



Biodigester User Survey Report



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Prepared by:

Dr. Kang Chandarot

Liv Dannel

Cambodia Institute of Development Study

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National Biodigester Programme

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Executive Summary

Introduction

- The principle objective of this research is to evaluate the effects of domestic biodigester installations, as supported by the National Biodigester Programme (NBP), on 100 households in 3 provinces in Cambodia.
- Data were collected from individual interviews with plant owners using a structured and comprehensive questionnaire.
- A total of 108 households with plants in operation of at least 3 months were surveyed - 34 in Kandal, 45 in Kampong Cham and 29 in Svay Rieng.

Socioeconomic Characteristics of Plant Owners

- Eight out of ten interviewees were male in their late 40s. While the majority of interviewees noted in the questionnaire were male, almost all interviews were inclusive, including both the husband and wife. Interviewees from all three provinces generally have large families, average of 6 members per household.
- Plant owners interviewed owned about 2 hectares of land on average.
- The main types of livestock raised by the plant owners surveyed are cows and pig. Cattle-rearing households own 5 cows on average, and pig raisers own 71 pigs on average. Households collect the most dung from pigs (49 kg per day per household), followed by cattle (35 kg per day per household).

About the Biogas Plant

Pre-construction information

- The majority of plant owners (66 people out of 108 interviewed) first learned about biogas plants from their Provincial Biodigester Programme Office (PBPO) through village workshops, leaflets, posters in the village and visits from PBPO staff.
- Survey findings show that the majority of plant owners in Kandal did not receive introduction materials from the program, such as user manual, leaflets and information folders, while those in Kampong Cham and Svay Rieng did.

Motivations for the installation of the biodigester

- Among the 108 plant owners surveyed, the top motivation for constructing a biodigester across the three provinces was to **reduce their firewood consumption**, which has become more difficult to find and more expensive to buy.
- The second main reason that encouraged them to install a plant was the **convenience of cooking** with a biogas stove.

Decision making process

- In most families (56 out of 108 households interviewed), the decision to install a biodigester plant was a participatory one that included discussion between male and female (usually husband and wife).

- For matters such as selecting the mason, plant location and making improvements in livestock sheds, males usually made the decision. This is because men are traditionally responsible for technical issues related to construction and/or maintenance.
- In deciding the plant size, most plant owners stated that their decision was primarily based on the amount of dung available (53% of 108 respondents), their households size (44%) and/or the number of livestock they owned (40%).

Financing modalities for the investment of the biodigester

- On average, plant owners spent around \$382 to construct their biodigester including, sometimes and improvements on their kitchen. Among the three provinces, plant owners in Kandal spent more than those in Kampong Cham and Svay Rieng, possibly because households in Kandal constructed larger plants.
- Almost all of the interviewees financed plant construction solely from their savings (102 of 108 owners), while 2 people financed the whole construction from loans and 4 people took out loans to partially finance the construction. Among the 6 people who borrowed money, most borrowed from their relatives and/or friends and only 1 person borrowed from a bank/MFI.

Satisfaction with services provided by Masons

- Almost all of the plant owners surveyed expressed that they are satisfied with the performance of the mason (94% of 108 owners). One owner in Kandal was disappointed in the construction services, complaining that he waited a long time for construction to start, after which construction took 30 days until completion.
- On average, plant construction took around 14 days until completion, including digging time. In one extraordinary case in Kandal, it took 60 days until completion because the plant was built in the rainy season, which resulted in some delays.

Post construction training

- According to 100 of the 108 interviewees, the mason explained to them how to operate the plant after construction. In seven cases, the mason did not give any instructions to the user.
- Only 75 out of 108 plant owners surveyed received additional training on how to operate their biogas plant. The training was usually provided by the PBPO staff and sometimes the mason. Based on the memory of the interviewees, the main topics covered in these trainings were techniques for mixing feed, frequency of feeding, and making compost out of bio-slurry, among other things.

Operation

Satisfaction with plant size and gas production

- Overall, the majority of interviewees (73%) own a 4 m³ or 6 m³ biogas plant. Plant owners in Kandal tend to have large plants, while those in Kampong Cham and Svay Rieng typically have small plants.
- Almost all of the plant owners (97 of the 108 interviewed) are satisfied with the size of their plant, though 11 interviewees complained that the plant size is too small.

- The majority of people interviewed (102 of 108 people) stated that gas production is always sufficient for them. For those who experience insufficient gas production (mostly because of high consumption needs), they try to increase the volume by increasing dung feed.

Method of operation

- The common practice among the 108 plant owners surveyed is to collect dung daily when needed (sometimes in the morning and sometimes in the evening), which is then fed into the plant immediately.
- For 89 of the 108 plant owners interviewed, all available dung is fed into the plant. The other 19 plant owners, however, use only a portion of their dung supply. This, according to the respondents, is generally because the plant is already producing sufficient gas.
- Dung is generally collected and feed into the plant by male household members or male servants.

Bio-slurry usage

- Of the 108 plant owners surveyed, 78 owners use their bio-slurry and 30 do not.
- For owners who do not utilize the bio-slurry, the main reason was because they possess no agricultural land (see Table 12), especially those in Kandal and Kampong Cham province. A few interviewees (8 respondents) informed that they are waiting for the rainy season (which is rice planting season) to use the bio-slurry.
- For plant owners that use bio-slurry, the most common form of use is liquid (52% of 108) and dried, non-composted (25%).

Maintenance

- All of the plant owners interviewed (except 1 in Kandal)¹ stated that the mason have conducted follow-up visits to check whether the biodigester is up and running. During these routine visits, the mason stops by to see whether there are any problems with the plant. Interviewees describe that the mason usually does not inspect the actually plant unless a problem is mentioned.
- Interviewees informed that the only major problem they have encountered with their biodigester is the break-down of appliances, commonly the biogas lamp (78% of 108 users have faced this problem). Generally, the broken lamp is fixed by the plant owner, costing around 8,000 – 13,000 riels.

Uses of Biodigester

Cooking

- Prior to plant installation, most households surveyed used improved fuel wood stoves for cooking (97 households of 108 surveyed), while 27 households used LPG stoves and 26 households used charcoal stoves. Generally, households used two types of stove. After plant installation, all 108 households interviewed installed a biogas stove. Some households stopped using their previous stoves: 75 households stopped using

¹ The interviewee did not explain why the mason did not come to follow up.

fuel wood, 22 stopped using LPG and 11 stopped using charcoal. Some households used their old stoves less than before: 22 households reduced fuel wood consumption, 4 households decreased usage of LPG and 10 households cut back on charcoal use.

- The majority of households (63 respondents) have two stoves/burners, 39 owners have one stove/burner and 6 have more than two stoves/burners. The average consumption per household is 3 hours of stove use per day for cooking meals.
- All but one interviewee feel satisfied with their biogas stove. For the one interviewee who is only partially satisfied, she commented that it scares her to light the stove with a lighter and would prefer if there was a light switch instead.
- The top reason most frequently raised by interviewees on why they enjoy their biogas stove is that it is faster than cooking with their previous equipment (101 respondents of 108).² Other reasons mentioned by plant owners are: cooking is smokeless (73 respondents), cheaper than previous methods (56 respondents) and easy for cooking (50 respondents).

Lighting

- Prior to plant installation, 83 households used a lead-acid battery for lighting, 40 households used kerosene and 19 household used electricity. After constructing a plant, 11 households stopped using battery, 35 households stopped using kerosene and 1 household stopped using electricity for lighting.
- According to the responses, 102 interviewees of 108 have installed biogas lamps. For the 6 plant owners who do not have biogas lamps, each of them have different reasons why. For one case in Kandal, the plant owner is diverting the gas into a generator, which then powers his electricity.
- The majority of the plant owners have at least 2 lamps (minimum is 0 lamps and maximum is 10 lamps³). By province, owners in Kandal and Kampong Cham tend to have more than 2 lamps, while those in Svay Rieng usually have two or less than two lamps.
- The majority of users are satisfied with their biogas lamp (97 of 102 households with biogas lamps, Figure 9) and only 2 are dissatisfied. For the few who are not satisfied, they complained that the lamp does not provide enough light and that the lamp frequently breaks down.

Overall User Satisfaction with the Programme

Subsidy

- Regarding the subsidy provided by the program, all of the interviewees received a subsidy of \$100.

² Interviewees could not quantify the gain in time from using the biogas stove over their previous method.

³ One plant owner in Kandal is currently using 10 biogas lamps, mainly as a lighting source for his pig farming activities.

- Only one of the respondents mentioned having problems with getting a subsidy, complaining that the process for getting the money is long⁴. On average, plant owners waited 20 days after plant completion to receive their subsidy.
- The four respondents who stated that they are only partially satisfied explained that while the \$100 subsidy is helpful, they commented that it is not enough because the cost of equipment still adds up to a lot of money. One respondent also complained that he did not like the fixed subsidy for all plant sizes.

Quality Guarantee

- About the quality guarantee, 104 of the 108 plant owners interviewed are satisfied with this policy. Four interviewees, however, complained that the insurance plan is too short.
- When asked if they were glad they made the investment, *every single plant owner expressed that they are satisfied with the investment*. They explained that the biogas plant is very useful and provides a lot of benefits such as eliminating the foul smell of animal dung, reducing smoke in the kitchen, cleaner house, and producing bio-slurry, which is a good fertilizer. In the words of one plant owner, "***The investment is only one time but the benefits can last for a long time.***" All of the interviewees said that they would recommend others to make this investment too.

Impacts of Biodigester on Users (Household Level)

Economics

Financial Saving

- After installing a biogas plant, households who stopped or reduced their fuel wood consumption saved \$7.5 per month on average. Households who stopped or cut back on charcoal and/or LPG consumption saved (\$4.5 and \$6 per month, respectively).
- In terms of lighting fuel, households who used battery saved \$0.80 per month on average after installing plant, while those who used kerosene and electricity saved \$2.3 and \$4.9 per month, respectively.
- Overall, households saved over \$11 per month on both cooking and lighting fuel after installing a biodigester.

Effect of the biodigester on time allocation and work load

- According to the findings, most of the interviewees spend more time collecting dung and water than before. However, most stated that there has been no change in the amount of time they spend on caring for their cattle and pigs.
- Interviewees also mentioned that the biogas plant has saved them time with other chores, such as less time on cleaning cooking utensils (94 of 108 surveyed) and in collecting firewood (85 respondents).

Effect of the biodigester on animal husbandry issues

⁴ The system of subsidy channeling has meanwhile changed. Owners will get their subsidy via the ACLEDA bank upon showing their plant completion form.

- For the most part, the installation of a biodigester appears to have had little impact on *livestock feeding*. Most of the plant owners who raise livestock have not changed the amount of feeding.
- The majority of interviewees informed that they spend the same amount of time on fodder collection as before (78 of 108 respondents). Though 22 of the interviewees did say they are spending a great deal more, mostly in Kampong Cham province (14 respondents).
- Related to *livestock sheds*, survey findings show that 56 households have made some improvements to their shed conditions since installation of a biodigester.

Effect of bio-slurry use for agriculture production and chemical fertilizers

- Eight out of ten of the interviewees who grow crops reported an *increase in their yields* after applying the bio-slurry. According to households who experienced an increase in crop yields, they attributed the increase to the application of bio-slurry and/or slurry compost on well-managed soil, as well as the reduction of pests and diseases associated with the use of bio-slurry.
- Four out of nine plant owners surveyed (who use bio-slurry) stated that they have decreased their dosage of chemical fertilizer since using bio-slurry; while, two out of seven plant owners have stopped using chemical fertilizers completely. Sixty-eight percent reported that bio-slurry resulted in uniform crop growth and higher yields, and 32% stated that bio-slurry helped loosen the soil, making it easier to work with than in the past.

Health

Effect of the biodigester on health and sanitation of the household

- The majority (105 households out of 108 interviewed reported that there has been a *major reduction of smoke* in the kitchen. Interviewees (especially women) also stated that the reduction of smoke has made their *household environment more sanitary and clean* than before.

Social

Effects of biodigester on gender roles

- According to the 108 plant owners interviewed, 85 stated that women have more time to take care of their children now because of the ease and reduction in time for certain chores such as cooking. However, most women household members need to spend more time on fetching water to feed the plant.
- Training is usually attended by a male household member (76 interviewees stated that women are not involved with attending training on biodigester operation). In most households, women are very involved with the operation of the plant on a daily basis and when there is a problem with the plant; however, men are generally responsible for consulting with relevant persons if the plant needs severe maintenance.

- The routine of feeding dung into the plant is commonly done by a male, either the husband, son or male servant. The kitchen is the domain of women, where 103 of the interviewees stated that women are very involved with managing the kitchen environment.

Conclusions

- Overall, it is clear that users are generally satisfied with their investment and the performance of their biodigester. All users stated that they would recommend the biodigester to other people.

Recommendations

- It may be a good idea for the PBPO to organize *additional training on plant operation and maintenance* to ensure that households are using their plant at full capacity. To be most effective, such trainings may need to include both female and male household members involved with plant usage, given that tasks are usually gender-specific.
- Research and development should be conducted to *improve the quality of biogas appliances*, specifically the biogas lamp (78% of 108 have encountered breakdowns with this appliance).
- As the NBP reaches out to poorer households, it is very strategic and important to *market and illustrate to potential users on the real benefits that existing users have gained from biogas plants*. Also, the amount of subsidy may be viewed as insufficient by poor households, especially given that the price of construction materials such as cement and sand has increased.
- Furthermore, initiatives to *link poor clients with microfinance* may be necessary.
- For poorer households, *ensuring availability of feeding materials* may be a big challenge. Falling profits are discouraging pig farmers from staying in this business. The NBP may want to *collaborate with government initiatives and NGOs* working in this issue to consider possible interventions and solutions.

I. Introduction

In May 2005, SNV and the Ministry of Agriculture, Forestry and Fisheries (MAFF) agreed to a joint development of a National Biodigester Programme (NBP) in Cambodia as a way to create an indigenous, sustainable energy source in the country and to utilize the potential of biogas in the country. The overall objective of the first phase of the National Biodigester Programme is ‘The dissemination of domestic biodigesters as an indigenous, sustainable energy source through the development of a commercial, market oriented, biodigester sector in selected provinces of Cambodia’. The program aims to support the construction of 17,500 biodigesters in at least 6 provinces over the period of 2006 to 2009.

To gain insights and feedbacks on the impacts of their activities to date, NBP commissioned the Cambodia Institute of Development Study (CIDS) to carry out a Biodigester User Survey in January 2007. The purpose of the survey is to evaluate the effects of domestic biodigester installations, as supported by the program, on 100 households in 3 provinces in Cambodia- Kampong Cham, Kandal and Svay Rieng.

II. Objectives

As listed in the terms of references developed by the NBP, the principle objective of the research is to evaluate the effects of domestic biodigester installations, as supported by the programme, on 100 households in 3 provinces in Cambodia. Some of the specific objectives are:

- a. the socio economic background of the sampled households;
- b. motivation of the households for the installation of the biodigester;
- c. pre-construction information gathering and decision making process;
- d. the impact of subsidy on the decision making process;
- e. financing modalities for the investment of the biodigester;
- f. the quality of instruction to the biogas households on participation fee, guarantee, operation and maintenance and bio-slurry use;
- g. satisfaction of the household with the services rendered by the Biodigester Mason and the Provincial Biodigester Programme Office;
- h. user satisfaction with operation and maintenance of the biodigester;
- i. bio-slurry use as applied by the households;
- j. the effect of the biodigester on the financial situation of the household;
- k. the effect of the biodigester on (avoided or additional) time allocation for water collection for the installation, fuel collection and preparation, cleaning of cooking vessels;
- l. the effect of bio-slurry use either as organic fertilizer for agricultural production;

- m. the effect of the biodigester on health and sanitation of the household;
- n. suggestions from users for possible improvements of the Biodigester Programme

III. Methodology of the Survey

Data were collected from individual interviews with plant owners using a structured and comprehensive questionnaire. The questionnaire (see Appendix 1) covers issues such as the socio-economic background of the interviewee, pre and post plant construction issues, operation of biodigester, maintenance of biodigester, biodigester uses and impacts of the plant on the household in terms of economic, health and social. In designing the questionnaire, CIDS consulted with NBP and reviewed questionnaire formats implemented in other countries to ensure that the results would be useful and relevant for the NBP. CIDS also pre-tested the questionnaire before final roll out.⁵

A total of 108 households with plants in operation for at least 3 months were surveyed - 34 in Kandal, 45 in Kampong Cham and 29 in Svay Rieng. The 108 households were randomly selected from a longer list of plant owners and include two demonstration plant owner (both in Kampong Cham). The target for interview was the plant owner. If the plant owner was not available, the surveyor interviewed another family member knowledgeable about plant operation.

Table 1: Sample Size by Province

Province	Frequency	Percent
Kandal	34	31.5
Kampong Cham	45	41.7
Svay Rieng	29	26.9
Total	108	100.0

IV. Socioeconomic Characteristics of Plant Owners

Eight out of ten interviewees were male in their late 40s (average age among 108 interviewees is 46 years old). While the majority of interviewees noted in the questionnaire were male, almost all interviews were inclusive, including both the husband and wife. Give the comprehensive nature of the questionnaire, field surveyors expressed that it was useful to interview both the husband and wife together because some questions were role-specific. Surveyors observed that women household members usually did not know a lot about the construction and mechanical aspects of the

⁵ In the inception report, it was suggested that the team would also use an observation sheet to collect data on the plant. This activity was canceled during the field work because of complaints from interviewees that the questionnaire alone was too long (roughly 1 hour for each interview).

biodigester (i.e. days of construction, daily dung collected), but were more knowledgeable than male household members on operational aspects such as daily gas consumption and financial savings.

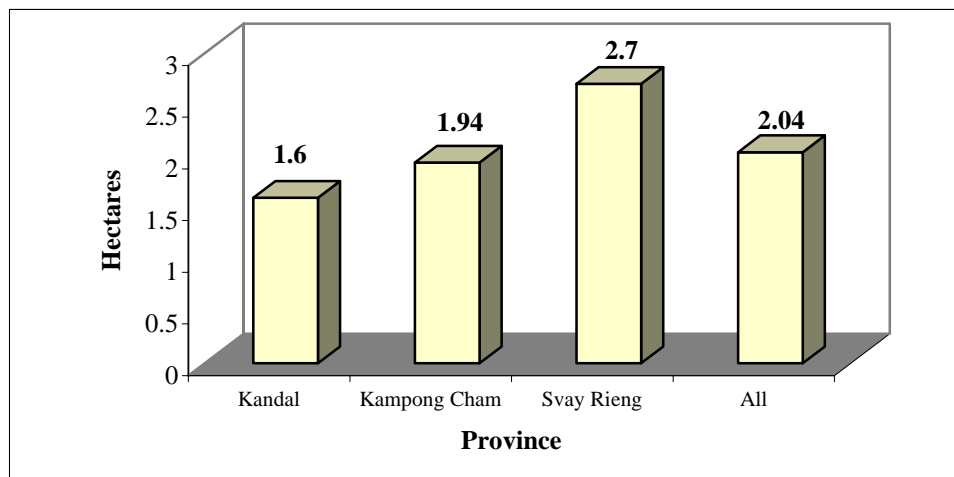
Many of these interviewees have a long residency in the area – 75 people have lived there for more than 20 years and 15 have lived there at least 11 years (Table 2). Interviewees from all three provinces generally have large families, average of 6 members per household.

Table 2: Number of Years Living in Area

Years of Residency	Total
less than 1 year	1
1 year to 5 years	11
6 years to 10 years	6
11 years to 20 years	15
more than 20 years	75
Total	108

In terms of asset, plant owners interviewed owned about 2 hectares of land on average, where those in Svay Rieng have slightly more with 2.7 hectares (illustrated in Figure 1). Overall, the 108 plant owners together own 220 hectares of land. In terms of livestock assets, households own 5 cows on average and 71 pigs on average⁶.

Figure 1: Average hectares of land owned by interviewees



The main types of livestock raised by the plant owners surveyed are cattle and pigs, which are their main sources of plant feed (see Table 3 for a summary). Among the

⁶ Some of the interviewees have large scale pig raising activities.

different types of animal, households collect the most dung from pigs (49 kg per day per household), followed by cattle (35 kg per day per household). The routine of feeding dung into the plant is commonly done by a male, either the husband, son or male servant.

Table 3: Number of livestock and daily dung collected

Animal	All Provinces		
	# of HH Involved	# of Animals	Daily Dung (kg)
Cattle	81	466	2,857
Buffalo	20	93	564
Pig	68	5192	3,587
Chicken	66	4747	n/a
Goat	9	123	n/a
Duck	9	184	n/a
Horse	2	6	n/a

Note: N/A means not applicable

V. About the Biogas Plant

A. Pre-Construction and Construction

Pre-construction information

The majority of plant owners (66 people out of 108 interviewed) first learned about biogas plants from their Provincial Biodigester Programme Office (PBPO) through village workshops, leaflets, posters in the village and visits from PBPO staff. Some learned about it from their neighbors, friends, and relatives (19 respondents) and local authorities (8 respondents). Six of the respondents stated that they did not know where or who provided information, possibly because these members are not the head of household. These findings are similar across the three provinces. Almost all of the plant owners feel that the information they received was accurate.

Table 4: Sources of Information

Information Source	Total
Provincial BPO	66
Neighbors/friends / relatives	19
Local authorities	8
Masons/Constructors	6
I don't know	6
Veterinarian	5
National BPO	2
Television	2
Radio	3
Plant owners in the neighborhood	1

Survey findings show that the majority of plant owners in Kandal did not receive introduction materials from the program, such as user manual, leaflets and information folders (see Table 5). Among the 34 plant owners interviewed in Kandal, only 13 received user manuals and just 11 have leaflets. In Kampong Cham and Svay Rieng, most people confirmed that they received the project documents.

Table 5: Program documents received

Documents Received	KD	KC	SV	Total
User manual	38%	73%	72%	62%
Leaflets/Brochures	32%	67%	69%	56%
Home poster	24%	62%	79%	55%
T-shirt	9%	40%	21%	25%
Poster	9%	36%	24%	24%
Information folder	15%	18%	24%	19%

Motivations for the installation of the biodigester

Among the 108 plant owners surveyed, the top motivation for constructing a biodigester across the three provinces was to **reduce their firewood consumption**, which has become more difficult to find and more expensive to buy (listed in Table 6). The current price of 1 small bundle of firewood (roughly 0.0004 m³) is 200 riels in Kandal, 150 riels in Kampong Cham and 350 riels in Svay Rieng. The second main reason that encouraged them to install a plant was the **convenience of cooking** with a biogas stove.

Table 6: Principle reasons for constructing a biodigester

Reasons	RATINGS of HOUSEHOLD: 1 = most important, 8 = least important			
	ALL	KD	KC	SV
Reduce firewood	1	1	1	1
Convenient cooking	2	2	2	2
Save time	3	4	2	3
Smokeless kitchen	4	6	3	4
Substitute fertilizer with slurry	6	5	6	5
For lighting	6	4	4	6
To get rid of foul smell	7	7	8	7
Subsidy provided	8	7	8	8

Decision making process

In most families (56 out of 108 households interviewed, see Table 7 below), the decision to install a biodigester plant was a participatory one that included discussion between male and female (usually husband and wife). Interviewees informed the field surveyors that before deciding to install a biodigester the family weighed the potential benefits and costs, especially related to the financial and time savings.

Table 7: Decision Maker of Biodigester-Related Activities

Activities	Male	Female	Both	Total
Installing plant	45	7	56	108
Selecting mason	62	5	41	108
Connecting toilet to plant*	3	0	3	6
Selecting location of plant	67	6	35	108
Improving livestock sheds**	32	2	22	56
Total	209	20	157	386

Notes: * 102 interviewees do not have plants connected to toilets, ** 52 interviewees have not made any improvements to their shed conditions

For matters such as selecting the mason, plant location and making improvements in livestock sheds, males usually made the decision. This is because men are traditionally responsible for technical issues related to construction and/or maintenance. Related to the plant site, enumerators observed that the location was generally appropriate. Plants were mostly constructed in sunny spots behind or beside the house and close to livestock sheds for easy feeding, and not too close to the kitchen (about 4-5 meters away).

In deciding the plant size, plant owners explained that they learned about the criteria for selecting a suitable plant size from the PBPO staff during workshops, house visits and promotional materials. Most plant owners stated that their decision was primarily based on the amount of dung available (53% of 108 respondents), their households size (44%) and/or the number of livestock they owned (40%). About household size, it is possible that larger households, who usually spend a lot on energy sources, see high financial returns in using biogas. Other factors considered by some plant owners when selecting a plant size includes: recommendations of masons, sizes of plants in the neighborhood, money available and land size.

Table 8: Decision factors in selecting plant size

Decision Factors	KD	KC	SV	Total
Amount of dung available	20	26	11	57
Family size	9	20	19	48
Number of livestock	16	16	11	43
Recommendations of masons	3	2	0	5
Plant sizes in the neighborhood	1	1	1	3
Advertisement on television	2	1	0	3
Money available	0	1	2	3
Cooking and lighting needs	2	0	0	2
Land size	0	0	1	1

Financing modalities for the investment of the biodigester

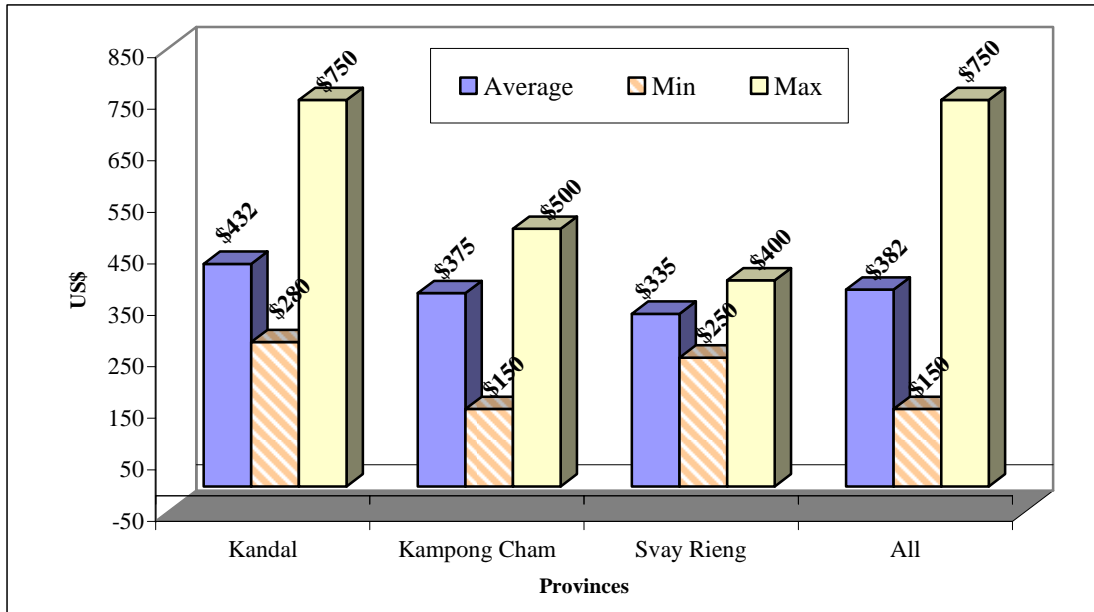
On average, plant owners spent around \$382 to construct their biodigester, which includes the cost of plant construction and improvements on their kitchen (see Figure 2 below). Among the three provinces, plant owners in Kandal spent more than those in Kampong Cham and Svay Rieng, possibly because households in Kandal constructed larger plants. One plant owner in Kampong Cham saved money by hiring his cousin, a NBP trained mason (total cost of \$160 for a 4m³ biogas plant)⁷. Also in Kampong Cham, one plant owner spent only \$150, the lowest of all plant owners. He explained that his plant was a demonstration plant, so most of the construction and service fees were supported by the programme. According to the NBPO, there are 20 promotional or demonstration plants in each province.

For plant owners who spent higher than average on plant construction, it is observed that their investment included not only bigger plants but also additional improvements in their stable and extra biogas appliances. For one plant owner in Kandal, he informed surveyors that his investment cost was high because he doubled the brick layer of his plant.⁸ These plant owners generally had medium to large-scale farming activities and/or other profitable business activities such as a small grocery shop.

⁷ Mason's name is By Pheap and plant code is 303060001.

⁸ Plant owner's name is Mr. Tang Hangly, located in Dei Edth Commune, Kien Svay District, Kandal province.

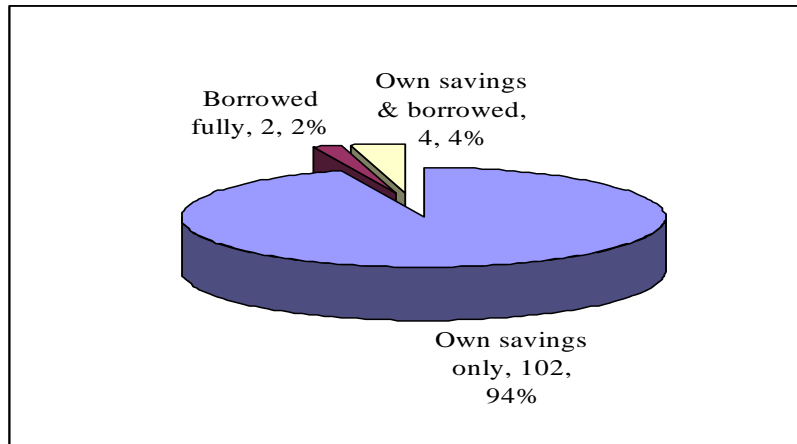
Figure 2: Total cost of plant construction (in US\$)



Note: "Average" is calculated by dividing the sum of total costs by the number of interviewees. "Min" refers to the minimum amount spent by interviewees, while "Max" is the maximum amount spent by interviewees. The figures for "All" refers to statistics for all 108 households surveyed in the three provinces.

Almost all of the interviewees financed plant construction solely from their savings (102 of 108 owners) while 2 people financed the whole construction from loans and 4 people took out loans to partially finance the construction (see Figure 3). This finding is in line with field observations. Surveyors noticed that interviewees were generally financially well-off in terms of the quantity of livestock, assets and living conditions. Among the 6 people who borrowed money, most borrowed from their relatives and/or friends and only 1 person borrowed from a bank/MFI.

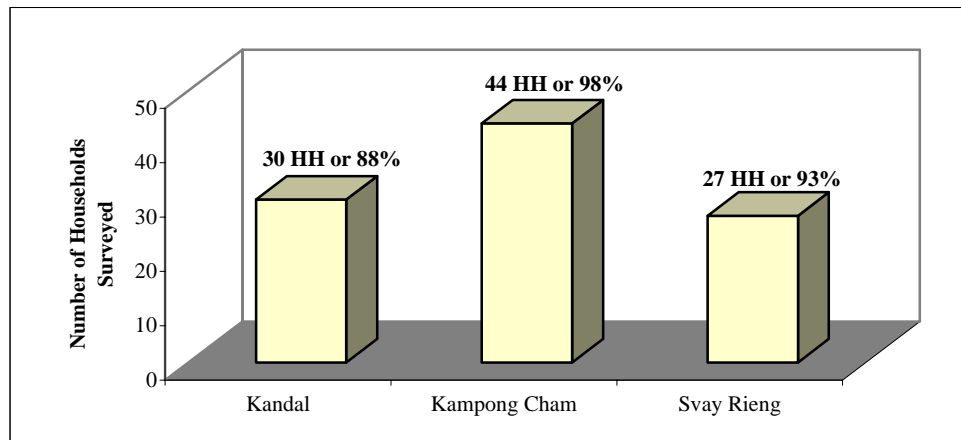
Figure 3: Method of financing plant construction (Of 108 households surveyed)



Satisfaction with services provided by Masons

Almost all of the plant owners surveyed expressed that they are satisfied with the performance of the mason (94% of 108, Figure 4). Six interviewees revealed that they are somewhat satisfied with the services, while 1 owner in Kandal was disappointed in the construction services. The disappointed plant owner informed that he had to wait a long time for the mason to start construction, after which construction took 30 days until completion (also refer to Box 1 for a list of complaints). Also, the mason did not explain to him how to operate the plant. Other complaints from interviewees included: mason lacks responsibility, is not careful with work, and appears to have low construction skills. Possibly, some of the problems may be associated with the quality of appliances such as the biogas lamp and main valve, rather than the skills of the mason.

Figure 4: Households very satisfied with the skills of mason (Out of 101 respondents)



Note: 101 interviewees answered that they are *very satisfied*, 6 interviewees said they are *somewhat satisfied* and 1 interviewee was *not satisfied*.

Box 1: Complaints about the Skills and Quality of Masons

Complaints about the skills and quality of masons:

- leakage from valve and rubber hose due to carelessness
- construction workers lack skills
- do not pay attention to their work
- waiting time until construction is long
- construction of plant was too long

Generally, interviewees informed that they did not have to wait a long time for the mason to start the plant construction, though 14 out of the 108 plant owners did complain that they waited longer than the time agreed. Interviewees who encountered delays in plant

construction informed that this was because the mason was on holiday (i.e. Khmer New Year) and for some owners construction was prolonged because of the rainy season.

On average, plant construction took around 14 days until completion, which includes digging time. In one extraordinary case in Kandal, it took 60 days until completion because the plant was built in the rainy season, which resulted in some delays.

Upon completion of construction, 73% of the 108 interviewees stated that they received a warranty certificate. By province, only 59% of the 34 plant owners surveyed in Kandal received a warranty certificate, compared to 85% and 72% in Kampong Cham and Svay Rieng respectively. For those who did not receive a warranty certificate, they stated that their supervisor had not given them one.⁹

Post construction training

According to 100 of the 108 interviewees, the mason explained to them how to operate the plant after construction. In seven cases, the mason did not give any instructions to the user. The masons for these seven cases were different people. When asked why the mason did not provide any explanation, most interviewees stated that they do not know.

Table 9: Households receiving instructions from mason on how to use biogas plant

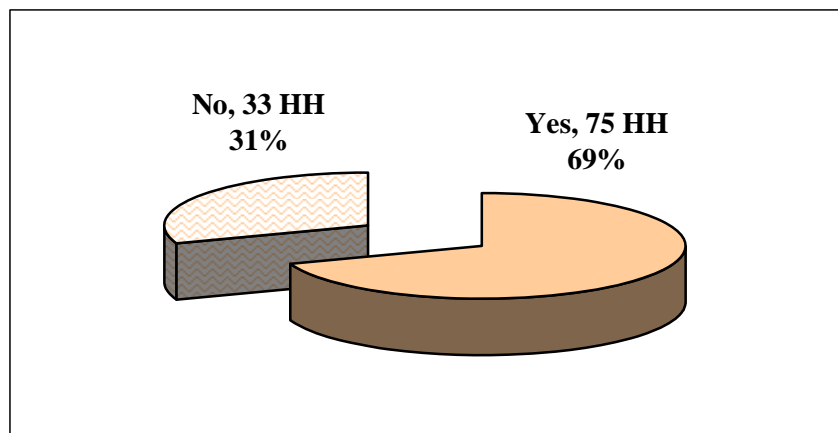
Response	Total
Yes, received	100
No, did not received	7
I don't know*	1
Total	108

Note:* The interviewee was not the plant owner but a member of the household who is knowledgeable about the plant's day to day operations

Only 75 out of 108 plant owners surveyed received additional training on how to operate their biogas plant (see Figure 5). The training was usually provided by the PBPO staff and sometimes the mason. Based on the memory of the interviewees, the main topics covered in these trainings were techniques for mixing feed, frequency of feeding, and making compost out of bio-slurry, among other things.

⁹ The Guarantee Certificate was made available when the programme was already well on it's way. Plants without certificates may be older ones, although they should have received one later.

Figure 5: Households receiving training on how to operate a biogas plant



B. Operation

Satisfaction with plant size and gas production

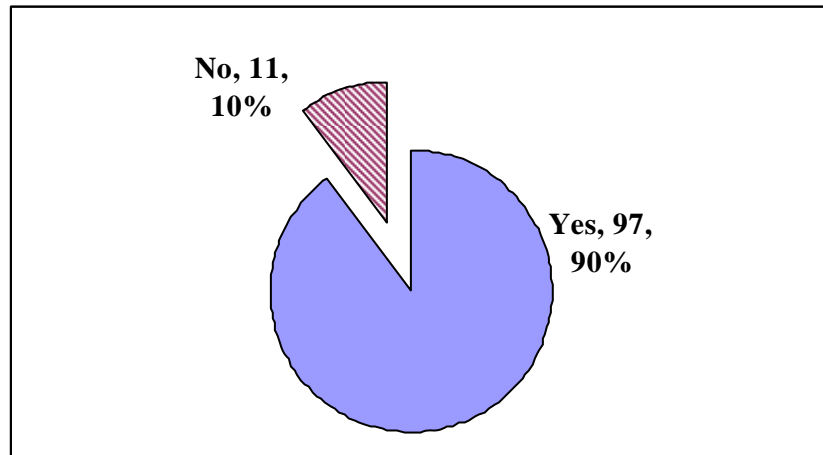
Overall, the majority of interviewees (73%) own a 4 m³ or 6 m³ biogas plant. Plant owners in Kandal tend to have large plants, while those in Kampong Cham and Svay Rieng typically have small plants.

Table 10: Plant Size of Interviewees

Plant Sizes	KD	KC	SV	Total
4 m ³	12	10	18	40
6 m ³	8	22	9	39
8 m ³	4	11	2	17
10 m ³	10	2		12
Total	34	45	29	108

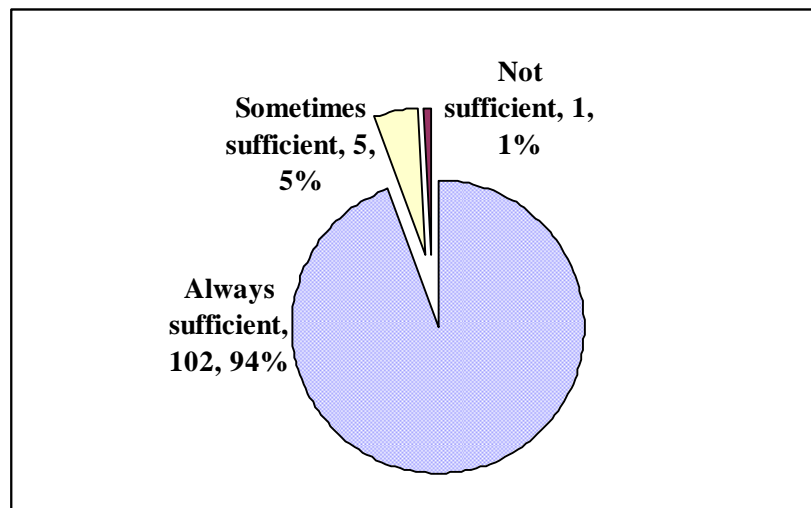
Across the three provinces surveyed, almost all of the plant owners (97 of the 108 interviewed) are satisfied with the size of their plant. Eleven of the interviewees complained that the plant size is too small. Among the eleven, seven plant owners have 4m³ plants and three have 10m³ plants. When field surveyors asked the plant owners why they selected a small plant, interviewees explained that they selected the plant size based on their expected needs for cooking and lighting at the time. The current size of their plant fully meets their expectations, but now, after seeing the usefulness of the biodigester, plant owners want to use the plant for additional purposes (i.e. to fuel their electricity generator). Thus, they perceive their current plant size to be too small because their demand has increased.

Figure 6: Satisfaction with the plant size



All of the biodigester are currently active and producing gas. The majority of people interviewed (102 of 108 people) stated that gas production is always sufficient for them. For those who experience insufficient gas production (mostly because of high consumption needs), they try to increase the volume by increasing dung feed.

Figure 7: Gas production



Method of operation

The common practice among the 108 plant owners surveyed is to collect dung daily when needed (sometimes in the morning and sometimes in the evening), which is then fed into the plant immediately. None of the plant users collect dung for storing purposes; but in the case that they collect excess dung (mentioned by 5 households), the dung is usually keep in a pile with a covering until needed.

For 89 of the 108 plant owners interviewed, all available dung is fed into the plant. The other 19 plant owners, however, use only a portion of their dung supply. This, according to the respondents, is generally because the plant is already producing sufficient gas. For a few plant owners, they save a portion of the dung to use as fertilizer for their farms and/or to give to other farmers.

Bio-slurry usage

The majority of plant owners interviewed (60%) learned about bio-slurry and its uses at the beginning of plant construction, while 15% received information after construction (see Table 11). For those who learned about bio-slurry before plant construction, it was usually through the PBPO staff either by house visits and/or village workshops.

Table 11: Time/events first received information on slurry use

Time Received	KD	KC	SV	Total
Beginning of plant construction	14	32	19	65
After plant construction	6	5	5	16
During village workshops	4	4	3	11
Don't know about bio-slurry	6	0	0	6
Before construction plant	0	3	1	4
Radio Free Asia	2	0	0	2
Never get information	1	0	0	1
Know by myself after plant construction	0	1	0	1
TV	0	0	1	1
Other plant users	1	0	0	1
Total	34	45	29	108

Of the 108 plant owners surveyed, 78 owners are currently using their bio-slurry and 30 owners are not using at present. For owners who do not utilize the bio-slurry, the main reason was because they possess no agricultural land (see Table 12 below), especially those in Kandal and Kampong Cham province. Some people (12 interviewees) informed that they are waiting for the rainy season (which is rice planting season) to use the bio-slurry.

Table 12: Reasons for not using bio-slurry

Reasons	KD	KC	SV	Total
No agricultural land	4	4	2	10
Raining season not yet come	3	6	3	12
To wet to transport to the fields	0	1	0	1
Too much work	1	0	0	1
Only have a small amount of slurry	1	2	1	4
Use only dung	1	0	0	1
Busy	0	1	0	1
Total	10	14	6	30

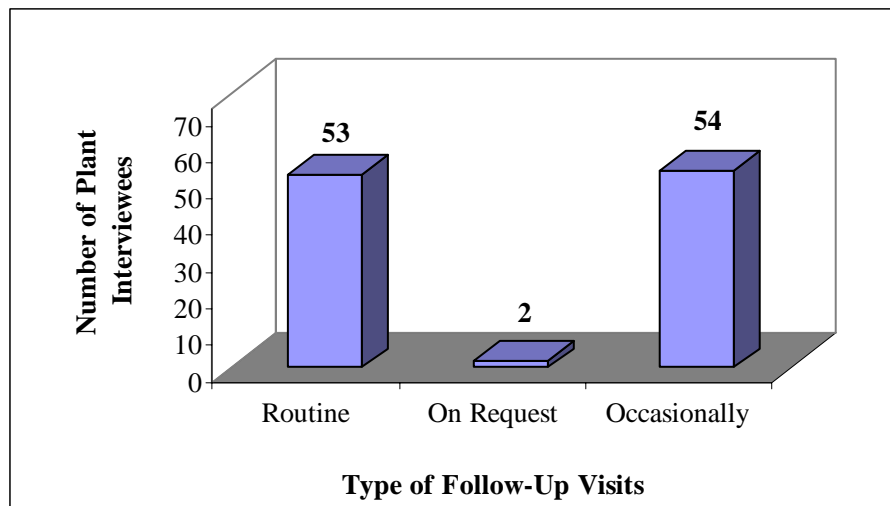
For plant owners that use bio-slurry, the most common form of use is liquid (52% of 108) and dried, non-composted (25%). Six of the plant owners surveyed compost their bio-slurry. Finished slurry compost is generally piled under a shed until it is time for application into the fields. When it is time to apply the slurry compost to the fields, plant owners stated that they generally spread the compost and apply immediately to the fields; while in some cases, plant owners spread it into small heaps and cover until the suitable time.

C. Maintenance

All of the plant owners interviewed (except 1 in Kandal)¹⁰ stated that the mason have conducted follow-up visits to check whether the biodigester is up and running. Half of the interviewees (53 of 108 owners), they informed that the follow-up visits were routine (most households have received at least 3 check ups). During these routine visits, the mason stops by to see whether there are any problems with the plant. Interviewees describe that the mason usually does not inspect the actually plant unless a problem is mentioned.

For 54 of the 108 plant owners, they state that the mason have not routinely checked up on their plant after construction, but have visited them occasionally when they are in the area doing other work.

Figure 8: Type of follow-up visits by masons



Note: This is a multi-response question, so interviewees can select more than one response.

Interviewees informed that the only major problem they have encountered with their biodigester is the break-down of appliances. Among the different appliances of the

¹⁰ The interviewee did not explain why the mason did not come to follow up.

biodigester, the *biogas lamp* was most frequently reported to have broken down during the course of usage (78%, see a complete list of break-downs by appliance in Table 13). Generally, the broken item is fixed by the plant owner, costing around 8,000 – 13,000 riels. In a few cases, the lamps are fixed by the mason.

Table 13: Items that have broken down

Appliance	KD	KC	SV	Total
Biogas lamp	22	40	22	84
Stoves	1	5	0	6
Main valve	0	1	2	3
Gas taps	1	1	0	2
Rubber Hose	0	0	1	1
Pressure gauge	0	1	0	1

VI. Uses of Biodigester

A. Cooking

Prior to plant installation, most households surveyed used improved fuel wood stoves for cooking (97 households of 108 surveyed, see Table 14 below), and some households used petroleum gas stoves (27 respondents) and charcoal (26 respondents). Generally, each household used two methods, commonly fuel wood and LPG stoves.

After plant installation, all 108 households interviewed installed a biogas stove. The survey findings show that after installing a biodigester, there has been a dramatic switch to using biogas stoves. Many households have **replaced their cooking methods with the biogas stove**: 75 households have stopped using improved fuel wood stoves, 22 have stopped using LPG stoves, and 11 have stopped using charcoal stoves after plant installation. Meanwhile, some households continue to **use their old methods but less than before**: 22 households reported that they have decreased use of fuel wood, 4 households decreased usage of LPG and 10 households have reduced charcoal use.

Table 14: Type of stoves used before and after biogas installation

TYPE OF STOVE	BEFORE	AFTER			
		Start	Decreased	Same	Stopped
Improved Fuel wood	97	0	22	0	75
LPG stove	27	1	4	0	22
Charcoal stove	26	1	10	4	11

The majority of households (63 respondents) have 2 stoves/burners, 39 have 1 stove/burner and 6 have more than 2 stoves/burners. The average consumption per household is 3 hours of stove use per day for cooking meals.

Table 15: Number of biogas stoves after plant installation (in number of households)

Province	1 Stove (1 burner)	2 Stoves (2 Burners)	> 2 Stoves	Total
Kandal	15	14	5	34
Kampong Cham	8	36	1	45
Svay Rieng	16	13	0	29
Total	39	63	6	108

With the exception of 1 interviewee (who is only partially satisfied with their biogas stove, noted in Table 16), all of the 108 interviewees expressed that they are satisfied with cooking on the biogas stove. For the one interviewee who is only partially satisfied, she commented that it scares her to light the stove with a lighter and would prefer if there was a light switch instead.

The top reason most frequently raised by interviewees on why they enjoy their biogas stove is that it is faster than cooking with their previous equipment (101 respondents of 108).¹¹ Other reasons mentioned by plant owners are: cooking is smokeless (73 respondents), cheaper than previous methods (56 respondents) and easy for cooking (50 respondents).

Table 16: Satisfaction with cooking using the biogas stove

Provinces	Very Satisfied	Partially Satisfied	Total
Kandal	33	1	34
Kampong Cham	45	0	45
Svay Rieng	29	0	29
Total	107	1	108

¹¹ Interviewees could not quantify the gain in time from using the biogas stove over their previous method.

B. Lighting

Before installing a biogas plant, 83 households used a lead-acid battery for lighting, 40 households used kerosene and 19 used electricity (most households used more than one source, see Table 17 below). After plant construction, 102 households installed biogas lamps (shown in Table 18 below). For these households, 11 households stopped using battery, 35 households stopped using kerosene and 1 stopped using electricity (via power grid). Some households also reduced their consumption of previous lighting sources: 40 decreased usage of battery, 4 used less of kerosene and 10 reduced usage of electricity.

Table 17: Sources of lighting before and after installing biogas plant

TYPE OF LIGHTING	BEFORE	AFTER			
		Start	Decreased	Same	Stopped
Battery	83	4	40	28	11
Kerosene	40	0	4	1	35
Electricity	19	0	10	8	1

For the 6 plant owners who do not have biogas lamps, each of them have different reasons why. For one case in Kandal, the plant owner is diverting the gas into a generator, which then powers his electricity. Also in Kandal, one plant owner explained that he plans to install a biogas lamp but has not done so yet because he is a mason and is busy constructing plants for his clients.

The majority of the plant owners have at least 2 lamps (minimum is 0 lamps and maximum is 10 lamps¹²). By province, owners in Kandal and Kampong Cham tend to have more than 2 lamps, while those in Svay Rieng usually have two or less than two lamps.

Table 18: Number of Biogas Lamps

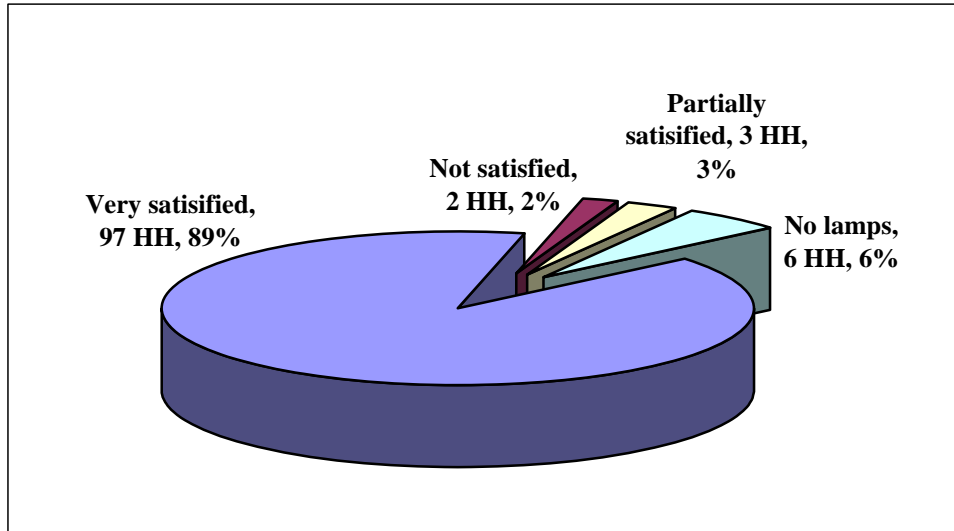
Province	None	1 lamp	2 lamps	> 2 lamps	Total
Kandal	4	10	5	15	34
Kampong Cham	0	6	19	20	45
Svay Rieng	3	10	14	2	29
Total	7	26	38	37	108

The majority of users is satisfied with their biogas lamp (97 of 102 households with biogas lamps, see Figure 9) and only 2 are dissatisfied. For those who are satisfied, they explained that some of the good features of the biogas lamp are: it offers a bright light

¹² One plant owner in Kandal is currently using 10 biogas lamps, mainly as a lighting source for his farming activities.

(75 respondents), is cheaper than their previous method (54 respondents) and is easy to use (42 respondents). For the few who are not satisfied, they complained that the lamp does not provide enough light and that the lamp frequently breaks down.

Figure 9: Satisfaction with lighting quality of biogas lamp (Of 108 households surveyed)



VII. Overall User Satisfaction with the Programme

Two components were tested to understand the users' satisfaction with the programme: subsidy and quality guarantee. The results suggest that plant owners are equally (104 respondents) satisfied with both components.

Subsidy

Regarding the subsidy provided by the program, all of the interviewees received a subsidy of \$100. Only one of the respondents mentioned having problems with getting a subsidy, complaining that the process for getting the money is long¹³. On average, plant owners waited 20 days after plant completion to receive their subsidy.

Almost all of the plant owners surveyed are satisfied with the subsidy (104 of 108 interviewed). The four respondents who stated that they are only partially satisfied explained that while the \$100 subsidy is helpful, they commented that it is not enough because the cost of equipment still adds up to a lot of money. One respondent also complained that he did not like the fixed subsidy for all plant sizes.

When asked what kind of suggestions they would like to propose to improve the subsidy, interviewees raised the following issues:

- Larger subsidy for bigger plant sizes
- Subsidy should cover 50% of costs
- Substitution of subsidy with equipments
- Closer and more convenient locations for picking up subsidy¹⁴

Regarding the amount of subsidy, seven out of ten interviewees think that it is sufficient. Twenty-eight of the 108 surveyed, however, think that the subsidy is not enough.

Quality Guarantee

About the quality guarantee, 104 of the 108 plant owners interviewed are satisfied with this policy (refer to Table 19). Four interviewees, however, complained that the insurance plan is too short.

¹³ The system of subsidy channeling has meanwhile changed. Owners will get their subsidy via the ACLEDA bank upon showing their plant completion form.

¹⁴ As mentioned in previous footnote, subsidy can be collected at ACLEDA bank now.

Table 19: Satisfaction with the Quality Guarantee

Response	KD	KC	SV	Total
Satisfied	31	44	29	104
Partially satisfied	2	0	0	2
Not satisfied	1	1	0	2
Total	34	45	29	108

Some comments made by the interviewees about what they like about the Quality Guarantee Policy are as following:

- Repairing with no charge
- Insured for 2 years
- Plant lasts long and produces enough gas
- Having insurance for 20-25 years¹⁵
- No hassles to find a mechanic when plant breaks down

Some suggestions mentioned by the interviewees on how to improve the Quality Guarantee Policy are as following:

- Longer insurance plans, may up to 10-20 years
- Masons should visit the plant when there is a problem and visit regularly
- Need for more convenient places for buying spare parts
- Better quality of light from biogas lamp
- Masons should explain about the biodigester more clearly
- Need better quality equipments, such as the valve

When asked if they were glad they made the investment, *every single plant owner expressed that they are satisfied with the investment*. They explained that the biogas plant is very useful and provides a lot of benefits such as eliminating the foul smell of animal dung, reducing smoke in the kitchen, cleaner house, and producing bio-slurry, which is a good fertilizer. In the words of one plant owner, ***"The investment is only one time but the benefits can last for a long time."*** All of the interviewees said that they would recommend others to make this investment too.

¹⁵ These were the words of the interviewee, which just means that he thinks that the life span of the plant is long.

VIII. Impacts of Biodigester on Users (Household Level)

A. Economic

*Financial Saving*¹⁶

After installing a biodigester, 75 households stopped using improved fuel wood stoves, 22 stopped using LPG stoves, and 11 stopped using charcoal stoves.¹⁷ Also, 22 households reported that they have decreased their usage of fuel wood, 4 households reduced usage of LPG and 10 households have reduced charcoal use. With these changes, households who used fuel wood stove saved about \$7.5 per month on average, while those who used LPG saved \$6.36, and those who used charcoal saved \$4.50 (see Table 20).

Table 20: Financial Savings on Cooking Fuel

Savings	Fuel Wood	Charcoal	LPG
<i>Aggregate</i>			
Per day in Riels	97,528	15,614	24,930
Per month in Riels	2,925,843	468,405	747,900
Per month in US Dollars	\$ 731.46	\$ 117	\$ 186.98
<i>Average</i>			
Average per day in Riels	1,005	601	848
Average per month in Riels	30,163	18,015.58	25,425
Average per month in US Dollars	\$ 7.54	\$ 4.50	\$ 6.36

Note1: Average is out of the number of households using the type of fuel

Note 2: The exchange rate US\$ - Cambodian Riel at the time of the study was US\$1 = 4000 Riels

For lighting, 11 households stopped using lead-acid batteries after plant installation, while 35 households stopped using kerosene and 1 stopped using electricity (via power grid). Some households also reduced their consumption of previous lighting sources: 40 decreased usage of battery, 4 used less kerosene and 10 reduced usage of electricity. These changes have resulted in average monthly savings of: \$0.80 for battery users, \$2.30 for kerosene users, and \$4.90 for electricity users (shown in Table 21).

¹⁶ In addition to financial savings from reducing or changing cooking and lighting fuel sources, most plant owners also saved money from reducing chemical fertilizers. However, interviewees could not clearly quantify how much they saved.

¹⁷ Total does not add up to 108 households surveyed because some households use more than one type of cooking stove.

Table 21: Financial Savings on Lighting Fuel

Savings	Battery	Kerosene	Electricity
<i>Aggregate</i>			
Per day in Riels	8,710	12,281	12,423
Per month in Riels	261,300	368,430	372,690
Per month in Dollars	\$ 65.33	\$ 92.11	\$ 93.17
<i>Average</i>			
Average per day in Riels	106	307	654
Average per month in Riels	3,186.59	9,210.75	19,615.26
Average per month in Dollars	\$ 0.80	\$ 2.30	\$ 4.90

Note: Average is out of the number of households using the type of fuel

To calculate the total financial savings due to the installation of a biodigester plant, we added the amount of money households saved from reducing and/or changing their cooking and lighting sources. The calculation includes savings on all types of energy sources used by the household for cooking and lighting. On average, households saved over \$11 per month by cutting back and/or stopping their use of certain fuels such as fuel wood, charcoal and kerosene (as summarized in Table 22).

Table 22: Total Financial Savings

Savings	
<i>Aggregate</i>	
Per day in Riels	159,483
Per month in Riels	4,784,482
Per month in Dollars	\$ 1,196.12
<i>Average</i>	
Average per day in Riels	1,477
Average per month in Riels	44,301
Average per month in Dollars	\$ 11.08

Note: Average is out of 108 households surveyed

Effect of the biodigester on time allocation and work load

In order to smoothly operate and maintain their biodigester, plant owners mentioned that they have to spend more time on some chores. According to the findings, most of the interviewees spend more time collecting dung and water than before (see Table 23). However, most stated that there has been no change in the amount of time they spend on caring for their cattle and pigs.

On the positive side, interviewees also mentioned that the biogas plant has saved them time with other chores. For instance, the majority of interviewees spend less time on

cleaning cooking utensils (94 of 108 surveyed), and in collecting firewood (85 respondents). These situations have freed up time, giving more time for socializing at home and in the neighborhood.¹⁸

Table 23: Changes in time spent on relevant activities since plant installation

Activities	Increased	Decreased	No Change	I don't know	N/A	Total
Cattle care	27	4	54	1	22	108
Pig care	23	6	47	0	32	108
Collecting water	60	2	46	0	0	108
Collecting dung	67	5	36	0	0	108
Cleaning cooking utensils	6	94	8	0	0	108
Collecting lighting fuel	0	85	23	0	0	108
Collecting firewood	3	89	4	0	12	108

Effect of the biodigester on animal husbandry issues

For the most part, the installation of a biodigester appears to have had little impact on *livestock feeding*. Most of the plant owners who raise livestock have not changed the amount of feeding (see Table 24). This may be because plant owners initially selected the plant size based on their existing livestock assets and available dung, which is related to their feeding practices. Thus, installation of a plant did not require them to increase feeding.

Table 24: Changes in the amount of feeding provided to livestock since biogas plant installation

Provinces	Changes	Cows	Buffalo	Pigs	Chicken
Kandal	Increased	4	0	4	2
	Unchanged	18	0	21	17
	Don't know	1	0	0	0
Kampong Cham	Increased	5	0	3	0
	Unchanged	31	5	24	25
	Don't know	0	0	0	0
Svay Rieng	Increased	2	2	5	1
	Unchanged	18	14	15	17
	Don't know	0	0	0	0
Total	Increased	11	2	12	3
	Unchanged	67	19	60	59
	Don't know	1	0	0	0
	All	79	21	72	62

¹⁸ Interviewees perceive that they have more time than before, but could not quantify how much.

Since installing a biogas plant, there seems to be no changes in the work load needed to collect *fodder crops* for livestock. The majority of interviewees informed that they spend the same amount of time on fodder collection as before (78 of 108 respondents). Though 22 of the interviewees did say they are spending a great deal more, mostly in Kampong Cham province (14 respondents).

In general, the majority of the plant owners surveyed do not grow any fodder crops for their livestock. Before installing a biogas plant, 18 of the interviewees grew fodder crops. Fourteen of these people continued to grow after construction of a biogas plant.¹⁹ Ten people started growing fodder crops after they installed the biodigester.

Related to *livestock sheds*, survey findings show that there have not been any major changes in the shed conditions since installation of a biodigester. Of 108 plant owners surveyed, 56 of them have made some improvements to their sheds, such as smoothing the floor of the shed or adding a roof cover.

Effect of bio-slurry use for agriculture production and chemical fertilizers

Eight out of ten of the interviewees who grow crops reported an *increase in their yields* after applying the bio-slurry (see Table 25). According to households who experienced an increase in crop yields, they attributed the increase to the application of bio-slurry and/or slurry compost on well-managed soil, as well as the reduction of pests and diseases associated with the use of bio-slurry.

Table 25: Impression about the change in the yield of crops due to slurry application

Province	Increase	No change	Don't know	Total*
Kandal	19	3	1	23
Kampong Cham	24	3	5	32
Svay Rieng	20	2	1	23
Total	63	8	7	78

Notes: *Includes only interviewees who plant crops

Four out of nine plant owners surveyed (who use bio-slurry) stated that they have decreased their dosage of chemical fertilizer since using bio-slurry; while, two out of seven plant owners have stopped using chemical fertilizers completely. From the perspective of 78 bio-slurry users, bio-slurry has some advantages over chemical fertilizers. Sixty-eight percent reported that bio-slurry resulted in uniform crop growth and higher yields, and 32% stated that bio-slurry helped loosen the soil, making it easier to work with than in the past.

¹⁹ The four interviewees who stopped growing fodder crops did not explain why they stopped.

B. Health

Effect of the biodigester on health and sanitation of the household

According to the survey results, the biogas plant has had a *positive effect on the sanitation* of households. The majority (105 households out of 108 interviewed, refer to Table 26) reported that there has been a *major reduction of smoke* in the kitchen. For two cases, the level of smoke is unchanged because they did not use fuel wood prior to plant installation. Interviewees (especially women) also stated that the reduction of smoke has made their household environment more sanitary and clean than before. Obviously, installation of a biodigester has had a positive impact on the health of household members, especially women, who are responsible for managing the kitchen.

Table 26: Reduction of smoke in the kitchen after the biogas plant installation

Province	Yes, a lot	Yes, a little	NO	Total
Kandal	33	0	1	34
Kampong Cham	44	0	1	45
Svay Rieng	28	1	0	29
Total	105	1	2	108

C. Social

Effects of biodigester on gender roles

Survey findings suggest that the installation of a biodigester has positive impacts on women household members. According to the 108 plant owners interviewed, 85 stated that women have more time to take care of their children now because of the ease and reduction in time for certain chores such as cooking (see Table 27). Many also mentioned that the household environment is easier to clean and more sanitary than before, mostly because of the reduction and/or elimination of smoke. However, most women household members need to spend more time on fetching water (though males are usually responsible for mixing dung and water, and feeding into plant). The situation with collecting animal feed and occurrences of disease in the household remains unchanged since plant installation.

Table 27: Impacts of Biodigester on Women

Impacts	Increased	Decreased	No Change	Don't know	Total
Time available for child care*	85	3	19	0	107
Fetching water**	57	8	40	1	106
Cleaner household environment	55	23	30	0	108
Collecting animal feed***	29	6	66	1	102
Occurrences of disease in household*	0	45	56	6	107

Notes: *1 household not applicable, **2 households not applicable, and ***6 households not applicable

Related to the biodigester, women have been very involved in some stages and less involved in some (see Table 28). Training is usually attended by a male household member (76 interviewees stated that women are not involved with attending training on biodigester operation). In most households, women are very involved with the operation of the plant on a daily basis and when there is a problem with the plant; however, men are generally responsible for consulting with relevant persons if the plant needs severe maintenance. The routine of feeding dung into the plant is commonly done by a male, either the husband, son or male servant. The kitchen is the domain of women, where 103 of the interviewees stated that women are very involved with managing the kitchen environment. This also means that women are the main users of biogas stoves.

Table 28: Involvement of Women in Biodigester-Related Activities

Activities	Very Involved	Somewhat Involved	Not Involved	Total
Training on biodigester operation*	24	7	76	107
Performing plant operation daily	52	32	24	108
Performing plant operation when required	42	33	33	108
Consulting with relevant persons in severe cases of plant maintenance	21	30	57	108
Managing kitchen	103	2	3	108
Managing livestock shed**	32	36	31	99
Making compost***	5	2	8	15

Notes: *1 household did not participate in training at all, **9 households do not have sheds, ***93 households do not make compost

IX. Conclusions and Recommendations

Conclusions

Overall, it is clear that users are generally satisfied with their investment and the performance of their biodigester. In terms of impact, survey findings indicate that households who have installed a biogas plant have generally experienced positive changes in their economic, health and social status.

Fuel wood consumption, which is the main type of energy source used by households surveyed, have dramatically reduced juxtapose to an increase in use of renewable energy. Seventy-five of 95 households who previously used fuel wood stoves for cooking stopped using fuel wood after plant installation, while 22 households have decreased their consumption of fuel wood. Changes in the consumption of fuel wood have saved households \$7.5 per month on average. On average, households saved over \$11 per month due to cutting back and/or stopping use of certain cooking and lighting sources.

On the other hand, there has been *trade-offs in terms of time allocation for certain activities*. Households are spending less time with cleaning kitchenware and collecting fuel wood, but need to spend more time with fetching water and taking care of livestock. However, most households seem to have more free time after installing a plant, especially women, who feel that they have more time to care for their children now.

The biodigester appears to have *little effect on the level of animal feed, fodder crop production, and livestock shed conditions*. Households reported that these issues remain unchanged after plant construction. However, through the utilization of bio-slurry, households report that the biodigester has positively effected production. According to interviewees, *application of bio-slurry has resulted in higher crop yields, and a reduction in pests as well as crop diseases*.

Health and sanitation has improved after installing a biogas plant. *Households stated that smoke has reduced and household environment is cleaner*.

In sum, the biodigester has had positive and visible impacts on households and the natural environment. These positive outcomes in combination with the high user satisfaction provide a good foundation and evidence for scaling up the Programme.

Recommendations

While the majority of biodigester users surveyed are satisfied with their plant, some measures could be taken to ensure continuous usage. For one, the survey findings show that only 75 of the 108 owners interviewed received training on operation and maintenance after plant construction. Though most interviewees did not complain about plant performance and quality, it may be a good idea for the PBPO to organize *additional training on plant operation and maintenance* to ensure that households are using their plant at full capacity. To be most effective, such trainings may need to include both female and male household members involved with plant usage, given that tasks are usually gender-specific.

Research and development should be conducted to *improve the quality of biogas appliances*, specifically the biogas lamp (78% of 108 have encountered break-downs with this appliance).

In addition, the Programme may want to follow up on a few issues, which were raised by the interviewees, as following:

- check on why some households did not receive a warranty certificate, especially in Kandal, and on the method of distributing programme materials
- check on biogas lamps, as many users complained about frequent break-downs and low quality of light
- building good relationship between mason and user, especially in instruction provision
- assess the potential of building in a light switch for the biogas stove
- assess the potential of modifying the subsidy and quality guarantee policy as suggested by interviewees (see Chapter VII)

From the experiences of current biodigester users, there are important lessons to keep in mind as the Programme expands its coverage area and market. According to plant owners surveyed, the ***most important thing that potential users need guarantee on is the life span of the biogas plant and the reliability and capacity of gas production.*** Potential users also expect the mason and Programme to be active before and after plant construction, and to continue providing advice and services on demand.

Given that the NBP intends to reach out to poorer households as the program progresses, special measures may need to be considered to ensure speedy dissemination and usage of biogas technology. Culturally, locals (especially the poor) are very keen on imitating successful experiences. They are generally risk-averse to new ideas and change, but if they see others succeed, they will follow the bandwagon. Therefore, it is very strategic and important to ***market and illustrate to potential users on the real benefits that existing users have gained from biogas plants.***

The amount of subsidy may become a problem as the program expands to poor households. Regarding the amount of subsidy, 28 of the 108 households surveyed think that the subsidy is not sufficient. The households surveyed, which have owned a plant for at least 3 months, are relatively financially well-off. On average, they own 2 hectares of land, 5 cows and/or 76 pigs²⁰. As the programme reaches out to poorer households, this problem may intensify. On top of this, the price of construction materials such as cement and sand has also risen since the start of the programme.

Furthermore, initiatives to ***link poor clients with microfinance*** may be necessary. The NBP along with the FMO and a number of local microfinance institutions recently discussed the potential of developing a program to ensure that potential users have access to finance.

For poorer households, ***ensuring availability of feeding materials*** may be a big challenge. Pig-raising is the most common type of livestock raised by poor households. At present, small-scale pig raisers in areas such as Kampong Cham and Svay Rieng are having difficulties competing with imported pig/pork. Farmers complain that the unit price of pork is falling (or staying constant), but production costs are raising, especially for animal feed. Falling profits are discouraging farmers from staying in this business. In response to this, the NBP may want to ***collaborate with government initiatives and NGOs*** working in this issue to consider possible interventions and solutions.

²⁰ The average number of pigs is on the high end because some interviewees are large-scale pig raisers.

Appendix 1: Biodigester User Survey

Questionnaire for Biogas User Survey

1 General Information

- 1.1 Name of Plant Owner: _____
- 1.2 Sex of Plant Owner: [] 1. female [] 2. male
- 1.3 Age of Plant Owner: _____
- 1.4 Plant completion date: _____
- 1.5 Plant size: _____ M³
- 1.6 In what year did you start living in this village? _____

2 Socio-Economic Characteristics

- 2.1 No. of household members under 14 years:

Male _____ persons	Female _____ persons	Total: No. _____ persons
--------------------	----------------------	--------------------------

- 2.2 No. of household members over 14 years:

Male _____ persons	Female _____ persons	Total: No. _____ persons
--------------------	----------------------	--------------------------

- 2.3 Educational level of household members over 14 years:

Level	Head of House	Family Members (> 14 years)		Total
		# Male	# Female	
illiterate or almost illiterate				
some primary education, but not completed				
primary (grades 1-6)				
lower secondary (grades 7-9)				
secondary (grades 10-12)				
associate degree or higher				
technical diploma				

- 2.4 Major occupation of household members over 14 years:

Level	Head of House	Family Members (> 14 years)		Total
		# Male	# Female	
Agriculture-based (e.g. pig raiser)				
Manufacturing-based (e.g. bricks)				
Service-based (e.g. pork retailer)				
Public servant (e.g. teacher)				
Not working (e.g. student, retired)				
Apprentice (e.g. not paid)				

- 2.5 Main source of water for household? *Fill out table below.*
- 2.6 Location of water sources? *Fill out table below.*
- 2.7 How long does it take to fetch water from the source(s) mentioned above? *Fill out table below.*

2.8 How many trips to the water source each week? *Fill out table below.*

Source	Season	Location (1: At home, 2: Outside)	Average Minutes each trip	Trips per week
[] 1. Tap	[] Dry [] Wet			
[] 2. Well	[] Dry [] Wet			
[] 3. River, Canal	[] Dry [] Wet			
[] 4. Rain water	[] Dry [] Wet			
[] 5. Other (specify):	[] Dry [] Wet			

2.9 After biogas installation, water consumption of household has?

- [] 1. Increased
 [] 2. Stayed the same
 [] 3. Decreased
 [] 4. I don't know

2.10 Hectares of land owned by the household: _____ ha

3 Agriculture Activities

3.1 How many animals reared? *Fill in table below.*

3.2 After biogas installation, any changes in feeding? *Fill in table below.*

3.3 How much dung is available each day? *Fill in table below.*

Type	No. of Animals	Feeding 1: increased 2: stayed the same, 3: decreased, 4: I don't know	Daily Dung Collected
Cattle (Big)	heads		kg
Cattle (Small)	heads		kg
Buffalo (Big)	heads		kg
Buffalo (Small)	heads		kg
Pig (Big)	heads		kg
Pig (Small)	heads		kg
Chicken	heads		kg
Other (specify) _____	heads		kg
Total			kg

3.4 After biogas installation, any changes in livestock shed condition? *Select all that applies*

Animal	Codes	Shed Condition
Cattle (Big)	[1] Smooth, earthen floor	
Buffalo	[2] Smooth, concrete floor	
Pig	[3] Urine collection pit	
Chicken	[4] Dung collection pit	
Other (specify)	[5] No change	
	[6] Roof cover of shed	
	[7] Mud during rainy season	
	[8] Others (specify)	

- 3.5 Did you grow fodder crops before or after biogas installation? 1. before 2. after
- 3.6 Are you spending more time on fodder collection after biogas installation?
 1. Yes, a great deal more
 2. Yes, a little more time
 3. No, no change

4 Bio-slurry

- 4.1 Do you use Bio-slurry or not? 1 Yes 2 No
- 4.2 If no, what is the reason for not using the slurry? *Select all that applies.*
 1. Not aware of fertilizing value
 2. Toilet attached, problem to transport to fields
 3. Do not know application method
 4. Too little available to bother
 5. Not convinced of fertilizing value
 6. Too wet, making it difficult to transport to the fields
 7. No agricultural land
 8. Others (Specify): _____
- 4.3 If no, how do you dispose the slurry?
 1. Dump into lake or river
 2. Dump into irrigation system that flows into field
 3. Dump into forest
 4. Bury in soil
 5. Sell
 6. Other (Specify): _____
- 4.4 How many slurry pits does the plant have?
 1. One
 2. Two
 3. Three
 4. None
- 4.5 If yes, in what form is the bio-slurry applied? *Select all that applies.*
 1. Liquid
 2. Composted
 3. Dried, not composted
 4. Other (Specify): _____
- 4.6 For composted bio-slurry, once slurry compost is ready, how is it stored outside until it is applied in the fields?
 1. Spread and dried on the ground
 2. Piled and covered
 3. Piled and left uncovered
 4. Piled under a shed
 5. Other (Specify): _____
- 4.7 How is compost applied to the field?
 1. Transported and temporarily stored in the field
 2. Transported and spread in the field into small heaps without covering
 3. Transported, and spread in the field into small heaps and covered until application
 4. Transported to the field, spread, and incorporated immediately
 5. Transported to the field and spread during slack season and put into soil only when preparing land
 6. Other (Specify): _____

- 4.8 What is the effect of bio-slurry manure on the use of chemical fertilizers?
- 1. Stopped using chemical fertilizer completely
 - 2. Using less chemical fertilizer than before
 - 3. Using more chemical fertilizer than before
 - 4. Still using the same quantity of chemical fertilizer
 - 5. Do not know
 - 6. Never used chemical fertilizers
 - 7. Other (Specify): _____

- 4.9 What are the advantages of slurry compared to chemical fertilizer? *Select all that applies.*
- 1. Uniform crop growth, more yield
 - 2. Crop can tolerate adverse water stress
 - 3. Soil is loose and easy to work with
 - 4. Food is tastier
 - 5. No advantages
 - 6. Do not know
 - 7. Never used chemical fertilizers
 - 8. Others (specify): _____

- 4.10 When did you get information on slurry use?
- 1. Beginning plant construction
 - 2. During workshops
 - 3. After plant construction
 - 4. Other (Specify): _____

- 4.11 Who do you get agricultural extension services from (e.g. technical support for farming)?
- 4.12 What is your impression about the change in the yield of crops due to slurry application?

Type of Crop	Increase	Decrease	No Change

- 4.13 If increased, do you think that the increase in yield was due to:
- 1. Application of well managed soil with compost and/or slurry
 - 2. Reduction in pests and diseases
 - 3. Combination of organic matter and bio-slurry
 - 4. Combination of chemical fertilizer and bio-slurry
 - 5. Combination of all above
 - 6. Do not know

5 About the Plant

- 5.1 Where did you get information about biodigester?
- 1. Provincial Biodigester Programme Office
 - 2. Neighbors / friends / relatives
 - 3. Masons / Constructors
 - 4. Local authorities
 - 5. Others (Specify): _____

- 5.2 Who gave you further information about the plant?
- 1. Provincial Biodigester Programme Office
 - 2. Neighbors / friends / relatives
 - 3. Masons / Constructors
 - 4. Local authorities

- [] 5. Others (Specify): _____
- 5.3 Was information correct?
 [] 1. Yes, all correct
 [] 2. Yes, some correct and some not
 [] 3. No
 [] 4. I don't know
- 5.4 Was the contract conditions clear to you?
 [] 1. Yes, very clear
 [] 2. Yes, somewhat clear
 [] 3. No
 [] 4. I don't know
- 5.5 Are you satisfied with the National Biodigester Programme brochures?
 [] 1. Yes
 [] 2. No
 [] 3. I don't know
 [] 4. I never received one
- 5.6 Principal reasons for installation. Rank options from 1 to 7, where 1 is most important and 7 is least important)
 [] 1. Reduce firewood collection
 [] 2. Convenient cooking
 [] 3. Smokeless kitchen
 [] 4. Save time
 [] 5. Substitute fertilizer with slurry
 [] 6. Energy source for lighting
 [] 7. Subsidy provided
 [] 8. To get rid of foul smell
- 5.7 Did you have to wait a long time for construction?
 [] 1. Yes, longer than agreed
 [] 2. No
 [] 3. I don't know
- 5.8 How long was the construction of plant? _____ days
- 5.9 Are you satisfied with the skills of the mason/constructor?
 [] 1. Yes, very satisfied
 [] 2. Yes, somewhat satisfied
 [] 3. No
 [] 4. I don't know
- 5.10 Did the mason/constructor explain how to use the plant?
 [] 1. Yes
 [] 2. No
 [] 3. I don't know
- 5.11 Is the user manual clear to you?
 [] 1. Yes, very clear
 [] 2. Yes, somewhat clear
 [] 3. No
 [] 4. I don't know
- 5.12 How did you decide on the plant size? Select all that applies.
 [] 1. Based on family size

- 2. Based on number of livestock
- 3. Based on the amount of dung available
- 4. Based on the plant sizes in the neighborhood
- 5. Other (specify): _____

5.13 Who decided on the plant size?

- 1. Husband
- 2. Wife
- 3. Son
- 4. Daughter
- 5. Other (Specify)

5.14 Are you satisfied with the plant size?

- 1. Yes
- 2. No, it is too big.
- 3. No, it is too small.

5.15 Is the plant currently producing gas?

- 1. Yes, as expected
- 2. Yes but less than expected
- 3. No --> Number of days not working: _____ days
- 4. I don't know

5.16 If not producing gas, what could be the reasons? *Select all that applies.*

- 1. No dung
- 2. No water
- 3. Civil structure damaged
- 4. I don't know
- 5. Other (Specify): _____

5.17 Is there a toilet attached to your plant?

- 1. yes
- 2. no – Why? _____

6 Biogas Production and Use

6.1 What kind of stoves did you use before and after biogas installation?

Type of Stove	Before	After
Biogas stove		
Charcoal stove		
Improved fuel wood stove		
Gas stove (Liquid Petroleum Gas Stove)		
Electric stove		

6.2 Number of biogas stoves and type (after biogas installation)

Number	Types
<input type="checkbox"/> 1. One stove (single burner)	
<input type="checkbox"/> 2. Two stoves (double burners)	
<input type="checkbox"/> 3. More than two stoves	

6.3 Hours of gas used for cooking per day (Average)

Meals	Number of Biogas Stoves Used	Average Hr. of Cooking per Stove	Time Start	Time Stop
Morning				

Afternoon				
Evening				
Other				

- 6.4 Are all meals cooked with biogas stove? 1. Yes 2. No
 6.5 Are you satisfied with cooking on biogas? 1. Yes 2.No 3.Partially

- 6.6 **Reasons for satisfaction:**
 1. Cooking is smokeless
 2. Cooking is faster
 3. Meals are tastier
 4. Easy to clean pots
 5. Stove does not need constant attention
 6. Cheaper than previous method
 7. Other (specify): _____

- 6.7 **Reasons for dissatisfaction:**
 1. Cooking needs more time
 2. Meals are less tasty
 3. Gas is often not sufficient
 4. Gas use is complicated
 5. Appliance often breaks down
 6. More expensive than previous method
 7. Other (specify): _____

- 6.8 Number of biogas lamps
 1. One
 2. Two
 3. More than two : _____ (Number)
 4. None

- 6.9 Average Hours of gas used for lighting per day

Lamps	Average Hr. of Lighting per Lamp
1	
2	
3	
Total	

- 6.10 Are you satisfied with lighting on biogas? 1. Yes 2.No 3.Partially

- 6.11 **Reasons for satisfaction:**
 1. Bright light
 2. Easy to use
 3. Cheaper than previous method
 4. Other (specify): _____

- 6.12 **Reasons for dissatisfaction:**
 1. Not enough light
 2. Lights in only one place
 3. Frequently breaks down
 4. Too much gas is used
 5. Too hot to use
 6. More expensive than previous method
 7. Other (specify): _____

- 6.13 Is gas production sufficient for you?
 1. Always sufficient
 2. Sometimes sufficient
 3. Not sufficient
- 6.14 What measures do you take to increase gas production?
 1. No special measures
 2. Increase dung
 3. Pre-warm feeding in the sun
 4. Cover plant dome with straw or mud
 5. Add special feeding to plant
 6. Others (specify): _____
- 6.15 If you increase dung, how do you obtain?
 1. Own dung is available --> _____ kg per day
 2. Buy extra dung --> _____ kg per day
 3. Other (specify): _____
- 6.16 Priority of biogas use. Rank in order of priority from 1 to 3. If no biogas lamp installed, priority to 1 and 3 only.
- | | |
|--|--|
| With biogas lamp | No biogas lamp |
| <input type="checkbox"/> 1. Cooking family meals | <input type="checkbox"/> 1. Cooking family meals |
| <input type="checkbox"/> 2. Lighting | <input type="checkbox"/> 2. Other (specify) |
| <input type="checkbox"/> 3. Other (specify) | |

7 Operation

- 7.1 Who is generally putting dung into the plant?
 1. Male head of household
 2. Female head of household
 3. Wife
 4. Son
 5. Daughter
 6. Male servant
 7. Female servant
 8. Other (Specify): _____

- 7.2 Frequency of dung fed into the plant?

Frequency	Kg
<input type="checkbox"/> 1. Twice a day	
<input type="checkbox"/> 2. Once a day	
<input type="checkbox"/> 3. Every second day	
<input type="checkbox"/> 4. Every third day	
<input type="checkbox"/> 5. Twice a week	
<input type="checkbox"/> 6. Once a week	

- 7.3 How do you collect and store dung?
 1. In piles, covered
 2. In piles, uncovered
 3. In a pit, covered
 4. In a pit, uncovered
 5. Collect and put in the plant immediately
- 7.4 How long does the dung remain in the pit or piles?
 1. less than 1 month
 2. 1 month to less than 3 months
 3. 3 months to less than 4 months

- 4. 4 months to less than 5 months
- 5. 5 months to 6 months

7.5 Is all available dung fed into the plant? 1. Yes 2. No
7.6 If no, why?

- 1. Gas is sufficient as it is
- 2. Use dung as fertilizer
- 3. Too much work
- 4. Other (specify): _____

- 7.7 What kinds of documents did you receive from the program? *Select all that applies in table below.*
 7.8 How many of each document did you receive? *Fill in table below.*
 7.9 How useful were the documents? *Fill in table below.*

No.	Document	Amount	Usefulness
1	Leaflets / Brochures		[] 1. yes [] 2. no
2	Information folder		[] 1. yes [] 2. no
3	Poster		[] 1. yes [] 2. no
4	User manual		[] 1. yes [] 2. no
5	Warranty certificate		[] 1. yes [] 2. no
6	T-Shirt		[] 1. yes [] 2. no
7	Home poster		[] 1. yes [] 2. no
8	Others (Specify):		[] 1. yes [] 2. no

7.10 Was training provided to you on how to operate biogas plant? [] 1. Yes [] 2.No

7.11 If yes, from who?

- [] 1. Mason / Constructor
 [] 2. Provincial Biodigester Program Office
 [] 3. Local authorities
 [] 4. Friends and/or relatives who also own a plant
 [] 5. Other (specify): _____

7.12 If yes, what topics were covered in the training?

- [] 1. Amount of dung to be added
 [] 2. Quantity of dung and water to be added
 [] 3. Use of air regulator
 [] 4. Use of water drain
 [] 5. Frequency of plant feeding
 [] 6. Greasing (eg. For opening and closing)
 [] 7. Composting technique
 [] 8. Direct use of slurry
 [] 9. Other (specify): _____

8 Maintenance

8.1 What kinds of appliance broken down? *Fill out table below.*

8.2 Number of failures? *Fill out table below.*

8.3 Who repaired failures? *Fill out table below.*

Break-Down Items	No. of Failures	Repaired by			
		Mason	Own	No One	Other
Mixer					
Main valve					
Gas pipe					
Water drain					
Rubber Hose					
Gas taps					
Stoves					
Biogas lamp					
Outlet tabs					
Pressure gauge					
Other (specify):					

- 8.4 What kinds of civil structure broken down? *Fill out table below.*
 8.5 Number of failures? *Fill out table below.*
 8.6 Who repaired failures? *Fill out table below.*

Break-Down Items	No. of Failures	Repaired by			
		Mason	Own	No One	Other
Inlet pit					
Toilet					
Dome					
Digester					
Drain pit					
Drain pit cover					
Outlet					
Outlet covers					
Other (specify):					

8.7 Amount spent on repairs since installation: _____ Riels

8.8 Has repair and maintenance service been provided in time?

1. Yes
 2. No
 3. Sometimes in time

8.9 How long does it take to repair and do maintenance?

1. The same day
 2. Less than two days
 3. A week
 4. Two weeks
 5. More than two weeks

8.10 Who do you contact if there is a problem with your plant? *Select all that applies.*

1. Provincial Biodigester Programme Office
 2. National Biodigester Programme Office
 3. Mason / Constructor
 4. Neighbors / friends / relatives
 5. Local authorities
 6. Other (Specify): _____

8.11 How do you check for gas leakage?

1. Use soap foam
 2. Lighting the gas
 3. I don't know how to check
 4. Look at pressure gauge
 5. Other (specify): _____

9 Plant Financing

9.1 What was total cost of plant? _____ U.S. Dollars

9.2 How as the plant financed (not considering subsidy from program)?

1. Own cash savings only
 2. Borrowed fully
 2.1 money lender
 2.2 banks / MFIs
 2.2.1 Which institutions? _____
 2.2.2 What was interest rate? _____

- 2.3 relatives and/or friends
- 2.4 savings group
- 2.5 other (specify): _____
- 3. Own cash savings and borrowed some from
 - 3.1 money lender
 - 3.2 banks / MFIs
 - 3.2.1 Which institutions? _____
 - 3.2.2 What was interest rate? _____
 - 3.3 relatives and/or friends
 - 3.4 savings group
 - 3.5 other (specify): _____
- 4. Other (specify): _____

- 9.3 Loan repayment situation?
- 1. Repaying in installments, no late or overdue
 - 2. Repaid the whole loan already
 - 3. Still repaying some overdue installments
 - 4. Default

9.4 How much subsidy did you receive? _____ U.S. Dollars

9.5 Any problems with getting subsidy? 1. yes 2. no 3. I don't know

9.6 How many days after construction did you receive subsidy? _____ Days

- 9.7 Was subsidy one reasons for constructing plant?
- 1. yes, very much
 - 2. yes, to some extent
 - 3. no
 - 4. I don't know

- 9.8 Is subsidy enough?
- 1. yes
 - 2. no
 - 3. I don't know

10 After Sales Service

10.1 Does company come to supervise the plant? 1. Yes 2. No

10.2 If yes, were the visits on routine inspections or on request?

Frequency of Visits to Date	Routine	On Request
1 time		
2 times		
3 times		
More than 3 times		

- 10.3 Are quality guarantee conditions clear?
- 1. yes, very clear
 - 2. yes, somewhat clear
 - 3. no
 - 4. I don't know

- 10.4 Is quality guarantee certificate available?
- 1. yes
 - 2. no

[] 3. I don't know

11 Health and Environment

11.1 Has smoke in the kitchen reduced after the biogas installation?

- [] 1. Yes, by a lot
 [] 2. Yes, by a little
 [] 3. No

11.2 Any incidence of burning related to the use of biogas plant? [] 1. Yes [] 2. No

12 Energy Use

12.1 Main energy sources for cooking before and after biogas installation (on average per day, on average per week or on average per month)

Energy Source	Units	Before (#)	After (#)
Firewood			
Kerosene			
Agriculture residue			
Coal			
Electricity			
Hydropower			
Solar power			
Other (specify):			

12.2 Time spent on collecting cooking fuel before and after biogas installation

Energy Source	Before	After
Firewood	hours per day	hours per day
Kerosene	hours per day	hours per day
Agriculture residue	hours per day	hours per day
Coal	hours per day	hours per day
Other (specify):	hours per day	hours per day

12.3 Main energy sources for lighting before and after biogas installation

Energy Source	Units	Before (#)	After (#)
Kerosene			
Electricity (Battery)			
Candles			
Electricity Grid			
Solar power			
Other (specify):			

12.4 Current local fuel prices

Fuel Type	Unit	Price(Riel)
Firewood		
Kerosene		
Dung		
Agriculture residue		
Coal		
Electricity		
Candles		

13 Time Savings

13.1 Time Savings Before and After installation of biogas

Activity	Before (Average)	After (Average)
Cattle care	hrs per day	hrs per day
Pig care	hrs per day	hrs per day
Collection of water	hrs per day	hrs per day
Collection of dung	hrs per day	hrs per day
Cooking	hrs per day	hrs per day
Cleaning cooking utensils	hrs per day	hrs per day
Collection of lighting fuel	hrs per day	hrs per day
Collection of firewood	hrs per day	hrs per day

14 Gender Issues and Impacts

14.1 Who is the owner of resources?

Resource	Male	Female	Both
Livestock			
Land			
Home			
Transportation (motorcycle, car, bike)			
Biogas Plant			
Bank Account			

14.2 Who makes decisions on these activities related to the biogas?

Resource	Male	Female	Both
Plant installation			
Selection of biogas plant construction company			
Connection of toilet to biogas plant			
Selection of location of biogas plant			
Construction on improvements in livestock sheds			

14.3 Are the female members of the household involved in the following activities?

Activity	Very Involved	Somewhat Involved	Not Involve
Training on biogas operation			
Performing plant operation daily			
Performing plant maintenance when required			
Consulting with relevant persons in severe cases of plant maintenance			
Managing kitchen			
Managing livestock shed			
Making compost			

14.4 Benefit/Impacts of biogas plant on female household members (main manpower)

Benefits / Impacts	Increased	Decreased	No Change
Time available for child care			
Clean household environment			

Benefits / Impacts	Increased	Decreased	No Change
Disease occurrences in family			
Fetching water			
Collecting of animal feed			

15 Additional Questions

15.1 What requirements do you expect from your biogas plant? *Choose three points*

- 1. Long life span
- 2. Reliable and maximum gas production
- 3. Low maintenance required
- 4. Easy to operate
- 5. Easily available spare parts
- 6. Proactive approach of companies before and after construction

15.2 Have you received Subsidy on biogas plant? 1. Yes 2. No

15.3 Are you satisfied with the Subsidy and Quality Assurance? Explain

Subsidy	Quality Assurance
<input type="checkbox"/> 1. Satisfied	<input type="checkbox"/> 1. Satisfied
<input type="checkbox"/> 2. Partially satisfied	<input type="checkbox"/> 2. Partially satisfied
<input type="checkbox"/> 3. Not satisfied	<input type="checkbox"/> 3. Not satisfied
<i>Strong Points</i>	<i>Strong Points</i>
<i>Strong Points</i>	<i>Strong Points</i>

15.4 Any suggestions to improve Subsidy and/or Quality Assurance?

Subsidy	Quality Assurance

15.5 Overall, are you satisfied with the performance of the plant in terms of cooking and lighting?

- 1. Yes, very much
- 2. Yes, somewhat
- 3. No – Why? _____

15.6 Are you glad you made the investment?

- 1. Yes 2. No 3. I don't know

15.7 Will you recommend plant construction to others?

- 1. Yes 2. No 3. I don't know

THANK YOU FOR YOUR COOPERATION

Appendix 2: List of Interviewees

Plant code	Plant Owner Name	Khmer Name	District	Commune	Village	Plant Size	Date Completion	Supervisor	Mason
Kandal									
808060057	Kem Ra	គឹម រ៉ា	Angk Snoul	Damnak Ampil	Serey Sokha	10	2-Oct-06	Kry Thani	Nghek Noeun
808060024	Yem Phal	យឹម ផល	Angk Snoul	Damnak Ampil	Kdan Roy	4	24-May-06	Kry Thani	Roeru Noun
808060004	Kao Suon	កៅ សួន	Angk Snoul	Damnak Ampil	Kdan Roy	4	18-Apr-06	Kry Thani	Nghek Noeun
808060055	Sarng Soy	សារង សយ	Angk Snoul	Damnak Ampil	Damnak Ampil	6	2-Aug-06	Kry Thani	Nghek Noeun
808060050	Morn Yan	ម៉ែន យាន	Angk Snoul	Damnak Ampil	Damnak Ampil	4	17-Jul-06	Kry Thani	Nghek Noeun
808060023	Phann Bunthorn	ផាន់ ប៊ុនថុន	Angk Snoul	Damnak Ampil	Porng Tuek	4	8-May-06	Kry Thani	Nghek Noeun
808060022	Kheng Khorn	ខេង ខន	Angk Snoul	Damnak Ampil	Porng Tuek	4	16-Jul-06	Kry Thani	Nghek Noeun
808060044	Kim sophea	គឹម សុភា	Angk Snoul	Damnak Ampil	Porng Tuek	4	4-Jul-06	Kry Thani	Nghek Noeun
808060049	Phorn Som	ផុន សំ	Angk Snoul	Damnak Ampil	Porng Tuek	4	1-Jul-06	Kry Thani	Nghek Noeun
808060054	Maes Sarin	មាស សារិន	Angk Snoul	Samraong Lue	Sre Om Prom	6	1/0/1900	Kry Thani	Oeun Laove
805060070	Siang Sitha	សាំង សីថា	Leuk Daek	Preaek Ton Leab	Preaek Pak	6	16-Aug-06	Kry Thani	Leng Long
805060060	So Long	សូ ឡុង	Leuk Daek	Preaek Dach	Preaek Tuch	10	Dec.06	Kry Thani	Leng Long
805060016	Thaong Samkol	ថោង សំកុល	Leuk Daek	Preaek Ton Leab	Preaek Ton Loab	10	18-Jul-06	Kry Thani	Leng Long
805060064	Kea Cheu	ក្លៀ ជឺ	Leuk Daek	Preaek Ton Leab	Preaek Ton Loab	6	Junly-06	Kry Thani	Leng Long

Plant code	Plant Owner Name	Khmer Name	District	Commune	Village	Plant Size	Date Completion	Supervisor	Mason
811060006	Um Sam Oeun	អ៊ុំ សំអឿន	Ta khmau	Kampong Samnanh	Kampong Samnanh	6	30-Apr-06	Sok Rotana	Arn Sok Roeun
811060027	Dy Sokha	ឌី សុខា	Ta khmau	Ta khmau	Praek Samroung	10	Junly-06	Ouk Sokun	Nghek Noeun
	Pun Tum	ប៉ុន ទុំ	Sáng	Ro ka khpos	Praek Thmei	6	7-Dec-06		
810060020	Touch San	ទូច សាន	Sáng	Touek vil	Praek Rang	6	June.06	Ouk Sokun	Yun Yoeun
810060019	Lonh Neang	ឡូញ នាង	Sáng	Sáng Phnum	Praek Khmer	4	8-Jul-06	Ouk Sokun	Yun Yoeun
802060025	Kim Dyna	គីម ឌីណា	Kien Svay	Samraong Thum	Sak Si	10	0	Kry Thani	Pech Kdeb
802060002	Ly Lin	លី លីន	Kien Svay	Samraong Thum	Chrouy Dang	8	19-Apr-06	Kry Thani	Pech Kdeb
802060028	Phum Mich	ភុំ ម៉ិច	Kien Svay	Preaek Aeng	Ro Bous Angkanh	8	2-Jun-06		
802060045	Uy Savy	អ៊ុយ សាវី	Kien Svay	Preaek Aeng	Chung Praek	10	6-Jul-06	Kry Thani	
802060046	Sam Seun	សំ សឿន	Kien Svay	Preaek Aeng	Chung Praek	10	Oct.06	Kry Thani	Sun Pengleang
802060001	Oak Chhoeun	អោក ឈឿន	Kien Svay	Preaek Aeng	Chung Praek	8	4-Apr-06	Kry Thani	
802060079	Meng Seng	ម៉េង សេង	Kien Svay	Dei Edth	Porpeal Khae	10	Nov.06	Kry Thani	Sun Pengleang
802060077	Chhem Phun	ឈឹម ភុន	Kien Svay	Dei Edth	Porpeal Khae	4	June.06	Sok Rotana	Chea Sokkhon
802060075	Sngourn Simorn	ស៊ួន ស៊ីមន	Kien Svay	Dei Edth	Koah Phous	4	1-Aug-06	Sok Rotana	Chea Sokhon
802060005	Tiang Hengly	តាំង ហេងសី	Kien Svay	Dei Edth	Sdov Kanleng	10	Oct.06	Kry Thani	Sok Piseth
802060038	Srun Sitha	ស្រួន ស៊ីថា	Kien Svay	Kokir	Tuol Tnot	10	15-Jul-06	Kry Thani	Leng Long
802060047	Born Heng	ប៊ុន ហេង	Kien Svay	Kokir	Tuol Tnot	8	Junly.06	Kry Thani	Chea Sokhon

Plant code	Plant Owner Name	Khmer Name	District	Commune	Village	Plant Size	Date Completion	Supervisor	Mason
802060003	Pong Savrin	ពង សេរិន	Kien Svay	Kokir	Tuol Tnot	4	10-Jul-06	Kry Thani	Long Bor
802060012	Chhun Bun Eng	ឈុន ប៊ុនអេង	Kien Svay	Kokir	Slab Ta Oan	6	21-Jun-06	Kry Thani	Nghek Noeun
802060010	Tea Sokorn	តឿ សុខន	Kien Svay	Phum Thum	Ror Teang	4	3-May-06	Kry Thani	
Kampong Cham									
301060085	Ouch Oun	អុច អួន	Batheay	Trab	Roung Damrey	8	1-Nov-06	Kong Sambath	Ear Art
	Oun Peun	អួន ពៀន	Batheay	Trab	Roung Damrey	8	Nov-06		
301060004	Som Reit	សុំ រ៉ែត	Batheay	Cheung Prey	Cheung Prey	8	Apr-06	Det Vanara	Ear Art
313060050	Mom Bunthong	ម៉ុំ ប៊ុនថុង	Prey Chhor	Mien	Khloy Tib	6	8-Jul-06	Kong Sambath	Sorn Barn
313060026	Men Vuthey	ម៉ែន វុទ្ធី	Prey Chhor	Trapeang Preah	Doung	6	16-Jun-06	Cheun Chet	Sorn Barn
313060003	Hun Tang oun	ហ៊ុន តាំងអួន	Prey Chhor	Trapeang Preah	Doung	4	1-Apr-06	Mam Daval	Sorn Barn
306060038	Krouch Chhan	ក្រូច ឆាន	Kampong Siem	Ou Svay	Prey Chak Krey	8	June.06	Cheun Chet	Li Sokha
306060109	Sem Seang Theng	សែម ស៊ាងថេង	Kampong Siem	Ou Svay	Prey Chak Krey	8	25-Dec-06	Cheun Chet	Li Sokha
306060101	Meach Chamreun	មឿច ចំរើន	Kampong Siem	Ou Svay	Prey Chak Krey	6	9-Dec-06	Cheun Chet	Li Sokha
306060056	Douch Lek	ខុច ឡេក	Kampong Siem	Han Chey	Krouch seuch	6	28-Jul-06	Mam Daval	Soam Thy
306060053	Seang Sok Khom	ស៊ាង សុកខុម	Kampong Siem	Han Chey	Krouch seuch	4	21-Jul-06	Kong Sambath	Soam Thy
306060043	Khin Meng Hour	ឃីន មេងហ៊ូ	Kampong Siem	Han Chey	Lve Te	10	3-Jul-06	Cheun Chet	Soam Thy
303060035	Morn Mork	ម៉ែន ម៉ក់	Cheung Prey	Sdaeung Chey	Pong Ror	8	June.06	Kong Sambath	Phin Savorng

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303060001	Sok Morn	សុខ ម៉ន	Cheung Prey	Sdaeung Chey	Pong Ror	4	31-Mar-06	Cheun Chet	By Pheap
303060002	Sou May	សូ ម៉ាយ	Cheung Prey	Sotip	Thmei	6	1-Apr-06	Kong Sambath	Phin Savornng
303060054	Heng Sy	ហេង ស៊ី	Cheung Prey	Prey Char	Pnov Keut	8	Junly.06	Kong Sambath	Phin Savornng
303060062	Dourng Thon	ដួង ធន	Cheung Prey	Prey Char	Pnov Keut	6	15-Aug-06	Kong Sambath	Phin Savornng
303060049	Hou Nareit	ហ៊ូ ណារ៉េត	Cheung Prey	Prey Char	Pnov Keut	6	Junly.06	Kong Sambath	By Pheap
303060022	Sim Suy	ស៊ឹម ស៊ុយ	Cheung Prey	Prey Char	Pnov Keut	6	June.06	Kong Sambath	Phin Savornng
303060010	Tai Pheach	តៃ ភៀច	Cheung Prey	Prey Char	Phnov Lech	6	11-Apr-06	Mam Daval	Phin Savornng
303060046	Un Kea	អ៊ុន គា	Cheung Prey	Prey Char	Pnov lech	6	10-Jul-06	Kong Sambath	Phin Savornng
303060021	Phol Phath	ផល ផាត	Cheung Prey	Srama	Trepeang Thmat	8	22-May-06	Kong Sambath	Phin Savornng
	Oun Reit	អ៊ុន រ៉េត	Cheung Prey	Srama	Trepeang Thmat	8	Dec.06	Kong Sambath	By Pheap
303060047	Math Hun	ម៉ាត់ ហ៊ុន	Cheung Prey	Srama	Trepeang Thmat	4	June.06	Kong Sambath	Phin Savornng
	Seik Noy	សែក ណយ	Cheung Prey	Srama	Trepeang thmat	4	Dec.06	Kong Sambath	Phin Savornng
311060083	Heing Khorn	ហេង ខន	Ou Reang Ov	Mien	Thmor Samleang	6	5-Oct-06	Chheang Sarith	korng Sokhon
311060051	Harb Chorn	ហាប ចន	Ou Reang Ov	Mien	Thmor Samleang	4	16-Jul-06	Chheang Sarith	korng Sokhon
311060072	Kang Oum	កង អ៊ុម	Ou Reang Ov	Mien	Kampol Serey	4	20-Sep-06	Chheang Sarith	korng Sokhon
311060066	Louch Seang horn	ឡូច ស៊ាងហន	Ou Reang Ov	Mien	Kampol Serey	4	0-Jan-00	Mam Daval	korng Sokhon
308060045	Seng Chhueng	សេង ឈឿង	Kaoh Soutin	Pong Ro	Preaek Romdeng Keut	6	27-Jun-06	Kong Sambath	Nay Buna

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308060091	Yib Yi	យីប យី	Kaoh Soutin	Pong Ro	Preaek Romdeng Keut	6	13-Nov-06	Mam Daval	Nay Buna
308060065	Khim Luhg	យឹម ឡុញ	Kaoh Soutin	Pong Ro	Orn Lung Dong	8	17-Aug-06	Chheang Sarith	Nay Buna
308060077	Khin Sopheap	យិន សុភាព	Kaoh Soutin	Peam Prathnaoh	Phsa Thmei	6	23-Sep-06	Chheang Sarith	Nay Buna
308060044	Heng Sokhom	ហេង សុខុម	Kaoh Soutin	Moha leaph	Damnak Preang Keut	4	30-Jun-06	Mam Daval	korng Sokhon
307060059	Yun Thoeun	យុន ធឿន	Kang Meas	Roka Ar	Svay Sranaoh	6	1-Aug-06	Chheang Sarith	Pove Sameudy
307060040	Tim Neang	ទឹម នាង	Kang Meas	Roka Ar	Chroy Krobau II	6	8-Jul-06	Cheun Chet	Tri Ser
307060041	Keo Vibol	កែវ វិបុល	Kang Meas	Roka Ar	Chroy Krobau II	6	10-Jul-06	Kong Sambath	Pove Sameudy
307060069	Vann Vy	វ៉ាន់ វី	Kang Meas	Roka Ar	Roka Ar	6	20-Sep-06	Cheun Chet	Mith Theara
307060033	Bun Chheng	ប៊ុន ឆេង	Kang Meas	Peam Chi Kang	Damnak Chhrey	6	22-Jun-06	Kong Sambath	Srim Chea
307060030	Por Kimsorn	ប៉រ គឹមសន	Kang Meas	Peam Chi Kang	Damnak Chhrey	6	0-Jan-00	Kong Sambath	Thai Sophoan
	Chhom Leangsae	ឆុំ លាងសៃ	Kang Meas	Peam Chi Kang	Sam Bourmeas	6	22-Dec-06		
307060015	Eaek Kim Lay	ឯក គឹមឡាយ	Kang Meas	Roka Koy	Svay Tahaen	4	11-May-06	Cheun Chet	Srim Chea
307060060	Sok Soeun	សុខ សៀន	Kang Meas	Kang Ta Noeng	Phoum Ti Bey	6	3-Aug-06	Chheang Sarith	Mith Theara
307060073	Ung Phun	អ៊ុង ផុន	Kang Meas	Kang Ta Noeng	Kang Ta Noeng	8	Nov.06	Chheang Sarith	Tri Ser
307060081	Phen Sokha	ផេន សុខា	Kang Meas	Kang Ta Noeng	Kang Ta Noeng	6	10-Oct-06	Chheang Sarith	Tri Ser
Svay Reang									
2007060024	Mey Saron	ម៉ី សារ៉ន	Svay Teab	Svay Rumpea	Samor	6	June.06	Pa Sophy	Sum Vanna

Plant code	Plant Owner Name	Khmer Name	District	Commune	Village	Plant Size	Date Completion	Supervisor	Mason
2007060023	Phin Mom	ភិន ម៉ុម	Svay Teab	Sangkhoar	Preah Tonle	4	10-Jul-06	Pa Sophy	Ngoun Sam Ann
2007060035	Ouk Kongkea	អ៊ុក គង្កា	Svay Teab	Sangkhoar	Preah Tonle	4	12-Aug-06	Pa Sophy	Sum Vanna
2007060036	Orn Mannat	អ័ន ម៉ាន់ណាត	Svay Teab	Sangkhoar	Preah Tonle	4	17-Aug-06	Pa Sophy	
2007060040	Pork Sok	ប៉ក សុខ	Svay Teab	Sangkhoar	Preah Tonle	4	Aug.06	Pa Sophy	Sum Vanna
2007060018	Saom Sarorn	សោម សារ៉ន	Svay Teab	Kokir Saom	Sangkum	6	26-Apr-06	Pa Sophy	
2002060007	Tourn Seang	ទួន ស៊ាង	Kampong Rou	Tnaot	Thum	6	Apri.06	Chan Troeung	In Re
2002060026	Van chab	វ៉ាន់ ចាប	Kampong Rou	Tnaot	Kbal Thnal	6	June.06	Chan Troeung	In Re
2002060006	Nuth Som Ouen	នុត សំអឿន	Kampong Rou	Samyaong	Russey Thmei	6	20-May-06	Meas Samoeun	Yat Saren
	Aok Thy	អោក ធី	Kampong Rou	Samyaong	Russey Thmei	4	21-Dec-06		
2002060029	Nhem Sa Reurn	ញឹម សារឿន	Kampong Rou	Samyaong	Sam Yaong	8	17-Jul-06	Chan Troeung	Chan Chin
2002060027	Ros Phoeun	រស់ ភឿន	Kampong Rou	Samyaong	Russey Lieb	8	7-Jun-06	Chan Troeung	Soam Cheun
2002060042	Meas Seun	មាស សឿន	Kampong Rou	Svay Ta Yean	Bosse	4	Sep.06	Chan Troeung	Chan Chin
2002060037	Chhun Rotha	ឈុន រដ្ឋា	Kampong Rou	Svay Ta Yean	Pour Thmey	6	9-Aug-06	Chan Troeung	Sok Sarith
2002060044	Mouv Montha	មូវ មុន្តា	Kampong Rou	Svay Ta Yean	Prey Chneang	4	14-Sep-06	Chan Troeung	Soam Cheun
2001060032	Thaong Nab	ថោង ណាប	Chantrea	Chres	Trapeang Thlork	6	Junly.06	Pa Sophy	Tep Sao
2001060022	Yin Samnang	យិន សំណាង	Chantrea	Chres	Trapeang Thlork	4	Junly.06	Pa Sophy	Tep Sao
2001060021	Marng They	ម៉ាំង ថី	Chantrea	Chres	Trapeang Thlork	4	Junly.06	Pa Sophy	Tep Sao

Plant code	Plant Owner Name	Khmer Name	District	Commune	Village	Plant Size	Date Completion	Supervisor	Mason
2001060033	Srey Nau	ស្រី នៅ	Chantrea	Chres	Trapeang Thlork	4	27-Jul-06	Pa Sophy	Tep Sao
2001060034	Kong Sarin	គង់ សារិន	Chantrea	Chres	Bonla Sa Et	6	6-Oct-06	Pa Sophy	Tep Sao
2001060041	Ouch Sopha	អុច សុផា	Chantrea	Chres	Trapeang Dearleu	6	22-Aug-06	Pa Sophy	Tep Sao
2001060014	Ouch So Ny	អុច សូនី	Chantrea	Chres	Trapeang Dearleu	4	Apri.06	Pa Sophy	Tep Sao
2001060013	Svay Sokhon	ស្វាយ សុខន	Chantrea	Chres	Trapeang Dearleu	4	Feb.06	Meas Samoeun	Tep Sao
2005060045	Harb Silaen	ហាប ស៊ីឡែន	Svay Chrum	Ta Suos	Boeung Andaeng	4	16-Sep-06	Ou Sophal	Soam Deun
2005060031	Chev Lay	ជេវ លី	Svay Chrum	Kraol Kou	Prey Nhay	4	Sep.06	Ou Sophal	Pum Por
2005060003	Kruy Lay	ក្រុយ ឡាយ	Svay Chrum	Kraol Kou	Krol Kour	4	4-May-06	Ou Sophal	Pum Por
2005060002	Neang Loeng	នាង ឡឹង	Svay Chrum	Kouk Pring	Svay Brohout	4	17-Apr-06	Ou Sophal	Pum Por
	Suon Sambat	សួន សម្បត្តិ	Svay Chrum	Kouk Pring	Chambork Thloeng	4	26-Nov-06		
2005060001	So Sameng	សូ សាម៉េង	Svay Chrum	Kouk Pring	Chambork Thloeng	4	8-Apr-06	Ou Sophal	Pum Por