Lao Biogas Pilot Program

Biogas User Survey 2008

Final Report

Rietzler, Gaillard

Vientiane

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Biogas User Survey 2008

Lao Institute for Renewable Energy

LIRE

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About us

LIRE is a non-profit organisation dedicated to the sustainable development of a self sufficient renewable energy sector in the Lao PDR. The institute offers agronomical, technological and socio-economic research services, and works to provide a free public resource of information and advice on the use of renewable energy technologies in the Lao PDR. LIRE strives to support the development of the country by exploring commercially viable means to establish renewable energy technologies in rural parts of the country, in areas without connection to the national grid and with little access to technical expertise.
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**Exchange Rates (December 2008)**

1 USD = Kip 8,500
1 Euro = Kip 11,500

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1 Introduction

1.1 Background
Throughout much of the rural areas in the Lao PDR, the main domestic cooking fuel is firewood collected from the immediate surroundings of a community. In addition to the visible damage caused to the local environment, this practice represents a significant challenge to the development of a community for two reasons:

1) Cooking with firewood encumbers family members with the health difficulties associated to smoke inhalation, giving rise to reduced household productivity and increased costs for medication;

2) The time attributed to collecting firewood is a burden to members of households who could otherwise pursue educational or income-generating activities. In the Lao PDR this is a role typically given to women, and thus a significant gender issue is also to be addressed.

Domestic biogas digesters, that produce a combustible fuel gas from manure, can offer an alternative to firewood for small holder farmers. A typical household can meet its cooking needs with the biogas produced from a modest amount of livestock, providing they are kept in stables for a significant portion of each day. The digester additionally produces fertilizer as a by-product, which is also a valuable commodity for the end user. With no movable parts, the systems require relatively low maintenance, and brick and mortar digesters have a proven life time of around twenty years. In brief, the benefits of domestic biogas include:

- clean, safe and convenient cooking
- time savings of 1.5 hours per day$^1$
- cost savings of $89 per year$^1$
- healthier family members due to less smoke inhalation
- improved sanitation around the house
- a supply of free organic fertilizer to boost crop yields

1.2 Study Context
Since the 1990s SNV has supported the development of market-oriented biogas programmes in South East Asia and Africa, with its first endeavours in this area taking place in Nepal$^2$. As of 2007, 220,000 biogas digesters had been installed, bringing the above benefits to some 1.35 million people. Following these successes, the Lao Biogas Pilot Program (BPP) was initiated in November 2006 through a Memorandum of Understanding between the Department of Livestock and Fisheries (DLF), within the Ministry of Agriculture and Forestry (MAF), and SNV.

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$^1$ average results from the SNV’s Lao Biogas Users’ Survey in Vientiane Municipality, December 2007
$^2$ SNV’s website visited in October 2008
In March 2007 SNV supported the establishment of a BPP Program Office within DLF. The BPP strategy is to set up a biogas office in each active province. Each Provincial Biogas Program Office (PBPO) is run by a team of approximately five people. They are all officers employed by the provincial office of the Department of Livestock and Fisheries (DLF). They also receive a small commission for various BPP promotion, quality monitoring and management activities, based on the number of successful biogas installations. SNV trains local masons for installation work, and a team of one skilled mason and two unskilled labourers can construct a domestic digester in 7-9 days. In the pilot phase of the project in 2008, the responsibility of finding interested households was assigned mainly to the PBPO officers, with some help from District DLF officers and masons who were also offered a sales incentive. All organisational work and logistics are managed by the PBPO with support from the BPP program office. The total installation cost is from US$350 to US$500, depending on the size and location of digester and availability of construction materials and labour. A subsidy of 100 EUR (about US$135) is provided to mitigate part of the large initial investment cost for the end user, and micro financing opportunities are being actively pursued to reach low income households.

An important component of the BPP’s monitoring and evaluation procedure is an annual survey of biogas users (BPP customers). The survey provides an indication of the level of impact achieved by the program, and can identify trends and issues that deserve attention. Similar surveys are conducted by the SNV biogas programs in other countries, including the neighbouring countries of the Lao PDR, Vietnam and Cambodia. This enables some benchmarking and learning opportunities.

The first Biogas User Survey (BUS) in Lao PDR was conducted in December 2007. This report presents the second BUS, conducted by LIRE in December 2008.

### 1.3 Study Objective

The main objective of this study is to provide an accurate assessment of the impacts the BPP biogas digester installations are having on the end-users. A secondary objective is to collect information on certain aspects of the programme’s delivery to allow further management improvements. Thus, a broad overview of biogas users’ experiences is to be reported.

According to the terms of reference of this assignment, the study focussed upon a detailed survey of existing customers. The study considered the following issues:

a) Socio economic conditions of the households;

b) Awareness of biogas and BPP, the availability of information and the decision-making processes leading to an installation;

c) User’s experience of the construction process;

d) Delivery and effectiveness of user training;

e) User’s experience and attitude of general system operation, including appliances;

f) Energy savings and financial consequences;

g) Use of dung, fertilizer and bioslurry;

The complete Terms of Reference for this present study can be found in Annex 1.
1.4 Approach and Methodology

1.4.1 Study Tool

BPP provided LIRE a template questionnaire that was used for the Lao Biogas User Survey in 2007. Following a test interview with a biogas user near Vientiane capital, LIRE reviewed this questionnaire and proposed some minor amendments. The BPP team were consulted and gave their approval of the suggested changes. The revised questionnaire was intentionally kept sufficiently similar to the original, in order to permit comparisons to be drawn between the surveys of 2007 and 2008. The questionnaire tool developed for the 2008 survey is included in Annex 2.

1.4.2 Sampling

1.4.2.1 Existing Biogas Users

The survey was conducted in Vientiane Municipality province because this was the only area with BPP customers that had been using their digesters for more than 6 months. BPP only started in Savannakhet and Xiengkhouang provinces later in 2008. Moreover, a variety of biogas customers are represented in the province, including wealthy and poorer biogas customers, as well as different sizes of digesters (4 to 10 m$^3$) and numbers of livestock.

The following guidelines were adopted to enable the selection process:

i. Focus on the 4m$^3$ digesters but also include some larger (8-10 m$^3$) digesters,
ii. Randomise the selection of target villages for the interview,
iii. Include local biogas advisors (district level) for the interviews,
iv. Conduct the survey in 5 districts and interview the biogas customers in at least three different villages per district,
v. Ensure a geographical spread since each district uses different masons for construction, and government officers for promotion and management, and
vi. Include biogas customers that have been using their systems for at least 6 months in order to observe reliable evidence of impacts.

In order to identifying the location of interviewees, BPP provided LIRE with a list of potential sites for the survey. The list contained contact details of biogas customers, village names and information pertaining to the installation date and size of the digester. A randomised selection of target villages was formed from these data.
Table 1: Sample of the interviewed BPP users

<table>
<thead>
<tr>
<th>District</th>
<th>Village Name</th>
<th>Installed Digesters</th>
<th>Conducted Interviews</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sangthong</td>
<td>Namieng</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Khok hae</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Haitai</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Samphanna</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Phialat</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Xaithani</td>
<td>Khutsambat</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Don Makkai</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Phonexai</td>
<td>13</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Phoukham</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Vernkham</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Kengkai</td>
<td>14</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Thasomor</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Xaithani</td>
<td>Nong vea</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Saka kham nare</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Nahai</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>SaKipham Tai</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Somevang Tai</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Dongphosy</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Xaithani</td>
<td>Phangpheng</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>SaKiphan</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Sandeen</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Donglouang</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Pak-Ngum</td>
<td>Paknguem</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Nongphouvieng</td>
<td>24</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Naluet</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td><strong>46</strong></td>
</tr>
</tbody>
</table>

With the exception of two sites, all of the users had installed 4m$^3$ digesters. In total 180 biogas digesters had been installed in Vientiane Municipality Province at the time of the survey, 154 of which being older than six months and thus suitable for the study. Of these 142 were 4m$^3$ designs and 3 were 10m$^3$, thus the sample set represented 32% and 67% of the available populations respectively. Xaithani district has the highest density of installed digesters. The interviewed areas are marked with purple points on the map presented below.
1.4.2.2 Potential Biogas Users

For the potential user survey, 13 participants were selected in 4 different districts of Vientiane Municipality, in 6 different villages. In all these villages there were already biogas digesters installed. It is therefore likely that the level of knowledge about biogas technology was higher than in villages without installed biogas plants.

The selected villages and number of participants to the interviews are indicated in the table below. These villages were all electrified thanks to the national grid with a good road access.

Table 2: List of selected households for potential biogas users

<table>
<thead>
<tr>
<th>District</th>
<th>Villages</th>
<th>Number of participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Naxaythong</td>
<td>Sendeen</td>
<td>1</td>
</tr>
<tr>
<td>Xaythany</td>
<td>Phonexai</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Kengkai</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Phoukham</td>
<td>1</td>
</tr>
<tr>
<td>Paknguem</td>
<td>Pakngum</td>
<td>1</td>
</tr>
<tr>
<td>Haxayfong</td>
<td>Phonlao</td>
<td>5</td>
</tr>
</tbody>
</table>
Participants were selected based upon the presence of sufficient livestock in the area and according to suggestions from villagers and interviewed biogas users. It was assumed that existing biogas users would have a good awareness of fellow villagers who were interested in installing biogas digester. 9 (70%) households were selected according to promising recommendations from villagers or biogas users and 4 (30%) households were selected by visual observation. In the latter case the selection criterion was the presence of livestock in the immediate vicinity.

1.4.3 Methodology

Consultation with the BPP team

Meetings were held with BPP team members in order to prepare an appropriate strategy for the BUS. The agenda of these meetings included the questionnaire review, feedback on changes of the questionnaire, a discussion of proposed study areas, identification of interview focal points, and a discussion regarding the design of the data entry table.

Field visit organisation and execution of the questionnaire

The survey team was trained in order to ensure all interviewers were equipped with a full comprehension of the questionnaire fields. The field trips took a total of 11 days, and on average each interview lasted about 1 hour. Each interview started with a clear introduction of the survey aims and a declaration that all data received would remain confidential.

Data analysis and reporting

The questionnaires were compiled into an Excel computer spreadsheet, and analysed. The findings were then consolidated and adapted into a PowerPoint presentation and written report.

1.5 Limitations

Throughout the assignment, the study team and BPP maintained a good level of communication in order to meet as well as possible the aims of the study. Despite this, as with any short term study, constraints of resources result in unavoidable limitations. These are listed below.

a. Sample set

By its nature, the user survey was limited to survey existing users in parts of the country where BPP operates. This constraint introduces a limitation in the ability to extrapolate the results of this survey to other regions and communities. In particular, existing users may not be representative of the wider target population BPP seeks to reach, and hence the guidance this survey provides in engaging with those people is unfortunately limited. Additionally the relatively small sample size for potential users limits the accuracy of these results and

b. Time constraints

The assignment was carried out within a tight time frame as requested by BPP. Time constraints were particularly apparent in the first phase of the assignment, during which questionnaires were prepared and surveyors were trained. Limitations to both of these activities to a small extent
compromised the effectiveness of the survey, by increasingly the likelihood of errors during data collection. These were mitigated by verifying the data during the analysis phase.

c. Primary data source

An inherent limitation to the study is the accuracy of the primary data source. Some questions were difficult for the interviewees to answer for various reasons, and thus some uncertainty should be implicit in the findings of the study to allow for interviewees providing accidentally or intentionally false or biased data. Furthermore, there was not an opportunity for surveyors to verify all data through direct measurements and observations. For instance, the functional statuses of some components of the system were inaccessible because the digesters were operational.

d. Questionnaire

Despite undergoing some minor modifications, the questionnaires for both existing users and potential users were designed by BPP. Through the course of the analysis it became apparent that it was not possible to cross correlate certain fields that would have been of interest to BPP. In particular the capacity of the questionnaire to identify gender differences was found to be limited. Additionally, differences between questions in the existing and potential user questionnaires could have introduced a bias to limit the accuracy of comparisons between the two datasets.

2 Socio-Economic Characteristics

2.1 Demography

The 46 interviewed households represent a total population of 266 people, of which 18 were children under 5 years old (6.8%). The ratio gender was found to be 49.6% males for 50.4% females.

The households’ sizes ranged from 2 to 12 individuals, with an average size of 5.8 members. This figure is slightly above the average found in Vientiane Municipality (5.5 persons per household in 2005 - NSC 2005).

2.2 Educational Status

Approximately 85% of the surveyed households had received a school education (39 households of 46). For the majority of households (56.5%), one household member at least attended school and had received a primary, secondary or high school certificate. Additionally, 28.3% of households had a member who had participated in higher education and had graduated with a Bachelor degree (B.A) level. This high education level is well above both national and provincial averages. This shows a positive correlation between being highly educated and being a BPP user.
In this context, it is likely that the current biogas customers are aware of the technology and fully understand its benefits. When the use of biogas could be extended to less educated households, the provision of associated information and training will constitute an important factor to achieve the success of the project implementation.

2.3 Economic Status

Most of the interviewed households lived in good houses conditions built for a majority in bricks, and few other living in wooden houses. This indicates a general high level of wealth in the surveyed sample of BPP users. It is also to note that all households were electrified through the national grid. This may explain the presence of several recent businesses that could have generated substantial revenues.

2.3.1 Occupation

As it could be expected, most households work in the agriculture sector, with 33 households under the total 46 surveyed (71.7%). When considering the active population that composed the surveyed BPP customers, it is however interesting to discover that household members are engaged in more various economic sectors. Agricultural farming represents then 53% of the BPP customers, followed by small businesses with 24%. Government officials such as chiefs of villages, army or police civil servants account for 10% and teachers for 7%.
2.3.2 Land Holdings

The average land holdings of the surveyed households were of 2.24 hectares (ha) arable lands and of 0.83 ha non-arable lands. The majority of interviewed households own, however, between 1 and 2 ha of arable lands and about 1 ha of non-arable land.

Figure 3: Household members’ main occupations

Figure 4: Household arable and non-arable land holdings
2.3.3 Agriculture Activities and Products

Considering rice farming, 37 (80%) of the interviewed households mentioned to cultivate paddy rice. The production of rice was reported to average 4,357 kg per year. Of this production, about 1,800 kg on average are for self-consumption, and 2,350 kg were sold on the market at the average price of 2,400 Kip. It is unclear on how were employed the approximately remaining 210 kg produced; it could be either for self-consumption, for sell, or perhaps to able exchange of rice against labour or other products.

Moreover when asked about other agriculture products some farmers responded as it is shown in the table below.

Table 3: Agriculture products and annual earnings

<table>
<thead>
<tr>
<th>Agriculture product</th>
<th># Respondent Hhs (out of 46)</th>
<th>Income per Hhs per year, in US$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paddy rice</td>
<td>37</td>
<td>497.0</td>
</tr>
<tr>
<td>Cash crops</td>
<td>11</td>
<td>672.7</td>
</tr>
<tr>
<td>Fish</td>
<td>1</td>
<td>35.3</td>
</tr>
<tr>
<td>Fruits</td>
<td>3</td>
<td>298.0</td>
</tr>
<tr>
<td>Vegetables</td>
<td>5</td>
<td>357.6</td>
</tr>
<tr>
<td>Meat</td>
<td>2</td>
<td>100.0</td>
</tr>
<tr>
<td>Others</td>
<td>3</td>
<td>78.4</td>
</tr>
</tbody>
</table>

Of the 46 households included in the user survey, 35 owned cows, 6 owned buffalos, 15 owned pigs, and importantly 6 owned no livestock at all. The average herd sizes observed in the survey were 12.4 cows, 21.9 pigs, and 5.3 buffalos.

2.3.4 Income and Expenditure Patterns

Surveyed households generated on average 24,000,000 Kip per year (about US$ 2,800 per household per year), which is much above the national average.

Table 4: Income and expenditure

<table>
<thead>
<tr>
<th>HHs incomes, kip</th>
<th>Average/ Hh</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income (monthly)</td>
<td>2,040,200</td>
<td>0</td>
<td>6,000,000</td>
<td>1,686,800</td>
</tr>
<tr>
<td>Income (annual)</td>
<td>24,456,500</td>
<td>0</td>
<td>72,000,000</td>
<td>20,279,900</td>
</tr>
<tr>
<td>Expenditure</td>
<td>15,844,000</td>
<td>1,200,000</td>
<td>60,000,000</td>
<td>14,476,000</td>
</tr>
<tr>
<td>Surplus</td>
<td>7,998,434</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The largest range of households had an annual income of about 20,000,000-30,000,000 Kip, as shown in the figure below. This indicates the general wealthy conditions of the BPP users. It is to note that one household mentioned having no cash income at all. The head of this unique household reported to have taken a loan from a friend in order to install their biogas digester.

Figure 5: Households’ range of total (gross and other) annual incomes
2.3.5 Discussion

Assuming the sample of users is representative of all current users, it would appear that biogas is more accessible to wealthier households. This could be for a number of reasons, including the relative ease of access by promotion teams, and the affordability of the systems. Electrification is correlated to access in the Lao PDR, and electrified households tend to be wealthier.

Electrification could be used to identify potential biogas users, although the impacts of BPP would be compromised by focussing on the group of customers that would be found by using this indicator alone. In terms of health, biogas is expected to provide greater benefits to non-electrified households, which have less access to improved cooking fuels. Moreover the use of the gas lamps may be less common in electrified households which already have access to a convenient source of lighting.

The impacts of BPP efforts will be considered later in this report. Considering the specific aims of BPP, these observations suggest that significant efforts are required to target poorer communities. If the BPP team wish to reach poorer households, the promotion of financing options should be considered.

3 Construction, Operation and Maintenance of Biogas Plant

3.1 Construction

3.1.1 Source of Information for Biogas Technology

The level of awareness should be sufficient for potential users to decide whether it is a good option for them.
The end user needs the following information to make the decision:

- Requirements for installing biogas plant (sufficient livestock and financial capacity)
- Financing possibilities
- Advantages of using biogas (reducing cooking fuel, health improvements etc.)
- Usage of the by-product (replace chemical fertilizer by using the slurry etc.)
- Technical understanding of the plant

Information about biogas can be broadcasted by different types of media to potential biogas users. The figure below displays the main sources of information cited by existing biogas users, who were asked to select one or more media from a shortlist.

Figure 6: Sources of information cited by existing biogas users

Information provided by BPP (service provider) was mentioned by 27% of the respondents. This indicates that the promotion activities of 2008 were quite successful for creating awareness about biogas to those households that have now become users. Public media (radio, television, newspapers) was almost equally effective with 25% of the interviewed households citing this source. This means that public media is a good way for creating awareness about biogas. It also means that this media source could be utilised for broadcasting additional information related to biogas (e.g. telephone number for service centre or next biogas office). Note that information from NGOs was included in the shortlist was not selected by any users.

Significantly, 30% of the respondents reported that they received information about biogas by the community leader, other biogas users or friends. Since the role of the community leader is quite important in the village there is a clear opportunity to make greater use of this local source of trusted information. If the community leader (Naj Ban) would become more active in providing information about biogas technology it could bring positive impacts to the awareness of biogas. Additionally this observation indicates a risk of not engaging community leaders: the negative opinion of the product could have a strongly detrimental impact.
3.1.1.1 Comparison to Potential Biogas Users

Potential biogas users were asked where they sourced their information about biogas. The graphic below displays the relative effectiveness of information distribution for various media. Here also, the interviewees were given the option of selecting multiple answers.

Figure 7: Source of information for potential biogas users

The highest percentages are from those people who know about it through other biogas users (48%) and through friends or relatives (33%). This is not surprising, given that the questionnaires were conducted in villages with existing biogas installations. The overlap between both categories was not explored but could also be significant. A small percentage (14%) of respondents was aware of biogas through service providers, most likely SNV BPP. Only a small percentage (5%) was not aware of the existence of this technology. All these figures show that word of mouth is a very effective method to disseminate information.

It is quite interesting to review the options that did not receive any scores: public media, government official and NGO/CBOs. This may represent an opportunity for improvement by cooperating with relevant organisations and acting through government channels. Although word of mouth is generally very effective in the Lao PDR, by its nature, it tends to be relatively short-ranged. Similarly, creating greater awareness amongst other stakeholders may increase the effectiveness of promotion efforts.

Another part of the survey was to assess the awareness of potential biogas users related to biogas. The respondents were asked which outcomes they believed biogas digester could offer to a household. The figure below illustrates the relative popularity of the multiple options presented to the interviewee.
The responses give an indication of how many people understand about the technology. The main answers, cooking stove (41%) and time saving (31%) are very much in line with the main advantages as experienced by current biogas users. Other reasons mentioned are lighting (16%), fuel wood replacement (6%) and fertilizer replacement (3%). One respondent also cited money savings as an outcome of installing a biogas digester.

Lighting is the only surprising element here, since all the participants live in currently grid electrified areas. It should be noted that the potential users were unaware of the use of biogas to improve hygiene and sanitation standards.

The respondents were also asked to list the three main advantages of biogas as an open question. A wide range of answers was obtained and grouped into 8 categories, as shown in the figure below.
The main advantages cited were that using biogas could save money (31%) and a subsidy is available (19%). This shows that half of the people see the economic advantages of installing a digester. The other advantages mentioned are related to the benefits related to cooking (12%), fuel cost saving (12%), time saving (12%), ease of operation (8%) use of organic fertilizer (4%) and safety (4%).

3.1.1.2 Need for Further Information for Potential Biogas Users

The results summarised above show that people have a generally positive attitude towards biogas and they are aware of many of the advantages. Hence, it is also interesting to identify the principal reasons for not yet installing a biogas digester and what other information they would require to persuade them to make the investment.

The outcome of the latter question can be seen in the figure below.
The main types of information required are about finances: the costs of a digester (30%), the subsidy provided (22%) and the financing possibilities in general (12%). This confirms the importance for people to know about the investment and the benefits of biogas. The other demands for information are of a more technical nature and deal with the use of slurry (15%), the feedstock supply (10%) and the different possibilities for utilizing the gas produced (8%). Other advantages listed elsewhere in the questionnaire, such as time saving, environmental and health benefits did not feature in the answers to these questions. This could either mean that the people are already convinced about these advantages or that their primary concerns are about the financing and the technical aspect of biogas.

Combining these responses with potential users’ expectations of biogas, it is evident that further information should also be provided about health, hygiene and sanitation improvements, and also the potential financial benefits.

3.1.1.3 Recommendations

Most of the biogas users in the survey received the biogas brochure and a poster about biogas but a general observation of the survey teams was that these were either stored together with the documents of the biogas installation or elsewhere but rarely on display or in use. This behaviour would verify the fact that none of the potential biogas customer mentioned public media or advertising as source of biogas information despite the fact that all potential biogas customers were located in villages with installed biogas plants. Furthermore an opinion voiced by many interviewees was that the level of publicly-available information is generally too low. Combined, these two observations may reflect a need to improve the distribution and introduction of these materials.

Since the survey amongst potential users was carried out in villages with biogas digesters already installed, people seemed to be well aware of the technology and some of its main uses and
advantages. This observation indicates BPP’s strategy of installing “Demonstration Plants” in new provinces and districts is successful.

In terms of usage, people are aware that biogas can alleviate the daily burden of cooking by time savings, and this is a major motivating consideration for potential users. However, the main advantages to be recognised are financial: the availability of subsidies and the expected savings spent on buying fuel.

For future activities, it is therefore suggested that at least one poster is placed in a publicly visible location (perhaps with the assistance of the Naj Ban, either at the Naj Ban’s office or local market), that displays a toll-free contact number for enquiries. Additionally, the usage of brochures could be improved by better introducing them to customers, who can in turn pass on this information to their neighbours. These two measures could support the secondary means of raising awareness, namely word-of-mouth. Finally, when extrapolating the observations of this study to new target areas, the availability of media and the communication network should also be considered, in order to direct the design of appropriate promotion activities.

3.1.2 Reasons for Installing Biogas

The reasons given by existing users for deciding to invest in a biogas digester can help to direct future maintenance and promotion services. The biogas users were offered a selection of ten motivating factors to choose from in order to explain their decision to install a biogas digester. The following graphic shows the total amount of votes for each reason suggested by the interviewer.

Figure 11: Motivation / reasons for installing biogas

There were 32 (70%) of the interviewed households that cited time and energy savings as a major factor in their decision to install biogas. The current subsidy was another important motivating factor, cited by 22 (48%) interviewees. Economic benefits including cost savings for cooking fuel were the third most commonly stated factor, expressed by 16 (35%) households. Environmental benefits (26%), health benefits (24%) and motivation through the efforts of the BPP promotion team
(15%) also appeared relevant for the biogas users. Social prestige and motivation through other biogas users were each stated by 7% of the respondents.

Time and energy savings were the main reasons to install a biogas digester for most people already reached by BPP. This is in agreement with the assumption that the daily cooking routines for a family consume a lot of time. The time to prepare fires, collect cooking fuel, clean utensils, and the necessary slow cooking with weak heating, can all be mitigated by using biogas, and this information should take a major role in future promotion efforts. Since these mentioned tasks were mostly carried out by women and children, they are (at least indirectly) perceived as the main beneficiary by the households.

Similarly, promotion activities should highlight to the existing subsidies available as it has been identified as a major factor to have motivated existing users. It is interesting to see that the provided subsidy plays such a crucial role for the decision making process, especially given that 32 (70%) users stated that they would have installed their biogas plant even if no subsidy was available. Although current users were relatively wealthy, it still would appear that using biogas is seen as a highly attractive option for people in the areas already reached by BPP.

Finally, the information recovered in this part of the survey relating to the availability of other fuel sources also provides some interesting indications. 2 (4%) households reported the non-availability of fuel sources to be a motivating factor for installing biogas, and additionally some villagers expressed concerns about cooking fuel shortages in the future. Although this issue was identified by a relatively small group of interviewees, it is interesting since this survey took place in an area where biomass is still readily available. In other regions such as Xiengkhouang province the price of fuel wood is much higher and hence it may be a much more important reason for the decision making process. This regional variation should be considered when designing future promotional activities.

### 3.1.2.1 Comparison with Potential Biogas Users

All respondents reported that they had already given some serious consideration to installing a biogas digester, with 11 of the 13 having decided to purchase one and the remaining two being undecided. The interviewees were asked to give reasons for their decision, and these are summarised in the figure below.
Most people said that they would like to have a digester because it can improve the safety (40% of the respondents) and comfort of cooking (35%). Other reasons, such as the use of organic fertilizer (10%), fear of wood shortage (5%), economic reasons (5%) and enough feedstock (5%) were mentioned only sparsely.

The subsidy was not mentioned by this group, in contrast to the existing users. It would appear that the primary interests of potential users are the more general improvements to their standard of living, rather than the economic benefits as cited by existing users. However, it should be noted that the phrasing and sequence of the questions differed in the two questionnaires and this may have introduced the discrepancy. A more controlled comparison (and a larger sample) would be necessary to identify any clear difference between the two groups.

3.1.3 Decision Maker for Biogas Installation

Installing a biogas digester is an important decision for the family since it represents a substantial financial commitment to most households in the group targeted by BPP. The figure below shows which family members were the main decision makers.
According to the existing users, the decision to install a biogas digester was primarily made by the heads of households, with 67% of interviewees reporting this to be the case. Approximately two-thirds of those respondents stated that the decision maker was a man, and so some male dominance is apparent. Women did contribute to the decision process in many households however, with 26% of all the digesters in the sample being installed due to a woman’s sole decision, and another 26% being installed after family discussion. Since women are identified as a key beneficiary of BPP, it is essential to engage them with the decision making process, and to ensure they are reached by the promotional information distributed by BPP. In order to bring about such improvements, BPP could consider involving of an intermediary group such as the Lao Women’s Union.

### 3.1.4 Construction Management

The construction of each BPP biogas digester is co-ordinated and monitored by officers from the PBPO and district office. Masons trained by the program carry out the construction work. Moreover the technical supervisors for each district visit the site at least twice during the construction process to conduct a standard quality management inspection and record the results in a standard form. Following the decision of a villager to install a biogas digester, a district biogas officer visits the household in order to conduct a site survey. The site and household is checked to meet the program’s eligibility requirements, and also to complete a baseline survey is carried out to determine improvements and impact on livelihood after the system has been used. The PBPO then co-ordinates a construction schedule including the delivery of appliances and purchase of materials with the mason and household.

The end user receives a subsidy to offset the initial investment cost for a biogas digester, as described in Section 3.1.6. A warranty fee is included as part of the standard cost of the system provided in the subsidy. After installing the digester, a warranty certificate with the digester number is provided to the user which entitles them to maintenance service for 2 years. The mason also provides a brief training to the user, who is also given a copy of the operation manual.

During the survey, biogas users were asked for their impression of the mason’s level of competence. The table below highlights the main responses.
Table 5: Quality of mason carried out the work

<table>
<thead>
<tr>
<th>Quality of mason</th>
<th>Number of households</th>
</tr>
</thead>
<tbody>
<tr>
<td>unskilled mason</td>
<td>0</td>
</tr>
<tr>
<td>Skilled mason without biogas knowledge</td>
<td>17</td>
</tr>
<tr>
<td>Skilled mason with good biogas knowledge</td>
<td>44</td>
</tr>
<tr>
<td>unknown</td>
<td>1</td>
</tr>
</tbody>
</table>

According to the survey, skilled masons with a good knowledge of the biogas systems were present at almost all construction sites (96%). In many cases these masons were supported by other experienced workers. One user reported that a skilled mason with good knowledge of the biogas digesters was not present for their installation, and one other user did not respond.

According to the interviewed persons the construction process is well organised and as a result, good construction documentation is maintained and high quality biogas digesters are installed. These two features offer good prospects for the long term operation of the digesters.

3.1.5 Quality Control During Construction

For almost all biogas installations some level of monitoring and quality inspection was provided by district or PBPO supervisors during the construction phase. For 65% of the digesters, BPP supervisors visited the sites on more than two occasions. Furthermore, 28% of the biogas users reported that they were visited twice. However, one user (5% of sample set) mentioned that no inspector was present during the construction.

The average time taken to construct the 4m³ digesters was 12.3 days with a relatively large standard deviation of 7.2 days. The fastest construction site for the 4m³ digester was only 6 days while the longest construction process took 45 days (this extreme instance was the result of construction materials being stolen from the site). Both of the users with 10m³ digesters reported 14 day construction times. Other prolonged delays in construction of more than 20 days were encountered at 4 (8%) sites, due to the reasons listed in the table below.

Table 6: Effects on construction duration

<table>
<thead>
<tr>
<th>Reason for delay (&gt;20 days)</th>
<th>Number of households</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mason did not carry work out as agreed</td>
<td>1</td>
</tr>
<tr>
<td>Rainy season</td>
<td>2</td>
</tr>
<tr>
<td>Others (financial problems)</td>
<td>1</td>
</tr>
<tr>
<td>No delay</td>
<td>42</td>
</tr>
</tbody>
</table>

3.1.6 Financing For Construction

According to the SNV/ BPP estimations, each biogas digester costs between US$350 to US$500 to install, depending on the size and location of digester, and the availability of construction materials and labour. A subsidy of 1,360,000 Kip (approximately equivalent to 100 EUR at the start of 2008) is
provided to reduce the initial investment costs for households and to act as an incentive for participation in the project.

The customers are responsible for purchasing locally available construction materials such as bricks and cement and also for providing unskilled labour to assist the construction process. Additionally, part of the BPP subsidy is provided in the form of equipment such as pipes and appliances as well as the service of a skilled mason. The average total investment cost for 4m³ biogas plants were found to be 3,425,000 kip, with a range in the sample set from 2,000,000 kip to 4,500,000 kip. The average costs and provided subsidies for 4m³ digesters are summarised in the table below in kip, with the equivalent current USD and EUR values given to compare with BPP expectations.

Table 7: Construction costs for 4m³ biogas digesters

<table>
<thead>
<tr>
<th></th>
<th>Average</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total cost</td>
<td>3,425,000</td>
<td>2,000,000</td>
<td>4,500,000</td>
<td>504,000</td>
</tr>
<tr>
<td>(298 EUR, 403 USD)</td>
<td>(174EUR, 235 USD)</td>
<td>(392 EUR, 529 USD)</td>
<td>(44 EUR, 59USD)</td>
<td></td>
</tr>
<tr>
<td>Subsidy received</td>
<td>1,649,000</td>
<td>800,000</td>
<td>4,000,000</td>
<td>711,000</td>
</tr>
<tr>
<td>(143 EUR, 194USD)</td>
<td>(70 EUR, 94 USD)</td>
<td>(347 EUR, 471 USD)</td>
<td>(62 EUR, 84 USD)</td>
<td></td>
</tr>
<tr>
<td>End-user contribution</td>
<td>1,633,000</td>
<td>0</td>
<td>3,500,000</td>
<td>879,000</td>
</tr>
<tr>
<td>(142 EUR, 192 USD)</td>
<td>(304 EUR, 412 USD)</td>
<td>(76 EUR, 103 USD)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The range in total construction costs lie general within BPP expectations, but the distribution appears a little higher. Similarly, according to biogas users the average BPP subsidy was larger than the planned amount. This was partly caused by currency fluctuations in the current year, and comparing to the exchange rate at the start of 2008, the average BPP subsidy (according to biogas users) was 122 EUR. However, it should be noted there is some inaccuracy in this measurement, because the subsidy was estimated by villagers, and it was not always given in cash but rather in terms of construction material. Instead, a more accurate estimate is provided by considering the end-user contribution. On average the digesters cost the end user approximately 142 EUR (192 US$).

For 35 (81%) households the installation cost of the biogas digester was considered reasonable. 4 (9%) biogas users' explained that the installation costs are cheap and the same amount of interviewed persons mentioned that the digester costs are expensive.

Table 8: Biogas users' impressions about installation costs

<table>
<thead>
<tr>
<th>Impression from biogas users' about the installation costs</th>
<th>Frequency of response</th>
</tr>
</thead>
<tbody>
<tr>
<td>It is cheap</td>
<td>4</td>
</tr>
<tr>
<td>It is reasonable</td>
<td>35</td>
</tr>
<tr>
<td>It is quite expensive</td>
<td>4</td>
</tr>
<tr>
<td>It is very expensive</td>
<td>0</td>
</tr>
</tbody>
</table>

Since 91% of the interviewed persons explained that the implementation price is quite affordable, the provided subsidy reached its aim making biogas technology affordable for interested households!
One remarkable outcome of the survey was that only two biogas users took loans to finance their contribution. Neither of these approached a bank. Instead, one borrowed money from friends, and another received a loan from a local army office. It is interesting to consider the reasons for this observation. 92% of the users declared that they had adequate savings and thus did not need to take out a loan. However, 8% percent of the households reported that loans were unattractive due to prohibitively high interest rates. The results of the present study are also influenced by the unrepresentatively high income level of the users: for many of the interviewees, the installation cost represented less than 10% of their annual income.

Assuming initial investment costs of approximately 200 USD is a high expenditure for many households in the Lao PDR, strategies should be developed to enable more people to consider loans as a financing option. Without financing options, a large fraction of the wider target population may be unable to afford the implementation of a digester.

### 3.2 Operation and Maintenance Services

#### 3.2.1 Introduction

Biogas digesters are easy to operate with only a few maintenance efforts. Nevertheless the correct operation of a digester can only be ensured if a sufficient feedstock is provided and careful attention is paid to maintenance needs.

Adding enough feedstock is the most important daily operational task for biogas users. Manure must be provided to the digester on a daily basis with a water/dung ratio of 50%\(^3\).

Regarding maintenance, the following activities are essential for the long term performance of the system:

- frequent draining of condensed water;
- cleaning of stoves and lamps;
- oiling of gas valves and gas taps;
- cleaning of overflow outlet;
- checking of gas leakage;
- adding of organic materials to slurry pits.

If all of these small activities are carried out regularly, the biogas plant can have an operational lifetime in excess of 20 years.

#### 3.2.2 Feedstock Supply

The amount of gas production in biogas digesters depends on the quantity and kind of feedstock material. The availability of sufficient feedstock in the surrounding area is crucial. If insufficient gas is produced for the household’s needs, the user may consider their investment to be a failure. Indeed, the dissatisfaction of one biogas user can rapidly develop into a negative public perception of the technology.

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\(^3\) Biogas Sector Partnership Nepal, [www.bspnepal.org.np](http://www.bspnepal.org.np)
It is essential that biogas promotion teams verify that enough livestock is available at the owner’s premises to supply the minimum required feedstock. Additional contributing factors include types of livestock and the time animals spend in stables. During the survey cattle manure was found to be the most abundant, followed by pig and buffalo manure. However, it should be noted that in the Lao PDR, cattle and buffalos are usually left to graze outside in fields during daylight hours. In many cases livestock are kept inside a stable near the house only during the night. This is problematic for the collection of manure as feedstock, since the material produced in the field cannot be easily fed to the digester. In the figure below the theoretical manure production of the visited households is shown.

**Figure 14: Manure production estimated from livestock**

![Graph showing theoretical manure production](image)

The majority of existing biogas users (76%) is producing sufficient manure from owned livestock, which is 20 kg and 80 kg for 4m³ and 10m³ digesters respectively. A few users (9%) had much larger livestock herds, equivalent to more than 250 kg of manure per day. Several households could provide sufficient manure for 6, 8 or even 10m³ digesters. Although there are several reasons for these users to have chosen a smaller system, it is worthwhile to check that all options are being presented to potential users by BPP promotion teams.

One observation that gives some cause for concern is that 6 biogas users (15%) stated that they did not own any livestock. When asked, these users typically justified their eligibility for biogas by stating that they had access to manure from the livestock of their neighbours.

3 (7%) other households also reported gathering additional dung from the surroundings in order to meet their daily supply demand. According to most users, this activity was not considered a significant burden. However, this observation does have implications for the desired impacts of BPP.

The issue of gas production is further explored in Sections 3.3.1 and 4.4.1 in the contexts of gas use and customer satisfaction.
3.2.2.1 Feedstock Eligibility of Potential Biogas Users

Potential biogas households were asked about their current livestock situation. The information about the production of manure, based on the total number of livestock, is shown in figure below. The vertical bars at 25 and 62.5 kg per day of manure mark the threshold for a 4 and 10m$^3$ digester. The figure thus shows that nearly all potential biogas users should be able to supply a 4m$^3$ biogas digester and that 5 of them even produce enough manure for a large 10m$^3$ digester. Therefore, the selection of the potential biogas user to survey seems successful. Indeed, method used to select these potential users should be included in future promotion efforts.

Figure 15: Manure production from potential biogas users

3.2.3 Digester Feeding

The size and dimensions of the biogas digesters have been decided based upon 40 days retention time and 50% gas storage. This means that the fresh feeding fed into the digester should remain inside for at least 40 days before it comes out through outlet. Likewise, the plant should be able to store 50% the gas produced in 24 hours. Therefore the size of the biogas digester has to be selected based upon the daily available quantity of feeding materials. In accordance to the BPP Mason’s Training Manual, the table below presents the suggested amount of manure supply for the GCC biogas digesters.
Table 9: Required supply of feedstock

<table>
<thead>
<tr>
<th>SN</th>
<th>Capacity of plant (M3) *</th>
<th>Daily gas production (M3)</th>
<th>Fresh dung required every day ** (Kg)</th>
<th>Water required every day (litre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>0.8 - 1.6</td>
<td>20-40</td>
<td>20-40</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
<td>1.6 - 2.4</td>
<td>40-60</td>
<td>40-60</td>
</tr>
<tr>
<td>3</td>
<td>8</td>
<td>2.4 - 3.2</td>
<td>60-80</td>
<td>60-80</td>
</tr>
<tr>
<td>4</td>
<td>10</td>
<td>3.2 - 4.0</td>
<td>80-100</td>
<td>80-100</td>
</tr>
</tbody>
</table>

Notes: *Capacity of plant means the volume of digester and gas storage dome  
** Average retention time: 40 days

From the table the 4m³ and 10m³ are relevant to the current survey. The amount of feedstock required for a 4m³ digester has a range between 20 – 40 kg per day. For a 10m³ digester 80 – 100 kg/day of feedstock is required in case the retention time is assumed with 40 days.

During the survey biogas users were asked about their feedstock supply. In the table below the actual feedstock supply is listed.

Table 10: Feedstock supplied to 4m³ digesters

<table>
<thead>
<tr>
<th>Feed status</th>
<th>Actual feedstock supply (kg/day)</th>
<th>Amount of households</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underfeed</td>
<td>0 - 20</td>
<td>7</td>
</tr>
<tr>
<td>Optimal feed</td>
<td>20 – 40</td>
<td>38</td>
</tr>
<tr>
<td>Over feed</td>
<td>&gt; 40</td>
<td>1</td>
</tr>
</tbody>
</table>

The majority of users (83%) were feeding their digesters according to the BPP guidelines. In only one case (2%) the digester was overfed, and 7 (15%) households were found to be underfeeding the digester. Of these users, three had sufficient feedstock available according to their livestock.

**Digester size compared to available feedstock:**

Biogas users were asked for information about the exact daily amount of dung which they supply to the digester. 28 (64%) households are supplying their digester with 20 kg of animal dung per day. Although this is within the optimum range advised by BPP, digester performance could be increased by adding up to 25% more feedstock. Biogas users typical used a 20 litre bucket as a unit of measurement to prepare the feedstock. It should be noted that some biogas users mentioned the usage of agricultural (9%) and kitchen waste (4%) as a substitute for the normal dung/water mixture.

Providing users have access to adequate gas, these observations do not require further action. The availability and use of gas is treated in detail in Sections 3.3 and 4.4.

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4 BPP Mason’s Training Manual
3.2.4 Feeding Frequency and Ratio

The optimal operational conditions of a biogas digester are met by daily feeding. Regarding the frequency of feeding, 85% of the interviewed households feed their digester every day. Only 15% mentioned that they feed their digester only every second or third day. The table below shows the feeding frequency.

Table 11: Feeding frequency

<table>
<thead>
<tr>
<th>Feeding frequency</th>
<th>Daily</th>
<th>85%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Every 2$^{nd}$ day</td>
<td>11%</td>
</tr>
<tr>
<td></td>
<td>Every 3$^{rd}$ day</td>
<td>4%</td>
</tr>
</tbody>
</table>

The dung/water ratio should be 50/50 which ensures optimum environment for micro-organisms in biogas digesters. If more water than dung is added, solid particles may precipitate to the floor of the digester, thereby reducing the effective volume of digester. Similarly detrimental to biogas evolution, a high ratio of manure to water increases the risk of scum formation on the surface of the slurry layer.

Table 12: Dung / water ratio of biogas feedstock

<table>
<thead>
<tr>
<th>Water / dung ratio</th>
<th>More than the volume of dung</th>
<th>8%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Equal to the volume of dung</td>
<td>85%</td>
</tr>
<tr>
<td></td>
<td>Less than the volume of dung</td>
<td>7%</td>
</tr>
</tbody>
</table>

According to the survey 85% biogas users are feeding their digester with the correct ratio. 8% of the total biogas plants received more water than required and approximately 7% were fed with less water than prescribed. Therefore the related component of training for biogas users has been very successful.

3.2.4.1 Digester Feeding Summary

The feeding of the digesters seems generally to be performed appropriately, and it is encouraging to see that the feeding is mostly done on a daily basis with an adequate amount of manure. However there is some space for improvements since 6 (13%) biogas users mentioned an insufficient gas production (see Section 4.1.3). These users should be advised to increase the feedstock supply if possible. The cause for underfeeding the digester should be discussed with the BPP team and strategies developed how to avoid an underfeeding since it can harm the biogas satisfaction level. Inadequate gas production could also be caused by technical faults such as gas leaks, although the functional condition of the digesters was generally good.

3.2.5 Connection of Latrine

Latrines can be attached to biogas digesters as a source of additional feedstock. Attaching the toilet to the biogas plant improves the sanitation situation and prevents ground water contamination by human effluent.
The BPP digesters are designed and installed with two inlet pipes – one reserved for attaching to a human latrine. To date BPP has not promoted this practice due to the anticipation of negative customer perceptions that could affect general acceptance of biogas technology. SNV has learned in other countries to introduce the concept of attaching human latrines only after there is already good acceptance and awareness of the technology.

In the present survey no interviewed households had a toilet attached to the digester, but users were asked to consider the possibility. The table below summarises their views.

Table 13: Restrictions for not attaching toilets to biogas plant

<table>
<thead>
<tr>
<th>Social taboos in attaching toilets to biogas plants</th>
<th>No problem</th>
<th>67%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas from toilet attached plants are considered to be un-sacred</td>
<td>13%</td>
<td></td>
</tr>
<tr>
<td>People are hesitant to handle the bioslurry from toilet attached plants</td>
<td>13%</td>
<td></td>
</tr>
<tr>
<td>afraid of destroying biogas bacteria by toilet cleaner</td>
<td>7%</td>
<td></td>
</tr>
</tbody>
</table>

Interestingly, a majority (67%) of the interviewed biogas users did not have any reservations about attaching toilets. As it could possibly be socially acceptable, further investigation could be conducted for determining the actual potential of attaching toilets at the installed digesters.

3.2.6 Maintenance during Operation

Biogas digesters installed by BPP are designed to require very little maintenance apart from the daily chore of feeding the digester. Most of the interviewed biogas users reported that they only performed maintenance activities when needed. This can be interpreted as evidence that biogas plants operate almost maintenance free, but could also indicate some lack of awareness about regular maintenance.

Table 14: Maintenance activities and frequency

<table>
<thead>
<tr>
<th>Maintenance/ Frequency</th>
<th>Daily</th>
<th>Weekly</th>
<th>When needed</th>
<th>Never</th>
<th>Not installed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Use of main valve</td>
<td>26%</td>
<td>2%</td>
<td>28%</td>
<td>43%</td>
<td>0%</td>
</tr>
<tr>
<td>2. Checking leakages</td>
<td>9%</td>
<td>2%</td>
<td>33%</td>
<td>57%</td>
<td>0%</td>
</tr>
<tr>
<td>3. Use of water trap</td>
<td>0%</td>
<td>4%</td>
<td>40%</td>
<td>56%</td>
<td>0%</td>
</tr>
<tr>
<td>4. Cleaning of overflow</td>
<td>2%</td>
<td>7%</td>
<td>53%</td>
<td>38%</td>
<td>0%</td>
</tr>
<tr>
<td>5. Slurry composting</td>
<td>2%</td>
<td>4%</td>
<td>35%</td>
<td>59%</td>
<td>0%</td>
</tr>
<tr>
<td>6. Oiling of gas tap</td>
<td>0%</td>
<td>2%</td>
<td>25%</td>
<td>73%</td>
<td>0%</td>
</tr>
<tr>
<td>7. Cleaning of gas stove</td>
<td>17%</td>
<td>13%</td>
<td>41%</td>
<td>28%</td>
<td>0%</td>
</tr>
<tr>
<td>8. Cleaning of gas lamp</td>
<td>5%</td>
<td>0%</td>
<td>5%</td>
<td>10%</td>
<td>81%</td>
</tr>
</tbody>
</table>

As shown in the table above, many biogas users are only actively maintaining their digester when it is necessary. The awareness of the need for maintenance can be increased by improving the follow-
up service after biogas installation. In the survey sample 65% of the interviewed biogas users reported that they received a follow up service / visit from BPP after installation, so the main issue is the content rather than the frequency of the service.

Using the main valve is important for safety and technical issues. If the main valve is permanently open, the gas pipes (PVC and plastic tubes) are subject to pressure for most of the time. This puts unnecessary load to the material and can increase the aging process of the material. Regarding to security issues it is always better having a double security (main valve and regulation valve near the stove). Despite the fact that serious accidents with domestic biogas plants are hardly reported, closing the main gas valve excludes the risk for burning accidents completely.

Another neglected aspect of maintenance that deserves special attention is the frequent usage of the water tap. If this maintenance duty is not carried out, condensation water can block the gas tube. Moreover sediment and corrosion can occur in flooded gas tubes. It should be noted that in some cases the water trap was not easy to maintain due to either a heavy cover or being difficult to reach. This should be considered for future installations.

### 3.2.7 Training for Biogas Users

Digester performance is not only linked to the quality of construction and workmanship of the digester. Biogas users also need training regarding basic orientation on various aspects of operation and maintenance such as proper feeding of the plant, optimal use of biogas, effective application of slurry, regular maintenance of plant components and improving cooking environment. The graphic below displays the kinds of training received by biogas users from the service providers on the operation and maintenance of their digesters.

**Figure 16: Training means for new biogas users**

![Training Means for New Biogas Users](image)

Some form of training was given to most users. 39% of the interviewees received a short one/half day training from the service provider. 5% reported receiving a short-term operation and maintenance training lasting up to 7 days. Another 26% of biogas users did not receive a personal
instruction by biogas experts but did possess the manuals and brochures. However, according to the existing users, 30% did not receive any training from the service provider. If true, this issue should be addressed. No users reported having been trained by masons/technicians, nor on the sport instructions from masons/company supervisors.

It could also be informative to compare these figures with BPP records of training and materials supplied. A discrepancy could indicate a need to improve the introduction of materials to the users.

In general, training efforts should be increased to ensure that biogas customers are fully competent to manage their digester. This will also lead to an increased awareness of plant maintenance and better feedstock supply to the digester and may increase the user satisfaction.

### 3.3 Gas Production and Use

#### 3.3.1 Gas for Cooking Purposes

Sufficient gas production is one of the most important criteria relating to biogas user satisfaction. If the gas production is less than predicted, it can cause dissatisfaction for the plant owner. If the biogas plant is working optimally and sufficient operational maintenance with an adequate feedstock supply, the gas production should be enough for one household to meet major cooking fuel demand. All households reported the main use of the biogas was for cooking purposes. Moreover some gas lamps were installed (30%).

Biogas users indicated that the main application of biogas was for cooking purposes. Biogas stoves were mostly used in the morning and evening for meal preparation. The average operation time of biogas stoves is approximately 116 minutes per day.

It is interesting to see that during lunch most biogas users are not preparing the meal or use the biogas stove. The table below shows further information about the cooking stove operational time.

**Table 15: Biogas stove in operation**

<table>
<thead>
<tr>
<th>Time of usage</th>
<th>Non-zero responses</th>
<th>Average use (minutes)</th>
<th>Standard deviation (minutes)</th>
<th>Maximum (minutes)</th>
<th>Minimum (non-zero) (minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morning</td>
<td>45</td>
<td>55</td>
<td>32</td>
<td>120</td>
<td>20</td>
</tr>
<tr>
<td>Afternoon</td>
<td>11</td>
<td>10</td>
<td>17</td>
<td>60</td>
<td>20</td>
</tr>
<tr>
<td>Evening</td>
<td>44</td>
<td>51</td>
<td>36</td>
<td>180</td>
<td>15</td>
</tr>
</tbody>
</table>

According to the table above, during lunch time only 11 (24%) biogas users are using the cooking stove. This may reflect the common occurrence that most family members are in the field during this time of day.

When asked whether biogas is sufficient to meet the cooking fuel demand, most biogas users (56%) responded that, since installing biogas, no other cooking fuel is required during ordinary days. This excludes special occasions when there is a demand for other fuel sources as well. 17% of the interviewed households reported a regular need for additional cooking fuels (charcoal, LPG or fuel wood) to meet their daily demand of cooking fuel. Of these, several could add additional feedstock to their digesters, based on the number of livestock they own.
Table 16: Source of main cooking fuel after installing biogas

<table>
<thead>
<tr>
<th>Description</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fully cook with biogas</td>
<td>26</td>
</tr>
<tr>
<td>In general biogas but sometimes other sources (e.g. fuel wood, charcoal)</td>
<td>12</td>
</tr>
<tr>
<td>Other sources (e.g. fuel wood) because gas is not enough</td>
<td>8</td>
</tr>
</tbody>
</table>

### 3.3.2 Gas for Lighting

In 30% of the interviewed households, gas lamps were installed despite the fact that all households were electrified. The opinions of the interviewed users varied, but in general the users that did have gas lamps preferred electric lighting. A few users mentioned that biogas lamps reported using gas as a back-up lighting option in the event of power cuts. Additionally, some users appeared uncomfortable to use their lamps, mostly as a result of unfamiliarity from infrequent use.

In contrast to these opinions, some biogas users that did not have a gas lamp in fact wanted to install one. Two reasons were given: the availability of excess gas, and also a preference to electric lighting due to the advantage of gas lamps in the cold season as they provide “warm light”.

Given the range of responses of existing uses, or the future installation strategy, new customers should be given the option to install gas lamps. The installation costs could be reduced by excluding components that will not be utilised (pipe, joints, fittings, wire and gas lamp).

### 4 Physical Status and Functioning of Biogas Plant

The survey sought to develop an understanding of the overall performance of biogas plants following six months of operation.

### 4.1 Plant Components

A uniform fixed-dome digester design has been used for the BPP programme to date. This design is based on a digester type that has been successfully installed in many countries prior to the Lao BPP, and is favoured due to its user-friendly design and long expected operational lifetime. The following section summarises the components of the biogas digesters that were inspected in this survey.

#### 4.1.1 Inlet Tank

The inlet tank is a cylindrical construction for mixing dung and water together. At the bottom of this construction a PVC pipe is connected to the digester. For the construction bricks and cement were used to create a base and walls which were then plastered with mortar. From the floor of the cylindrical inlet tank a 10 cm diameter PVC pipe leads to the digester. Typically a wood or stone plug and pull cord was used as a barrier during the mixing process. After the mixing of dung and water in the inlet tank the feedstock mix is flushed into the digester by pulling the string.
Figure 17: Inlet tank seal used during mixing and feeding the biogas plant

The name and identification number were engraved on some digesters, to facilitate recognition during follow-up visits. This practice could be extended to include all digesters. The quality of the workmanship was found to be good and met the required standards. No risk is anticipated of this component causing serious problems in the near future.

Plate 1: Additional inlet system

The above picture shows an unusual practice of feedstock supply found at one site. Instead of using the inlet tank to feed the digester, the unused toilet inlet pipe was used as a feedstock inlet. This modification offers the advantage of removing the need to collect manure manually. Disadvantages of this practice are twofold. Firstly, the mixing ratio between water and dung is difficult to control. Secondly, there is an increased risk of contaminating the feedstock. BPP should review the merits of this modification, and additionally consider whether biogas users should be encouraged or discouraged from altering the standard digester system design.
4.1.2 Digester and Gas Dome

The digester itself takes the form of an inverted bowl. The justification behind this design is to minimise the number of corners and edges, which are pressure weak-points, and to provide even gas pressure as the storage level changes. The produced gas accumulates at the top of the dome and therefore it is essential to ensure this part of the construction is gas-tight. Since the dome is built beneath ground level and all visited digesters were in operation, it was not possible to carry out an inspection of digester interiors. However, according to the interviewees, no technical problems had arisen due to the digester construction itself. Thus it can be assumed that none of the visited digesters had fractures at the bottom or leakage at the top of the dome.
Most digesters were well constructed, but an installation fault was observed at a few sites. The fault concerned the depth of the installation; the excavation had been to shallow and the dome was not entirely below ground level. The fault is illustrated in the figure below. The construction team had apparently not dug a deep enough pit, and had instead used excavated material to cover the dome. Digesters should be fully subterranean as the earth both acts as a counterbalance to gas-pressure and as insulation to reduce temperature fluctuations. Exposed surface concrete is vulnerable to temperature fluctuations that may lead to the formation of cracks and eventual structural failure.

**Figure 18: Graphic of a too high installed digester**

In the above illustration, the left-hand schematic shows a digester that has been constructed to high in the ground, and the right-hand image illustrates a correct installation. Particularly in areas prone to flooding, digesters must be placed correctly to avoid updraft, which can cause damage at the digester construction.
4.1.3 Gas Outlet

The generated biogas is stored at the top of the digester. A cast-iron pipe passes through a turret on the apex of the dome, and down into the top of the dome where gas is stored. Any damage of the outlet pipe would lead to serious problems and repairs would likely require significant work on the dome. The visited digesters all had gas outlet pipes that were properly secured within the small brick turret for protection. All main valves at the top of the gas outlet were functional and no damage was reported from biogas users.

4.1.4 Outlet System

The fixed dome plants consist of one outlet tank with the function to ensure a counterbalance between the different stages of the digester status (full and empty gas dome). Moreover it provides necessary pressure that the biogas can flow to the cooking stove etc. The outlet system consists of one manhole and an outlet displacement chamber as well as an overflow opening.

Plate 4: Outlet system

The above photograph shows a BPP biogas digester, with a surveyor standing on the outlet system and inspecting its quality. This site is an example of good practice, with the outlet oriented such that it is close to the garden plot wherein the bioslurry is used.

The outlet systems of the visited digesters were well constructed and no technical problems had arisen. However, in some cases outlet tanks were constructed on raised ground in order to avoid inundation during rainy season. With this arrangement the absence of a soil surrounding removes an important form of support for when the outlet tank is full. Therefore the construction has to handle additional static pressure which can result in fractures.
4.1.5 Slurry Pits

The slurry pits function as storage and composting item for the used slurry after it drains from the outlet. Slurry pits should be sized to store a volume of slurry equal to that held in the digester. During the survey two types of slurry pits were found. One system comprised a single slurry pit and another had two separate slurry pits. With the latter system biogas users can alternate between the pits to allow time for composting. The depth of the pits should be minimised to avoid accidents. During the survey several pits were recognized where biogas users dried the slurry for further use on the field or composted the slurry with other organic matter.

Plate 5: Slurry pit with the function of drying the bioslurry

In the photograph above a slurry pit is shown where the slurry get dried for further transport to the field. In this case the farmer protected the slurry pit with a wire net preventing that animals or children fall into the pit. The farmer explained that he uses the slurry in his fruit garden and is convinced about the effect of organic fertilisation.

Regarding to the quality, the slurry pits were well constructed and functioning. The depths and volume of the slurry pits were appropriate. No risk is anticipated of this component causing serious problems in the near future.
4.1.6 Pipeline and Fittings

The biogas plants include several subcomponents to deliver the gas from the biogas plant to the kitchen where the gas is used.

The pipe system includes the following items:

- main gas valve (at the top of the gas holder)
- pipeline with fittings
- water trap
- pressure gauge

Many biogas users (76%) do not usually use the main gas valve. This is not ideal because if the valve is left open there is an increased chance of leaks in the pipe and fittings leading to the house, and this could also present a fire risk. Also, unless the valve is moved from time to time, it can get stuck in the open position. In general the PVC pipelines are laid underground between the main gas valve and just outside the kitchen. This is a good practice to prevent contact with sunlight, which can damage PVC, and also to prevent damage from various traffic.

Another important part of the gas delivery system is the function of the water drain system. Biogas is produced in high humidity conditions and therefore the gas “carries” a lot of water. Due to temperature differences between the digester and the gas pipes condensate water is produced which accumulate in the pipes. The water trap has the function to remove the water from the pipe system, preventing that the gas pipe gets blocked by water. An observation by the surveyor was that the water trap is sometimes placed on hidden placed, and could benefit from redesign.

The cover of the water trap cavity is quite heavy and therefore it is uncomfortable to remove these parts for conducting the maintenance activities. Moreover the screw of the water trap is difficult to turn, especially after a prolonged period without use. In some cases an extra tool (such as pliers) is needed to open and close the screw of the water trap.

Another component of the gas distribution network is the pressure gauge. It gives an indication of the amount of biogas available, how long the gas will last for cooking, and also whether gas production is sufficient. Thus users require a good understanding of this important diagnostic tool, and this should be ensured through the operation and maintenance training.
Plate 6: Pressure gauge

The above photograph shows an installed pressure gauge indicating sufficient amount of available biogas. In two cases the pressure gauge was broken and biogas users did not know where to obtain a replacement part.

Overall, the gas distribution systems worked correctly and were functional. Still, a more frequent maintenance schedule should be implemented by users to ensure this state remains over a longer period of time.

4.1.7 Biogas Stove, Lamps and Rice Cookers

Biogas has less energy content than LPG due to lower methane content. However in comparison to electrical or fuel wood cooking stove the heat power from biogas is higher which results in faster cooking. For utilising biogas in common LPG stoves small adjustments such the modification of the injection needle are necessary to ensure a clean combustion (blue flame) of the biogas. In all surveyed biogas households the same gas stove was used: this preferred stove model includes a gas injection nozzle which can be regulated with a valve. Furthermore a so called “pilot” that allows a small flame burn constantly over the burner ring was an item of the stoves. If the stove needs to be turned on and off regularly (like in a restaurant), then no spark for ignition is needed. However since this function is hardly used the “pilot” could be cut back for further stoves resulting in reduced equipment costs.

As was observed to be the case for other components, inadequate maintenance of gas stoves was observed in many households. Some stoves were not cleaned and gas outlets from the stove were clogged by remaining particles. Early signs of corrosion had appeared on some burner rings.
Plate 7: Biogas stove and pressure gauge

The photograph below shows a typical kitchen with a biogas stove, which has suffered from corrosion on the burner ring. The stove stands on bricks which is a safety measure, to prevent the stove from being in direct contact with the wooden work top. The pressure gauge is placed properly allowing the biogas user a direct visual control of the remaining amount of gas. The pipe which goes on to the top is connected to the gas lamp (see next section). All together this kitchen is a good example of an installed biogas stove; the outstanding gas tube could, however, be placed in a better position.

Biogas-operated rice cookers were seen in some households (17%). This is surprising and in contrast to the fact that all households were connected to the national electricity grid. Indeed some users switched from the electrical operated rice cooker to the gas operated model. Biogas users who own a rice cooker were fully satisfied with it and highlighted the very short preparation time required for preparing the rice. The rice cooker seems an attractive item for biogas users and should be added in the list of biogas assets.
In 30% of the visited households Chinese-made biogas lamps had been installed. These were rarely used since all visited households were equipped with electrical lighting. In two cases (14%) the glass of the gas lamps was broken.

**Plate 8: Installed biogas lamp**

The above photograph shows an installed biogas lamp that has been well-positioned in the middle of the living room. Additionally the distance to the wooden roof is approximately 40 – 50 cm, which is sufficient to minimise the risk of fire accidents. Although the user explained that the lamp is hardly in use, he said to be happy to have an alternative light in case of electricity shortcuts.

**4.2 Functional Status**

All visited biogas plants were functioning and in good condition. None were out of order due to poor construction or poor workmanship. Small technical problems appeared, however, in a few digesters. The failure rate can be seen in the figure below.
Figure 19: Technical problems appearing at biogas plants

At three digesters the pressure gauge broke and therefore the biogas user wasn’t able to check the amount of available gas in the digester anymore. This does not limit the performance of the plant but the user friendliness of the digester is compromised. The concerned biogas users voiced a need for the spare parts but were not aware of where they could be purchased. In two other cases the digester was affected by a flood\(^5\) and could not be operated for 1-2 months. After the flood had passed these digesters went back into operation. It is remarkable that the concerned digesters did not suffer any serious damage, and is a testament to good workmanship. However, these incidents could be interpreted as instances of inappropriate site selection for biogas digester.

Table 17: Description of biogas installation and status of technical parts

<table>
<thead>
<tr>
<th>Location of plant (601)</th>
<th>Sunny</th>
<th>64%</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Partly sunny</td>
<td>32%</td>
</tr>
<tr>
<td></td>
<td>Shadow</td>
<td>5%</td>
</tr>
<tr>
<td>Distance of plant from kitchen</td>
<td>Less than 10 m</td>
<td>41%</td>
</tr>
<tr>
<td></td>
<td>10 - 20 m</td>
<td>52%</td>
</tr>
<tr>
<td></td>
<td>More than 20 m</td>
<td>7%</td>
</tr>
<tr>
<td>Condition of the surrounding of plants</td>
<td>Well maintained</td>
<td>56%</td>
</tr>
<tr>
<td></td>
<td>Fair</td>
<td>44%</td>
</tr>
<tr>
<td></td>
<td>Poor</td>
<td>0%</td>
</tr>
<tr>
<td>Distance of plant from water sources</td>
<td>Less than 10 m</td>
<td>60%</td>
</tr>
<tr>
<td></td>
<td>10 - 20m</td>
<td>26%</td>
</tr>
<tr>
<td></td>
<td>&gt; 20 m</td>
<td>14%</td>
</tr>
<tr>
<td>Distance of cattle shed/ poultry enclosure</td>
<td>Distance less than 10 m</td>
<td>46%</td>
</tr>
<tr>
<td></td>
<td>10 - 20 m</td>
<td>29%</td>
</tr>
<tr>
<td></td>
<td>&gt; 20 m</td>
<td>25%</td>
</tr>
<tr>
<td>Condition of plant as a whole</td>
<td>Good</td>
<td>95%</td>
</tr>
<tr>
<td></td>
<td>Fair</td>
<td>5%</td>
</tr>
</tbody>
</table>

\(^5\) In 2008, there was the biggest flood event in Vientiane municipally since 1966
### 4.3 Efficiency of Biogas Plant

The efficiency of biogas plants can be calculated by comparing the amount of used dung with the amount of produced gas. The table below shows the calculation for 4m³ digesters.

**Table 18. Operational summary of biogas supply and consumption**

<table>
<thead>
<tr>
<th>Description</th>
<th>Amount</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average feedstock supply</td>
<td>24</td>
<td>kg / day</td>
</tr>
<tr>
<td>Gas stove in operation</td>
<td>115</td>
<td>minutes /day</td>
</tr>
<tr>
<td>Gas consumption (stove)</td>
<td>350</td>
<td>l / h</td>
</tr>
<tr>
<td>Gas production rate (feedstock)</td>
<td>40</td>
<td>l / kg</td>
</tr>
<tr>
<td>Daily gas consumption</td>
<td>671</td>
<td>l</td>
</tr>
<tr>
<td>Daily gas production</td>
<td>960</td>
<td>l</td>
</tr>
</tbody>
</table>

According to the above table the theoretical amount of gas produced per day is 960 l/day assuming an average feedstock supply of 24 kg/day with a gas production ration of 40 kg/day. Moreover the gas consumption was calculated by 671 l/day assuming that the gas stove is used for 115 minutes per day with a gas flow of 350 litres per day. As a result, only 70% of the theoretical amount of gas is utilised for cooking purposes which indicated that the plant performance has some space for improvement.

This can be caused by the fact that many biogas users apply Buffalo dung which naturally has a lower gas production rate. Moreover since the 4 m³ digester can be fed with up to 40 kg of feedstock per day, the full capacity of the plant is not used yet. The following section documents user satisfaction, which gives an insight into the most important outcomes of biogas system and thus provides a more useful evaluation of performance.
4.4 User Satisfaction

The respondents were encouraged to evaluate the performance of their plants by asking various direct and indirect questions. This section analysed these answers to reach a conclusion on the overall satisfaction of people using a biogas digester.

4.4.1 Rate of Satisfaction and Reasons

Regarding the level of satisfaction of uses related to the functioning of their biogas digesters, 38 (83%) responded that they were fully satisfied and 8 (17%) responded that they were partly satisfied. None of the users expressed their dissatisfaction during the time of the survey. This is comparable to last year’s survey results, that reported 80% fully and 20% partly satisfied customers.

Figure 20: Biogas users’ satisfaction ratio

Biogas users were asked in a multiple choice question about the reasons for full satisfaction. Easy cooking (33 respondents), enough gas (27) and workload reduction (20) were the most commonly cited reasons. Thus the main benefit observed by the end-user is more convenient cooking. This observation is supported by the observed time savings of over an hour per day for users of biogas digesters. Other reasons given for full satisfaction were that biogas is trouble free (15 respondents), has health benefits (11) and brings economic benefits (11). This secondary group of answers shows that the impact on the health of the people and their expenses are also viewed as important, but less than those outcomes related to cooking. The savings on cooking fuel expenses were less significant factors in terms of user-satisfaction. Environmental benefits (1) apparently carry minimal value, which may reflect the low awareness of environmental issues in the Lao PDR. Moreover, social benefits/prestige does not seem to play a role at all, which could indicate a rather limited role for word-of-mouth dissemination of information.
Figure 21: Reasons for full satisfaction by using biogas

Of the minority of users to report partial satisfaction with their digesters, four reasons were reported. The main reason was disappointment due to less gas produced than expected (5 respondents: 11%). This correlates well with the observation that users value the aspect of cooking most when it comes to satisfaction. Future promotion efforts should ensure more accurate expectations of gas expectations. The other reasons mentioned are related to the technical aspects of operating a biogas digester: additional work (1), technical problems (1), and difficulty to operate (1).

Figure 22: Reasons for partial biogas users’ satisfaction

All biogas users which mentioned insufficient biogas production had sufficient feedstock available. It was however found that the daily feedstock supply was less than the available amount. The table below demonstrates this figure. The reasons for not adding more manure should be further investigated. In fact, it would appear that all of these users had access to more than 40kg/day of manure, which would have made them eligible for a larger biogas digester.
Finally, one possible reason for inadequate gas production despite supplying 20kg of manure can be low quality manure. Indeed this was found to be the case for one user, who mostly used buffalo manure for feedstock, which provides less gas than pig or cattle dung.

Table 19: Potential feedstock production and supply

<table>
<thead>
<tr>
<th>Biogas user</th>
<th>Potential feedstock production (kg/day)</th>
<th>Feedstock supply (kg/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>56</td>
<td>20</td>
</tr>
<tr>
<td>2</td>
<td>72</td>
<td>40</td>
</tr>
<tr>
<td>3</td>
<td>258</td>
<td>20</td>
</tr>
<tr>
<td>4</td>
<td>128</td>
<td>20</td>
</tr>
<tr>
<td>5</td>
<td>44</td>
<td>20</td>
</tr>
</tbody>
</table>

4.4.2 Experienced Advantages

It is interesting to compare the reasons for full and partial satisfaction with the experienced advantages of users as shown in the figure below. The main advantages were the comfort and ease of operation mentioned by 29 (63%) biogas users. The same amount of households (63%) explained that reduced expenditures for cooking fuels are great advantages. The environmental friendliness (12 households; 26%) has a much higher significance according to this question, which could due to fewer options presented to the user. The energy efficiency benefit (10 Hhs; 22%) was the least frequently mentioned.

Figure 23: Advantages of biogas against other cooking fuels mentioned by biogas users

4.4.3 Conclusions about Customer Satisfaction

In general, the users of biogas seem to be very satisfied with their digester, mainly because i) it provides them with a fast and reliable way of cooking, and ii) it saves them time and money by avoiding the need to collect other sources of fuel. Benefits of biogas related to changes in the home and surrounding environment are less frequently mentioned in relation to customer satisfaction. The main reason given by the small group of customers that were not fully satisfied was that their digester did not produce as much gas as they expected.
5 Impacts of Biogas

5.1 Impacts on Time Saving and Workload Reduction

When fully utilised, biogas can significantly reduce the amount of time required for meal preparation and collection of fuel wood. However the biogas system also requires some time for its operation, such as collection of water and feeding the digester. The figure below details the time required and saved as the direct impact of using biogas. It was found that an average household saves a total of 63 minutes per day by using biogas instead of conventional fuels.

Figure 24: Time savings from using biogas

Cooking

The impact of using biogas for cooking purposes results from the stronger heat of the gas flame that can be used straight to the demand. Moreover time for preparing and starting the fire can be saved. In comparison to traditional cooking methods such as using fire wood or charcoal on simple stoves, Biogas is much faster due to “fire on demand” and a higher calorific value of the flame. Even despite the fact that all households were fully electrified and some of them used electricity for cooking (e.g. electrical rice cooker), 40 (87%) households mentioned a significant amount of time savings for preparing the meal for the family, with an average time saving of 45.5 minutes per day. The maximum reported time saving was 180 minutes while the minimum time saving was 10 minutes.

Collection of water

Water is required for the daily feedstock supply. This activity can entail an increased workload for biogas user, which depends on the distance to the water source. The users included in this survey however only reported relatively small amounts of time taken up by this activity. Only 6 households mentioned an increased workload due to the water collection. The maximum additional time effort was 30 minutes while the majority of the interviewed households (87%) do not consider...
water collection for their biogas digester as an additional effort. According to the survey an average of 2 minutes per household was calculated for gathering water for the biogas plant.

**Plant feeding**

Feedstock supply has to be done on a daily basis in order to ensure a trouble free operation of the biogas system. Plant feeding contains collect and transport manure from the stable to the plant and mixing dung together with water. 20 (43%) households consider this activity as an additional workload. The maximum additional time effort was mentioned with 30 minutes and the minimum time effort for 3 minutes. The average time was calculated by 5 minutes per household.

**Collection of fuel**

According to the survey, firewood and charcoal were reported to be the main conventional fuel sources used in the households for cooking before biogas was installed. Firewood was the major source of cooking fuel, used by 36 (78%) households, followed by charcoal (10 households, 22%). Most of the interviewed households purchased their fuel wood and charcoal at the local market.

When asked whether they have experienced any changes in allocated time to collect fuel before and after the introduction of biogas, 9 (20%) households mentioned that they recognize time savings by using biogas. The maximum time saving was mentioned with 300 minutes. On average, this gives a time saved of 47.8 minutes per day.

**Caring of animals**

Biogas users were asked whether they had experienced any change in the time allocated for cattle care after the installation of biogas plant. All of the interviewed persons reported no change related to the care of animals.

**Gender related impact**

In general, it was observed that women particularly benefit from the utilisation of biogas. Since women typically prepare meals in households, they are the immediate beneficiaries of the time savings through using biogas. The survey questionnaire did not enable more detailed information about the impacts as a function of gender

**5.2 Impacts on Saving of Conventional Energy Sources**

Cooking fuel replacement by using “free” biogas has a direct financial impact to the biogas user, in addition to environmental and social impacts. Expenditures for cooking fuels can be reduced or even eliminated.

Most of the users interviewed (35 of 46) in the study had used firewood prior to installing a biogas digester. Additionally, 9 user electric cooking appliances, 1 used LPG gas, and 5 cooked with charcoal. The costs and savings are summarised in the table below.
Table 20: Financial savings by cooking fuel replacements

<table>
<thead>
<tr>
<th>Average monthly cooking expenses</th>
<th>Before (Kip/month)</th>
<th>After (Kip/month)</th>
<th>Saving (Kip/month)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel wood</td>
<td>48,200</td>
<td>21,400</td>
<td>26,800</td>
</tr>
<tr>
<td>LPG cylinder</td>
<td>300,000</td>
<td>150,000</td>
<td>150,000</td>
</tr>
<tr>
<td>Electricity</td>
<td>42,200</td>
<td>18,800</td>
<td>23,400</td>
</tr>
<tr>
<td>Charcoal</td>
<td>60,800</td>
<td>2,900</td>
<td>57,900</td>
</tr>
</tbody>
</table>

The average expenditure for fuel wood was 48,200 kip per month with a maximum expenditure of 140,000 kip per month and a minimum expenditure of 0 kip (free source of fire wood). The average expenditure for electricity used for cooking purposes was 42,200 kip per month.

Biogas users experienced significant cooking fuel savings regardless of type of cooking fuel. After installing biogas the average expenses for fuel wood decreased to 21,400 kip, that is a reduction of 26,800 kip per month / household. The average expenditures for electricity were also reduced by 23,400 to 18,800 kip per month. For charcoal the expenditures decreased to an average of 2,900 kip per month. The one user that cooked with LPG found they could reduce their reliance on bottled gas by half.

In terms of reduced material consumption, the average savings for users are summarised in the table below.

Table 21: Reduction in cooking fuel consumption

<table>
<thead>
<tr>
<th>Average monthly cooking consumption</th>
<th>Before (per month)</th>
<th>After (per month)</th>
<th>Saving (per month)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fuel wood</td>
<td>54.1kg</td>
<td>9.2kg</td>
<td>44.9kg</td>
</tr>
<tr>
<td>LPG cylinder</td>
<td>2 cylinder</td>
<td>1 cylinder</td>
<td>1 cylinder</td>
</tr>
<tr>
<td>Charcoal</td>
<td>45kg</td>
<td>12.5kg</td>
<td>32.5kg</td>
</tr>
</tbody>
</table>

The above table indicates a substantial decrease in the material consumption of conventional fuels, including a 44.9 kg reduction in the use of fire wood.

Besides reduced expenditures for cooking fuels, biogas users also changed their attitude related to cooking fuels as well. The graphic below illustrates the change of cooking fuel after introducing biogas.
In total, 22 (48%) biogas users completely stopped using fuel wood for cooking purposes. Furthermore 5 (11%) of the interviewed households stopped using electricity for cooking purposes anymore.

5.3 Impacts of Bio-Slurry Used as Fertilizer

Another output of biogas plants besides biogas is the digested bioslurry. This organic material can be composted, stored and applied as a high quality fertilizer. Using the bioslurry as a by-product increases the performance of the biogas plant since farmers can replace chemical fertilizer by using this organic material.

According to the survey 37, (80%) households mentioned that they use bioslurry actively for fertilizing. When asked why they do not use the slurry for fertilization, other households mentioned that they do not have enough land or any purpose for the slurry.

The table below indicates different applications of the slurry of the 37 households that use it.

Table 22: Utilisation of bioslurry (number of respondents)

| Use as organic fertilizer without composting | 26 |
| Use as organic fertilizer after composting | 10 |
| Use as fish feed | 3 |
| Use slurry through irrigation canal directly | 1 |

According to the above table, 26 (57% of all users) households are using the digested slurry straight from the slurry pits without any further treatment. 10 (22% of all uses) of the interviewed biogas users explained that they mix the slurry with other organic material together for making compost
with it. Amongst these users, 3 (7%) also used the bioslurry to feed fish, and 1 (2%) used the slurry through an irrigation channel.

The table below presents the users satisfaction with Bioslurry compared to Farm Yard Manure (FYM).

Table 23: Users experience with bioslurry

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Same as FYM</td>
<td>17</td>
</tr>
<tr>
<td>Better than FYM</td>
<td>17</td>
</tr>
<tr>
<td>Worse than FYM</td>
<td>2</td>
</tr>
</tbody>
</table>

According to the above table, 17 (47%) households mentioned that Bioslurry is as effective as normal FYM. Another 17 (47%) households even mentioned that Bioslurry has a better performance than FYM. Only 2 (6%) households mentioned Bioslurry has less effect than FYM.

Regarding to fertilizer savings, 14 (30%) households explained that they could cut down expenditures for NPK fertilizer. The average amount of financial savings due to fertilizer replacement was 700,000 Kip per year. This result is encouraging since the replacement of NPK fertilizer by bioslurry brings besides a healthy food production another important financial benefit for the biogas user. The full utilization of the by-product is quite important.

5.4 Impacts on Health and Sanitation

Biogas brings the opportunity of improved health and sanitation situation to the household. The health improvement can be achieved by eliminating indoor air pollution from simple fuel wood stoves, by replacing wood fires with cleaner gas stoves.

The use of biogas for cooking can eliminate harmful smoke resulting in fewer incidences of smoke-borne diseases. Particularly women and children benefit from such improvement since they are traditionally responsible for maintain the fire and cooking. Moreover biogas can help in improving environmental sanitation in and around the house since toilets and sanitation facilities can be attached or fed into the digester. Interviewees were asked about the frequency of various ailments in their household, and whether the situation had improved following the installation of their biogas digester. The outcomes of the survey related to health issues are given in the table below

Table 24: Health impact of using biogas

<table>
<thead>
<tr>
<th>Households which felt a reduction of diseases</th>
<th>Respiratory diseases</th>
<th>Headache and dizziness</th>
<th>Eye diseases</th>
<th>Diarrhoea and dysentery</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>13</td>
<td>17</td>
<td>2</td>
</tr>
</tbody>
</table>

14 (30%) households noted reductions in headaches, dizziness and respiratory diseases. Furthermore in 17 (36%) users that had family members suffering from eye diseases witnessed an improvement of the situation due the absence of smoke in the kitchen. 2 (4%) households explained that using biogas reduced the frequency of diarrhoea and dysentery. 23 (50%) of the interviewed
households did not experience a change of the health situation. This was a result of an already good health / sanitation situation at the concerned households.

6 Conclusions

This section provides some concluding remarks on the Biogas User Survey. In general, minimal problems had arisen in terms of the technical functioning of the units, some inadequacies were observed in the operational and maintenance practices that could lead to faults in the future. As the units will get older, issues related to maintenance and service will more frequently arise and pose a risk to long-term satisfaction.

Survey area

The survey area was limited and the conclusions can only cautiously be generalised. The survey was carried out in Vientiane Municipality, a relatively wealthy province in the Lao PDR. If biogas digesters are to be disseminated in other provinces throughout the country as well, it would be good to repeat parts of the questionnaire to assess whether the level or wealth and livestock are comparable to Vientiane Municipality and how the status of socio-economic conditions have an effect to the biogas user.

Moreover, the results show that the households with a digester are the ones which are relatively wealthy compared to people in their surroundings. This is understandable given that the initial investment for a digester is substantial and that maintaining sufficient livestock requires enough income. However, if SNV BPP wants to make their technology available in other provinces were the current socio-economic conditions are not as favourable as in Vientiane Municipality province, alternative strategies will have to be developed.

Livestock situation

The livestock situation deserves special attention since the availability of sufficient amount of manure is essential for ensuring an adequate biogas production resulting in satisfied biogas customers. The fact that 6 households did not have any livestock is a concern. This contrasts with the fact that 24 households mentioned that they increased their livestock since having biogas.

Moreover it is interesting that a large proportion of biogas users are not using the full amount of produced manure despite the fact that digesters could be fed more manure to create more gas and bioslurry.

Awareness about biogas

There is awareness about biogas, its use and its merits, amongst users, but also amongst non-users seems to be reasonable. The non-user survey indicates that most people know about the technology and can mention the main uses and advantages, although all questionnaires were carried out in villages were there were already digesters present. In addition, the sources of information through which people know about biogas are limited to friends and family and existing users and a little bit to the service provider. Therefore, there is scope for alternative promotion strategies.
Although the number of participants was small, the potential biogas users’ survey shows a number of interesting results. First of all, the method to select the potential users has shown to be effective, because all the interviewed users have enough livestock for at least one 4 m³ digester. Moreover, most of them showed a strong interest in the technology and most would like install biogas digesters providing they gain access to the information that they requested.

Since the survey amongst potential users was carried out in villages with biogas digesters already installed, people seemed to be well aware of the technology and some of its main uses and advantages. In terms of usage, people know that biogas will improve the comfort of cooking by saving time. These kinds of reasons would also be the main arguments given when asked why people would adopt the technology. The main advantages mentioned are, however, the possibility to get subsidy and save money spent on buying fuel.

There seems to be a need for more information. The most important sources of information are the current owners of biogas and/or friends and relatives. Although this is an effective way of spreading information, there is still a demand for more. The main questions people seem to have are related to the economics of biogas and some of the technical issues. Since, it is unlikely that potential users can access sufficient information about these issues from their peers, it would be recommended to promote the technology amongst governmental and non-governmental institutions as well to reduce the pressure on the service provider alone for this role.

Construction

The construction of the surveyed digesters seems to be of good quality. Moreover, construction process and quality control of the local biogas digesters seems to be sufficient as there was a proper supervision from biogas experts ensured during the construction process. There seems to be currently little room for improvement in the construction of the digesters. However after sale service and maintenance need more urgent attention.

Operation

There is hardly maintenance being done on the digesters, according to findings from the user survey. Fortunately, there are only small impacts on the performance of the plants to date as all the digesters covered in the survey were fully operational. However, without proper maintenance, the digesters might not reach their expected 20 years lifetime. Some households are in need of spare parts, such as a new pressure gauge or just some help on the operation. The latter could be achieved by making it easier to reach the service provider by phone.

The problems with feedstock supply are already mentioned, but deserve a lot of attention. Most of the households in the survey provide too little feedstock to their digesters, leading to underperformance of the plant and limited satisfaction of the user.

Gas production itself is mostly satisfying, although 17% of the participants mentioned that gas is not sufficient for being independent of traditional fuel sources.

The biogas equipment that comes with the digester has to be reconsidered. The stove needs more maintenance, as rusting was frequently observed, and the biogas lamp is hardly in operation. This is
not surprising, given that all the digesters are installed in electrified areas. However, not providing the lamps in these areas could reduce the initial investment costs. A rice cooker, on the other hand, was perceived to be interesting and deserved further exploration.

Impact

In general using biogas seemed to have the desired impact on the time and money saved for cooking. Moreover, many of the respondents used the slurry as fertilizer which increases the performance of the biogas plant as well. Although the convenience, time and money savings are the most important perceived impacts, digesters also contribute to improve environmental and health conditions in the house and its surrounding. However, since these items are not frequently mentioned by users, more awareness can be raised on this aspect of biogas digesters.

Impact on time savings

Significant amount of time savings resulted by using biogas were confirmed during the survey. The time savings appeared for cooking and cooking fuel collection activities. Taken it into account that these tasks are traditionally conducted by women and children biogas technology enables to strengthen the position of this group. As a direct impact these group will have additional time for other tasks available such as educational or income generating activities. However further studies should be done for exploring if the new accumulated time is used effectively.

Impact on fuel reduction

According to the survey fuel wood consumption was significantly reduced by the installation of biogas digesters. Biogas users experienced financial benefits to having their own environmentally friendly “energy production”; those users interviewed in this study saved on average 40 US$ per year on firewood for fuel expenses. A similar saving was observed for interviewees that used electricity for cooking, and for charcoal the save was approximately twice as large. Therefore users recover their investment within a few years.

7 Recommendations

Although biogas seems to have its desired impact, there is room for improvement to speed up the dissemination and sustain the high levels of satisfaction.

Alternative strategies to target the poorer households

Biogas seems to be successful as a renewable energy technology. However, in terms of poverty alleviation, it has not achieved the desired impact. In order to reach poorer households within the current district and eventually the poorer district as well, alternative strategies will have to be developed. Primarily, our suggestion is to explore the funding options available to people. To date, only one user has taken credit for their digester (borrowed from relatives). Micro-credit could make biogas available to many people and, indeed, contribute to more economic activity as a whole. Additionally, the instrument of subsidy could be refined, so as to provide additional subsidies for disadvantaged households or districts. Alternatively, the idea of sharing digesters between
households can be explored, as this will make the technology affordable for more households as well.

**Feedstock supply**

The actual feedstock supply deserves special attention since sufficient amount of gas production has the most impact related to the biogas user satisfaction. It seems that the digesters are not operating on its full capacity since a high amount of biogas users (64%) claimed that they only provide a daily amount 20 kg. This amount is the lowest suggested feedstock supply but it has to be concerned that the kind of manure plays an important role. The survey could not distinguish between the kind of feedstock (cattle, pig or buffalo) or feedstock mix which the concerned biogas user fed into the digester. Moreover, the observation that some users owned no livestock implies that the baselines study and site selection process implemented by BPP warrants some attention.

In case that a high content of buffalo dung was used as feedstock the gas production rate is lower than from pig or cattle dung.

In general it seems to be important that these users will receive an additional training related to a sufficient feedstock supply. Moreover it has to be investigated if the amount of theoretical produced dung matches with the real amount of produced manure. In the Lao PDR the livestock management differs between the dry and rainy seasons. As a result of this the duration where animals are kept in the stable can fluctuate as well. Moreover many investigated stables don’t have a concrete floor which means that some amount of manure and urine is lost in the soil. This has to be particularly taken into consideration with cattle livestock. Farmers which breed pigs are mostly using stables with concrete floors which make the manure collection easier.

Furthermore additional research and effort has to be put in to the development of an understanding of how users in the Lao context can collect enough manure and how digesters affect the use and management of livestock. This should be done from a holistic livestock perspective.

**Alternative promotion strategies**

Alternative promotion strategies can be employed to make the technology of biogas better known amongst the people in the Lao PDR. Of course, there is a role for the service providers here to make the technology better known. However, governmental and non-governmental organizations could be informed as well to make them sensitive for high potential areas. The main communication method in the country, word of mouth, should be exploited by making people more proud and willing to share their experiences with biogas.

**Improve after-sale services**

After sales services will become more important as the digester becomes older. The survey shows a need for replacement of some parts and a source for information.

**Reconsider biogas equipment package**

Depending on the specific conditions of a site, some components of the biogas system may not be needed. For example, the lamp can be left out in those areas already electrified. Similarly, there is a
need for other types of equipment or appliances that can be used with biogas digesters, such as rice cookers. As the awareness of biogas improves in the Lao PDR, it will become more appropriate to engage with the existing market channel to sell equipment. Furthermore, by promoting the emergence of secondary services for supply and maintenance, the technology may approach critical mass and may eventually become self-sustainable, especially in more wealthy areas.
8 Main References


Biogas – Sector – Partnership Nepal: www.bspnepal.org.np

Ludwig Sasse, 1991. Improved Biogas Unit for Developing Countries, GTZ.
9 Annexes

Annex 1: Terms of Reference

Annex 2: Biogas user household questionnaire

Annex 3: Potential biogas user household questionnaire
Terms of Reference for Consultant to Conduct
Lao Biogas User Survey 2008

1. BPP Background

The Lao Biogas Pilot Project (BPP) was established in November 2006 with the signing of a Memorandum of Understanding between SNV (Netherlands Development Organisation) and the Department of Livestock and Fisheries (DLF) inside the Ministry of Agriculture and Forestry.

The aim of the BPP is to establish a sustainable commercial market for the deployment of household biogas digester technology, resulting in the reduction of biomass resource depletion and a significant improvement in the quality of life of the families concerned. The initial pilot phase period is from March 2007 to December 2010, with a target of 6,600 household systems installed. The BPP has successfully completed its first 18 months of implementation with over 220 systems installed for households in Vientiane Capital, Savannakhet and Xiengkhouang provinces.

An important part of the BPP’s monitoring plan is to conduct a survey of biogas users (BPP customers) once a year. This provides data on the level of impact that the program is having, and can also indicate trends and issues for management attention. Similar surveys are conducted by the SNV biogas programs in other countries such as Vietnam and Cambodia. This allows some benchmarking and learning opportunities. The first Biogas User Survey (BUS) in Laos was conducted in December 2007.

2. Objectives of the Assignment

The main objective of this assignment is to make an accurate and justified assessment of the effects that installing a BPP biodigester has had on BPP customers. A secondary objective is to collect some information on certain aspects of the program’s delivery to allow management improvements.

This will be based on a detailed survey of a significant sample of existing customers. The issues to be investigated fall into 11 main areas, as follows:

a) Socio economic conditions of the households, before and after;
b) Awareness of biogas and BPP, information sources and decision making processes leading to the installation;
c) User’s experience of the construction process;
d) Delivery and effectiveness of user training;
e) User’s experience and attitude of general system operation, including appliances;
f) Energy savings and financial consequences;
g) Use of dung, fertilizer and Bio-slurry;
h) Effects on household and agricultural practices (eg: cooking, livestock management etc);

i) Effects on household hygiene, health and amenity;

j) Users’ experience of the after-sales service; and

k) Differences in levels of service and / or levels of benefits experienced by users that may be linked to gender or ethnicity.

For the consultant’s reference, a questionnaire of a previous BUS, and also one from Cambodia, will be provided. The consultant should use these samples as a basis for this assignment but make any improvements deemed necessary for this assignment, with BPP’s approval.

3. **Scope of this Consulting Assignment**

This assignment includes:

a. Review relevant background material such as the BPP program documents and previous user survey reports from Laos and other countries;

b. Reviewing the sample questionnaire (provided) and, in consultation with the BPP, make any changes necessary to improve the quality and reliability of the survey results;

c. Plan how to most effectively conduct the survey and conduct the analysis and reporting within the schedule (Note: the sample will be selected within 7 districts of Vientiane Capital only, see below);

d. Participate in a kick-off meeting with BPP;

e. Test the agreed survey tools and train appropriate enumerators;

f. Organise and conduct the survey (within Vientiane Capital only);

g. Capture the data with appropriate accuracy;

h. Conduct the required analysis of the data and draft a report of the findings, plus a summary powerpoint presentation, to meet the objectives of the assignment;

i. Present the findings and draft report in a meeting with the BPP;

j. Finalise the survey report and incorporate relevant comments from BPP.

4. **Methodology**

The Consultant should propose an appropriate sampling plan, based on the budget, time frame and customer data already available. This plan should ensure that the sampled households, and the results, are representative of BPP’s total group of customers.

Some of the issues to consider in sampling:

a) The sampled customers should have been using their systems for at least 6 months already in order to see reliable evidence of impacts. Therefore the potential sample group is reduced to about 180 households within 7 districts in Vientiane Capital.¹

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¹ Installations in Savannakhet and Xiengkhoung only started in August and September 2007 respectively.
b) There are four sizes of digester available, but most customers choose the smaller sizes (4m³ and 6m³), and the survey should include some customers with the larger sizes (8m³ and 10m³);

c) The sample should have a good geographical spread since each district uses different masons for construction, and government officers for promotion and management;

BPP will provide the Consultant with a spreadsheet table of all details of existing customers to allow for random sample selection. A summary table of the existing BPP customers is provided here:

Table 1: Summary table of biogas households with at least 6 months experience of use.

<table>
<thead>
<tr>
<th>District</th>
<th>4 m³</th>
<th>6 m³</th>
<th>8 m³</th>
<th>10 m³</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parkngeum</td>
<td>29</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>36</td>
</tr>
<tr>
<td>Xaithany</td>
<td>69</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>72</td>
</tr>
<tr>
<td>Hatxayfong</td>
<td>11</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>Naxaythong</td>
<td>26</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>27</td>
</tr>
<tr>
<td>Sangthong</td>
<td>7</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>7</td>
</tr>
<tr>
<td>Sikhot</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Saisetha</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>142</strong></td>
<td><strong>6</strong></td>
<td><strong>3</strong></td>
<td><strong>3</strong></td>
<td><strong>154</strong></td>
</tr>
</tbody>
</table>

5. Deliverables and Schedule

The Consultant shall deliver:

a) Detailed Work Schedule, Sampling Plan, Questionnaires and other survey tools for BPP approval prior to starting field work;

b) Survey Report (draft and final versions) that is clear and concise, and meets the objectives of this assignment (examples can be provided);

c) Summary Presentation of Findings in Powerpoint format that uses appropriate charts, graphs and photographs to illustrate the results;

d) Raw survey data collected, in the form of a spreadsheet table; and

e) Digital photographs documenting the survey being conducted, and any particular points of interest or concern.

This assignment should start as soon as possible, and be completed before the end of December 2008.
6. **Consultant Qualifications and Experience**

The successful consultant must have the following:

a) Demonstrated capacity and experience in similar assignments;

b) Knowledge and experience with relevant statistical processes to ensure rigorous and reliable output;

c) Proven ability to manage the logistics and government approvals needed for village surveys in Laos (BPP will help where possible);

d) Access to appropriate teams of experienced enumerators; and

e) Sufficient resources to perform the assignment within the required schedule.

7. **Terms of Engagement**

Suitably qualified consultants who are interested in this assignment must submit a very brief proposal to BPP that clearly describes:

a) Qualifications and relevant experience of the Consultant(s), and brief summary of the proposed enumerators (don’t need their detailed CV);

b) Proposed sampling strategy consisting of a brief explanation of how many households should be surveyed, and how they should be selected;

c) The proposed work plan that the Consultant would follow in order to meet the required project schedule (simple table showing the number of man-days needed for each activity and the schedule for when they will be conducted);

d) Proposed fees and payment structure; and

e) Any points of concern or suggestions for improvement.

Proposals should be submitted in electronic format to:

Mr Thongchanh Santhasith
BPP Project Manager
bpoffice@biogaslao.org
(+856) 021 214 947

BPP will select the proposal that provides the best value for money considering the required quality and probability of completion on schedule.
Greetings! My name is ______________________________. I am here on behalf of the Biogas Pilot Programme (BPP) of MAF and Netherlands Development Organization (SNV) which is conducting a Biogas Users’ Survey to monitor the effects of biogas and effectiveness of programme activities. In order to get more information about your biogas plant and its functioning, we are conducting a survey of households in the area. Your household has been selected by chance from all the households with biogas plant in the area. I would like to ask you some questions related to the installation, operation, maintenance and other aspects of your biogas plants.

The information you provide will be useful to find out the status of biogas plants in your community, and will be used to plan future improvement options on biogas plants and the programme procedures.

Participation in the survey is voluntary, and you can choose not to take part.

All the information you give will be confidential. The information will be used to prepare general reports, but will not include any specific names. There will be no way to identify that you are the one who gave this information.

If you have any questions about the survey, you can ask me, my survey field supervisor who is here with the survey team. At this time do you have any questions about the survey?

<table>
<thead>
<tr>
<th>Signature of interviewer</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Date:</td>
<td></td>
</tr>
<tr>
<td>Respondent agreed to be interviewed</td>
<td>1. YES 2. NO</td>
</tr>
</tbody>
</table>
1. HOUSEHOLD IDENTIFICATION
This section is to be completed for each household visited.

101. Name of the Plant Owner

102. District name

103. Village Name

104. Sample and Plant number

105. Type and Size of Plant

106. Installed by

107. Date of Installation

108. Type of House

109. Electrified

110. Respondent’s name

111. Date of interview

112. Time interview commenced

113. Time interview ended

Interviewers: Remember to obtain consent from each household. Write answers directly in the tables and mark the boxes on the right side of each form.

Field Supervisors: Check ALL answers recorded in each section, ensuring gaps or missing answers are obtained BEFORE leaving the household. Mark tick in the right hand side for checked answers after correction and validation.

Please complete this part of the form

<table>
<thead>
<tr>
<th>Interviewer</th>
<th>Data entry personnel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td></td>
</tr>
<tr>
<td>Date</td>
<td></td>
</tr>
</tbody>
</table>

Record Number

2
2. HOUSEHOLD CHARACTERISTICS

Can you please tell me the names of all the members of your household who usually live here, sleep here and eat from the same kitchen, including yourself. Please include children, relatives or orphans, but do not count temporary visitors. First names are sufficient. This information is confidential and will not be shared with anyone. Names are only used in the interview and will not be related to data in the report. **Make a list of ALL names before asking other questions.**

After getting the full list of family members, continue with the other questions in the table for each person in the list.

<table>
<thead>
<tr>
<th>201</th>
<th>202</th>
<th>203</th>
<th>204</th>
<th>205</th>
<th>206</th>
<th>207</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name of all the members</td>
<td>Gender</td>
<td>Age</td>
<td>Highest-level education completed?</td>
<td>Main Occupation</td>
<td>Secondary Occupation</td>
<td>Approximate Income</td>
</tr>
<tr>
<td>Coding For Answers Name</td>
<td>1. Male</td>
<td>For children &lt; 5 years write the number of months</td>
<td>Write the number for the grade level passed. Put 0 = never 1=BA 2=BA 3=MA 4=MA 5=PhD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Female</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>208</th>
<th>209</th>
<th>210</th>
<th>211</th>
<th>212</th>
<th>213</th>
<th>214</th>
</tr>
</thead>
</table>
| Gross family income from individuals per YEAR(208) | Income from other sources such as selling of agricultural productions per YEAR(209) in Kips  
- Cereal…………………..  
- Cash-crops……………..  
- Milk and Milk-product ……………..  
- Fish……………….  
- Fruits……………….  
- Vegetables……………..  
- Meat and Meat Product…………..  
- Others …………….. | Monthly Income (Estimated) in Kips | |
| | | | | | | |
| 1. | | | | | | |
| 2. | | | | | | |
| 3. | | | | | | |
| 4. | | | | | | |
| 5. | | | | | | |
| 6. | | | | | | |
| 7. | | | | | | |
| 8. | | | | | | |
| 9. | | | | | | |
| 10. | | | | | | |
| 11. | | | | | | |
| 12. | | | | | | |

Net surplus/deficit per YEAR(211)

---

**Land Holdings**

<table>
<thead>
<tr>
<th>212</th>
<th>213</th>
<th>214</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arable Land (Ha/Acres)</td>
<td>Non-arable Land (Ha/Acres)</td>
<td>Total Land Area (Ha/Acres)</td>
</tr>
</tbody>
</table>

**Agricultural Production**
## Agri. Production

<table>
<thead>
<tr>
<th>Agri. Production</th>
<th>Production in Kg</th>
<th>Consumption in Kg</th>
<th>Saving/Deficit in Kg</th>
<th>Current market price (Kip.) per Kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paddy (215-218)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wheat (219-222)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maize (223-226)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Potato (227-230)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oilseeds (231-234)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pulses (235-238)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vegetables (239-242)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fruits (247-250)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Others (251-53)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Livestock Ownership

<table>
<thead>
<tr>
<th>Livestock</th>
<th>Numbers (current)</th>
<th>Numbers (before 1 years)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Adult Stall-fed</td>
<td>Adult Open-grazed</td>
</tr>
<tr>
<td></td>
<td>Calf Stall-fed</td>
<td>Calf Open-grazed</td>
</tr>
<tr>
<td></td>
<td>Total Stall-fed</td>
<td>Total Open-grazed</td>
</tr>
<tr>
<td>Cow/Oxen (251-257)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buffalo (258-264)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Goats (265-271)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pigs (272-278)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horse/Donkey (279-285)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poultry (286-287)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other (288-294)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Total quantity of dung production (295)

**Have there any changes in family size after the installation of biogas plant?** (296)

- [ ] No
- [ ] Yes, increased
- [ ] Yes, decreased

**Have there any changes in cattle size after the installation of biogas plant?** (297)

- [ ] No
- [ ] Yes, increased
- [ ] Yes, decreased

## 3. INSTALLATION AND FUNCTIONING OF BIOGAS PLANT

301. How did you know about biogas plant?

1. Through publicity media
2. Through government officials
3. Through service providers
4. Through NGO/CBO
5. Through community leaders
6. Through friends/relatives
7. Through other biogas owners
8. Other (specify)

302. Who in your family took decision to install a biogas plant?

1. The head of household, male member
2. The head of household, female member
3. Your son/daughter
4. After discussions in the family
5. Service provider
6. Other (specify)

303. What is the motivating reason behind installing a biogas plant? (answers can be more than one)

1. Subsidy
2. Non-availability of other fuel sources
3. Social benefits/Prestige
4. Health benefits
5. Environmental benefits
6. Economic benefits
7. Motivation from service provider
8. Motivation from existing plant owners
9. Compulsion from neighbors (in the case of poultry)
10. Saves time and energy
11. Other (specify)

304. What was the total cost of your biogas plants including subsidy, if any, and your contribution including loans, if any?
   1. Kip…………
   2. Do not know

305. What was the subsidy amount received from the project?
   1. Kip. ...........
   2. No subsidy
   3. Do not know

306. How much cash contribution you made from your part?
   1. Kip…………..
   2. Do not know

307. Did you take loan to install biogas plants?
   1. No
   2. Yes, Kip…………

308. If yes, from where you take loans?
   1. Bank
   2. Local Cooperatives
   3. Local Money lenders
   4. Friends and relatives
   5. Others

309. What is the interest rate?
   ……….% per month

310. Have you paid the loan?
   1. No
   2. Yes, partly
   3. Yes, whole

311. If loan not taken why?
   1. You are well off
   2. You are against the philosophy of taking loans
   3. Interest rate is too high
   4. Processing for the loan is cumbersome
   5. Loan was not available/bank is far
   6. Taking loans degrade your social status
   7. Collateral asked, which you could not fulfill
   8. Other (specify)

312. Who constructed your biogas plant?
   1. Unskilled Mason
   2. Skilled Mason without knowledge on biogas plant
   3. Skilled Mason with good knowledge on biogas plant
   4. Do not know

313. Were any standards set by the service provider as regards the quality of construction materials and mason to construct biogas plants?
   1. No
   2. Yes
   3. Do not know

314. If yes, what types of quality standards were set (answers can be more than one)?
   1. Trained masons should be used
   2. Standards on construction materials
   3. Standards on pipe and appliances
   4. Standards on plant design
   5. Do not know

315. How many times BPP/DAFO technicians visited the plant during construction for supervision?
   1. Never
   2. 1 time
   3. 2 times
   4. More than 2 times

316. How many days it took to complete the construction and installation works of biogas plant?
1. ………… Days
2. Do not know

317. What was (were) the reasons for the delay? (in case more than 20 days spent)
1. Mason did not carry out the work as per agreed schedule
2. User could not manage the locally available materials on time
3. The appliances were not received on time
4. There was problem with high ground water
5. Others, specify……………..

318. Is your biogas plant functioning?
1. No if no, go to 323
2. Yes, partly
3. Yes, fully

319. If yes, are you satisfied with the functioning of the plant?
1. No if no, go to 322
2. Yes, partly
3. Yes, fully

320. If partly satisfied, what are the reasons for not fully satisfying? (answers can be more than one)
1. Less gas for cooking/lighting
2. Difficult to operate
3. Often encounter technical problems
4. More added work
5. Food cooked in gas is not tasty
6. Others (specify)

321. If fully satisfied, what are the reasons for fully satisfying? (answers can be more than one)
1. Enough gas for cook/lighting
2. Trouble free functioning of plant
3. Easy cooking/lighting
4. Economic benefit
5. Health benefits
6. Social benefits such as prestige
7. Environmental Benefits
8. Workload reduction
9. Food cooked in gas is more tasty
10. Others (specify)

322. If not satisfied, what are the reasons for not satisfying?
1. Plant has failed, it does not work at all
2. Very less gas for cooking/lighting
3. Very difficult to operate
4. Often encounter technical problems
5. More added work
6. Food cooked in gas is not tasty
7. Others (specify)

323. If plant has failed, how long is the plant defunct?
1. Less than a month
2. 1 to 4 months
3. 4 to 8 months
4. More 8 months

324. If plant has failed, what are the reasons for such failure?
1. Poor workmanship during construction
2. Sub-standard quality of construction materials and appliances
3. Poor operation (over fed, under-feed, more water, less water)
4. Poor maintenance/No maintenance service available
5. Non-availability of spare parts
6. Natural/manmade disasters
7. Toilet attachment in plant was considered to be un-sacred
8. Slurry entered into the gas pipe
9. Water collected in pipe clogged it
10. Higher water table/flooding during rainy season
11. Others (specify)

325. How often you feed the dung into the biogas plant?
1. Daily
2. Once in two days
3. Once in three days
4. Once in four days
5. Others (specify)

326. How much dung is feed at one feeding? (check the feeding scoop and evaluate the quantity)
   1. ............. Kg
   2. Do not know

327. Do you collect dung from outside?
   1. Yes, ........... kg
   2. No

328. Do you feed other feeding materials besides dung?
   1. No
   2. Kitchen and household wastes
   3. Human excreta
   4. Poultry droppings
   5. Agricultural wastes
   6. Other (specify)

329. How much water is used to mix dung/poultry dropping?
   1. More than the volume of dung/ poultry dropping
   2. Equal to the volume of dung/ poultry dropping
   3. Less than the volume of dung/ poultry dropping

330. Do you know how much dung is required to be feed into your plant daily?
   1. No
   2. Yes, ............ kg

331. Has anyone in your family received training on operation and maintenance of biogas plants?
   1. No training received
   2. Training not provided but leaflet/booklet/manual provided
   3. Short orientation by mason/technician
   4. Half/One day training provided by service provider
   5. Short term O & M training (7days or less)
   6. On the spot instructions from mason/company supervisors etc.
   7. Others (specify)

332. What is the frequency of following activities?
   1. Use of main valve – daily/once in a week/in 15 days/as and when needed/never
   2. Checking leakages – daily/once in a week/in 15 days/as and when needed/never
   3. Use of water trap – daily/once in a week/in 15 days/as and when needed/never
   4. Cleaning of overflow – daily/once in a week/in 15 days/as and when needed/never
   5. Slurry Composting – daily/once in a week/in 15 days/as and when needed/never
   6. Oiling of gas tap – daily/once in a week/in 15 days/as and when needed/never
   7. Cleaning of gas stove - daily/once in a week/in 15 days/as and when needed/never
   8. Cleaning of gas lamp - daily/once in a week/in 15 days/as and when needed/never

333. Have you received any follow up services from the service provider?
   1. No, not even when requested
   2. No, not at all
   3. Yes, on call
   4. Yes, regularly

334. Is there any service center nearby?
   1. No
   2. Yes, very near (with in 5 km reach)
   3. Yes, quite far (more than 5 km reach)

335. Is toilet attached to biogas plant?
   1. No, we do not have toilet
   2. We have toilet but not attached to biogas plant
   3. Toilet is attached to biogas plant

336. If toilet attached to plant, who encouraged you to attach toilet to biogas plant?
   1. Self
   2. The service providers
   3. Friends and relatives
337. Are there any social taboos in attaching toilets to biogas plants?

1. No
2. Gas from toilet attached plants are considered to be un-sacred
3. People are hesitant to handle the bio-slurry from toilet attached plants
4. Others (specify)

338. Have you ever faced any problems in repair and maintenance of your plant?

1. No
2. Yes (Specify)...........

339. What are the common problems with your plant?

1. .........................
2. .........................
3. .........................
4. .........................

340. What are the repair works that have been carried out in your plant?

1. .......................... Expenditure………….kip
2. .......................... Expenditure………….kip
3. .......................... Expenditure………….kip
4. .......................... Expenditure………….kip

341. How much Kip. you need per year for operation and maintenance of your plant?

1. Less than Kip.20,000
2. Kip.20,000 – 40,000
3. Kip.40,000 – 60,000
4. Kip. 70,000 – 100,000
5. More than Kip. 100,000

For those whose biogas plant is not working,

342. Will you like to adapt the technology again with some modifications?

1. No
2. Yes

4. SAVING OF CONVENTIONAL FUEL SOURCES

401. For what purpose is biogas used?

1. Cooking only
2. Lighting only
3. Cooking and lighting both
4. Other (specify)

402. How many stoves/gas lamps do you have installed?

1. 1/2/3/4 stoves (… single burner, …… double burners)
2. 1/2/3/4 gas lamps

403. How long the stove is burnt in a day (calculate the timing of all the stoves)?

Stove

1. ……am to …….am (…..Hrs in the morning)
2. ….. pm to …….pm (…..Hrs in the afternoon)
3. …... pm to …….pm (…..Hrs in the evening)

Lamp

1. ……am to …….am (…..Hrs in the morning, if used)
2. ….. pm to …….pm (…..Hrs in the afternoon, if used)
3. …... pm to …….pm (…..Hrs in the evening)

404. Is gas enough for cooking and/or lighting?

1. Not enough
2. Enough for cooking and/or lighting
3. Enough for cooking but not enough for lighting
4. Enough for lighting but not enough for cooking

405. If not enough, for how many months?

1. Throughout the year
2. During winter months (From............. to ..............)

406. How much gas do you need for cooking and/or lighting?

Stove

1. ……am to …….am (…..Hrs in the morning)
2. ….. pm to …….pm (…..Hrs in the afternoon)
3. …... pm to …….pm (…..Hrs in the evening)
Lamp

1. .......am to .......am (.....Hrs in the morning)
2. .......pm to .......pm (.....Hrs in the afternoon)
3. .......pm to .......pm (.....Hrs in the evening)

407 If gas is not enough, what is the reason(s)?
1. Small plant size
2. Under-fed plants
3. Over-fed plants
4. Plants not regularly fed
5. Less gas production due to defective construction
6. Less gas due to defective operation and maintenance
7. Less gas production during winter months
8. Others (specify)
9. Do not know

408 How much fuel was required for cooking BEFORE the installation of biogas plant per month?
1. Fuel wood ------- kg @ Kip. ............ per Kg
2. Kerosene ------- litre @ Kip. .......... per litre
3. LPG ------- cylinder @ Kip. ............ per cylinder of ... kg
4. Electricity ------- unit @ Kip. ............. per unit
5. Died dung ------- Kg @ Kip. .......... per Kg
6. Agricultural wastes ------- Kg @ Kip. .......... per Kg
7. Others (specify) .................

409 How much fuel is required for cooking AFTER the installation of biogas plant per month?
1. Fuel wood ------- kg @ Kip. ............ per Kg
2. Kerosene ------- litre @ Kip. .......... per litre
3. LPG ------- cylinder @ Kip. ............ per cylinder of ... kg
4. Electricity ------- unit @ Kip. ............. per unit
5. Died dung ------- Kg @ Kip. .......... per Kg
6. Agricultural wastes ------- Kg @ Kip. .......... per Kg
7. Others (specify) .................

410 How much fuel was required for lighting BEFORE the installation of biogas plant per month?
1. Kerosene ------- litre @ Kip. ............. per litre
2. Electricity ------- unit @ Kip. ............. per unit
3. Candle ...... nos. @ Kip. ............. per no.
4. Others (specify) .................

411 How much fuel is required for lighting AFTER the installation of biogas plant per month?
1. Kerosene ------- litre @ Kip. ............. per litre
2. Electricity ------- unit @ Kip. ............. per unit
3. Candle ...... nos. @ Kip. ............. per no.
4. Others (specify) .................

412 Do you buy fuel wood, dried dung or agricultural wastes or collect it from Jungle/ own sources?
1. Buy fuel wood @ Kip. ............. kg, dried dung @ Kip. ............. kg and agricultural wastes @ Kip. ............. kg from vendors
2. Collect from jungle/own land/other sources
3. Both 1 and 2

413 How much fuel wood can you collected from Jungle/own source in one day?
1. less than 25 kg
2. 25-35 kg
3. 35-50 kg
4. 50-75 kg
5. More than 75 kg

414 What is the average time required to transport kerosene from market to the house?
1. Less than 0.5 hrs
2. 0.5 to 1 hr
3. 1-2 hr
4. 2-4 hrs
5. 4-7 hrs
6. More than 7 hrs

415 Do you feel that your expenditure in fuel collection has gone down because of the biogas plant?
1. No, not at all
Have you experienced any advantages of biogas over the other conventional fuel sources?

1. No
2. Less costly
3. Comfortable and easy to operate
4. Environment friendly
5. More advanced and energy efficient
6. Others (specify)

Have you experienced any time saving after the installation of biogas plant?

1. No; time is not saved
2. Cooking, ------- hrs saved per day
3. Collection of water, ------- hrs added
4. Mixing of dung and water, ---------hrs added
5. Collection of fuels, --------- hrs saved
6. Cleaning of cooking utensils, --------- saved
7. Caring of cattle, --------- hrs saved/added
8. Other (specify), --------- hrs saved/added

5. USE OF SLURRY

Do you use biogas slurry on farm

1. No
2. Yes, if yes, go to 504

If no, what do you do to the slurry?

1. Sale to others
2. Give out to others
3. Make dung cakes to burn
4. Drain to water courses or drains
5. Others (specify)

Why do not you use slurry?

1. It has lesser nutrient value
2. It is difficult to use
3. People are reluctant to use the slurry from latrine attached plants
4. No land to use
5. Others (specify)

If yes, what do you do to the slurry?

1. Use as organic fertilizer without composting
2. Use as organic fertilizer after composting
3. Use as fish feed
4. Use slurry through irrigation canal directly
5. Others (specify)

What is your experience with bio-slurry?

1. Same as Farm-yard manure (FYM)
2. Better than FYM
3. Worse than FYM

How much chemical fertilizer (all N,P,K) you used to use before the installation of plant?

1. Never use chemical fertilizers
2. About …. kg Nitrogen……kg Phosphorus and ……..kg Potassium
3. Do not know

Have you experienced any saving in chemical fertilizer after the use of bio-slurry?

1. No
2. About …. kg Nitrogen……kg Phosphorus and ……..kg Potassium
3. Do not know

What is the price of chemical fertilizer in your local market?

1. Nitrogen………….kip, Phosphorus ……….kip, Potassium………….kip
2. Do not know

6. Effect on Health

Did any of the family members have any of these health problems BEFORE the installation of
**biogas plant?**

1. Respiratory diseases: No/at least one member
2. Headache and dizziness: No/at least one member
3. Eye diseases: No/at least one member
4. Diarrhea and dysentery: No/at least one member
5. Other diseases (specify………): No/at least one member

601. What is the status of these diseases AFTER the installation of biogas plant?

1. Respiratory diseases: Not applicable/same/reduced
2. Headache and dizziness: Not applicable/same/reduced
3. Eye diseases: Not applicable/same/reduced
4. Diarrhea and dysentery: Not applicable/same/reduced
5. Other diseases (specify………): Not applicable/same/reduced

602. What are the main benefits of biogas plants related to health and hygiene?

1. Liberation from smoke borne diseases
2. Reduction in burning cases
3. Absence of black soot in kitchen/house
4. ………………………

603. What are the main demerits of biogas plants related to health and hygiene?

1. None
2. ………………………
3. ………………………

Finally,

605. Do you advice others to install biogas plants?

1. No
2. Yes

606. Would you have installed biogas plant if subsidy was not provided?

1. No
2. Yes

607. What is your opinion on the cost of installation of your biogas plant?

1. It is cheap
2. It is reasonable
3. It is quite expensive
4. It is very expensive

608. What are the three major benefits that you are getting from your biogas plants?

1. 
2. 
3. 

609. What are the three major disadvantages of biogas plants?

1. 
2. 
3. 

610. Do you have any suggestions for future biogas program?

1. 
2. 
3. 

Any interesting story/fact about biogas plant
## 6. OBSERVATION CHECKLIST

<table>
<thead>
<tr>
<th>Component</th>
<th>Observation (a,b,c)</th>
<th>Any maintenance done? (j,k)</th>
<th>Who did the maintenance? (l, m, n)</th>
<th>What was the cost for maintenance (o)</th>
<th>Remarks (p,q)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condition of cattle shed/ poultry firm (605)</td>
<td>Distance Less than 10 m from Plant</td>
<td>Distance more than 20 m from plant</td>
<td>Yes/No</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Condition of plant as a whole (606)</td>
<td>Good</td>
<td>Defective but working</td>
<td>Not working at all</td>
<td>Yes/No</td>
<td></td>
</tr>
<tr>
<td>Condition of water trap (610)</td>
<td>Good</td>
<td>Defective but working</td>
<td>Not working at all</td>
<td>Yes/No</td>
<td></td>
</tr>
<tr>
<td>Condition of main-gas valve (612)</td>
<td>Good</td>
<td>Defective but working</td>
<td>Not working at all</td>
<td>Yes/No</td>
<td></td>
</tr>
<tr>
<td>Condition of Gas Tap (613)</td>
<td>Good</td>
<td>Defective but working</td>
<td>Not working at all</td>
<td>Yes/No</td>
<td></td>
</tr>
<tr>
<td>Condition of gas-lamp (614)</td>
<td>Good</td>
<td>Defective but working</td>
<td>Not working at all</td>
<td>Yes/No</td>
<td>Some household has no gas lamp</td>
</tr>
<tr>
<td>Condition of Stove (615)</td>
<td>Good</td>
<td>Defective but working</td>
<td>Not working at all</td>
<td>Yes/No</td>
<td></td>
</tr>
<tr>
<td>Type of stove (616)</td>
<td>Single burner</td>
<td>Double burner</td>
<td>Multiple burner</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Condition of pressure gauge (617)</td>
<td>Good</td>
<td>Defective but working</td>
<td>Not working at all</td>
<td>Yes/No</td>
<td></td>
</tr>
<tr>
<td>Condition of Slurry pits (s)... nos (618)</td>
<td>Well maintained</td>
<td>Fair</td>
<td>Poor (no pit)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Greetings! My name is ______________________________. I am here on behalf of the Biogas Pilot Programme (BPP) of MAF and Netherlands Development Organization (SNV) which is conducting a Biogas Users’ Survey to monitor the effects of biogas and effectiveness of programme activities.

In order to get more information about your awareness and meaning about using biogas, we are conducting a survey of households in the area. Your household has been selected by chance from all the households with biogas potential in the area. I would like to ask you some questions related to your awareness of Biogas and other aspects which deal with biogas.

The information you provide will be useful to find out more about how is biogas known in the public. The information will be used to plan future activities and some other adjustments on the programme procedures.

Participation in the survey is voluntary, and you can choose not to take part.

All the information you give will be confidential. The information will be used to prepare general reports, but will not include any specific names. There will be no way to identify that you are the one who gave this information.

If you have any questions about the survey, you can ask me, my survey field supervisor who is here with the survey team. At this time do you have any questions about the survey?

<table>
<thead>
<tr>
<th>Signature of interviewer</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Date:</td>
<td></td>
</tr>
</tbody>
</table>

Respondent agreed to be interviewed

1. YES
2. NO

1. HOUSEHOLD IDENTIFICATION

This section is to be completed for each household visited.

101. Name of interviewed person
102. District name

103. Village Name

104. Sample number

108. Type of House
Wood, Brick, Farmers house

109. Electrified

Yes / No

If yes, since when?

110. Date of interview

112. Time of interview commenced

Interviewers: Remember to obtain consent from each household. Write answers directly in the tables and mark the boxes on the right side of each form

Field Supervisors: Check ALL answers recorded in each section, ensuring gaps or missing answers are obtained BEFORE leaving the household. Mark tick in the right hand side for checked answers after correction and validation.

Please complete this part of the form

<table>
<thead>
<tr>
<th>Interviewer</th>
<th>Data entry personnel</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name</td>
<td></td>
</tr>
<tr>
<td>Date</td>
<td></td>
</tr>
</tbody>
</table>

Record Number

1.1 Household selection criteria

101 Who selected the household?

1. Villager
2. Interviewer

101 Why was the household selected?

1. Villagers explained the interviewer promising information
# 2. HOUSEHOLD CHARACTERISTICS

Can you please tell me the names of all the members of your household who usually live here, sleep here and eat from the same kitchen, including yourself. Please include children, relatives or orphans, but do not count temporary visitors. First names are sufficient. This information is confidential and will not be shared with anyone. Names are only used in the interview and will not be related to data in the report. **Make a list of ALL names before asking other questions.**

After getting the full list of family members, continue with the other questions in the table for each person in the list.

<table>
<thead>
<tr>
<th>Name of all the members</th>
<th>Gender</th>
<th>Age</th>
<th>Highest-level education completed?</th>
<th>Main Occupation</th>
<th>Secondary Occupation</th>
<th>Approximate Income</th>
<th>Monthly Income (Estimated) in Kips</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

**Coding for Answers Name**

1. Male
2. Female

For children < 5 years write the number of months

Write the number for the grade level passed.

Put 0 = never

13 = BA
14 = MA
15 = PhD

**Income from other sources such as selling of agricultural productions per YEAR(209) in Kips**

1. Cereal………………………….
2. Cash-crops…………………..
3. Milk and Milk-product ……………….
4. Fish………………………….
5. Fruits…………………….
6. Vegetables…………………..
7. Meat and Meat Product…………..
8. Others …………………

**Total expenditure in (1) food, (2) education, (3) health, (4) clothes, (5) others. per YEAR (210) (specify cost items)**

**Net surplus/deficit per YEAR(211)**

**Land Holdings**

<table>
<thead>
<tr>
<th>Arable Land (Ha/Acres)</th>
<th>Non-arable Land (Ha/Acres)</th>
<th>Total Land Area (Ha/Acres)</th>
</tr>
</thead>
</table>

**Agricultural Production per year**

<table>
<thead>
<tr>
<th>Agri. Production</th>
<th>Production in Kg</th>
<th>Consumption in Kg</th>
<th>Saving/Deficit in Kg</th>
<th>Current market price (Kip.) per Kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paddy (215-218)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Livestock Ownership

<table>
<thead>
<tr>
<th>Livestock</th>
<th>Numbers (current)</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Adult (Stall-fed</td>
<td>Open-grazed)</td>
<td>Calf (Stall-fed)</td>
<td>Open-grazed)</td>
</tr>
<tr>
<td>Cow/Oxen (251-257)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buffalo (258-264)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Goats (265-271)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pigs (272-278)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horse/Donkey (279-285)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poultry (286-287)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total quantity of dung production (295)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Expenses for energy

401 What energy sources do you use for cooking purposes?

1. Fuel wood
2. LPG
3. Electricity
4. Charcoal
5. Others (specify)

401a How much do you spend for the fuel for cooking purposes KIP/month?

1. Fuel wood
2. LPG
3. Electricity
4. Charcoal
5. Others (specify)

401b Where do you get your fuel for cooking purposes?

1. Buy / collect fuel wood from
2. Buy LPG from
3. Buy electricity from
4. Buy / collect charcoal from
5. Others

401c How much fuel wood can you collected from Jungle/own source in one day?

1. less than 25 kg
2. 25-35 kg
3. 35-50 kg
4. 50-75 kg
5. More than 75 kg

402 What energy sources do you use for lightning purposes?

1. Kerosene
2. Electricity
3. Candle
7. Others (specify) …………….

402a How much do you spend for the lightning purposes KIP/month?

1. Kerosene
2. Electricity
3. Candle
7. Others (specify) …………….

403 What is the average time required to transport kerosene from market to the house?
### Use of fertilizer

501 How much chemical fertilizer (all N,P,K) do you use (kg/year)?
- 1. Never use chemical fertilizers
- 2. About …..kg NPK
- 6. Do not know

502 What is the price of chemical fertilizer in your local market?
- 1. NPK fertilizer
- 2. Other fertilizer
- 3. Do not know

503 Do you know about the advantages of organic fertilizer
- Yes
- No

### Biogas awareness

701. Are you aware of the biogas technology?
- 1. Yes
- 2. No
- 3. Partly

701a Biogas plant can be used for?
- Cooking stove
- Lightning
- Fertilizer replacement
- Fuel wood replacement
- Time saving
- Hygiene and sanitation improvement
- Others (specify)

702. How did you know about this technology?
- 1. Through publicity media
- 2. Through government officials
- 3. Through service providers
- 4. Through friends/relatives
- 5. Through other biogas owners
- 6. Through NGO/CBO
- 7. Other (specify)

702a Do you have a demand for further information about biogas particularly to
- 1. How much it costs
- 2. The provided subsidy
- 3. Financing possibilities
- 4. About its financial and health benefits
- 5. About the feedstock supply
- 6. About the use of the slurry
- 7. About the utilization of the gas (gas-lamp, stove etc.)

702b What would be the most demanded information that you require?
- 1.
- 2.
- 3.

703. What are the reasons for not installing a biogas plant?
- 1. Do not know about the technology
- 2. No trust in the technology
- 3. No understanding of the benefits
4. Family members/community do not like it
5. High investment cost
6. Not enough livestock/feeding materials
7. Others (specify)

704. What are the three main advantages of biogas plants?
1. 
2. 
3.

705. What are three main disadvantages of biogas plants?
1. 
2. 
3.

706. Would you like to adopt the biogas technology?
1. No
2. Yes
3. Can not say now

707. If yes, why?
1. 
2. 
3.

708. If no, why?
1. 
2. 
3.

709. What incentives would you expect from government to install biogas plant?
1. 
2. 
3.