Male	August 2011	4
114	Ramavtar Meena	Saravali	33	ST	Below 10th	Male	February 2011	2
115	Ramu	Saravali	60	ST	Non literate	Male	September 2010	2
116	Bhambu Ram	Saravali	44	ST	10th	Male	August 2011	2
117	Bal Ram	Saravali	20	ST	Degree	Male	February 2012	2
118	Jagmohan	Saravali	22	ST	Below 10th	Male	January 2011	2
119	Babulal Meena	Saravali	40	ST	Below 10th	Male	March 2011	2
120	RatiRam Meena	Saravali	41	ST	Below 10th	Male	October 2011	2
121	Keshav Singh	Saravali	32	OC	Intermedi-ate	Male	March 2011	2
122	Siya Ram Meena	Saravali	39	ST	Degree	Male	September 2011	2

123	BaneSingh	Seet	35	OBC	10th	Male	December 2011	2
124	Raja Ram	Seet	55	OBC	Non literate	Male	May 2011	2
125	Ramkishan	Seet	35	OBC	Below 10th	Male	June 2010	2
126	Mohini Devi	Seet	35	OBC	Non literate	Female	March 2010	3
127	Guddi	Sinduki	35	OBC	Non literate	Female	February 2011	2
128	Doli	Sinduki	40	ST	Non literate	Female	February2011	2
129	Gopiram	Sinduki	40	ST	Degree	Male	July 2010	3
130	Fakiskhan Basri Khan	Sinduki	30	OBC	10th	Male	February 2011	2
131	Kajodhi Meena	Naya Goan	22	ST	Degree	Male	February 2011	2
132	Meera Devi	Naya Goan	35	ST	Non literate	Female	March 2011	1
133	Daram Singh Meena	Naya Goan	35	ST	Degree	Male	February 2011	2
134	Nathi Meena	Naya Goan	35	ST	Below 10th	Male	February 2011	2
135	Gyan Singh	Naya Goan	40	ST	Below 10th	Male	February 2011	2
136	Raja Ram	Naya Goan	40	ST	10th	Male	August 2011	2
137	Dinesh Meena	Naya Goan	22	ST	Below 10th	Male	August 2011	2
138	Leela Ram	Goya Ka Baas	58	ST	Below 10th	Male	June 2012	2
139	Sakita	Goya Ka Baas	22	OBC	Non literate	Female	July 2010	2
140	Chand Singh	Goya Ka Baas	21	OBC	10th	Male	March 2011	2
141	Ramlal Gujar	Goya Ka Baas	45	OBC	10th	Male	March 2011	2
142	Siya Ram	Goya Ka Baas	35	ST	Degree	Male	June 2012	2
143	Chaube Ram	Khawda	50	OBC	Non literate	Male	October 2011	2
144	Shyam Singh	Khawda	28	OBC	Below 10th	Male	March 2012	2
145	Mahendar Sharma	Khawda	50	OC	Below 10th	Male	February 2012	3
146	Jaldheer	Amarpur	45	OBC	Below 10th	Male	July 2011	2
147	Mukut	Amarpur	38	OBC	Below 10th	Male	June 2011	3
148	Shivdayal	Amarpur	30	OBC	Below 10th	Male	May 2011	3

ANNEXURE III: DETAILS OF NON BENEFICIARIES RESPONDENTS

The details of non beneficiaries are as follows:

Table 4: Details of non beneficiaries

S.No	Name	Village	Age	Social Status	Education
1	Bato Mukesh	Nandna	35	SC	Below 10th
2	Saba Govind	Nandna	55	OBC	Non literate
3	Balram Yogi	Rasidpur	21	OBC	Degree
4	Rajendra Naidari	Rasidpur	60	OBC	10th
5	Sugar Singh	Tudiyana	37	OBC	Intermediate
6	Shivchapur	Tudiyana	45	OBC	Non literate
7	Rajendra	Tudiyana	18	OBC	Degree
8	Malla Devi	Tudiyana	30	OBC	Non literate
9	Hari Chasan	Tudiyana	40	OBC	Non literate
10	Muresh	Tudiyana	45	OBC	Non literate
11	Hariram	Dolekese	40	ST	Non literate
12	Amagdev	Dolekese	26	OBC	Non literate
13	Hiracha	Dolekese	35	OBC	Below 10th
14	Chiranji Lal	Dolekese	52	OBC	Below 10th
15	Dharme Singh	Backanpura	20	OBC	10th
16	Jaswanth Singh	Dolekese	36	OBC	10th
17	M.P.Meema	Goya Kavas	22	ST	10th
18	Asha Meena	Goya Kavas	25	ST	Non literate
19	D.P.Meena	Goya Kavas	40	ST	10th
20	Balichran Meena	Goya Kavas	24	ST	10th
21	Chhate Meena	Goya Kavas	30	ST	Non literate
22	Ram Pati Meena	Goya Kavas	40	ST	Non literate
23	Kailsh Meena	Goya Kavas	45	ST	10th
24	Khemraj Meena	Goya Kavas	26	OBC	10th
25	Jaysem	Backanpura	40	ST	Below 10th
26	Ashok Shairya	Seeth	20	OBC	10th
27	Rajesh	Sindhkur	19	ST	Below 10th
28	Gagdish	Ramgar	32	ST	10th
29	Laxmi	Sarakali	40	ST	Non literate
30	Chet Ram Meena	Sarakali	30	ST	10th
31	Mukesh chand meera	Sarwali	38	ST	Degree
32	Amar singh Mane	sarwali	40	ST	10th
33	Hari Mohan	Virasane	42	ST	Below 10th
34	Satish	Virasane	36	ST	10th
35	Rambharasi meena	Ukrund	35	ST	Below 10th

36	Mahesh chand	Ukrund	22	ST	Degree
37	Malh Devi	Jatwada	35	ST	Non literate
38	Anil singh	Kesari	30	OC	Below 10th
39	Paapu	Kesari	32	OC	Intermediate
40	Mital singh	Bhapur	48	ST	Non literate
41	Dhevanji	Bhapur	42	OBC	Below 10th
42	Santa	Bhapur	35	OBC	Below 10th
43	Om Prakash	Bhapur	40	OBC	Non literate
44	Bharti	Pali	40	ST	Below 10th
45	Manu	Pali	45	ST	Non literate
46	Hari Prasad	Amarpur	43	OBC	Non literate
47	Keshpathi	Amarpur	35	OBC	Non literate
48	Sosingh	Amarpur	40	OBC	Non literate
49	Birmadevi	Bhapur	40	OBC	Non literate
50	Lakhan Singh	Bhapur	50	OBC	10th
51	Bharat lal	Kesari	28	OC	Degree
52	Mahindra saini	Pali	38	OBC	Below 10th
53	Himraj	Pali	35	OC	Intermediate
54	Gyan Singh	Nayagoan	36	ST	Degree
55	Bisrammina	Nayagoan	45	ST	10th
56	Kailas Meena	Nayagoan	30	ST	Non literate
57	Karnal	Sernat	23	OBC	Degree
58	Govind Sashya	Nandna	50	OBC	Non literate
59	Om Prakesh	Nandna	36	OBC	Below 10th
60	Pramod Kumar	Pali	19	OBC	10th
61	Hardesh Kumar	Pali	19	OC	Intermediate
62	Teja singh Saini	Pali	35	OBC	Non literate
63	Om Prakesh Jalava	Pali	36	SC	Below 10th
64	Bharat Lala	Pali	25	ST	Below 10th
65	Dev Prakesh	Pali	24	OC	Below 10th

ANNEXURE IV: DETAILS OF HPPI TEAM

The details of the HPPI implementing team members who were interviewed during the study are as follows:

Table 5: Details of HPPI Team

S.No	Name	Designation
1	Phool Chand Gurjur	Field officer
2	Jamiludding khan	Area Leader
3	Nekram	Field officer
4	Mohammad Juber	Field officer

1. Name: Harkesh
Age: 45
Village: Goyakabas

Harkesh lives in Goyakabas village. His family was totally dependent on firewood and dung cakes for meeting their energy requirement for cooking. Firewood collection was a tedious job for the women in the household. Collection of firewood took a lot of their time, and it was a strenuous job for the women of his household. Cooking using firewood also caused health problems forthe women due to the high levels of indoor pollution that were formed during the process.

He came to know about the project from the HPPI team. He was impressed and wanted to construct a biogas unit under the project. He also had the adequate number of cattle needed for a biogas unit. He was sanctioned a 3 Cum volume biogas unit of KVIC model. The total cost of constructing the biogas unit was Rs22,000. Of this sum, Rs 12,000 was borne by him and the remaining amount of Rs 10,000 was provided as subsidy from HPPI.

He started using the gas for cooking and lighting up his household. He is very satisfied with the project as the biogas unit has saved a lot of time and effort inthe collection of firewood and also reduced health related problems in his family. The additional time saved is now being used to do important household work and carry out farm related activities as well.He was the first person in his village to adopt the biogas unit and in the process has motivated many other people in the village to also adopt biogas units under the project.

2. Name: Roshanlaal Meena
Age: 50
Village: Ukrund

Roshanlaal Meena was the first person in Ukrund village to set up a biogas unit under the project. He had sufficient number of cattle that was needed for a biogas unit. He set up the Deenabandu model of the biogas plant in June 2012. He is now using the gas for cooking and lighting up his home.

He actively participates in project meetings and in the implementation of the project. He mobilized more than 10 farmers to set up biogas units in their homes. He was the president of the farmers group formed under the project. He was motivated by the discussions held in the in meetings on the adoption of diversified farming techniques and crops. He identified various crops like bhindi (lady's finger), tomato, brinjal (eggplant/aubergine), green chilly,

etc., and planted these in his 0.5 bigha of land. He applied slurry on these crops and was able to obtain a very good yield. Now he is saving on vegetable expenses for his family by producing them on his own farm with minimum expenditure. He is thankful and obliged to HPPI for their continued support.

3. Name: Mohini Devi W/O - Khemchand
Age: 35
Village: Seeth

Mohini Devi's family got a biogas plant sanctioned under a government scheme prior to the HPPI project. They spent Rs10,000 on the construction of the biogas unit. At that time, they were not provided any training by the government implementing agency on how to operate and maintain their biogas unit. Due to this lack of knowledge about the maintenance of their biogas plant, there was a blast in their plant soon after it had been installed. A part of their home was also damaged in the blast. They were convinced that biogas was unsuitable for them.

However, when biogas units were constructed by HPPI under the project, they saw the benefits that other households were receiving from their biogas units. She approached the HPPI team to find out how the biogas units worked, as well as how she could obtain a unit that would be sanctioned under the project. The HPPI team explained everything to her in detail. They told her about the project and the various benefits of having a biogas unit. The team also told her about the subsidy that she will be getting under the project. She became motivated enough to adopt the biogas unit under the project. She was sanctioned a Deenbandhu model biogas unit of 2 Cum volume in December 2010. The biogas unit volume was sufficient to meet the cooking requirements of her family.

The family is also using the slurry obtained from the biogas unit on their farm. The slurry is being used on 1 bigha of land, which is saving the household more than Rs 5,000 per year on fertilizer expenses.

3. Name: Maharaj Singh
Age: 60
Village: Tudiyana

Maharaj Singh is resident of Tudiyaan village. He lives in a large joint family of 30 members. He was sanctioned a Deenbandhu model biogas plant in 2010. A gas stove with one flame burner was also given to him. He was very satisfied with the biogas unit. Use of the biogas unit saved a lot of time and effort on the part of the women in the household as they would have to spend a lot of time in collecting firewood for their family's needs.The biogas unit reduced indoor pollution and thus reduced health problems related to indoor pollution as well as the expenses that had to be made earlier on the same. The family is also using slurry

from the biogas unit on 1 bigha of land. This has improved the productivity of the land and also reduced cost on purchasing other fertilizers.

As the family is very big, one plant is not providing sufficient gas to meet their cooking needs. They have adequate cattle, so enough dung is always available, and they can afford one more biogas unit due to this. They have requested HPPI to sanction one more biogas unit for them, under the scheme run by the project.

ANNEXURE VI: PHOTOGRAPHS

P1: Data collection from the field

P2: Data collection from the field

P3: Data collection from the field

P4: Data collection from the field

P5: Women's involvement in study

P6: Biogas being used for cooking

P7: Biogas being used for cooking

P8: Biogas being used for cooking

P9: Beneficiary with his Biogas Unit

P10: Project detail board

P11: Wall poster on the project

P12: A farm using slurry from biogas

P13: Beneficiary using slurry

P14: Farm using slurry from biogas

P15: Home lit up using biogas

P16: IEC material on the project

P17: Farm using slurry from biogas

P18: Farm using slurry from biogas

P19: KVIC model biogas unit

P20: Farms using slurry from biogas

Beneficiary Questionnaire: Biogas Evaluation

1. Beneficiary name: Village: District:
2. Age: Caste (SC/ST/OBC/OC): Education (Non literate, Below 10th, 10th, Intermediate, Degree) Gender: Male/Female Number of family members:

Effectiveness of Project Impact

3. Have you heard about biogas before: Yes No
4. Are there any made by the government / others prior to the project period i.e.before 2010 in your village: Yes No
5. Are they running/functional Yes No
6. If not , are you aware of the reasons why they are defunct Yes No
7. If yes , what are the reasons
8. Lack in construction /workmanship
   (a.) Lack of proper training (b.) Lack of follow up (c.) Other reasons
9. Why did you decide to set up a plant under the project
   (a.) for saving money on firewood for cooking
   (b.) for getting good organic fertilizer in the form of bio slurry
   (c.) for both of the above reasons
10. Are you confident that the plant will work Yes No
11. If yes, why do you feel so?
12. If No, why?
13. Please list the benefits from the project
14. How did you became aware of the project:
    (a.) Wall paintings (b.) Posters in village (c.) HPPI team (d.) Others (specify)
15. Source of energy used before the project:
    (a.) Firewood (b.) Dung cakes (c.) Kerosene (d.) Coal (e.) LPG (f.) Others
16. Number of cattle/livestock:

Cow:	Buffalo:	Goat:	Sheep:	Others

17. Availability of dung for biogas unit: (a.) High (b.) Moderate (c.) Low
18. Has the project benefited you: Yes No
19. Major benefits from project:
    (a.) additional income (b.) clean energy (c.) gender empowerment
    (d.) health benefits (e.) Increase in farm productivity (f.)Time saved
    (g.)Others (specify)
20. Are you satisfied with project outputs: Yes No
21. Satisfaction level: (a.)High (b.) Medium (c.) Low
22. Are you aware of the SHGs and farmers clubs formed under the project: Yes No
23. If yes, are you a part of an SHG/farmer club Yes No
24. Major role of SHGs

a. Motivating non beneficiaries to adopt a biogas unit

b. Savings and providing loans to members for livelihood

c. Motivating farmers for adoption of model plots

d. Supporting beneficiaries in cow dung collection from non beneficiaries

e. Others (specify)

Economic Impact

25. Cost of earlier energy source Rs_____ (per month)
26. Total cost of setting up biogas unit Rs_____
27. Initial cost borne by beneficiary in setting up a biogas unit Rs_____
28. Subsidy from government/other agency: Yes No
29. If yes, amount Rs _____
30. Subsidy from HPPI: Yes No
31. If yes, amount Rs _____
32. Recurring and maintenance cost Rs_____ (per year)
33. Do you use slurry from the biogas unit on your farm: Yes No
34. Do you sell the slurry also: Yes No
35. If yes, what quantity is sold per month (Quintals) _____

36. If yes, at what rate (per quintal): _____

37. Total land (bighas):_____

38. Cropped area details

S.No	Season	Cropped Area pre(beeghas)	Cropped Area post (beeghas)
1	Kharif		
2	Rabi		
3	Summer		

39. Has the usage of chemical fertilizer reduced post biogas project: Yes No

40. Usage of chemical fertilizer- Pre (Kg/ha): Post (Kg/ha):

41. Has the expenditure on chemical fertilizer reduced: Yes No

42. Chemical fertilizer expenses: Rs (per year pre): Rs (per year post):

43. Area under organic manure/FYM (ha): Pre Post

44. Has the irrigation requirement in your field reduced due to application of slurry: Yes No

45. If yes, irrigation hours Pre project (hours) Post project (hours)

46. Reduction in cost due to reduced irrigation hours Rs_____(per year)

47. Has the productivity increased due to slurry application: Yes No

48. Agriculture details:

S.No	Crop Name	Total Investment	Yield (Kg/ha) Pre	Yield (Kg/ha) post	Total Income (pre)	Total income (post)

49. Has the expenditure on cooking induced health diseases reduced: Yes No

50. Reduction in cooking induced health diseases expenses Rs_____ (per year)

51. Average HH income (per month) pre project: Rs_____

52. Average HH income (per month) post project: Rs_____

Gender Impact

53. Involvement of women in selection of biogas location, deciding number of burners etc:
    (a.)High (b.) Medium (c.) Low
54. Who decides to buy a biogas unit in the household: Male Female
    Who collects the dung for the biogas unit: (a.) Male (b.) Female (c.) Both
55. In case of dung shortage what is done: Collect dung from neighbors Others (specify)
56. Involvement of women in trainings on biogas orientation, maintenance etc under project:
    (a.)High (b.) Medium (c.) Low
57. Who is primarily responsible for maintenance of biogas units in the household:
    (a.) Male (b.) Female (c.) Both
58. Role of women in biogas unit maintenance: (a.)High (b.) Medium (c.) Low
59. Reduction in indoor pollution due to the biogas unit: Yes No
60. Extent of reduction: (a.)High (b.) Medium (c.) Low
61. Reduction in respiratory problems and eye ailments due to the biogas unit: Yes No
62. Extent of reduction: (a.)High (b.) Medium (c.) Low
63. Has workload on women decreased due to the biogas unit: Yes No
64. Additional spare time available (per day):
    (a.) 0-1 hours (b.) 1-2 hours (c.) 2-4 hours (d.) More than 4 hours
65. Time has been saved due to:
    (a.) less time taken for cooking (b.) time saved on collecting firewood (c.) time saved in cleaning utensils (with reduction of black soot) (d.) Others (specify)
66. Utilization of additional spare time: (a.) HH works (b.) Farming work (c.) Learning something new (d.) Others

Sustainability

67. Awareness of the project and its significance:
    (a.) Fully aware (b.) Partly aware (c.) Not aware
68. Awareness of biogas unit benefits: (a.) Fully aware (b.) Partly aware (c.) Not aware
69. Involvement of beneficiaries in planning of biogas unit in the household :
    (a.)High (b.) Medium (c.) Low
70. Involvement of beneficiaries in maintenance: (a.)High (b.) Medium (c.) Low

Yes No

71. Have trainings been conducted on biogas units:
72. Number of trainings conducted: (a.) 0-3 (b.) 3.5 (c.) 5-8 (d.) Above 8
73. Have you attended trainings: (a.) Yes (b.) No who attended- Male or female
74. Who attends the training : (a.) Male (b.) Female (c.) Both
75. Reasons for not attending: (a.) Not aware of training (b.) Not invited (c.) Training quality not good (d.) Don't perceive as important (e.) Others
76. Usefulness of the trainings: (a.) High (b.) Medium (c.) Low
77. Have exposure visit(s) been conducted: Yes No
78. If yes, places visited: (a.) Within the village (b.)Nearby village(s), (c.)Within district, (d.) Other district (e.) Other state
79. Benefits from exposure visit: (a.)High (b.) Medium (c.) Low
80. Who maintains/repairs biogas units: (a.) Self (b.) HPPI team
81. Are you able to identify the problem in the biogas unit and spare parts needed for its repair: Yes No
82. Are spare parts easily available locally: Yes No
83. Distance of nearest place where spare parts are available:
(a.) 0-2 Km (b.) 2-5 Km (c.) 5-10 Km (d.) Above 10 Km
84. Average repair and maintenance cost per year: Rs_____
85. Total repair cost till date Rs_____
86. How are you saving to ensure that money is available for maintenance?
87. Is the repair and maintenance cost: (a.)High (b.) Medium (c.) Low
88. Will you continue to use and maintain to biogas unit post project : Yes No

Environmental Impact

89. Quantity of earlier source of energy used per month

S.No	Source	Qty used (pre)	Qty used (post)
1	Firewood		
2	Kerosene		
3	Coal		
4	LPG		
5	Others		

90. Awareness of the impact of the biogas unit on forest and environment conservation: Yes No

91. Extent of awareness: (a.)High (b.) Medium (c.) Low

92. Has the greenery and tree cover increased post project: Yes No

93. If yes, how much is the increase: (a.)High (b.) Moderate (c.)Low

Design Suitability

94. Are you aware of the type of biogas unit installed: Yes No

95. Type of biogas unit installed: actual mentioned by beneficiary_____

96. Type of biogas unit installed:

97. Year and month of biogas unit construction: Month_____ Year_____

98. Status of biogas unit: (a.) Functional (b.) Partly Functional (c.) Non Functional

99. Volume of biogas unit (cum):

100. Ratio of water: cow dung, organic manure used:

101. Does the biogas unit work properly throughout the year: Yes No

102. If No, specify the problems:

103. Uses of biogas unit: (a.) Cooking (b.) Lighting (c.) Others (specify)

104. What is the light used for?

105. Are other types of light available (part time electricity, rechargeable lanterns):

Yes No

106. Are any savings recorded on the cost of these: Yes No

107. If yes, cost saved Rs _____ (per year)

108. Can the biogas provide fuel for all cooking (or is additional use of other sources needed):

Yes No

Non Beneficiary Questionnaire: Biogas Evaluation

1. Name: Village: District:
2. Age: Caste (SC/ST/OBC/OC):
3. Education (Non literate, Below 10^{th}, 10^{th}, Intermediate, Degree)
4. Number of family members:
5. Are you aware of the project: Yes No
6. Source of energy being used: (a.) Firewood (b.) Dung cakes (c.)Kerosene (d.) Coal (e.) LPG (f.) Others
7. Quantity of earlier source of energy used per month

S.No	Source	Qty used
1	Firewood	
2	Kerosene	
3	Coal	
4	LPG	
5	Others	

8. Monthly expenses on energy source: Rs_____
9. Number of cattle/livestock:

Cow:	Buffalo:	Goat:	Sheep:	Others

10. Availability of dung: High Moderate Low
11. Use of dung: (a.) Manure (b.) Cake for cooking (c.) Others (specify)
12. Are you aware of the SHGs/Farmers Club formed under the project: Yes No
13. Usage of chemical fertilizer- Chemical fertilizer expenses (Rs per year):
14. Irrigation hours per day:
15. Agricultural details

S.No	Crop Name	Total Investment	Yield (Kg/ha)	Total Income

16. Respiratory problems and ailments in HH due to indoor pollution: Yes No
17. How many times (a year) do you visit the hospital due to such ailments:
18. Expenditure on such diseases (Rs per year):
19. Total working hours a day for women:
20. Are you willing to adopt biogas: Yes No
21. Are you willing to make the investment for setting up a biogas unit: Yes No

HPPI Implementing Team Questionnaire

1. Name: Designation:
2. Relevance of the project to the national, provincial and local needs

3. What are the major benefits to the beneficiaries under the project

4. Did you conduct a need assessment prior to project planning: Yes No
5. If yes, any difficulties faced in need assessment

   ……..

   ……

   ……

6. Major difficulties faced in the project implementation

   ……..

   ……

   ……

7. Involvement of/support from government agencies/departments: Yes No
8. If yes, how:

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9. Have biogas units been constructed for households not having cattle: Yes No
10. If No, why:

    ……..

    ……

    ……

11. Who supplied the technical knowhow and design for the biogas units

    ……

12. Are beneficiaries fully aware of how to maintain and repair a biogas unit: Yes No

13. If No, why:

……

……...

14. Have the biogas units led to conservation of forests: Yes No

15. Has the greenery in villages increased post project: Yes No

16. Has indoor pollution been reduced: Yes No

17. Reduction in indoor pollution induced ailments: Yes No

18. Do women from beneficiary households have more spare time: Yes No

19. Has the dependence on chemical fertilizers and pesticides reduced: Yes No

20. Have model plots and organic farming techniques been promoted: Yes No

21. Was the monitoring done during implementation adequate and ensured quality: Yes No

22. If No, why:

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23. What is your (HPPI's) opinion of the contribution of UFF in the project:

(a.)High (b.) Medium (c.) Low

Elaborate

……..

……

……

24. Do you think that the results achieved were realistic considering time and other resources:

Yes No

25. If No, why

……..

……

……

26. What Is the scope of replicating the project at different locations:

27. (a.) High (b.) Medium (c.) Low

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