Final Evaluation Report

December 2016

Final Evaluation of Biogas for Enhanced Quality of Life Project, Dausa District, Rajasthan

Submitted By: M2I

UFF

Enabling Sustainable Enterprises

HUMANA PEOPLE TO PEOPLE INDIA

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Abbreviations

DAP	Di Ammonium Phosphate (a commonly used chemical fertilizer)
FGD	Focus Group Discussion
GPS	Global Positioning System
ha	Hectare
HPPI	Humana People to People India
Kg	Kilogram
LPG	Liquid Petroleum Gas (household cooking gas)
MFA	Ministry of Foreign Affairs, Finland
MNRE	Ministry of New and Renewable Energy
MPUAT	Maharana Pratap University of Agriculture and Technology
NBMMP	National Biogas and Manure Management Programme
NHQ	National Head Quarter (of HPPI)
OBC	Other Backward Classes
Rs	Indian Rupee
SC	Scheduled Caste
SDG	Sustainable Development Goals
SHG	Self-help Group
ST	Scheduled Tribe
UNDP	United Nations Development Programme
1 Euro =	INR 72
Bigha	Land size unit used in villages. 1 bigha = 0.4 ha
Chulah	A traditional stove used for cooking, fuel used is firewood or dung cake

Executive Summary

HPPI implemented a 3 year project called "Biogas for Enhanced Quality of Life" in partnership with UFF Finland and Ministry of Foreign Affairs (MFA Finland). It is a continuation of the project "Biogas as renewable energy source in Indian villages", which was implemented by HPPI from 2010 to 2012, and is referred to as Phase 1 in this report. The current project, referred to as Phase 2, started in 2014 and is due to end in December 2016. In order to understand the impact of the project, HPPI engaged M2i Consulting to conduct the final evaluation of the project.

The project was implemented in 100 villages in two blocks of Dausa district. Under the project, 400 Biogas plants had to be constructed. From the Biogas plants, families were expected to get access to clean energy for cooking and lighting. In addition, 100 Self-Help Groups (SHGs) and 100 Farmers' groups (FGs) had to be formed.

Methodology for evaluation

The project has been evaluated from the perspective of its relevance, effectiveness, impact, efficiency and sustainability. The focus of this evaluation is to understand the effectiveness with which the project was executed, outputs generated and the outcomes that are evident. The evaluation has tried to capture the impact to the extent possible at this stage, considering that the project has still not ended. For the evaluation, M2i carried out the literature review and discussions with the Project staff from the National Head Quarter (NHQ) level to field level. For beneficiary level checks, a random sample of villages was selected and all beneficiaries in the selected villages were visited. The sample size was 157 across 26 villages. In addition, M2i conducted Focus Group Discussions (FGDs) with various beneficiaries, including SHGs and Farmer groups that had been formed.

M2i also visited plants from Phase 1 of the project, and specifically chose some non-functioning plants to understand the issues. M2i met other stakeholders of the project and interviewed families that had not adopted Biogas.

Evaluation Findings

Project Relevance

Biogas, as a clean energy source, is completely relevant in the larger context of climate change. In rural areas in India where there is dependence on biomass fuels, Biogas makes perfect sense. The slurry produced from Biogas is rich in organic matter and has high utility in agriculture fields. Thus, all outputs of Biogas get productively utilized.

HPPI was very successful in targeting population who otherwise was using biomass as primary source of fuel. The data shows that 96.1% of the sample respondents had biomass as their primary source of cooking fuel prior to the project. The project was focused on women and targeted members belonging to social groups considered vulnerable in India i.e. scheduled castes, schedule tribes (SC, ST) and other backward

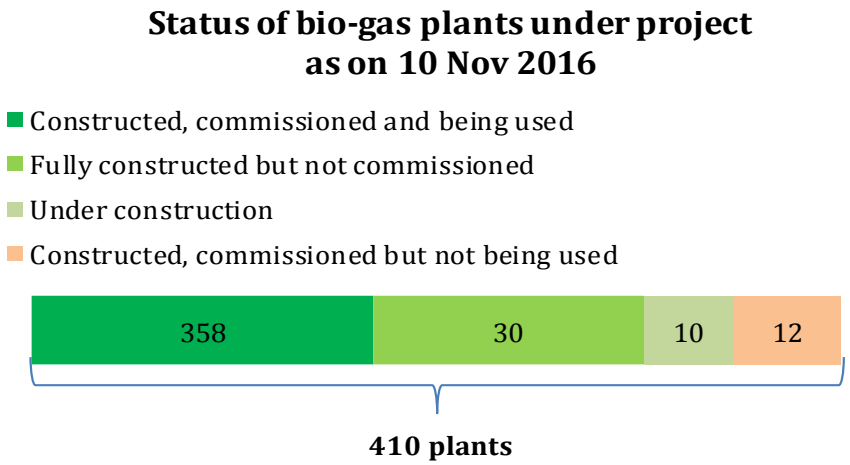
classes (OBCs). The sample had 86% of the respondents belonging to these vulnerable castes.

As far as alignment of project with prevailing policy environment is concerned; the government currently has focus on renewable sources of energy and 'solar' is being promoted in a big way. However, the government also has targets set for 'Bio-gas' and to that extent HPPI's project is contributing to the government's efforts.

Project results

Outputs

HPPI was able to achieve the key project outputs and has even exceeded them. Against the target of 400 Biogas plants, HPPI is likely to complete 410 plants by December 2016.



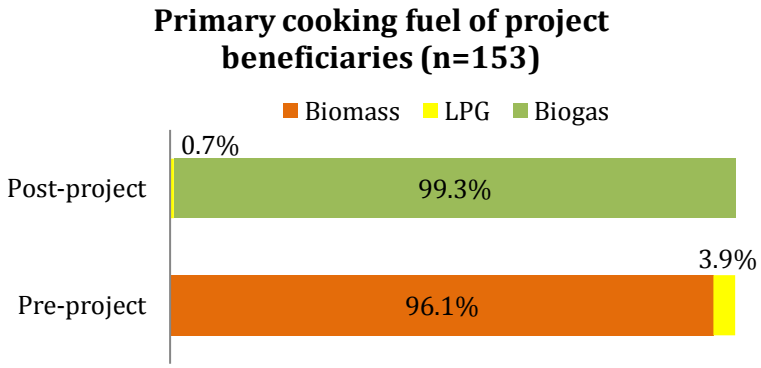
The status is shown in the chart. Besides, HPPI helped 268 beneficiaries receive government subsidy, ranging from 36% to 40% of the project cost. As per project plan, subsidy from the government was to be arranged from the second year of the project.

HPPI also trained 25 masons under the project against the target of 15. Furthermore, HPPI formed SHGs and Farmers' club. The performance on SHG front was found to be good. 102 SHGs had been formed and almost all were functioning. But the performance on Farmers' groups was moderate. 98 groups had been formed by the time of evaluation, of which, 75% of the groups were well functioning while 24% were not meeting regularly.

Quality

M2i physically verified each structure at the house of the beneficiary in the sample. Overall, the quality of the Biogas plants was found to be good. In the sample, all the plants could be located. It was observed, that 100% of the plants produced desired output of gas at the time of commissioning. There were no technical failures at the time of handing over the plant and almost all beneficiaries in the sample, whose plant had been commissioned, were satisfied with the quality and performance.

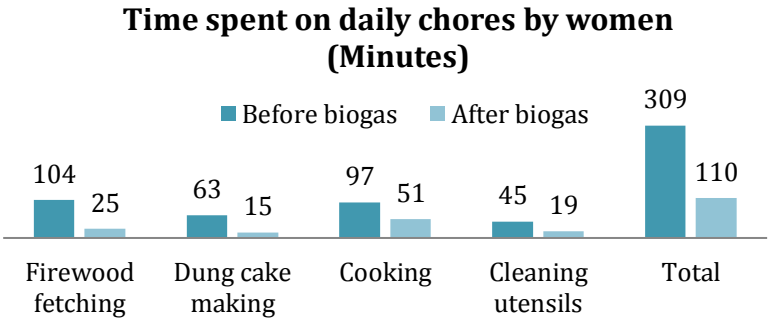
Fuel and slurry usage



A major achievement of the project was the fact that after having Biogas, 99.3% of the respondents in the sample were using it as their primary source of fuel and had completely shifted from biomass based fuels. The average consumption of biomass fuel in sample families, dropped from 17kg per day to 3.4 kg. People used fuelwood for cooking for the family, cooking for the cattle and for heating water. Another benefit of Biogas was observed on usage of bio-slurry. 94% of the respondents mentioned of using slurry in agriculture.

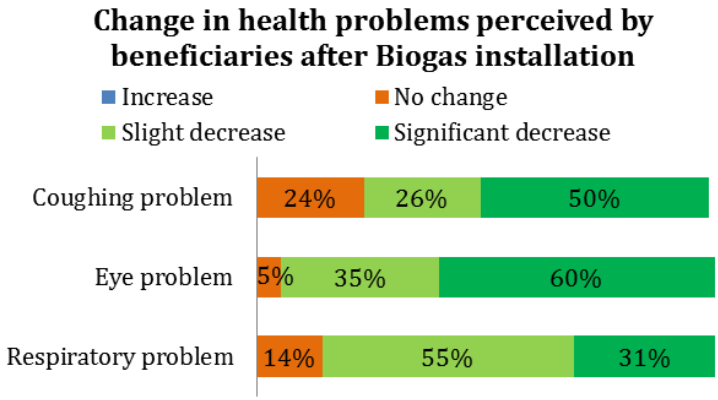
Effectiveness and Impact

Impact on women



With the Biogas replacing biomass fuel, the impact was significantly felt by women in terms of convenience and time saving. The average daily time saved on cooking and related activities was 3.3 hours.

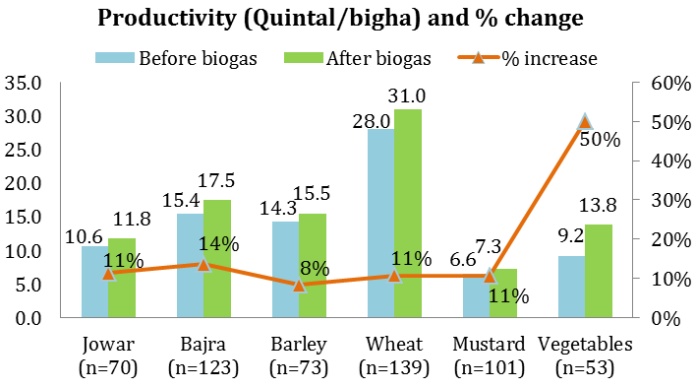
Health

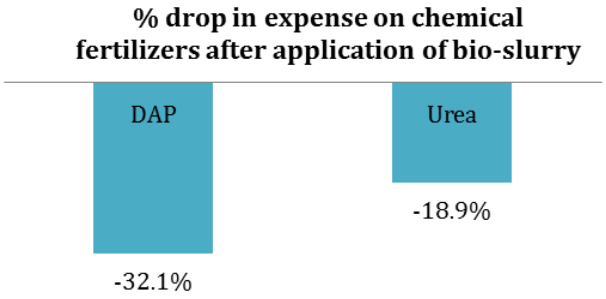


52% of the respondents mentioned they never had to inhale smoke after having Biogas, compared to only 1% saying that during baseline – those who used Liquid Petroleum Gas (LPG). Most women mentioned that before Biogas, they were exposed to smoke for 2-3 hours every day. The impact of this was also felt on health. 50% and 60% respondents mentioned 'significant decrease' in cough and eye problems respectively after having Biogas. The data shows 16% reduction in medical expenses.

Agriculture productivity and fertilizer usage

Another impact of Biogas was observed on productivity of various crops and reduced use of fertilizers. Farmers agreed that bio-slurry increased soil fertility and reduced need for chemical fertilizers. For most crops, productivity improvement was reported around 11%. However, farmers also mentioned that as slurry was not sufficient for their entire landholding, most used it in their kitchen garden. Thus, major impact was felt on vegetable production as quality and production both improved significantly.

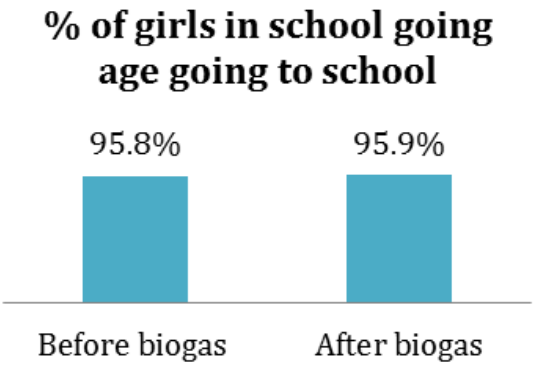




Use of slurry resulted in reduction in use of chemical fertilizers and hence, expenses needed on them also reduced.

Impact on children

Some indirect benefits were observed on school-going children. Beneficiaries mentioned that as now children did not need to fetch firewood and could get food on time, particularly the breakfast, their attendance in school and study hours at home had both improved. However, no increase in enrolment rates of girls in schools was observed.



Other impacts

Other impacts were on people becoming more active in maintaining kitchen gardens. However, no impact was seen in women taking up income generating activities. There was also some improvement on financial inclusion, but people did not attribute it directly to this project, although the project did create awareness on it.

Sustainability and scalability

Sustainability and scalability are critical as far as Biogas technology is concerned. The key factors that have influenced sustainability of Biogas plants and its continued usage

in past, can broadly be divided into following categories –technical factors, maintenance related factors, social factors and financial factors.

In M2i's opinion, HPPI has done well to control the technical and financial factors by constructing high quality plants with subsidy element in it. However, there is very little that HPPI can do to control other factors, that is, maintenance related and social factors. Even in HPPI's own experience from Phase 1, these factors had adversely affected sustainability of the plants. Further, as the whole model is currently subsidy driven it creates barrier for its scalability. People at large are still not inclined to adopt Biogas, particularly if no subsidy is available.

Project management and efficiency

HPPI has implemented the project quite professionally. The overall staff structure, quality of staff and implementation process were found to be adequate and good to manage a project of this nature. The human resource quality was very good as the team members had high level of understanding of the subject. HPPI had the advantage of the learning from Phase 1, which it utilized in Phase 2 and tried to eliminate some of the factors that result in plants getting dysfunctional. HPPI also had a good strategy to engage with external stakeholders. It had a dedicated staff to engage with government departments and local bodies. HPPI was very proactive in involving officials and community representatives at different levels in various activities undertaken during the project.

The project was executed efficiently as there were no costs or time overruns in the overall project. HPPI has been able to conduct all the proposed activities within the proposed timeline. It has not just achieved all the output targets, but has even exceeded them achieving the desired outcomes on the population that adopted and was using Biogas.

Recommendation

M2i sees potential for continuation of Biogas project. The key government programme to promote Biogas, NBMMP is still continuing. Government has its targets own Biogas to fulfill, and subsidies are also available. HPPI's project is helping government to create high quality structures, by supplementing government's subsidy with its own grants. Hence, M2i does see potential to implement even third phase of the project.

Context of final evaluation

Humana People to People India (HPPI) aims to contribute to the improvement of the economic status and quality of life of farmers' families in 100 identified villages in Bandi Kui and Mahwa blocks of Dausa district in Rajasthan, India. Towards achieving this, HPPI implemented a 3 year project called "Biogas for Enhanced Quality of Life" in partnership with UFF Finland and Ministry of Foreign Affairs (MFA Finland).

The project started in 2014 and is due to end in December 2016. This project is a continuation of an earlier similar project, which was implemented from 2010 to 2012 and is referred to as 'Phase 1' in this report. As the current project is nearing completion, HPPI and other project stakeholders wanted to understand the impact of the project on the beneficiaries. Hence, HPPI engaged M2i Consulting, a management consulting company to conduct the final evaluation of the project.

About the Project

"Biogas for Enhanced Quality of Life" is a 3 year project that started in in 2014. The project was implemented in 100 villages in two blocks of Dausa district. Under the project 400 Biogas plants had to be constructed. From the Biogas plants families are expected to get access to a clean energy used for cooking and lighting. The use of bio-slurry, the by-product of the fermentation process, can be used as farm manure resulting in increased agricultural output, and also reduced expenditure on chemical fertilizers/pesticides.
The objectives of the project were:

- Increased household economic status of farmer families du to adoption of Biogas technology
- Empowerment of women and improvement in quality of life and health

The specific outputs expected from the project were:

- Construction of 400 Biogas plants
- Training of 15 masons in construction of Biogas plants
- Reduced household expenses and increase in saving up to 30%
- 100 Farmer Groups are formed
- 200 beneficiaries are able to get government support to finance 34% or more, for construction of the Biogas plant
- 100 women's Self Help Groups (SHGs) with 1,200 members formed

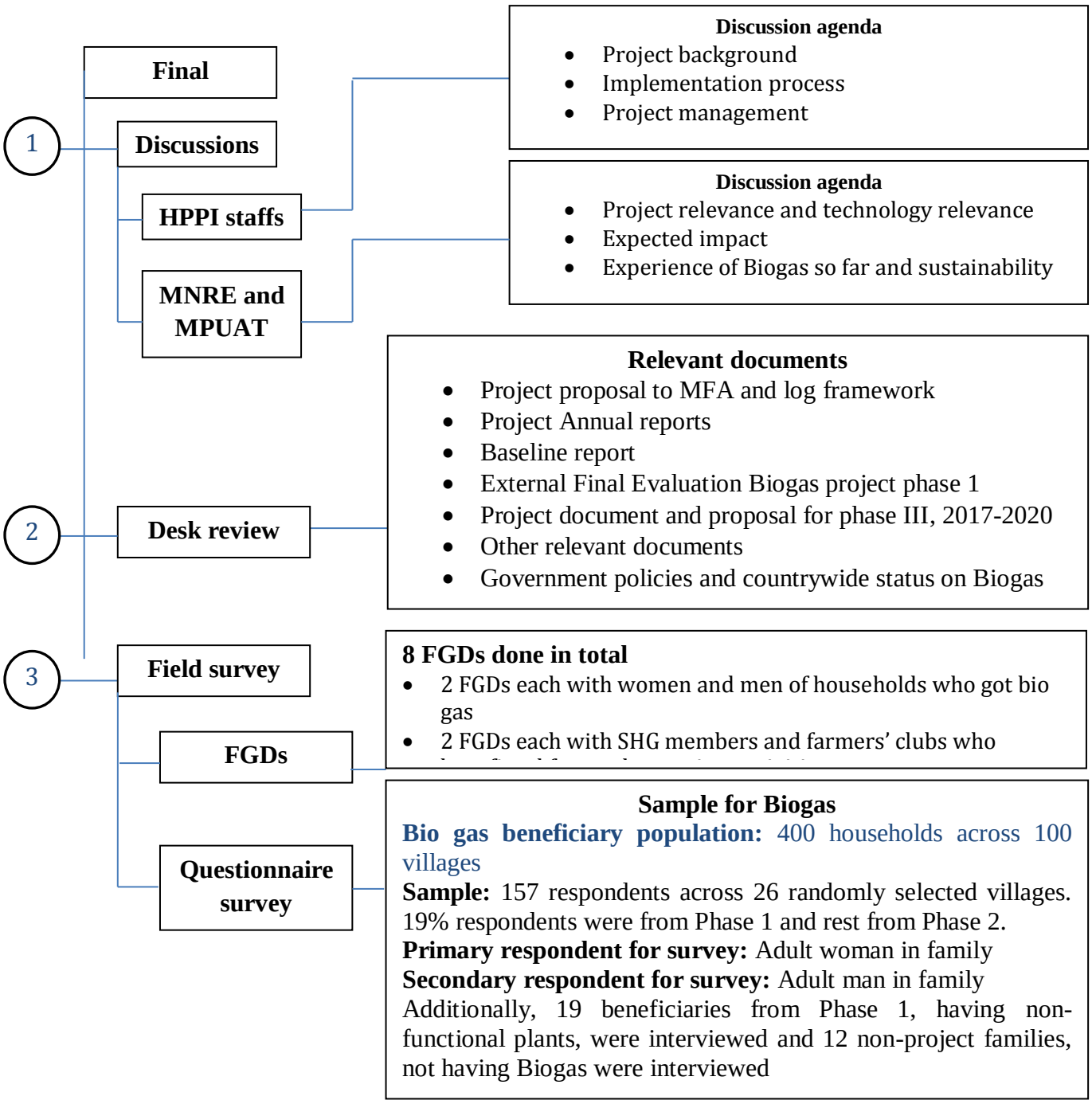
Scope of evaluation

The main objective of this evaluation was to find out to what extent the objectives set for the project and the results expected had been attained as well as to assess the quality of the project. The report evaluates the project from the perspective of relevance, results obtained, effectiveness and impact, efficiency and project management.

Methodology for the evaluation

Following was the framework for final evaluation.

Evaluation framework



The questionnaire survey was done using mobile survey application and data analysis was done using STATA 12.

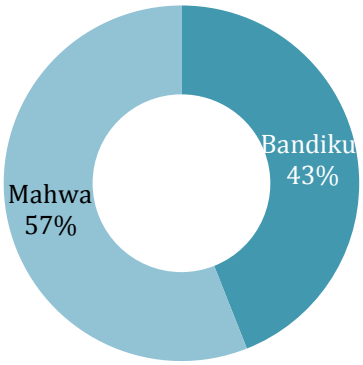
Research tools used

Respondents for evaluation	Research tools used
HPPI project team	Semi-structured interviews
Beneficiaries and other community stakeholders	FGDs using pre-prepared agendas
Biogas beneficiaries	Questionnaire

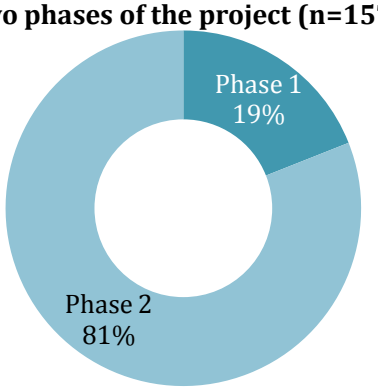
Tools are provided in the Annexure.

Respondent profile

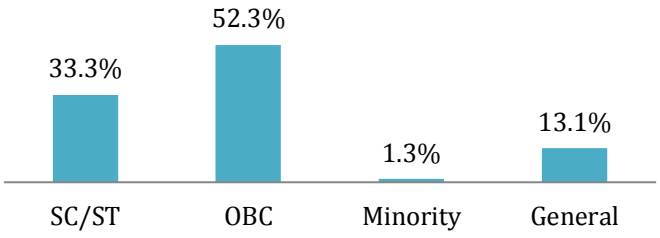
Respondents' composition from the two blocks of the project (n=157)



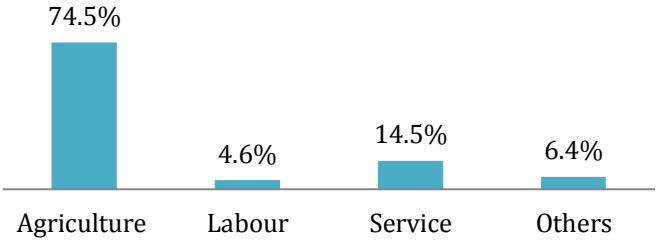
Respondents' composition from the two phases of the project (n=157)



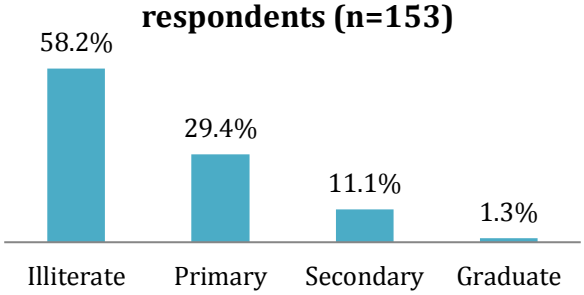
Social status of beneficiaries (n=153)



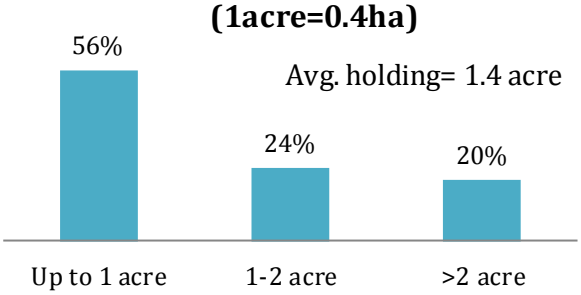
Primary occupation (n=153)



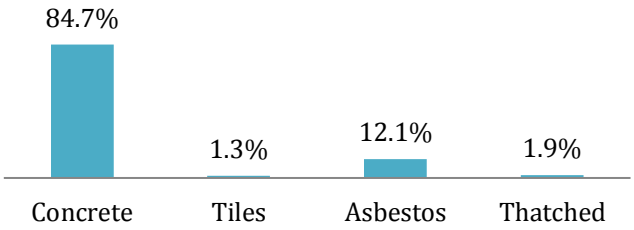
Education level of primary respondents (n=153)



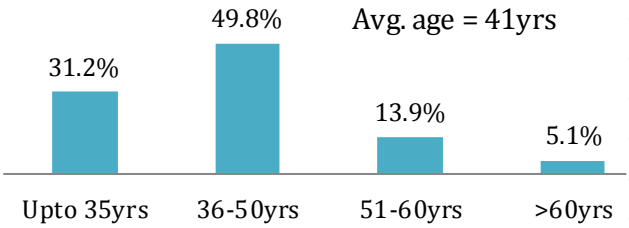
Landholding (n=153) (1acre=0.4ha)



House roof type(n=153)



Age of beneficiaries (n=153)



Sample distribution across villages

S. No.	Village	No. of beneficiaries interviewed
	Bandi kui Block	
1	Abaneri	4
2	Chokkarwara	7
3	Garhdoobi	5
4	Keechupada Kala	5
5	Manota	8
6	Nelochkagora	6
7	Nihalpura	14
8	Sumelkala	13
9	Unbada	6
	Total – Bandi kui	**68**
	Mahwa Block	
10	Balahera	7
11	Baldena	1
12	Bironda	3
13	Chandera	3
14	Dhaulkheda	9
15	Garh Himmat Singh	9
16	Goya Ka Baas	6
17	Haldena	2
18	Jhutahara Kala	4
19	Khawda	3
20	Lotwara	8
21	Mandawar	6
22	Nagal Sumer Singh	7
23	Naurangwada	10
24	Naya Gaon	5
25	Ramgarh	3
26	Udaypura	3
	Total - Mahwa	**89**

Survey location

The locations are exact survey locations marked by GPS, as survey was done using mobile based applications.

Evaluation Findings

1. Project relevance

Macro level relevance

As per Census 2011, 67.3% households in India are using solid fuels (fire wood / crop residue/ dung cake/ charcoal etc.). This translates to around 163 million households or a population of 814.5 million - a very huge population by any means. Further, Census 2011 shows that in Rural areas 86.5% households are using solid fuels for cooking. According to a UNDP report "Sustainable Energy for All", more than half of the global population lacking clean cooking facilities lives in India, China and Bangladesh with India having the maximum such population. Solid fuels produce very high level of indoor pollution. According to the same UNDP report, typically, 24 hour levels of PM10 in a home using biomass fuel range from 300 to 3000 micrograms per cubic meter. As cooking is done every day, most people using solid fuels are exposed to small smoke particles at a level many times higher than the accepted annual limits for outdoor air pollution.

As cooking is invariably done by women, they are the worst sufferers of this indoor pollution. The health impact of this pollution is very high and results in respiratory and eye related problems.

In this backdrop, any project that promotes a cleaner source of fuel that does not produce smoke is much desirable and is quite relevant in rural India context. The Project contributes directly to the SDG 7: Affordable and Clean Energy and to SDG 13 on Climate Action as it reduces emission of green-house gases.

HPPI's project on Biogas is relevant from the perspective that Biogas uses cattle dung which is relatively easily available in most rural households as cattle rearing is common.

Thus, from a macro environmental perspective and in the country context, the project is relevant.

Technological relevance

A Biogas reactor helps in anaerobic degradation of biodegradable waste such as cattle dung, kitchen waste, garden waste etc. The combustible gas produced is a mixture of methane and carbon dioxide produced as a result of fermentation of the waste. The byproduct of the process is 'slurry', which is rich in organics and nutrients and can be used as farm manure.

The Biogas technology has not proved successful for large scale production but has relevance for household use, particularly in rural areas where land and animal waste is available and there is also use for slurry, which can be used in farming.

The construction of the overall Biogas digester has to be done by skilled labour, having the required expertise in design and construction of Biogas reactors. Incorrectly constructed reactors can result in malfunction. The users also need to be trained on periodic cleaning and maintenance of the Biogas reactor.

These aspects had been taken care of under the project. Evaluation findings showed that HPPI had trained 25 masons, well above the project target of 15. Further, the construction of all Biogas reactors was done under expert supervision of the technicians. The households using Biogas had also been trained in its repair and maintenance.

Project relevance in the prevailing policy environment

Currently, the government has a very high focus on solar energy, where a lot of technological innovations are underway and the cost of solar energy has been coming down. Government sees solar energy as a long-term and scalable solution for India and hence is giving it a lot of policy push.

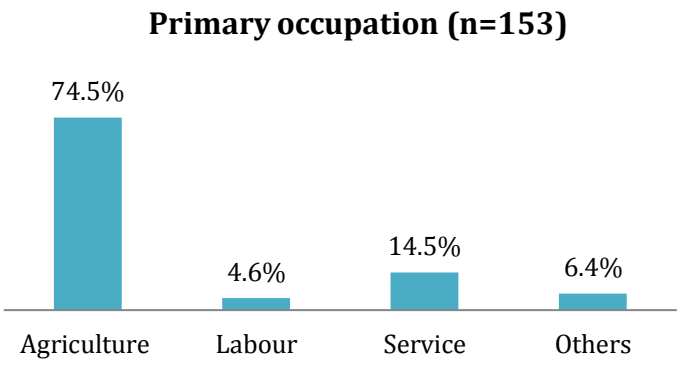
Government has set itself an ambitious target of deploying 20,000MW of grid connected solar power by 2022[1]. Due to this, current focus of Ministry of New and Renewable Energy (MNRE) is mainly invested in solar power.

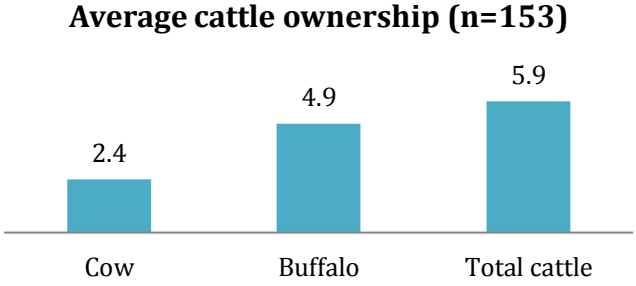
However, government does have a programme, National Biogas and Manure Management Programme (NBMMP) to support Biogas. HPPI, has done well to leverage the programme under this project. For the year 2014-15, government had a target of establishing 110,000 plants. NBMMP is on-going, creating opportunity for HPPI to continue working on biogas.

Relevance of project objects and activities to targeted beneficiaries

The overall project objectives and activities were found to be relevant for the target beneficiaries under the project. The beneficiaries belonged to rural areas having agriculture as the primary occupation.

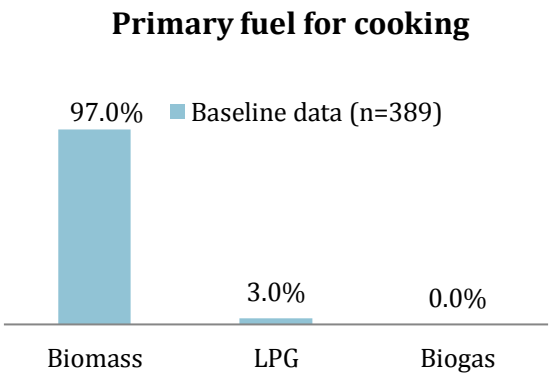
People had livestock and also had use for slurry. Even those beneficiaries whose primary occupation was not agriculture still had cattle and were involved in limited scale farming.





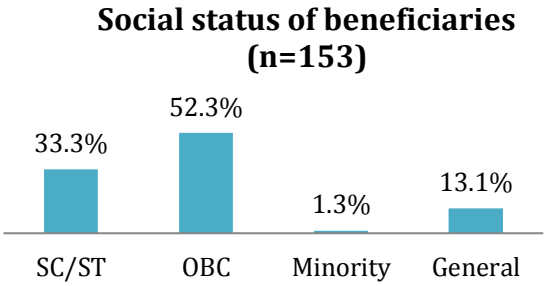
[1] Source: MNRE

As the project was focused on providing a cleaner source of fuel, hence a key criterion for effectiveness of targeting would be their existing source of fuel. The data shows that 96.1% of the sample respondents had biomass as their primary source of cooking fuel, prior to project implementation. This data of the sample respondents is consistent with the data collected during baseline, which showed 97% people using biomass fuel. Thus, the target beneficiaries for this kind of project were relevant.

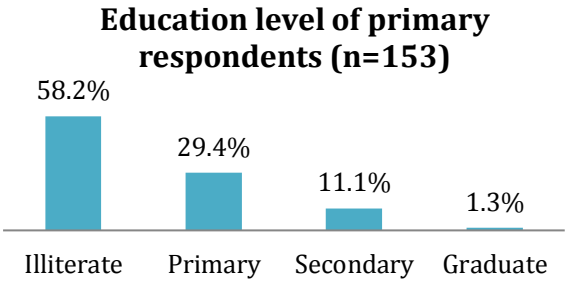


Inclusion of vulnerable groups in the project

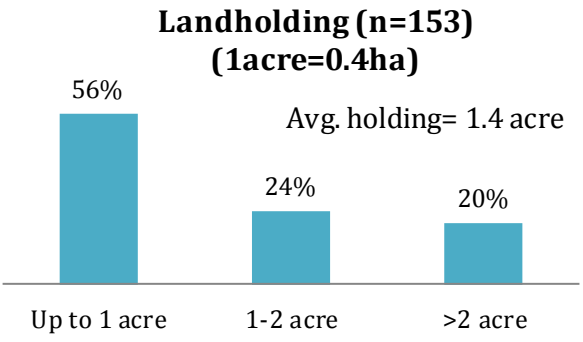
The project was targeted at members belonging to social groups that are vulnerable in India i.e. scheduled castes, schedule tribes (SC, ST) and other backward castes (OBCs). The sample had 86% of the respondents belonging to these vulnerable castes. Further, the project focus was on women, who are in any case very vulnerable in a state like Rajasthan that has high level of gender bias.



Further, the education level of women members in the beneficiary households was found to be low with as high as 58% being illiterate and another 29% only having primary education.



In terms of landholding, most beneficiaries under the project were marginal farmers. 80% of the respondents had landholding up to 2 acres. Average land holding size for the entire sample was 1.4 acres.



Thus, overall the project was successful in targeting people from low income segments and belonging to lower social hierarchy.

2. Project results

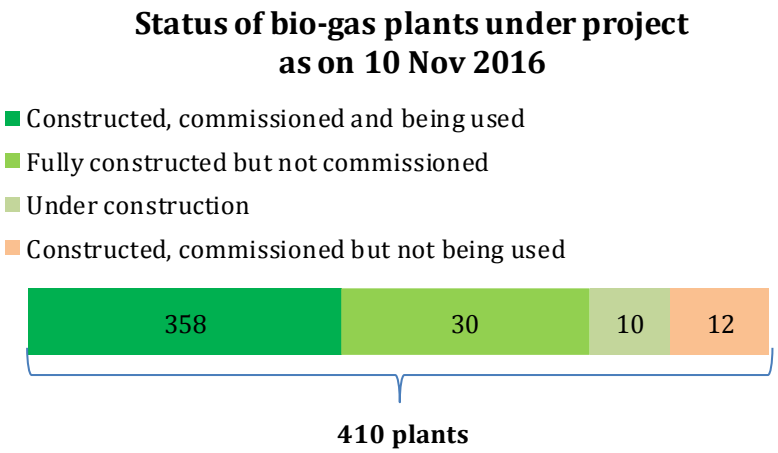
Key project outputs

M2i conducted the endline survey from 17th to 21st October 2016; the status on key project outputs at the time of visit and M2i's observations on them are summarized below.

Key target 1: To construct 400 new Biogas plants

M2i's Observation

By the time of evaluation, HPPI had either fully constructed or construction was underway of 410 plants. These plants were of 2m^3 capacity and were *Deenbandhu* model. Of the total plants, 358 plants had been commissioned (handed over to owner in a working condition). Rest of the plants were under different stages of commissioning. M2i physically verified the location, quality and operational status of all the plants in the sample.



Key target 1a: 50% of the beneficiaries (that is 200) are able to get government support to finance 34% or more, for construction of the Biogas plant

M2i's Observation

The project had the target of getting government subsidy for at least 200 beneficiaries, to the extent of at least 34% of the project cost. As per the project plan, in the first year, the project would bear the full cost of the biogas and from the second year onwards, government would be involved to provide the subsidy for at least 50% of the total plants.

Against this target, HPPI was able to get subsidy for 268 plants from the government. Government provided subsidy of either Rs. 9,000 or Rs. 11,000 (Euro125-153), based on the economic status of the household. Considering the cost of *Deenbandhu* model to

be around Rs. 25,000 (Euro347), the beneficiary got subsidy in the range of 36% to 40%, which was more than the target of 34%.

Key target 2: To maintain Biogas plants from Phase 1

M2i's Observation

By the time of M2i's visit for evaluation, HPPI had completed maintenance of 34 plants and maintenance of another 16 was under progress. All these plants were from Phase 1. After the maintenance will be over, a total of 164 plants of 200 plants from Phase 1 will be operational. The maintenance of these plants has been done with the project funds. Post project, the families are supposed to maintain the plants on their own.

Key target 3: 15 Masons to be trained in construction of 2-4m^3 capacity Biogas plants

M2i's Observation

A total of 25 masons had been trained by HPPI; this was more than the target. Masons were trained by technical staff from Maharana Pratap University of Agriculture and Technology (MPUAT) in a training of 10 days. Under the training, masons had to actually construct plants to learn the skill. After the training National Biogas and Manure Management Programme (NBMMP) of Ministry of New and Renewable Energy (MNRE) evaluated the performance of masons and certified them.

Key target 4: 100 SHGs with at least 1,200 members to be formed

M2i's Observation

HPPI had formed 102 SHGs with 1,290 members; 100% of whom were women. Of these SHGs, 2 were non-functional. All SHGs were involved in internal saving and credit activities and over 80% had bank accounts. HPPI had carried out various awareness campaigns training programmes for these groups.

Key target 5: 100 Farmers' groups to be formed

M2i's Observation

HPPI had formed 98 Farmers' groups by the time of evaluation. A Farmers' group have 10-12 members, mostly men, who meet monthly to discuss various agricultural issues and practices. It is a forum for knowledge sharing and learning.

Performance of farmers' groups in terms of their sustainability was moderate. 24 of the 98 groups formed were either not functioning or not functioning regularly. Unlike SHGs which are bound by regular financial transactions and have bank accounts, Farmers' groups do not carry out such transactions making it difficult to ensure their sustainability.

Status and quality of Biogas plants

The quality of Biogas structures created under the project was found to be good. In the randomly selected sample of 26 villages, all 157 Biogas plants could be located. Of these plants, construction had been completed in 153 plants while others were under different stages of construction or commissioning. The status of these plants is presented below.

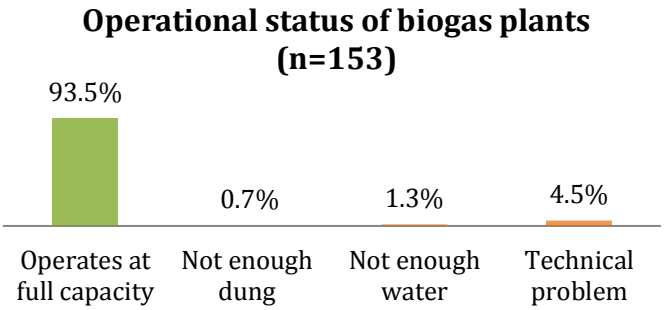
Status of Bio gas structure in sample (n=157)

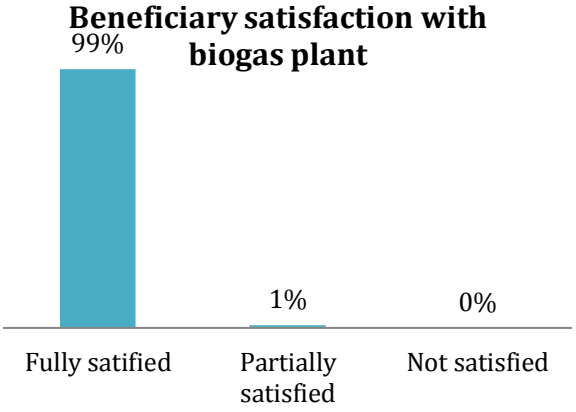
Status	Phase 1	Phase 2	Total
Abandoned	0	0	
Under construction	0	2	***2***
Constructed but not yet used	1	1	***2***
Constructed and used	29	124	***153***
Total	**30**	**127**	***157***

Of the 157 plants in the sample, 153 had been commissioned. All commissioned plants were found to be in working condition and all the households were using them.

All the plants were physically verified and photographic evidence were taken. All plants in the sample were of standard size and design. They were all *Deenbandhu* model of $2m^3$ capacities, as required in the project.

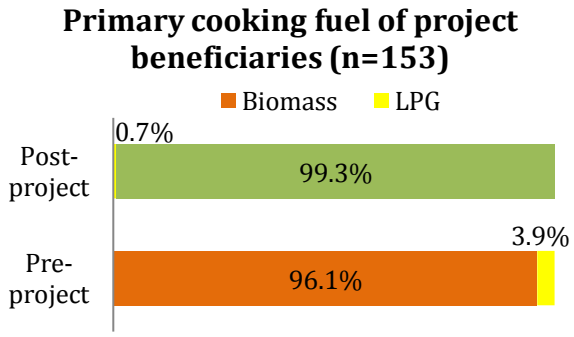
The Biogas plants installed under the project were functional. A high percentage of people reported of plants running at full capacity and had not faced any technical problem so far. In 7 plants, people mentioned of some technical problems occuring due to which they had carry to out some repairs. The average amount spent on repairs by these families was Rs1,652 (Euro23). 99% users expressed satisfaction with the plant.





Primary cooking fuel

The findings suggested that there was a significant shift in the primary cooking fuel used by the project beneficiaries. 99.3% of the project beneficiaries were using Biogas facility, installed under the

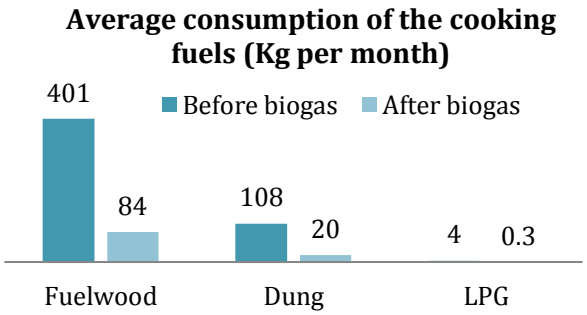


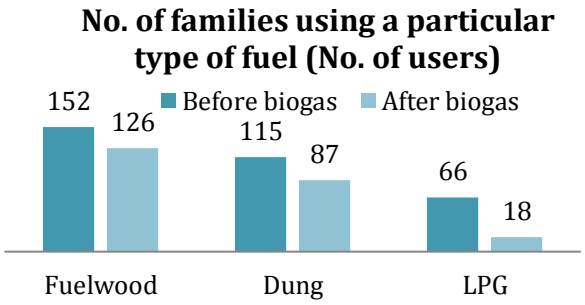
project, as their primary fuel source. Almost, all these families had biomass based sources such as wood and dung cakes as primary fuel prior to the project. None of these households, except for one, had a Biogas plant prior to project. The only family having a Biogas plant prior to the project had it installed a few years ago with support from government, but that plant stopped working after a year of installation.

Survey findings showed that the average number of meals cooked by a family in a month was 65. Of these families having biogas cooked on an average 50 meals using biogas, reflecting high utilization of biogas.

Usage of biomass fuel

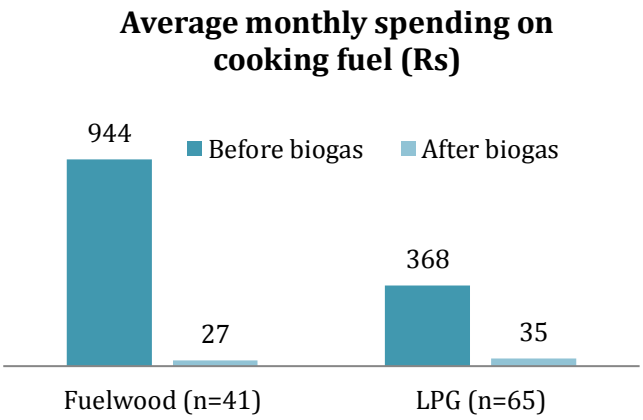
While the primary cooking fuel of the people changed after the implementation of Biogas plant, data shows that there has also been a significant overall decrease in consumption of biomass fuel. The average fuelwood consumption reduced by 79% while dung cake consumption reduced by 81.5%. There was also a fall in number of families using biomass fuels. 26 families (17%) had stopped using fuelwood all together while 28 families (24%) of the 115 families earlier using dung cakes stopped using it all together. There was also reduction in consumption of LPG as people started using Biogas considering it to be a cheaper source over LPG.





Monthly expense on fuel

Most people mentioned that they did not have to purchase firewood or dung cakes they were using prior to Biogas. They collected them from their own resources (field or cattle). In our sample, 27% families purchased fuelwood and spent an average of Rs944 (Euro13) per month on it. This expenditure came down to as low as Rs27 (Euro0.4) for these families. Similarly, expenditure on LPG also came down significantly for families using it regularly. However, some families mentioned, that as now they did not use the firewood from their fields, so they sell it. While, HPPI did provide training on environmental issues as part of motivating people to adopt biogas, there seems to be a greater need for sensitizing the community on not selling the wood for burning purposes.



Case of Sita Devi

Name: Sita Devi Village: Abaneri

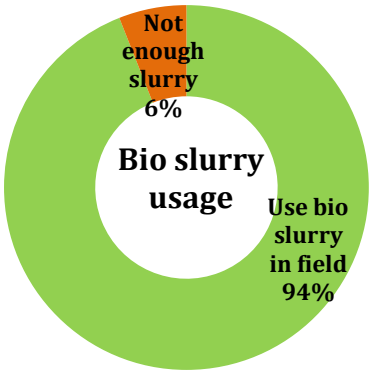
Sita Devi, 32 years old, has a family of 6 members. The family's primary fuel source prior to biogas construction was firewood and dung cakes.

Sita spent around 2 hours cooking every day, during which she was exposed to smoke and soot. Sita explained that due to the high level of exposure to smoke, she used to have regular eye problem and headache. She even visited doctors on a couple of occasions.

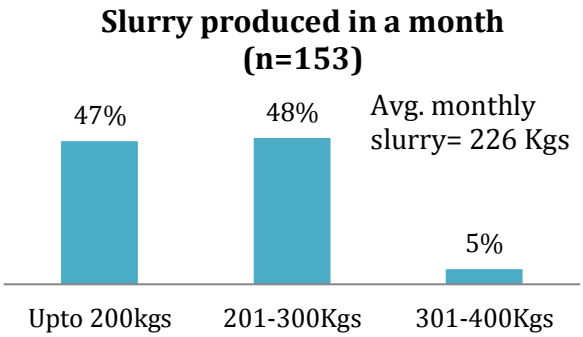
She mentions that for her, biogas was a very welcome relief. She now does not have to inhale smoke while cooking and finds the overall environment in the kitchen cleaner and healthier. She also mentions that due to biogas, she is now able to cook much faster.

Slurry use in agriculture

One of the by-products of Biogas plants is the slurry, which can be used as farm manure. The findings of the survey showed that 94% of the households were using slurry in agriculture. Most households had slurry production of up to 300 Kgs in a month, with the average production being, 226 Kgs. Although, project did not have any specific target for slurry production, the production was still analyzed to see the extent of usage and its impact.



Discussions with the farmers revealed that the amount of slurry produced from one plant was not sufficient for usage in the average size of agriculture fields they had. The average size of agriculture field in sample was 1.4 acres, which requires at least 15.0 – 18.0 tons of manure in a year. However, the slurry produced with a single Biogas plant was around 2.0 – 2.5 tons in a year.



While the amount of slurry produced was less, people mentioned that it does help in increasing the rate of composting and also reduces the requirement of chemical fertilizers. In our survey, 94% of the households mentioned of using the slurry in agriculture fields or in homestead or in both. 6% of the respondents mentioned that they did not have enough slurry production for agriculture usage.

Biogas cost and subsidy

The project worked closely with the government agencies. HPPI was able to arrange subsidy for establishment of Biogas plants. Against the target of 200 beneficiaries for subsidy, HPPI arranged subsidy for 268 beneficiaries. These beneficiaries received subsidy from government of either Rs9,000 (Euro125) or Rs11,000 (Euro153).

In our sample of 157, 76% of the respondents acknowledged of having received subsidy from the government, while 100% mentioned receiving monetary or in-kind support from HPPI. The table below shows the average cost of construction, as estimated by the respondents, and the average amount of their own contribution.

Average cost of construction	Rs.23,800 (Euro331)
Average amount of own contribution	Rs. 8,967 (Euro125)

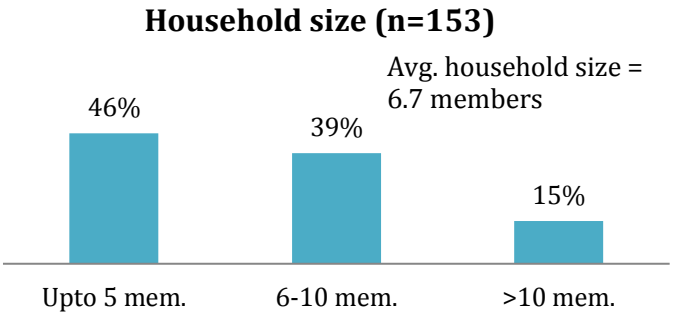
	Avg. subsidy amount, Rs.	**% respondents received subsidy**
HPPI	7,967 (Euro 111)	100%
Government	9,482 (Euro132)	76%

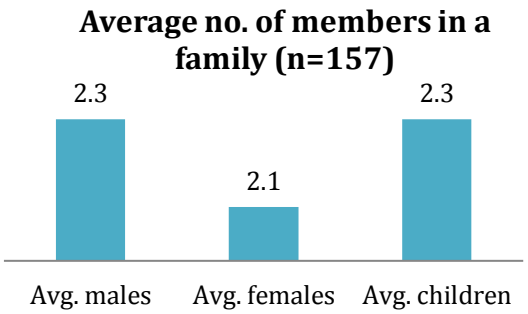
A biogas plant with details of government subsidy

3. Project effectiveness and impact

Direct beneficiaries impacted

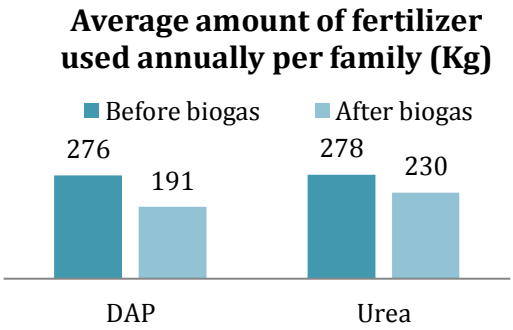
Total family members in 153 households in the sample were 1,049, average being 6.6 members per household. Considering the same proportion of family size in the area, the project with 400 Biogas plants would be able to positively impact 2,680 individuals. Of these 920 are likely to be children and 840 women.





Usage of chemical fertilizer

As the slurry was being used by the beneficiaries for agriculture, it had an impact on usage of chemical fertilizers. People mentioned that with usage of slurry, the need for chemical fertilizers reduced. The slurry use increased the rate of composting and improved soil quality and nutrients. The reduction in two common chemical fertilizers, as estimated by the respondents, is shown in the chart.



The survey data provides following information:

- 17% of the farmers mentioned that they now did not need to use Di Ammonium Phosphate (DAP)[2] after using bio-slurry. 67% of these who mentioned of not using DAP were small farmers having land size up to 6 bighas.

	No. of chemical fertilizer users		
Chemical fertilizer	**Before Biogas**	**After Biogas**	**Drop in users**
DAP	152	126	17.1%
Urea	151	144	4.6%

- 5% of the farmers mentioned that they now did not need to use Urea after using bio-slurry. 90% of these who mentioned of not using Urea were small farmers having land size up to 6 bighas.

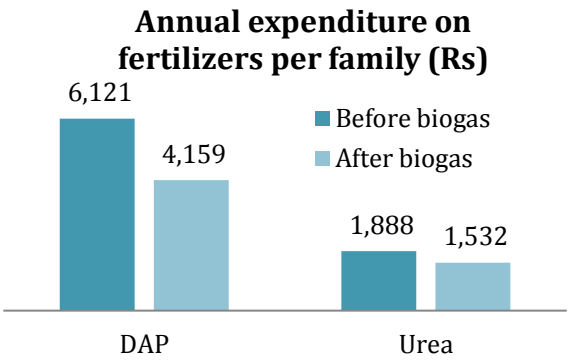
[2] DAP is a common chemical fertilizer used by farmers.

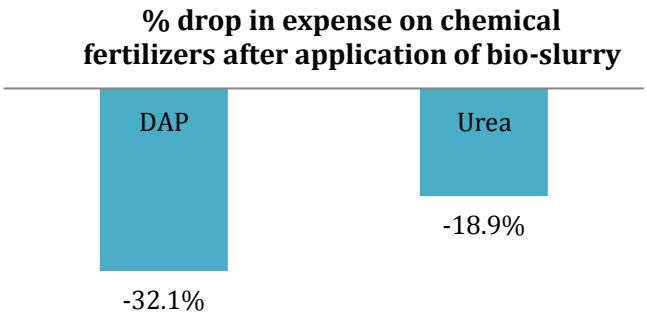
- Among those who still use the chemical fertilizers, 56% of DAP users and 37% of Urea users reported reduction in their use of these fertilizers.

Chemical fertilizer usage

	% reduction in average consumption	% who farmers stopped or reduced consumption
DAP	31%	63%
Urea	17%	40%

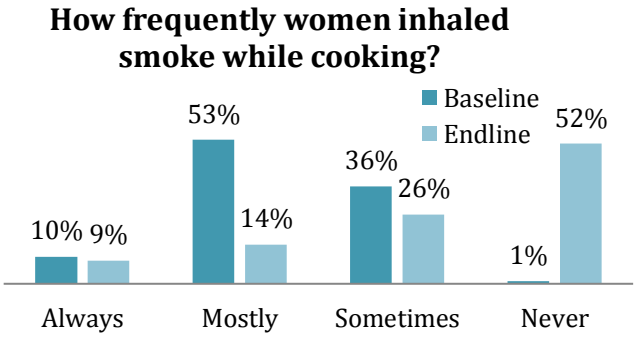
- As the usage of fertilizers had fallen, so had the expense on fertilizers. The data shows that there has been a drop of 32% in the annual expenditure on DAP and 19% on Urea, per family.





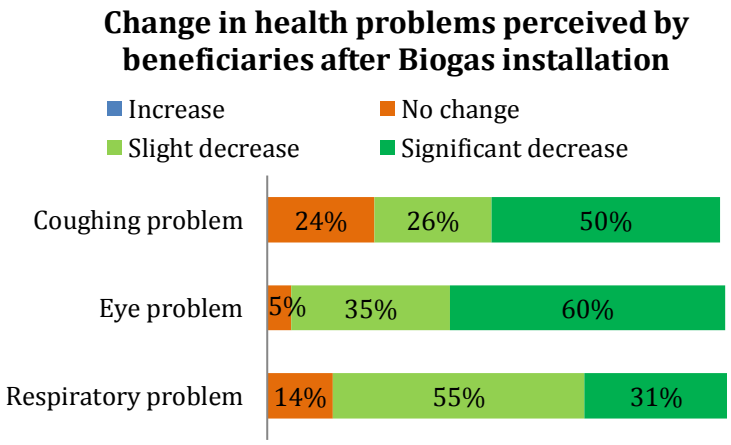
Incidence of inhaling smoke

As most families had started using Biogas, it had reduced women's exposure to smoke. While during the baseline 63% women mentioned that they had to inhale smoke, either always or most of the times while cooking, the same proportion during endline was only 23%. During the endline, 52% women mentioned that they did not have to inhale smoke now during cooking.



Health impact

The respondents mentioned considerable relief in problems related to respiration, eyes and coughing. Women mentioned that without Biogas, they were often exposed to smoke for 2-3 hours every day. With Biogas, that exposure to smoke is curtailed, directly reducing the inconvenience and the related health hazards.

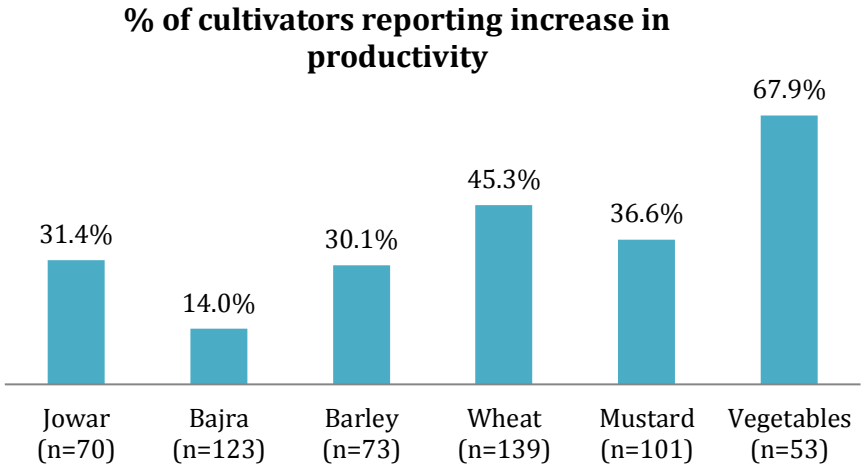


Medical expense

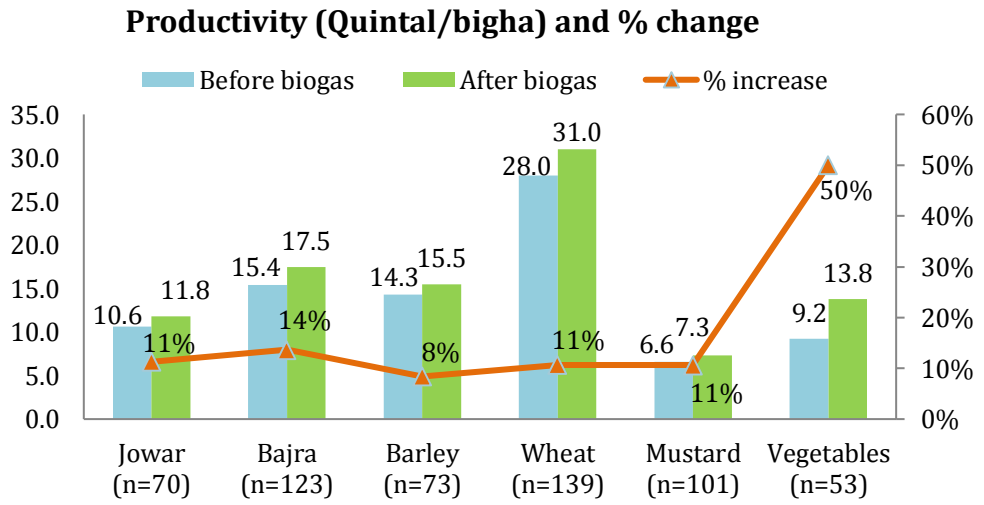
56% of the respondents mentioned decrease in their expenditure on health related reasons. The average annual expenditure on health reduced from Rs. 3,644 (Euro51) to Rs. 3,042 (Euro42), a reduction of around 17%.

Impact on agriculture productivity

As the people reported use of bio-slurry in the agriculture fields and the positive impact of it on the production, the evaluation checked the impact of it on productivity. The results showed that for most common crops, around 14-68% of the cultivators who cultivated that crop reported increase in productivity.



However, highest number of cultivators reporting increase in productivity was vegetable growers. The average productivity for the growers of different crops before and after application of Biogas slurry, and the % increase in productivity is shown in the charts.



The impact on vegetable was highest because most people mentioned that as the slurry was not enough for agriculture fields, they used it mostly in kitchen gardens.

Case of Sugni

Name: Sugni Gurjar, Ratiram Gurjar; Village: Garhdoobi, Bandikui Block

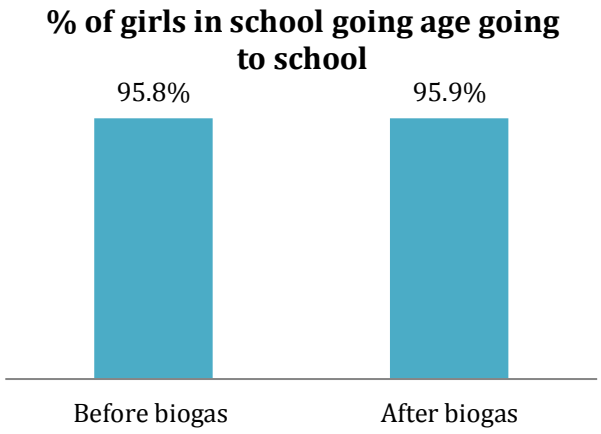
Sugni Gurjar and Ratiram Gurjar, aged 45 and 52 respectively, are residents of Garhdoobi, Bandikui. The family has 7 adult members and 6 school going children. The family's primary fuel source prior to Biogas construction was fuelwood, which was later substituted almost entirely by Biogas.

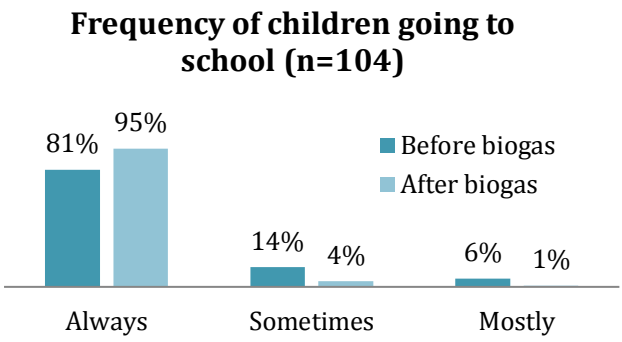
The family has an active kitchen garden of around 0.5 bigha, on which they grow vegetables such as Egg plant, leafy vegetables, chillies, peas and other seasonal vegetables. The produce is entirely consumed by the members of the family.

The family had started exclusively using Biogas slurry in the vegetable garden, and this was the third harvest after use of slurry. The family reported that the yield was higher than earlier when they used fertilizers and chemicals. In fact they saw significant improvement in the last harvest, perhaps due to the fact that it takes time for the nature of the soil to change in response to the manure application. The vegetable sizes have increased and they taste better now. The family also saw this superior produce as a prospective means of earning in the future by selling their produce, and now plan to allocate more land to their vegetable garden.

Impact on schooling

52% of the households in the sample had school going girls. One of the hypotheses of the project was that the biogas may result in increase in number of school going girls, as they may be involved in household chores. However, no change was observed on that front. Around 96% girls in school-going age were reported going to school even prior to Biogas; this proportion remained almost unchanged after Biogas implementation too.





Although the impact was not observed on school-going girls, there has been an increase in children's regularity of going to school and in their study hours.

In the sample of 153 families, 104 families had children in school going age. 35% of these families reported children being able to devote more hours to study after Biogas. These families could relate this increase directly to Biogas, as children now did not have to spend time fetching woods or help in making of dung cakes. In some families girls also helped their mothers in cooking and cleaning of dishes.

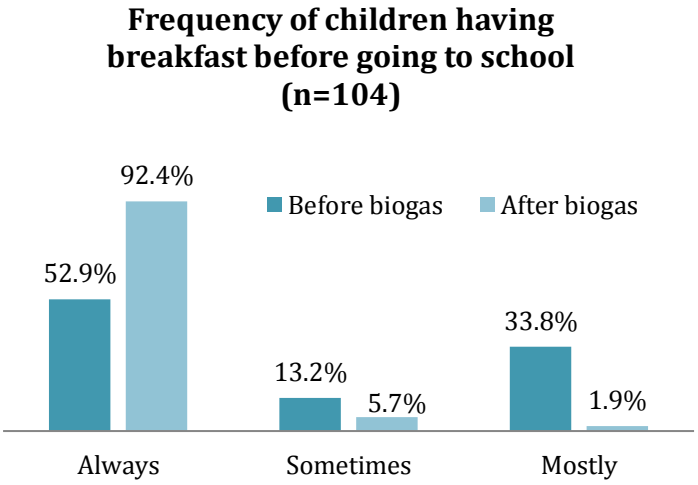
Case of Meera

Name: Meera; Village: Sumelkala

Meera is a 21 year old student studying in college. As she used to do the cooking for the family, it took significant amount of her study time. Meera used to collect firewood, cook food and even do dishes. She mentions that by the time she could finish all this work, it used get 11.00 am, leaving less time for her study, plus she got very tired by then.

With Biogas now she is able to finish all her work before 9.00 am and she gets enough time to study.

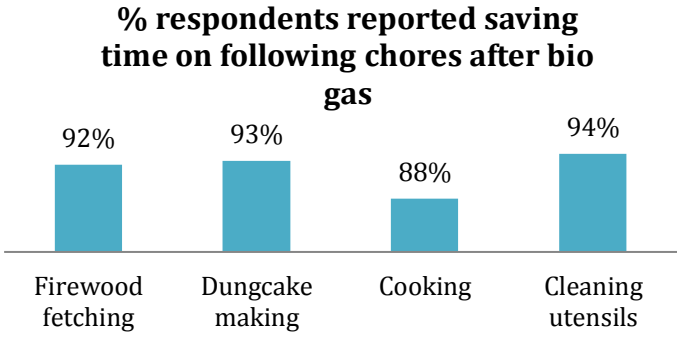
With Biogas, the overall effort in such chores had reduced resulting in children being able to devote more time to studies. Further, as cooking was not possible early morning in *chulahs*[3], children often had to skip breakfast before going to school. With Biogas mothers could now quickly prepare breakfast early in the morning and children could have it before going to school. Thus, there was an increase in proportion of children being able to have breakfast.



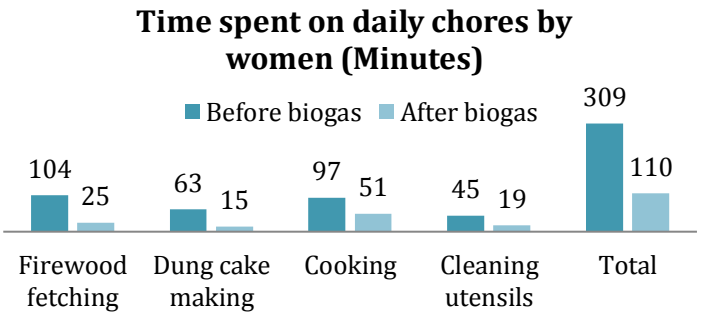
[3] Traditional stove using firewood or dung cake

Impact on time saving

A major impact was observed on the amount of time spent by women in household chores related to cooking activities. Over 90-94% women reported reduction in time on various activities related to cooking as shown in the chart.



The average time saved reported by women was also significant. Women estimated saving an average of 3.3 hours per day. The time was saved on fetching of firewood or dung cake, lighting of *chulah* and cleaning dishes, which used to blacken due to firewood or dung cake burning.



Not just time was saved, but most women mentioned of convenience and freedom from the labour required in these activities and from smoke as a major relief. Most women mentioned of using the time saved – in resting, in having more relaxed daily schedule and in giving more time to agriculture and kitchen garden. No impact was seen on women getting involved income generating activities.

Case of Roshan

Name: Roshan Gurjar; Village: Chokkarwara, Bandikui Block

Roshan Gurjar, aged 55, is a resident of Chokkarwara Village, Bandikui. Her family consists of her husband, parents-in-law and one school-going male child. The family's primary fuel source prior to Biogas construction was fuelwood.

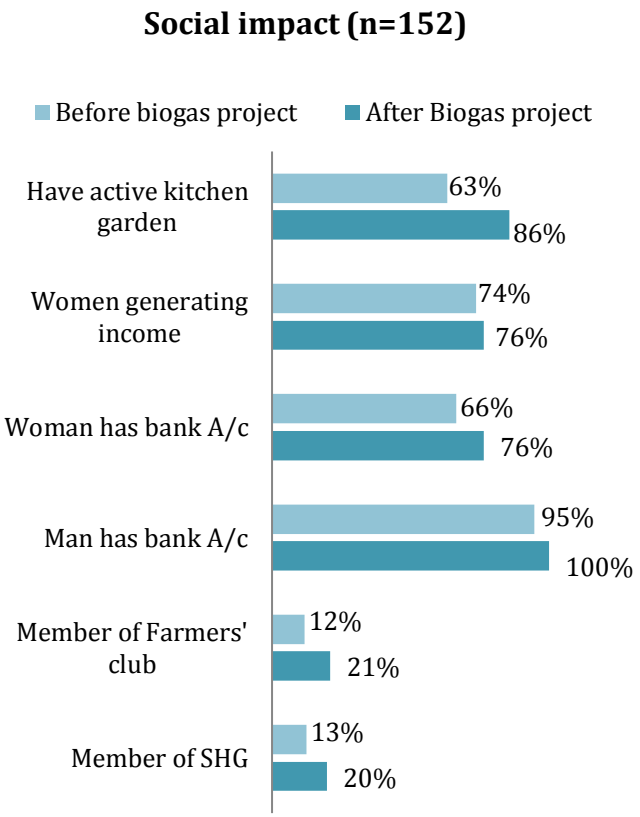
Roshan, who is solely responsible for all cooking activities in the household, including cooking cattle feed, collecting firewood, collecting dung and preparing dung cakes, suffers from diabetic nerve disorder, causing chronic pain and numbness in her legs and feet. With her condition doing all these household chores was a big trouble for her.

Ever since the construction of the Biogas plant, her family has shifted to Biogas as the primary fuel source for cooking and related activities, completely forgoing fuelwood and dung cake. Biogas provided much relief to Roshan in carrying out daily household chores, she feels less distressed now due to her illness. Using Biogas, she saves time and rests during the day.

Other impacts

As the project involved several awareness activities, the impact on some of the other indicators were measured.

The chart shows the response of Biogas beneficiaries. We find that among these beneficiaries, there seems to be a good impact on people doing kitchen garden activities and to some extent on women becoming members of SHGs and also farmers' groups. There is no impact as far as women's involvement in income generating activities is concerned. No evidence of it was also found during FGDs. There is also increase in percentage of women having bank accounts. But, there was no direct evidence to establish this as an outcome of the project, although project did provide awareness on financial literacy.



4. Sustainability and scalability

Analysis of factors driving sustainability and scalability

Sustainability is a key factor as far as Biogas is concerned. There is no doubt that as a fuel source, Biogas provides cleaner fuel from organic waste which is otherwise burnt inefficiently by people, resulting in smoke. Further, it provides slurry which is organic manure and helps increase farm productivity and reduce use of chemical fertilizers.

However, government's efforts in past towards Biogas has not achieved the desired results. Analysis suggests several reasons for failure of Biogas plants and hurdles in their scalability. These reasons can be broadly divided in to four categories:

1. Technical factors during construction
2. Financial factors
3. Maintenance factors after construction
4. Social factors

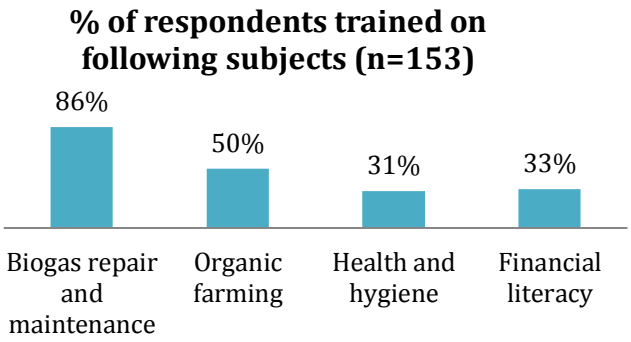
Technical factors during construction	Financial factors	Maintenance factors after construction	Social factors
• Biogas requires high level of precision during construction • Biogas can only be constructed by trained masons who are not easily available locally. With Biogas losing traction such masons are now even more difficult to find. • Biogas requires land, water and cattle; thus excluding population not having these in sufficient quantity. • Because of the high level of precision required during construction, gas output cannot be guaranteed unless the production starts. In case gas is	• The initial investment required is in the range of Rs25,000-30,000 creating entry barrier. • This investment is particularly high compared to taking LPG connection. • The cost of maintenance and repair is high. • The benefits that may accrue are in the future while investment is to be made upfront.	• After the plant is constructed, it needs to be fed a huge amount of dung initially, which people have to either buy or borrow from neighbours making it a cumbersome exercise in the beginning itself. • It needs regular feeding of high quality dung and water in right proportion. Failure to do so can result in scum formation or drying up of scum stopping the gas production. • In case of scum formation, the solutions may range from minor adjustments to whole plant needing to be opened up and cleaned. • The manure to be fed in the plant must be clean of impurities which is very difficult to ensure. Often the cow dung gets mixed	• Temporary migration by people results in plant not getting maintained. Once people return plants become non-functional. • Family feuds requiring division of land results in plant being demolished. • Family feuds related to who will maintain the plant also result in plants getting dysfunctional. • People sell cattle in times of need and are then not able to feed dung to plant. Restarting plants becomes too expensive and cumbersome. • Shortage of water,

not produced then repair may take even longer and more investment will be needed. If the dome is faulty then it may have to be redone altogether.		with grass and pebbles which stops the plant functioning. • As the plant is outside in the open and pipeline connects to the house several meters away, it often gets damaged by tractors or animals. • Every 5 year plant has to be overhauled.	even if temporary, can lead to plant becoming non-functional. • People find doing the whole exercise cumbersome when more convenient fuel source like LPG is available.

HPPI's efforts towards sustainability

With this backdrop, if we analyze HPPI's efforts in the project, we find that the organization has made tremendous efforts in ensuring that the plants construction is accurately done by highly skilled masons. HPPI collaborated with MPUAT which trained the masons and helped in supervision and quality control. The target beneficiaries had sufficient number of cattle (average of 5.9) and also had facility for water for the plant.

HPPI trained 25 masons who constructed the plant under strict supervision of technicians. Further, HPPI also trained the beneficiaries on various technical aspects like feeding the dung and water and the regular maintenance.



Thus, among the four factors discussed above, HPPI did well in controlling the first factor related to technical failures in initial construction. As a result of these efforts, HPPI did not have any technical failures after the commissioning of plants. This is also reflected in the high level satisfaction expressed by people on plant quality and gas outputs.

The subsidy element within the project also helped in convincing people to adopt the technology. Because of the subsidy, the initial entry barrier could be overcome.

However, the other two factors that define sustainability still remain a challenge.

Sustainability of plants from Phase 1

In Phase 1 of the project too, because of the factors discussed above, HPPI had to face the challenge. According to a study conducted by HPPI of the Phase 1 plants, 19% of the plants had become non-functional.

M2i did the analysis of the reasons for plants becoming dysfunctional, as stated in that study. It was found that 70% of the non-functional plants were not working for social and maintenance related reasons.

During this endline evaluation, M2i team directly interacted with the beneficiaries from Phase 1, whose plants were not working. The findings are presented in the box below.

Cases of defunct biogas plants: Key reasons for plants from Phase 1 not working

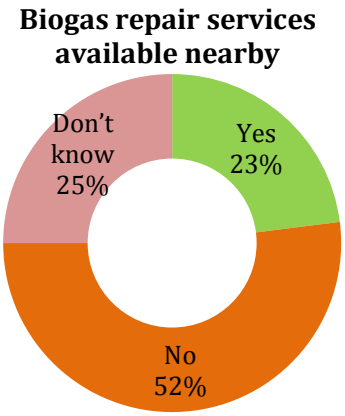
M2i visited 19 non-functional plants from Phase 1 to check various reasons for their status.

Following were the key reasons found for plants becoming non-functional.

- Family had to sell cattle.
- Family feud in joint family resulting in the abandonment of the plant.
- Husband died after that other members could not maintain the plant.
- As family distributed the land after death of father, the brother who got land with Biogas demolished it to construct house.
- As children got jobs in cities family shifted.
- As family went for seasonal migration, they could not restart the plant on return.
- Family had floating drum model plant and the drum got rusted. Family is finding it expensive to get it repaired.
- Family took LPG connection and did not maintain the plant.
- Family had to sell cattle in a medical emergency rendering the plant non-functional.
- In two cases plant was not functioning as pipeline was destroyed by a tractor trolley. In another case some monkeys had damaged the pipeline.
- A plant was not functioning as mud and stones had got into the plant.

Scalability

The project implemented by HPPI has proved that if the bio-gas plants are properly constructed by trained masons then the plants are effective in providing clean source of fuel. Thus, technology per se does not have a problem.



However, if other necessary factors needed for scaling up a technology are not available then its growth will be constrained.

Currently, as the technology is not wide spread, the required eco-system for it to grow is also not adequately available. There is lack of trained masons, lack of spare parts and lack of technicians. This means that it is difficult to construct a new plant and it is difficult to repair a broken one. 77% of the beneficiaries in the survey told that the repair facilities for the plants were either not locally available or they did not know about it.

Government will have to play a role in building the eco-system for bio-gas. Project of HPPI can help bring focus of government to this technology and in creation of this eco-system.

However, currently in the project area, there are no noticeable examples of adoption of biogas by demonstration effect. During the evaluation, M2i team met neighbors of project beneficiaries who did not have Biogas plants to have their views on it.

The table below summarizes the opinion of these respondents on Biogas.

Opinion of non-beneficiaries on Biogas and their reasons for not adopting Biogas

- The cost of getting a Biogas plant is very high and the subsidy offered by the government is less. Besides, subsidy is received after construction.
- Receiving subsidy from government is difficult and may take months.
- Biogas plants have the history of not working. They break down after a few years and hence and people do not want invest in an unsuccessful concept.
- To construct a Biogas, skilled masons are required who are not available. Most of the earlier plants setup by government failed due to technical problems, gas leakage or collapse of dome.
- Maintaining Biogas process is a cumbersome process. In every two days one has to fill cow dung in the plant.
- Improper maintenance can lead to gas blocking; maintenance is very technical.

- LPG is easily available and also government provides subsidy for it. No maintenance is required for it.

Discussions with the beneficiaries revealed that government subsidy was one of the key factors in convincing people. HPPI collaborated extremely well with the government that is the Ministry of New and Renewable Energy (MNRE) to get subsidy for the farmers under their National Biogas Manure Management Programme (NBMMP). Up to 40% of the cost was absorbed by the government and a large proportion by HPPI. People did not have to make much monetary contribution; their contribution was mostly in-kind. A model which is primarily driven by subsidy would be difficult to scale.

Adoption of biogas as clean source of energy is mainly benefitting the women

5. Project management and partner capacity

HPPI capacity

Based on this evaluation, M2i's view is that HPPI as an institution is fully capable of executing the project of this nature and size. HPPI is a large non-governmental organization with capacity to handle multiple projects of varying degrees of complexities. It has adequate infrastructure, staff capacity and management processes in place, to manage any project of the nature of Biogas and of this size.

In the past, HPPI has executed a similar project with high level of success in implementation. Further, HPPI has good understanding of the geography in which the current Biogas project was executed. HPPI has been working in Rajasthan and particularly in and around Dausa district for a long time. Currently, also there are several other programmes of HPPI including microfinance programme operating in that location.

HR Management

M2i reviewed the staff structure and staff profile involved in the project; the findings are discussed in this section.

Staff structure - HPPI had a formal staff structure having dedicated team with formal hierarchy to execute the project.

The Project was led by a Project Leader cum Coordinator. He was responsible for the overall implementation of the project on the field and for reporting the project progress.

Project Leader had a team of Area Leaders responsible for all the project activities and their effective execution. Each Area Leader was responsible for execution of project in 10 villages. As the project had to be implemented in 100 villages, a total of 10 Area Leaders were involved.

Apart from this field team, there was a dedicated Partnership Officer who was responsible for engaging with external stakeholders mainly - the government, agriculture experts, trainers and various officials from line departments.

Staff profile - Overall, the staff engaged by HPPI for project implementation was found to be good on quality and had enough experience to execute the project of this nature. The Project Leader, in past led similar projects and has deep understanding not just of the technical aspects of Biogas but also of social aspects. Other key team members such as Partnership Officer and the Area Leaders, also had adequate qualifications and experience. Staffs engaged in the project at all levels, were at least Graduates and had past experience of livelihood based or other similar projects.

M2i team verified the staff profile by going through the CVs of all the key staff members including the NHQ team.

Engagement with stakeholders

The level of HPPI's engagement with external stakeholders was found to be good. HPPI had a good strategy to engage with government, the local authorities and other stakeholders. HPPI had a dedicated staff called Partnership Officer for engaging with them.

Partnership Officer's role was critical in facilitating government subsidies for the project beneficiaries. Because of having a dedicated resource for the job, HPPI was able to help a high proportion of people get subsidies and also to engage effectively with other stakeholders like MPUAT, which helped in training of masons and in ensuring quality of construction.

In addition, the field team was proactive in maintaining regular contact with the district level and local level authorities, which created awareness about the project and ensured their participation. HPPI team regularly engaged with officials of various government departments such as horticulture, agriculture, veterinary, public administration, local bodies (Panchayat), village heads etc. Officials from these departments were also invited in training programmes and workshops organized by HPPI as part of the project. The officials were engaged in spreading awareness, delivering talks and in trainings to community on various subjects like clean energy, organic farming, financial literacy, health, hygiene, etc.

Project Monitoring

HPPI had multi-level checks for monitoring the project on a regular basis. At the field level, the Project Leader was responsible for day-to-day monitoring of progress and quality. From the National Head Quarter (NHQ), there was a Project Monitoring cum Support team. This team monitored the progress and quality on a quarterly basis and provided any inputs or support that the field team needed. It cooperated with the field team to troubleshoot any issues to ensure quality.

Finally, the project was monitored by HPPI's Grant Administration team. This team was completely independent and was not involved in the project execution or providing support to the field teams. This team monitored the project from the eyes of the funding partners.

The HPPI country team sent project progress and fund utilization reports to UFF, Finland every quarter. UFF Finland team also visited India to monitor the project progress.

Overall, the monitoring process of the HPPI to ensure quality, timelines and the budget was found rigorous and effective. All throughout the project, there was good communication between the team members to address any issues that arose.

Challenges and learning

HPPI had to face a number of challenges in the execution of the project. Many of these challenges had also been faced in Phase 1. HPPI had learning from Phase 1 and took measures to manage some of these challenges better this time.

- Convincing people to adopt Biogas: As per HPPI, there has been a very high failure rate of government constructed Biogas plants in the past. These plants had failed as they were built incorrectly by untrained masons often using poor quality material. As a result, people had very adverse opinion of Biogas plants. HPPI had to make a lot of effort in convincing people to participate in the project and to get the plant installed.

- Getting subsidy from government: It was very difficult to engage with government and to convince them to provide subsidy to people for Biogas. This was primarily because, government itself did not have very good experience with Biogas in past. Further, currently Biogas is not even in the priority list of government as a fuel source.

- Migration: In Phase 1 of the project, some plants became non-functional as people migrated for work and when they returned the plant stopped working due to lack of maintenance. In this Phase, HPPI tried to identify people who did not involve in migration or had some member at home to take care of Biogas. To find such families was additionally challenging. Despite the care taken by HPPI to avoid migratory families, the challenge still persists and failure of plant due to migration cannot be completely ruled out.

- Family disputes: In Phase 1 of the project many plants became dysfunctional as family members fought among themselves over property or other issues resulting in negligence of plant. Such issues were common among joint families or families having no clearly defined property rights. In this Phase, HPPI has tried to avoid families living jointly to mitigate this risk. However, as joint families were being avoided, it added another level of check to identify beneficiaries making it all the more difficult to identify the required number of beneficiaries.

- Client education: Due to moderate education levels of beneficiaries, HPPI found it difficult to train families on technical aspects and on upkeep of the Biogas plants.

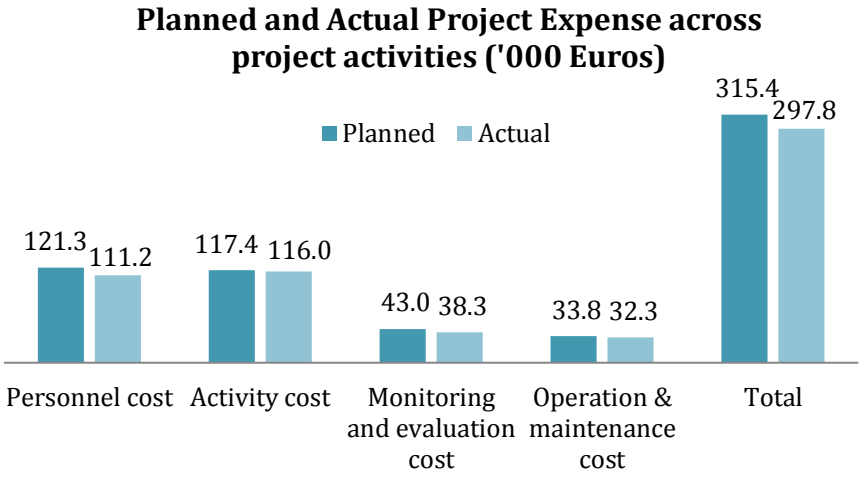
- Environmental factors and investment capacity: Construction of plants was hampered during monsoon and other seasons. The geography in which project was implemented is affected by extreme weather conditions in all seasons. Further, as the seasons change the cash flows of the people also change. Thus, people often did not have cash to invest towards making their own contribution for the Biogas plant. This was primarily because the subsidy component of the government can only be received as reimbursement after the construction and inspection of the plant by the government authorities. Hence, people needed cash upfront for the construction, posing challenge for HPPI team.

- Social factors (selling of animals, quarrels etc.): There are social and environmental factors which make it difficult to ensure continuity of Biogas. Selling of animals, family conflicts, damage to pipelines etc. are some of the reasons which are difficult for HPPI to take care of and pose challenge to sustainability and continued use of Biogas. These have already been discussed earlier.

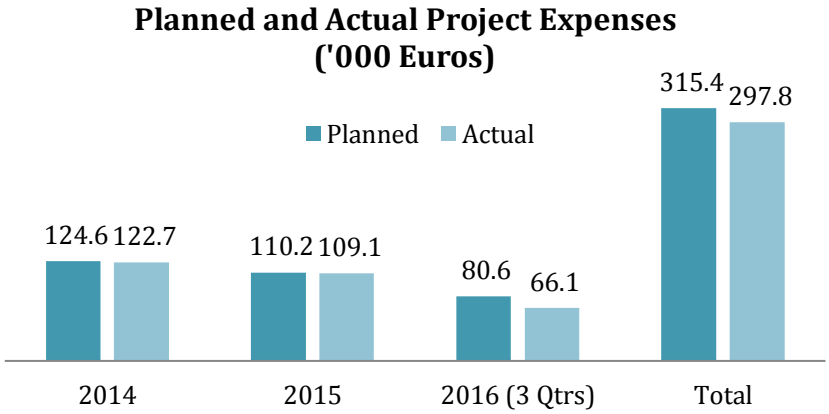
Farmers are using bio-slurry to raise the kitchen garden

6. Efficiency

The project has been executed efficiently as there were no costs or time overruns in the overall project. HPPI has been able to conduct all the proposed activities within the proposed timeline. It has not just achieved all the output targets but has even exceeded them. E.g. a total 410 biogas plants have been constructed or were under process against the target of 400; 25 masons were trained against the target of 15. HPPI has also formed SHGs and Farmers' groups and conducted various trainings and workshops as committed in the proposal.



In terms of costs too, there were no major deviations observed. The project activities were achieved well within the agreed budget and the funds were properly utilized. HPPI has been regularly sharing fund utilization reports.



As per the field observations of M2i, the funds appeared to be properly utilized and no activity or asset on the field was observed which can be considered wasteful or unnecessary.

M2i has not performed a financial audit, hence detailed observations on financial propriety are outside the purview of this evaluation.

Conclusion & Recommendations

Conclusion

Findings of the project evaluation shows, that HPPI has professionally implemented the project. The project staff structure, quality of staff and implementation process were found to be adequate and good to manage a project of this nature.

The Human resource quality was very good, as the team members had high level of understanding of the subject. HPPI had the advantage of the learning from Phase 1, which it also utilized in Phase 2 and tried to eliminate some of the factors that result in plants getting dysfunctional.

Due to good technical knowledge on the subject and the efforts made by the field team, HPPI was able to construct high quality Biogas plants. It has also been able to achieve all its project targets and has in fact exceeded them on some fronts.

Despite general reluctance of people for Biogas, HPPI still managed to convince people to implement the project. The quality of construction was found to be good resulting in high levels of satisfaction among beneficiaries as far as the structure quality and its working is concerned. At the time of commissioning, 100% of plants delivered by HPPI were working.

HPPI also had a good strategy to engage with external stakeholders. It had a dedicated staff to engage with government departments and local bodies. HPPI was very proactive in involving officials and community representatives, at different levels, in various activities undertaken during the project.

Since, the Biogas plants were effectively installed and were working, the intended benefits also accrued to people. The evaluation showed a high level of impact on reduction of biomass fuel use among beneficiaries, women's exposure to smoke and reduction in time spent on household chores related to cooking. While Biogas just resulted in overall convenience for family members, the impact has been significant on women. Women, who are mostly responsible for gathering fuelwood, cooking and washing dishes, biogas has significantly eased all these activities.

Apart from the above mentioned benefits, further benefits were seen on improved agriculture productivity, reduction in use of chemical fertilizers and reduction is money spent on chemical fertilizers. This was due to use of slurry in agriculture by a high number of beneficiary families.

Due to all these benefits, people mentioned of higher order impacts such as improvement in attendance of their children, perceived health benefits and children being able to give more hours to study.

There is no doubt that Biogas is a source of fuel which has multi-dimensional benefits and impacts. However, the biggest question that still remains is the sustainability and scalability of the model. Beyond technical issues there are several other factors that can

result in plants becoming non-functional. While HPPI has been successful in limiting the technical issues other factors that can result in plants becoming non-functional are beyond HPPI's control. Biogas is a resource intensive technology requiring a lot of meticulous maintenance making it cumbersome.

This becomes even more important in the face of increasing outreach of LPG, which is a convenient and subsidized source of fuel requiring no upfront investment. The upfront investments, intensive maintenance requirements, lack of trained masons and easy availability of alternatives like LPG, remain big barriers for the adoption and scaling of Biogas technology.

Recommendations

Based on the findings of the evaluation, following recommendations can be considered by HPPI:

- Clean energy solution from a long-term perspective: The key issue on biogas remains around its sustainability and scalability. The current approach of HPPI is focused on identifying potential beneficiaries, convincing them to adopt it and then constructing biogas plants through provision of subsidies. Under this approach, large population cannot be impacted. From a long-term energy solution perspective, HPPI may consider taking a strategic decision to promote some other cleaner technologies, which are scalable and have a market-driven model to sustain them.

- Immediate future of biogas project: Since, HPPI is involved in limited scale and targeted projects on biogas, there is potential for its implementation even for a third phase. This is primarily because, NBMMP is continuing and government has targets to support biogas plants. Thus, HPPI in the near future can continue to work with NBMMP using the same working methodology.

- Environmental education: During the FGDs, the beneficiaries informed that after having biogas, they have started selling the fuelwood which they earlier used to utilize themselves. Thus, people can be further sensitized on conserving wood rather than selling it, to prevent carbon emission.

- Group formation: It was observed that Biogas construction and group formation (SHGs and FGs), were two disjointed and distinct activities within the project. It is recommended that the activities within a project should be aligned and congruent.

Annexure

1. Discussion Agendas – HPPI staff

Project team

1. Background of project and project rationale. Who are the direct and indirect beneficiaries of the project?
2. How were the 100 villages selected?
3. How were the 400 beneficiaries within the project selected?
4. Key activities carried out under the project
5. What was HPPI's and beneficiary involvement in Biogas construction? What were financial contribution ratios? What are the costs involved for construction?
6. What trainings were provided to beneficiaries?
7. Project implementation staff structure and hierarchy
8. Has the project achieved all objectives as set in the proposal, any project deviations? Reasons for deviations, if any.
9. Major challenges faced in project implementation and how were they managed?
10. Bio gas has not been so successful in the country? We do not have examples of it scaling up? What is the difference in this project? Do you think it will scale? How and why?
11. What were the engagements with government? What subsidy did government provide?
12. What were the engagements with other stakeholders – MNRE, government departments, local elected bodies, universities, local administration, suppliers, labours, etc.
13. How was project's quality ensured – M & E framework for the project?
14. What work was done to develop Biogas eco-system to sustain the effort in the future – supply chain creation, labour trainings, after sale services?
15. What efforts were made to spread awareness on Biogas? Are there any examples of people adopting Biogas on their own just by looking at the project beneficiaries?
16. What were the activities done with SHGs and Farmer's club? How are they relevant to Biogas project? How do they complement the overall project?
17. What do you think will happen if you withdraw from the project site now?
    a. Will the constructed Biogas plants sustain? Will people invest to maintain it and are here service providers for maintenance and repair?
    b. Will it spread and do you think more people will adopt it? Are there any signs of people beyond project adopting Biogas outside the project?
18. What do you think are the major impact of project on:
    a. Direct beneficiaries
    b. Indirect beneficiaries
19. What data regarding project is maintained and how? Provide mentioned data needed as of 31 August 2016
    a. Number of bio gas plants constructed
    b. Number of bio gas plants reaching usable stage
    c. Number of bio gas plant not being used because of following reasons
        i. Broken

   ii. Design faults
   iii. Enough dung not available
d. Number of trainings of different stakeholders done under the project
e. Number of SHG and Farmers' club done
f. Outputs with SHGs ad Farmers clubs

20. Have the funds been used as proposed? If any deviation on fund utilization, reasons for it.

Finance team

1. Discuss fund utilization under different heads
2. Any deviation on fund utilization

2. FGD agendas

FGD with women of families having bio gas

1. What is the primary source of cooking and lighting fuel at home? What are different types fuel used at home and their approx. proportion in total consumption?
2. Has there been any change in the fuel consumption pattern and proportion of usage of different fuels after construction of bio gas? Capture the change
3. Does the Biogas work properly? Any problems you have to face?
4. What all trainings were you provided regarding bio gas plant?
5. Do you use bio gas regularly for daily cooking or only on some occasions or seasons? Capture approximate average no. of usage days in a month?
6. What are the key benefits of using bio gas specifically for women? Compare problems before and benefits now (smoke, health, drudgery in fetching fuel wood, time saving, etc.)
7. What has been the larger impact on family? (schooling, health of children, economic benefits, agriculture output, agriculture yield, kitchen garden, usage of slurry etc.)
8. What are the key challenges faced so far is usage in bio gas (breakages, shortage of dung, any seasonal variations in bio gas output etc.)?
9. Has anyone else built Biogas plant or asked you about it after seeing your plant? Do you see any impact on community?

FGD with men of families having bio gas

1. How did the idea of bio gas come to you? Did you know about bio gas before this project?
2. How many of you had had Biogas even before this project?
3. How much was the total cost of plant and how much was your own investment?
4. Did you get any subsidy from government? How was the overall process of subsidy?
5. Why did you not construct Biogas prior to this project? Would you construct Biogas if you had not received financial support from HPPI or government?

6. Does Biogas plant constructed works properly? Any problems faced? (Breakages, leakages, maintenance, repair etc.)
7. Are local vendors available for repair and maintenance?
8. What all trainings were you provided regarding bio gas plant?
9. Do you use slurry for agriculture? In how many hectares can one use the slurry? Take technical inputs (how many kg slurry produced in no. of days and in how much land can be applied?) How much of the land is generally being manured with slurry? Is it kitchen garden on main agriculture field?
10. What has been the change in yield and agriculture productivity? Reasons for it?
11. Has there been any impact on expenses related to agriculture on fertilizer etc.? What has been the impact on overall income?
12. What has been the larger impact on family? (schooling, health of children, economic benefits, agriculture output, agriculture yield, kitchen garden, usage of slurry etc.)
13. Has anyone else built Biogas plant or asked you about it after seeing your plant? Do you see any impact on community?

FGD with SHG members

1. Were you member of any SHG prior to this SHG?
2. What are the key activities done in the SHG? Take details of saving mobilized and credit activities?
3. Have you been linked to bank? Have you borrowed from bank? Take credit details.
4. How many members are members of MFIs? Which ones?
5. What trainings have been provided to you?
6. What have been the key benefits of these trainings? Have you changed any practices after receiving training?
7. What is the primary source of fuel for cooking and lighting for most members? Show of hand. What is common fuel for most families in the village?
8. Is LPG connection available in the village? Do people have LPG connections? Those who have not taken connections, why not? Is LPG cylinder easily available?
9. How many of you are aware bio gas plants constructed with support from HPPI? How many of you have bio gas plants? Why have (those who have not constructed it) you not constructed it? Explore different reasons? (Cost factor, no livestock, etc.)

FGD with Farmers' clubs

1. Were you member of any farmer club or group prior to this?
2. What are the key activities done in the farmers' club? Do you meet regularly, how often? Do you have minutes books? (Check documents, attendance etc.)
3. What trainings have been provided to you?
4. What have been the key benefits of these trainings? Have you changed any practices after receiving training?
5. Have you realized any benefits after becoming member of Farmers' club?

6. Is LPG connection available in the village? Do people have LPG connections? Those who have not taken connections, why not? Is LPG cylinder easily available?
7. How many of you are aware bio gas plants constructed with support from HPPI? How many of you have bio gas plants? Why have (those who have not constructed it) you not constructed it? Explore different reasons? (Cost factor, no livestock etc.)
8. Would people construct Biogas without subsidy?

Interview agenda with government officials, MNRE and MPUAT

1. Are you aware of HPPI's project on Biogas in two blocks of Dausa?
2. What has been HPPI's engagement with you?
3. What has been your role in the project so far?
4. Do you think a project on bio gas is relevant for the area? Why?
5. Bio gas has not been so successful in the country? We do not have examples of its scaling up? What is the difference in this project?
6. How will it compete with LPG? Or do they complement?
7. Do you think such a project should be promoted or are there any superior or cheaper technologies or products (solar etc.) available for fuel needs?
8. Do you think this project would sustain without subsidy? Will people construct it without receiving any subsidy?
9. What are your future plans regarding Biogas? Is there any structured government programme or policy push towards Biogas or is government's policy thrust is on some other sources of fuels? Are there any specific government programmes or R&D being done regarding bio gas?

3. Final Evaluation Questionnaire – Biogas, HPPI

1	**Block**		**2**	**Village**			**3**	**Date**							
4	**Name of the Head of Household**														
5	**Primary respondent name**		**6**	**Gender**	Female	Male	**7**	**Age**		**8**	**Education**	Illiterate	Primary	Secondary	Graduate
9	**Secondary respondent name**		**10**	**Gender**	Female	Male	**11**	**Age**		**12**	**Education**	Illiterate	Primary	Secondary	Graduate
13	**No. of adult (>=18yrs)family members (Male)**		**14**	**No. of child (<18yrs)family members (Male)**		**15**	**No. of adult (>=18yrs) family members (Female)**		**16**	**No. of child (<18yrs)family members (Female)**					
17	**Main source of income**	Farming	Livestock	Shop/Business/ Trade	Labour	Service									
18	**Secondary source of income:**	Farming	Livestock	Shop/ Business / Trade	Labour	Service	**19**	**Cultivable land holding Own (pucca bigha)**							
20	**Cultivable land holding Rented (pucca bigha)**		**21**	**Type of House**	Katcha (Mud+Stone)	Pacca (Bricked/Cemented)	Katcha/pacca	Jhopdi							
22	**Do you have toilet in the house**	Yes	No	**23**	**If Yes, type of toilet**	Pit latrine	Permanent	Open defecation							
Ownership of Livestock (Write Nos)		**24**	Bull/Ox		**25**	Buffalo		**26**	Cow		**27**	Camel			
28	Goat		**29**	Pig		**30**	Horse		**31**	Donkey/Mule		**32**	Hen		

Agriculture productivity

			Rabi (Oct-Mar)		**Kharif (Jul-Sep)**		**Zaid (Apr-Jun)**	
	Crop name		**Land used (pucca bigha)**	**Production (kg)**	**Land used (pucca bigha)**	**Production (kg)**	**Land used (pucca bigha)**	**Production (kg)**
33		33A		33B				
34		34A		34B				
35		35A		35B				
36		36A		36B				
37		37A		37B				

38		38A		38B									
39						39A		39B					
40						40A		40B					
41						41A		40B					
42						42A		42B					
43										43A		43B	
44										44A		44B	
45										45A		45B	

Household economic indicators

Average monthly household income in different seasons

		Rabi (Oct-Mar)		Kharif (Jul-Sep)		Zaid (Apr-Jun)
Agriculture	46A		46B		46C	
Sale of slurry	47A		47B		47C	
Livestock – Sale of Milk	48A		48B		48C	
Other income	49A		49B		49C	
Avg. total monthly HH income - A	50A		50B		50C	

Average monthly household expenses in different seasons

		Rabi (Oct-Mar)		Kharif (Jul-Sep)		Zaid (Apr-Jun)
Food	51A		51B		51C	
Health	52A		52B		52C	
Education	53A		53B		53C	
Other HH expenses	54A		54B		54C	
Average total monthly HH expenses - B	55A		55B		55C	
Average monthly savings – (A-B)	56A		56B		56C	

Agriculture

Fertilizer usage

		Rabi				Kharif				Zaid			
	Fertilizer name	**Quantity, Kg**		**Amount, Rs**		**Quantity, Kg**		**Amount, Rs**		**Quantity, Kg**		**Amount, Rs**	
57		57A		57B		57C		57D		57E		57 F	
58		58A		58B		58C		58D		58E		58 E	
59		59A		59B		59C		59D		59E		59 F	
60		60A		60B		60C		60D		60E		60 F	
61		61A		61B		61C		61D		61E		61	

												F	
Total chemical fertilizer expense for the season		**62**			**63**			**64**					

Organic manure	**Compost (Fill 0 if not used)**		**Vermi compost (Fill 0 if not used)**		**Bio slurry (Fill 0 if not used)**	
Crop name	Land size applied on (pucca bigha)	No. of months applied for	Land size applied on (pucca bigha)	No. of months applied for	Land size applied on (pucca bigha)	No. of months applied for
65	65A	65B	65C	65D	65E	65F
66	66A	66B	66C	66D	66E	66F
67	67A	67B	67C	67D	67E	67F
68	68A	68B	68C	68D	68E	68F
69	69A	69B	69C	69D	69E	69F
70	70A	70B	70C	70D	70E	70F

Water Availability & Usage (For Irrigation)

71	**Primary irrigation Source**	Borewell-Own	Borewell-Rent	Shared water	Canal	Stream/river	Rainfed

If borewell/electric pump is used, No. of hours used for irrigation on daily basis	72A	Rabi		73	**Approx. water discharge/hour of pump (litres)**	
	72B	Kharif				
	72C	Zaid				

Access to institutional support

74	Is anyone in family member of farmers' club or union?	**Yes**	**No**
75	Is anyone in the family member of Self Help Group?	**Yes**	**No**
76	Has anyone in family been trained on good/modern farming practices in last 3 years?	**Yes**	**No**
77	Has anyone in family been trained or made aware about organic farming in last 3 years?	**Yes**	**No**
78	Has anyone in family been formally informed on Biogas and its benefits in last 3 years?	**Yes**	**No**
79	Have you received benefit of any government scheme on agriculture in last one year?	**Yes**	**No**

Cooking fuel and women status – ask lady of the family

80	**Primary source of fuel for house hold**	Firewood	Crop residue/grass	Kerosene	Dungcake	Coal	electricity	LPG
81	**Secondary source of fuel for household**	Firewood	Crop residue/grass	Kerosene	Dungcake	Coal	electricity	LPG

Access/Availability to Purchase Energy Sources for cooking, lighting, heating and Average Cost

	Availability in the Village			**Distance if outside village (Kms)**		**Units**	**Rs. per Unit**		**Transportation Cost/month**		**Unit Consumption per month**			
											Purchased (quantity)		**Free/ Collected (quantity)**	
Firewood	**82**	Yes	No	**83**		Bundle^	**84**		**85**		**86**		**87**	

Crop Residue/grass	**88**	Yes	No	**89**		Kg	**90**		**91**		**92**		**93**	
Kerosene	**94**	Yes	No	**95**		Litre	**96**		**97**		**98**			
Dung cake	**99**	Yes	No	**100**		Nos.	**101**		**102**		**103**		**104**	
Coal	**105**	Yes	No	**106**		Kg	**107**		**108**		**109**		**110**	
Electricity	**111**	Yes	No	**112**		Units	**113**		**114**		**115**			
LPG	**116**	Yes	No	**117**		Kgs^	**118**		**119**		**120**			

* One Bundle is approx. _____ Kgs ^ 1 LPG Cylinder = 14.2 Kgs

	Women 18 yrs/ above		**Girls under 18 yrs**		**Men 18 yrs/above**		**Boys under 18 yrs**	
No. of person going for gathering fuel every day	121		122		123		124	
Avg. **minutes** spent per day per person in gathering fuel	125		126		127		128	
Avg. **kms.** travelled per day to gather fuel per person	129		130		131		132	

133	How difficult is it to access fuelwood in summer	Extremely difficult	Difficult	Reasonable	Not difficult
134	How difficult is it to access fuelwood in monsoon	Extremely difficult	Difficult	Reasonable	Not difficult
135	Where is cooking usually done in Summer?	In a room used for sleeping or living	In a separate room in the same house used as kitchen	In a separate building used as kitchen	Outside house in open
136	Where is cooking usually done in winter?	In a room used for sleeping or living	In a separate room in the same house used as kitchen	In a separate building used as kitchen	Outside house in open

137	How many hours on an average do you spend in cooking food in a day?				
138	Do you have to inhale smoke during cooking?	**Always**	**Mostly**	**Sometimes**	**Never**
139	How many times did any family member get respiratory problem (cough etc.) in last one year?				
140	Is anyone in family suffering or has suffered from TB, bronchitis, asthma or other lung disease?	**Yes**	**No**		
141	Has anyone in family suffered from eye infection in the last one year?	**Yes**	**No**		
142	Has anyone in family suffered from burn in the last one year in home?	**Yes**	**No**		
143	Has any member of the family suffered from Diarrheal problem in the last 3 months?	**Yes**	**No**		
144	How much time family spends in the cleaning of Utensils/pots (in Minutes)				
145	How much is the lady able to earn in a month from activities other than agriculture and livestock? (write 0 if nothing)				
146	How many hours in a day does the lady get for resting, leisure, with family or activities other than household chores?				

147	Do you have a kitchen garden?			**Yes**	**No**
148	How many women in family are members of SHG?				
149	How many girls under age of 17 go to school?				
150	Does the household save money in bank?			**Yes**	**No**
151	Has the household received credit from bank or MFI?			**Yes**	**No**
Perception about Biogas					
152	How much does family know about Biogas?	**Nothing**	**Some**	**Most**	
153	Have you seen a Biogas plant?			**Yes**	**No**
154	Do you feel Biogas is a useful technology?	**Yes**	**No**	**Don't know**	
Interviewer's Observation					
155	Overall Cleanliness in the House	Very Good	Good	Fair	Poor
156	Cleanliness of the floor of the kitchen	Dirty (woods residue, dung cake, etc.)			Clean
157	Walls & Roof of the kitchen / cooking area	Almost Black	Black patches		Clean
158	Cooking utensils, pots – Outer side	Almost Black	Black Patches		Clean

Biogas making a difference between the conventional and a clean energy