Asian Development Bank

Greater Mekong Subregion

Capacity Building for Efficient Utilization of Biomass for Bioenergy & Food Security in the GMS [TA7833-REG]

FINAL REPORT:

Feasibility for a Planned Pilot Investment Project for Scaling-Up Proven Biogas Technology and Efficient Bioslurry Management Practices, Cambodia

October 2013

Landell Mills
DEVELOPMENT CONSULTANTS

nexus
Carbon For Development

KEY DATA

Name of Project:	Capacity Building for Efficient Utilization of Biomass for Bioenergy & Food Security in the GMS TA-7833 REG
Contractor:	Landell Mills Limited (LML), Bryer-Ash Business Park, Trowbridge, Wiltshire, BA14 8HE, UK Tel: +44 1225 763777 (www.landell-mills.com) in consortium with: Nexus Carbon for Development (Nexus), #33 E3 Sothearos Blvd, Corner St. #178, Phnom Penh, CAMBODIA (www.nexus-c4d.org)
Contracting Authority:	Asian Development Bank (ADB)
Start/End Date:	15 Dec 2011 - 15 March 2015
Budget:	N/A
Beneficiary:	Ministries of Agriculture of Cambodia, Lao PDR and Viet Nam
Location:	Greater Mekong Subregion, incl. Cambodia, Lao PDR and Viet Nam

QUALITY ASSURANCE STATEMENT

Version		**Status**	**Date**
Feasibility for a Planned Pilot Investment Project for Scaling-Up Proven Biogas Technology and Efficient Bioslurry Management Practices, Cambodia		Final	22/10/2013
	Name	**Position**	**Date**
Prepared by:	[redacted]		[redacted]
Checked by:	[redacted]	[redacted]	[redacted]

Report submitted by
LANDELL MILLS LTD

This report was prepared at the request and with the financial support of the ADB. The views expressed are those of the Consultants and do not necessarily reflect those of the Government or the ADB.

Contents

LIST OF FIGURES

LIST OF TABLES

LIST OF ANNEXES

ABBREVIATIONS

ADB	Asian Development Bank
CIEDC	Cambodian Indian Entrepreneurship Development Centre
COMPED	Cambodian Education and Waste Management Organization
DAPH	Department of Animal Production and Health
GHG	Green House Gas
IFAD	International Fund for Agricultural Development
MAFF	Ministry of Agriculture, Forestry and Fisheries
MECAR	Mekong Carbon
NBP	National Biodigester Programme
NEDO	New Energy and Industry Technology Development Organization
PADEE	Project for Agriculture Development and Economic Empowerment
PBPO	Provincial Biodigester Programme Office
PPI	Preah Kosamak Politechnique Institute
SNV	The Netherlands Development Organization

EXECUTIVE SUMMARY

In March 2006, the Ministry of Agriculture, Forestry and Fisheries (MAFF) and SNV agreed on the joint development of a National BiodigesterProgramme (NBP) as a way to create a permanent national domestic bio-digester sector for the dissemination of household bio-digesters as a clean, sustainable energy source in Cambodia and to utilize the fertilizing potential of bio-slurry. Although NBP has successfully introduced the biogas technology by constructing almost 20,000 biodigester plants by 2012 throughout thirteen provinces of Cambodia, namely Kampong cham, Kandal, Svay Reang, Takeo, Kampong Speu, Kampong Chhnang, Kampot, Kep, Sihanouk ville, Prey Veng, Siem Reap, Pursat and Kampong Thom. It is necessary to further improving this work via various supports.

By reviewing and assessing the current development of biogas technology with stakeholders and the Government of Cambodia, the ADB TA7833 has identified the continued development of this technology with more appropriated options to fit Cambodian context on the plant design and bio-slurry management to reduce environmental risk and increase profitability as a priority technology to be demonstrated for wider adoption. In addition, in the second phase from 2013-2016, NBP has focused on up-scaling and commercialization of the biogas sector. Recently, NBP has been working on PADEE project aiming at developing a pro-poor biodigester model including bio-slurry management component.

Study approach

In supporting the 2nd phase of NBP, this study is looking at (1) the possibility of introducing a new biodigester plant design and (2) the improvement of bio-slurry management in a pilot province of Takeo. The approach is as follow: first a literature review on current and existing plant design and bio-slurry management were conducted following by key informant meeting with stakeholder DAPH, SNV and NBP, second, the field visit was conducted in the selected pilot areas where 75 biodigester users and 30 non biodigester users were interviewed and finally, a consultative workshop was held to collect all the comments and integrated them into the final report.

Situation of biodigester users' families

Based on the survey, most of the biodigester users are better off families whose houses 55% are wooden house with zinc roof/tile, 39% are wooden house with half brick and 5% are brick house. The average member in the family is 5.33 people with 70.67% are below 18 years old. The monthly average income is US$187.5 while the monthly average expense is US$145.5. That means in average US$24.00 is saved per month per family. The user owns in average of 3.25 adult cows per family and they are kept in stable 17.7h per day.

Biodidgester usage and its benefit

The average size of the 75-surveyed biodigesers is 4.9m^3 with the cost of USD 480.00. The majority of the users are satisfied with their plants and the cost is acceptable. According to the surveyed data, 97% of the users are happy with the plant performance, except 3% in which their plants could not produce enough gas for cooking. This problem was caused by the low amount of animal manure fed into biodigester. The daily average feeding per plant is

24.68kg of cow dung which are just enough for the daily average cooking of 1h30mn and 3h for lighting as mentioned by users in this study. The users can save about USD10.00 per month from buying fuel wood for cooking and 1h20mn time from firewood collection and cooking. Among the interviewed users, once they were asked about the new option for biodigester plant, 75% preferred NBP current plant model, while 23% wanted to try the new prefabricated model due to its fast construction and durable.

Bio-slurry management is in poor condition only 24% of users have compost hut. Four main reasons of not having the compost hut constructed were: "No Money" (44%), "No Labor"(23%), "Busy" (19%), "Broken"(12%) and "Take to the field directly"(2%). However in average 7 tons of bio-slurry compost were produced per year and it can reduce about haft of their yearly chemical fertilizer use 200kg per 1.1ha of rice field. This means 100kg of chemical fertilizer was saved per year which is equal to USD50.00.

Situation of non biodigester user's families

With the criteria of having at least 2 adult cows that can produce at least 20kg of dung per day, the majority of non users household are wooden with zinc roof or tile. The average member in the family is 5.41 people with 87.4% are below 18 years old. The monthly average income is US$166.33 while the monthly average expense is US$147.30. That means in average US$19.00 is saved per month per family. The user owns in average of 2.85 adult cows per family and they are kept in stable for 16.8h per day. In average the interview household used about 3.8 kg of fuel wood per day which comparable to the result of the Kitchen performance survey by NBP in early 2013, 3.1kg per family. The family spent in average about $11.00 per month on fuel wood for cooking. Related to the knowledge on biodigester technology, all of the non-biogas users know about NBP's biodigester model and majority of them want to have it, except some prefer composite plants because they look modern, durable and can be built faster.

Proposed pilot plan and budget

a) Improvement of biodigester plant design

Based on the survey of three different groups, biodigester users, non biodigester users and local authorities, it was shown that 24% of them preferred installing composite plant while 72% stuck to existing NBP's model, meaning there are some demands for the prefabricated plant. With the result of the survey and judging from technical point of view as well as the development trend, composite model plant has the potential to be introduced in Cambodia due to (1) fast installation time, (2) space saving, (3) gas tight and (4) movable plant, although its higher cost (no local workshop can produce it yet) and short cut digested slurry remain the challenges for this model. In addition, with the constraint of labor shortage, the high dropout rate of NBP certified mason (65%) and the increasing cost of NBP's current model, composite model is in the better position to cope with these issues. To confirm on the above finding and assumption, this model should be tested in the pilot project and if it proved to be successful it should be integrated into NBP design which will give NBP a full option for the clients with different models PADEE's model, NBP's farmer's friend model and composite's model.

In the project, five pilot plants will be imported and installed for monitoring and evaluation on it performance. Then if it proves to be success, the local workshop will be selected and train to produce the plant, locally and the model will be included in NBP's product list.

Improvement of bio-slurry management

It is surprised that most of the user acknowledged the benefit of fertilizer use but only 24% of them have managed the slurry properly by constructing a compost hut while the others did not. It is understood that NBP has been actively promoting the bio-slurry management via trainings, awareness raising, exchange visits, setting up model farms…etc. However, the adaptation of farmers is still limited due to some difficulty as stated below:

- Difficult to carry the slurry from slurry pit to the compost hut
- No labor to build compost hut
- No time to build compost hut
- Not enough money to build a solid structure and a long last use of compost hut
- The compost hut was eventually damaged after using for a while

Through the study, it is pointed out that farmers need to see the value of their bio-slurry in a more visible way and that will provide the incentive for them to manage it well. Thus, this study proposes a pilot project that will eventually become the win-win strategy for all. In collaboration with rice miller (Sok Keo import expert co. ltd.) in Takeo province, the project will help to set up a bio-fertilizer production plant in the rice mill compound by using bio-char and bio-slurry compost. The main outputs of the project are:

(1) Bio-slurry handling from outlet tank to slurry hut will be improved
(2) Composting technique will be improved
(3) Composting production will be set up and tested
(4) Field testing using pellet of mix bio-char compost fertilizer will be put in place
(5) Training and promotion will be carried out

b) Budgeting

The project will be implemented by NBP with technical support from COMPED on composting activity with the period of 12 months. The total budget is estimated to be USD 93,720.00 which covers both parts improvement of biodigester plant design and bio-slurry management.

1. INTRODUCTION

1.1 Background of the study

In March 2006, the Ministry of Agriculture, Forestry and Fisheries (MAFF) and SNV agreed on the joint development of a National BiodigesterProgramme (NBP) as a way to create a permanent national domestic bio-digester sector for the dissemination of household bio-digesters as a clean, sustainable energy source in Cambodia and to utilize the fertilizing potential of bio-slurry.

NBP has successfully introduced the biogas technology by constructing about 20,000 biodigester plants by 2012 in thirteen provinces of Cambodia, namely Kampong Cham, Kandal, SvayRieng, Takeo, Kampong Speu, Kampong Chhnang, Kampot, Kep, Sihanouk ville, Prey Veng, Siem Reap, Pursat and Kampong Thom. Despite such success, it is necessary to further improve this work with various supports.

By reviewing and assessing the current development of biogas technology with stakeholders and the Government of Cambodia, the ADB TA7833 has identified the continued development of this technology with more appropriated options to fit Cambodian context on the plant design and bio-slurry management, which in turn it can reduce environmental risk and increase profitability as a priority technology to be demonstrated for wider adoption.

This feasibility study will cover two main important parts (1) study on the possibility to introduce a new biodigester plant design which is preferably a prefabricated plant to Cambodia and (2) the feasibility of slurry management on existing and future biodigester plants.

1.2 Objective of the study

To conduct a feasibility study for scaling up biogas technology by looking at the possibility of introducing new biodigester plant design and improving thebio-slurry management in a pilot province of Takeo.

1.3 Scope of the study

The study is limited to only two districts namely Tram Kak and Samroang, where the pilot project was planned. The two districts have high number of biodigester users and they can be accessed for the purpose of project implementation. The total duration of study was three months beginning in July and ending in October 2013.

1.4 Study team member

This study was carried out by Mekong Carbon Co., Ltd (MECAR) but it was commissioned by Landell Mills Ltd (LML) under its contract with ADB's Capacity Building Technical Assistance (TA) 7833. Members of theMECAR study team were as follow:

No	Name	Position	Organization	Email
1	Mr. SarSamnang	President/ Financial Expert	Mekong Carbon Co., Ltd	sarsamnang7@gmail.com
2	Mr. MengChanvibol	Team Leader, Biogas Expert	Mekong Carbon Co., Ltd	chanvibolmeng@gmail.com
3	Mr. San Vibol	Environmental Expert	Mekong Carbon Co., Ltd	sanvibol@gmail.com
4	MrSaoBotumroath	Social Expert	Mekong Carbon Co., Ltd	botumroath.sao@gmail.com

5	MrKong Kea	Agronomist Expert	Mekong Carbon Co., Ltd	kea_ipm@hotmail.com
6	Mr. SroeyChannann	Survey enumerators	Mekong Carbon Co., Ltd	channann016@gmail.com
7	Miss MoungDalin	Admin & Account staff	Mekong Carbon Co., Ltd	dalinmong@gmail.com

Table 1.4-1 Study team member

2. STUDY METHODOLOGY

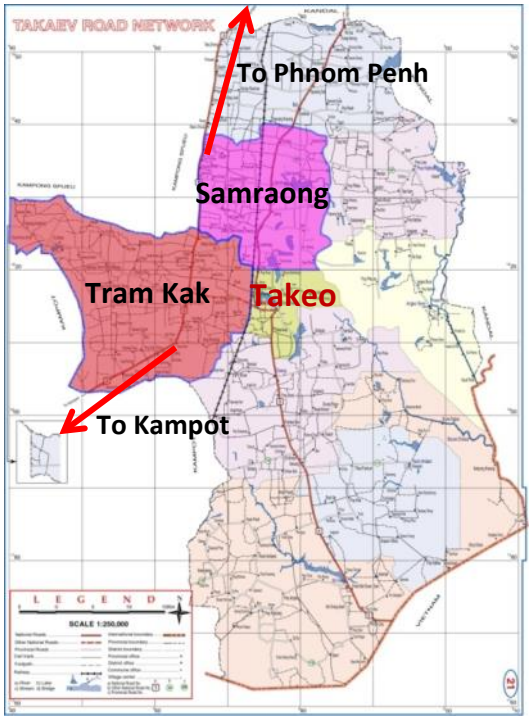
2.1 Study approach

The study approachis described as follow:

a) Desk study on existing and availability of bio-digester plant technology as well as bio-slurry management system.
b) Meeting with key informants or concerned organization such as Department of Animal Production and Health (DAPH), NBP, Provincial BiodigesterProgramme Office (PBPO), SNV.
c) Social and technical field survey on both biogas users and non-biogas users
d) Data analysis and compiling report
e) Consultative meeting and workshop with all stakeholders to present the result and collecting comment and suggestion
f) Final report submission

2.2 Study location

Figure 2.2-1 Map of study location (a)



No	Name of district	# plant 2006-2012	# plants with compost hut
1	Samraong	835	151
2	Tram Kak	778	126
3	Prey Kabbas	706	23
4	Angkor Borei	359	12
5	Treang	295	15
6	Bati	290	45
7	KiriVong	112	9
8	KaohAndaet	70	1
9	DounKaev	46	2
10	BoureiCholsar	26	0
	Total	3517	384

Source: National BiodigesterProgramme (NBP)

Figure 2.2-2 Map of study location (b)

2.3 Data collection

Data collection was conducted through (1) literature review and meeting with key informants and (2) field survey which includeddiscussing with biogas users, non-biogas users, masons, local authorities, rice millers and producer of compost pellet fertilizer.

2.3.1 Literature reviews

Various prefabricated biogas plant designs and bio-slurry management were reviewed basing on NBP's study reports and documents available on the internet. In addition consultation meeting with key informants the recommendation and information from those related experts are very valuable to sharpen the study.

2.3.2 Field surveys

Field surveys were conducted in two selected districts; Samraong and Tram Kak. Six villages with high number of biodigester were selected in each district for this survey. In each village, households having bio-digesters were used as the weight in order to determine the number of respondents. Households having biodigesters built prior to the end of 2012 were obtained from the data reported in NBP. These data were used as the sampling frame; and respondents were chosen through a random sampling method.

Based on the Terms of Reference (ToR) of the study, the total number of samples with biodigester was 75 in the two districts. For this survey, 35 and 40 samples were selected from Tram Kak and Samroang districts, respectively taking into account the percentage biodigesters in both districts. The names of respondents in each village are shown in annex 2.

To understand the situations of households without bio-digester (potential clients), 30non biogas users (13 families and 17 families) were respectively chosen from Tramkak and Samraong districts. Although only 25 non biogas users were proposed in ToR, our research team decided to add 5 more samples so as to provide better representing information, see annex 3. The criteria of the selection were based on a minimum of 2 adult cattle in the chosen household and respondents were then randomly selected for surveys. To make sure that all team members understand the survey methods and criteria, a one-day pre-survey meeting and field testing was organized to test the questionnaires and getting the feedback from the field.

2.4 Data analysis

The interview consists of a total of 111 questions for biogas users. All closed questions or questions with pre-determined answered were computed in a SPSS database that was developed specifically for this purpose. After completing data entry in SPSS, the data were finally exported to "Office Excel" for analyzing.

3. CURRENT SITUATION OF BIOGAS USERS AND NON BIOGAS USERS

3.1 Biogas users

75 Biodigester users were interviewed to assess their perception on the use of biodigester, family situation before and after having biodigester and other related information. The results are described in the flow of the overall biodigester system which composed of five parts including feeding, biogas usage, biodigester, bio-slurry management and bio-slurry usage as described in the figure 3.1-1

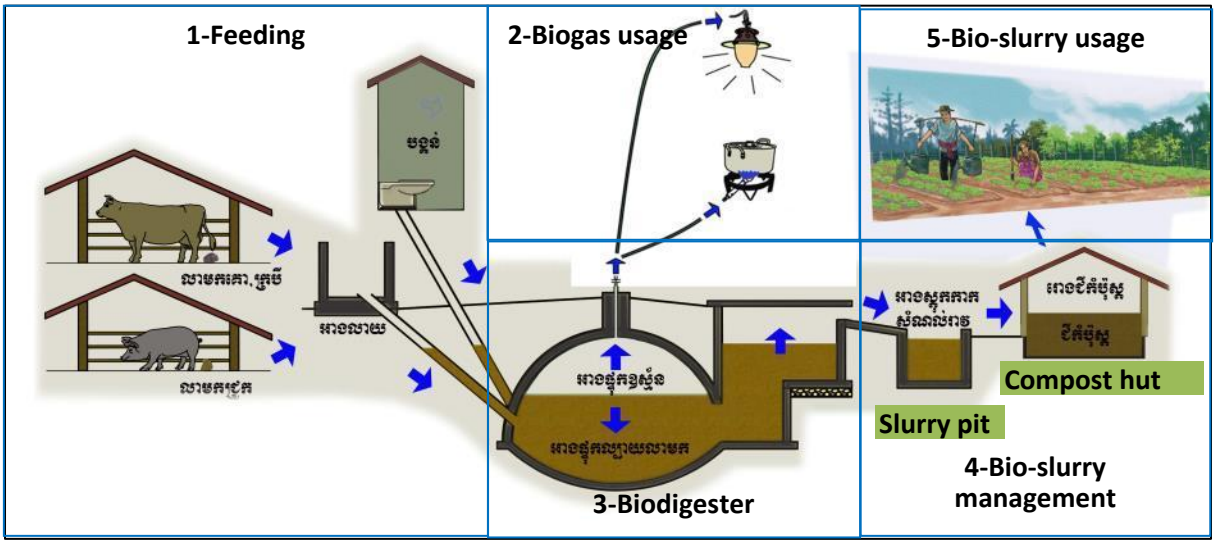


Figure 3.1-1: Overview of biodigester system

3.1.1 Socio economic

1) Type of house

Most households in the sample live in wooden houses in which 55% are wooden house with zinc roof/tile, 39% are wooden house with half brick and 5% are brick house. Only 1% of them live in wooden house with palm leave as shown in Figure 3.1-2.These results suggest that the economic situation of those household are better than the average rural Cambodian households and these explain why they could afford to have a biodigester.

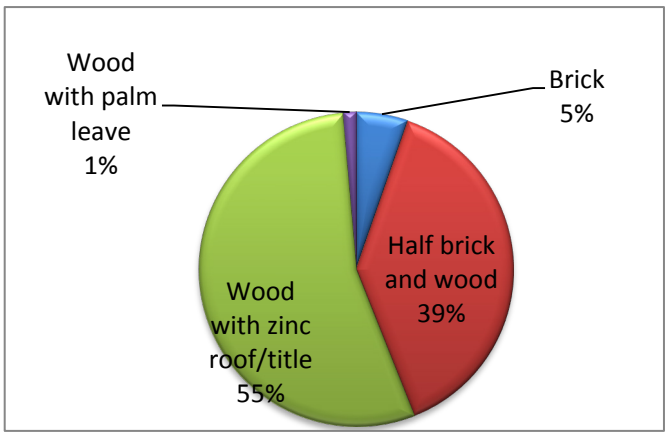


Figure 3.1-2 Type of house of biogas users

2) Household characteristics

The average household size is 5.33 people including (grand) parents and children. The families have an average of 2 children, 70.67% are below 18 years old and 77.61% of them go to school, as some are in the pre-school age category. The education level of the spouse is higher than that of the household head, with 11% of the household head having finished high school which compared to 13% of the spouse.

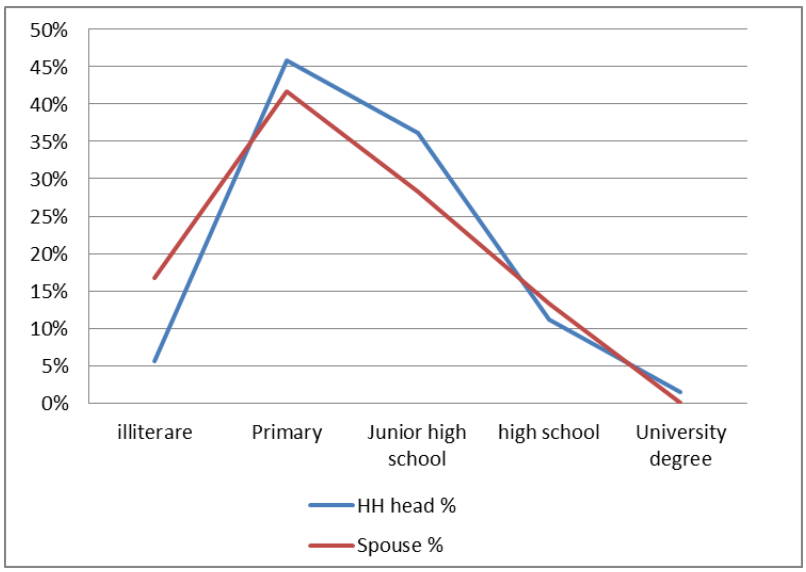


Figure 3.1-3 Level of education of household head and spouse in percentage

3) Income and expenditure

The combined income of monthly salaries such as government employee, teacher or NGO worker and the farm income from selling rice or pigs (costs are deducted) is calculated at US$187.5 per month or US$6.25 per day. The estimated yearly income is about US$ 2,250.
On average households spend about US$ 4.85 per day or US$1770.25 per year on food, transport, education, socialization and other small expenditures.

4) Impact of the Project on Gender Attitudes

Most of the beneficiaries saw that the project has generated jobs for them, and these jobs are suitable for women. The women always involved with all stages of the project, starting from decision for buying plant 83%, manure collection and mixing 81%, to use of bio-gas (for cooking) 99% and maintenance 73%.

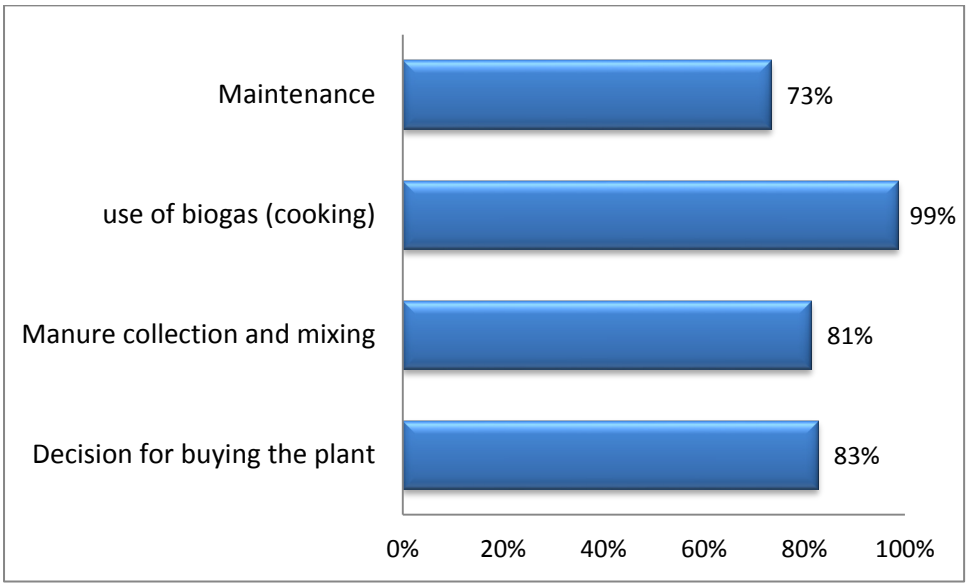


Figure 3.1-4 Involvement of women in biodigester work

Moreover, the data indicate that women were very important in decision-making. The husband and wife always discussed each other for decision-making to build bio-digester but wife is the final decision maker in terms of financial aspect.

Chart below shows the percentage of decision making in the household in respect to building the bio-digester.

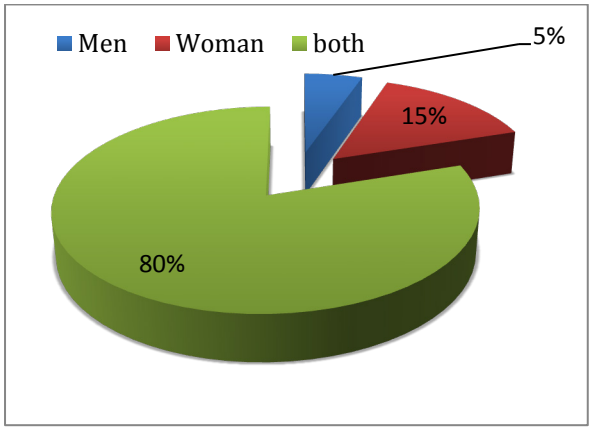


Figure 3.1-5 Decision making in building biodigester

5) Perspectives on the Range of Poverty Levels

The study made use of the Ministry of Planning (MoP)'sGTZ Identification of the Poorest Households module, which is a self-rating exercise providing a poverty range of the households. This is a comparative exercise on how they perceive themselves against other families within their community and how they use income and other poverty indicators, such as availability of food, land, work animals, residence and money among others.

The exercise showed that in a score range-- with the very poor scoring 59-60; the poor scoring 45-58 and the non-poor scoring from 0-44, most beneficiaries of the project place themselves at a mean poverty score of 94.60%. This meant that many see themselves as non-poor.

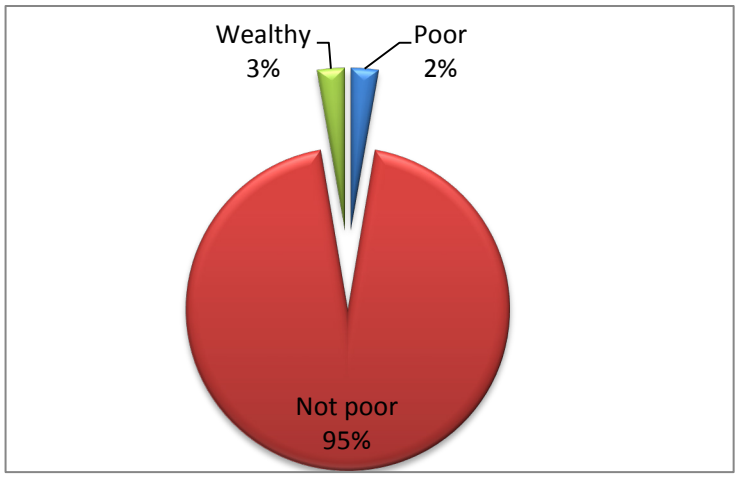


Figure 3.1-6 Self rating of biogas users

Another consideration is the perspective of the household whether they have moved up or down the poverty ladder in consideration of the factors they cited.Results showed that about 74% said they have moved up, 20.80% said there was no change while 5.20% said they moved down. The positive perspective based on two main reasons, namely they have more time to do a business and more time for farming.

For those having to pay for loan, having health problems and shortage labor in their family preferred to say "no change income".

3.1.2 Situation of biodigester and its use

1) Cost of biodigester

Based on the survey, the average total cost per plant isUSD480 with the average plant size of 4.9m^3. The majority of the users are satisfied with their plants and the cost is acceptable to them. According to the survey, 97% of the users are happy with the plant performance, except 3% in which their plants could not produce enough gas for cooking. This problem was caused by the low amount of animal manure fed into biodigester.

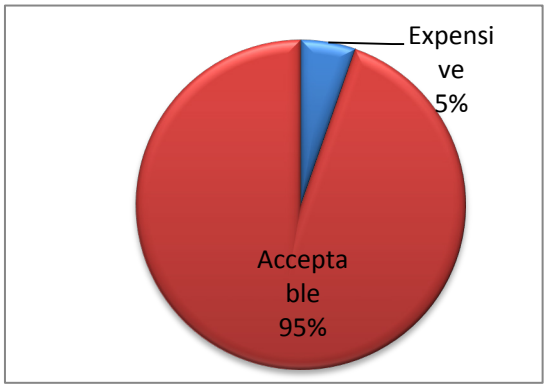


Figure 3.1-7 Perception of biogas user on the cost of biogas plant

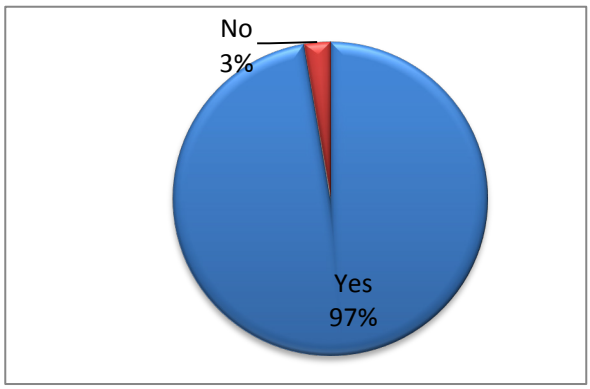


Figure 3.1-8 Level of satisfactory on biogas plant

Only 7% of users know other model (plastic type) in addition to NBP's model. A quick survey was done to evaluate what kind of biodigester model they like the most by showing the photos of five different models with explanation on each of model in terms of strong and weak points as well as the related costs. The result shows that among biodigester users 75% preferred NBP current plant model, while 23% wanted to try the new prefabricated model. On the other hand from local authority point of view, only 29% showed their interests in the current NBP's model, while the remaining 71% were very interested in the new modern plant model, composite plant.

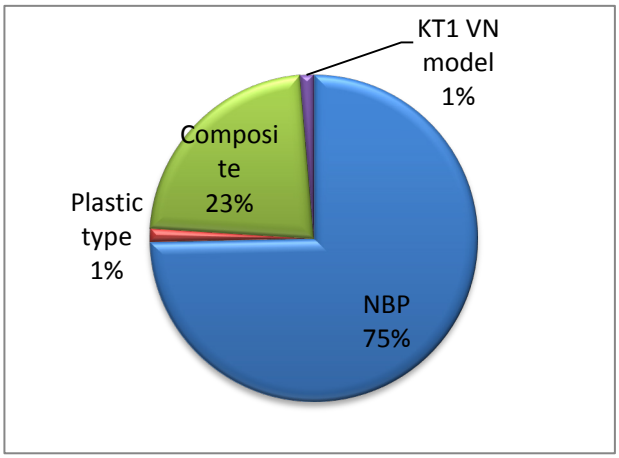


Figure 3.1-9 View of user's preferences on new model

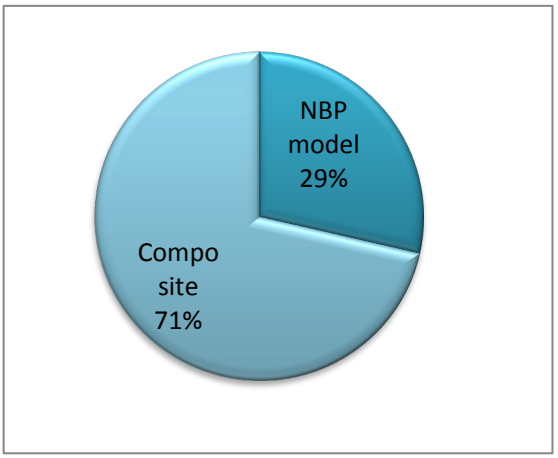


Figure 3.1-10 View of authority on new biogas model

2) Biodigester feeding

Although the plant can be fed by many kinds of manures, it is clear that 100% of the plant are primary fed by cow dung in average 24.68 kg while additional feeding are from pig manure with 10.68kg in average. However, only 25% of plants were fed by this pig manure. In addition, only 9% of the plants have toilet connection. This means that beside daily feeding with 24.68kg of cow dung in average, 25% of farmer supplementaryadded10.68 kg of pig manure into the plants; and 9% of biodigester plant owner additionally feed human excrement via toilet connection into biodigester.

Description	Cow dung (kg)	Pig manure (kg)
Average feeding	24.68	10.68
Percentage of plants fed by each type of manure	100%	25%

Table 3.1-1 Amount of manure fed in biodigester

3) Use of biogas

All biogas owners use biogas for cooking and boiling with the average of 1h30mn per day while only haft of them use it for lighting in average of 3h per day and just five percent use it for animal food preparation especially for piglets.

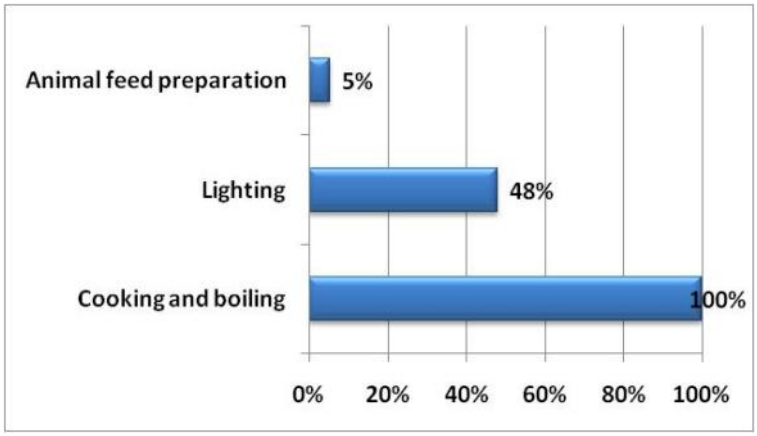


Figure 3.1-11 Use of biogas

Most of the household still keep their fuel wood stove to be used when they need to cook more for special events such as for gathering party during Khmer New Year, Pchum Ben's day…etc. Otherwise, during the normal cooking day, 63% have sufficient gas for cooking, 24% more than enough while only 13% don't have enough gas. The reason for insufficient gas is due to less feeding, which is in average of only 17 kg per day.

By comparing the table 3.1-1 and the figure 3.1-12, it can be seen clearly that the amount of feeding and the gas consumption are very much correlated, for example the 24% of biodigester users who claim to have more than enough biogas for use are the users who feed their plants with both cow dung (24.68kg) and pig manure (10.68kg), while the 63% of users who declare to have enough biogas for use are the users who feed daily their plants with cow dung (24.68kg). The remaining 13% who complaint for not having

enough biogas for use are corresponded to those who feed daily only 17kg of cow dung into their biodigesters.

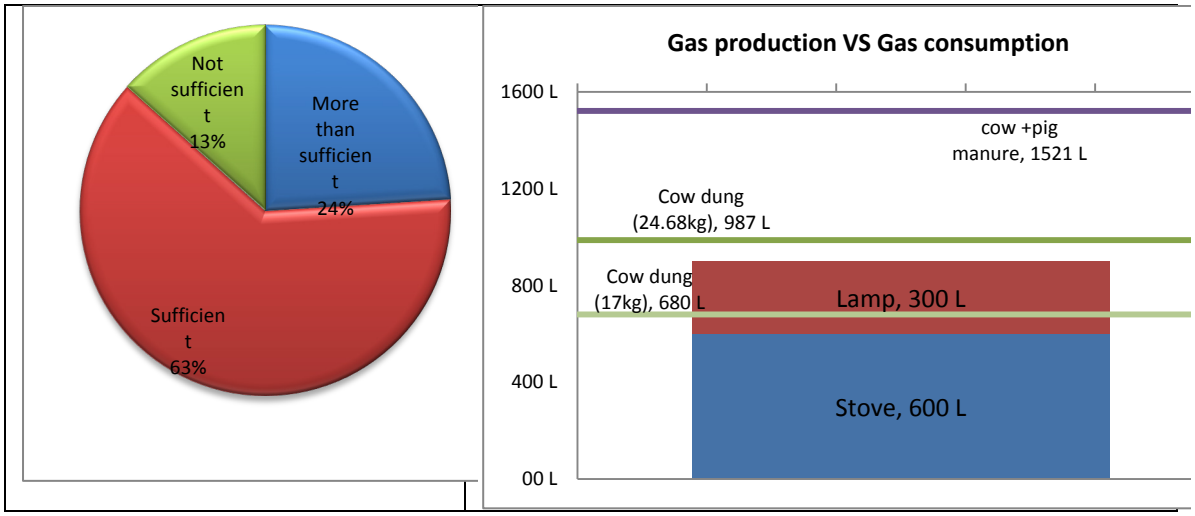


Figure 3.1-12 Situation of biogas use

4) Benefit of biogas use

The awareness on the benefit of biodigester is very high. Respondents using bio-digester for cooking and boiling, fertilizer, improved hygiene and lighting were 100%, 95%, 80% and 80%, respectively. In average, users can save about USD 10.00 per month from buying fuel wood and 1h20mn from firewood collection and cooking time.

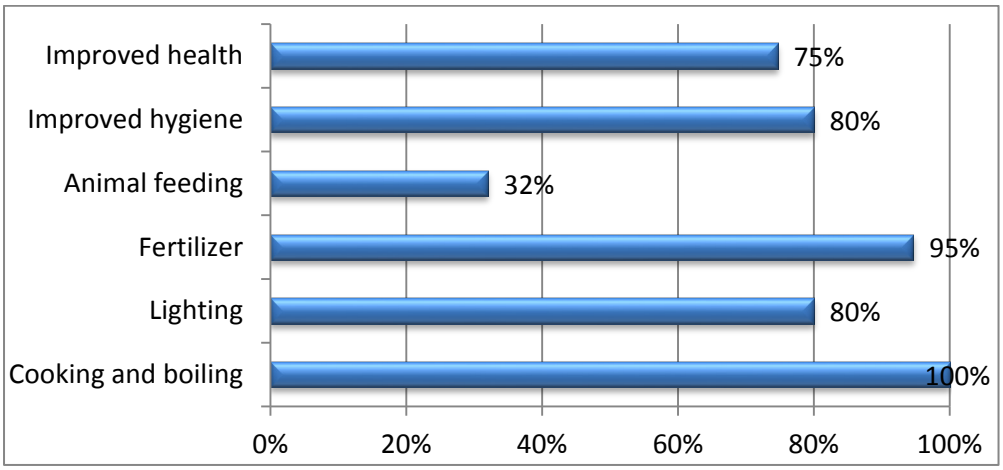


Figure 3.1-13 Awareness of biogas users on benefit of biogas

3.1.3 Animal holding

In Cambodian rural areas, farmers like traditionally raising cattle for dragging force and keeping them as the saving property, while pig raising is less popular due to the unstable market.

1) Average number of animals per family

The average number of animals per household including young and adult cow and sow and piglet are1.8, 3.25, 4.3 and 3.36 heads, respectively. However, the share per household is not equal with 100% of users owning 3.25 adult cows while only 39% of household had young cow with an average of 1.8 heads.

Description	Cow		Pig	
	Youngster	Adult	Piglet	Sow
Average animal per household	1.8	3.25	4.3	3.36
Percentage of household that has animal	39%	100%	16%	33%

Table 3.1-2 Average animal per household of biogas user

2) Animal stable hours

Stable hours are the duration that animals are not used in the field. The number of hours that cattle are stable in rainy season is at around 19.7 h, four hours longer than that of dry season. This is because in rainy season, farmers grow rice in the field where normally is used as grazing field for cattle. In average the cattle are stable about 17.7 hours per day. That means the total hour they are in the field is less than 7h.

Description	Hours of stable (h/day)
Cattle stable in rainy season	19.7
Cattle stable in dry season	15.67
Average	17.70

Table 3.1-3 Number of hours cattle stay in the stable

3.1.4 Bio-slurry storage and use

1) Bio-slurry storage

With the current NBP's biodigester design system as shown in figure 3.1-1, slurry pit is recommended to build between outlet of biodigester plant and compost hut. According to the survey, 85% of the plant attached with slurry pit while the remaining 15% did not. The function of slurry pit is to store the slurry temporary to be used in liquid form in gardening around the house and to make the good compost by taking it manually and spray on the waste in the compost hut layer by layer. The study also observes that there were additional workloads to bring slurry for making compost. In figure 3.1-14 shown that 57% of users found it as a fairly work while 34% found it difficult and only 9% found it very easy work.

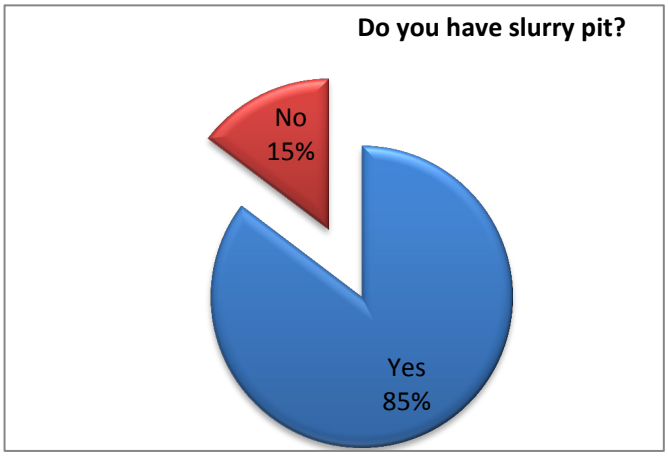


Figure 3.1-14 Percentage of household having slurry pit

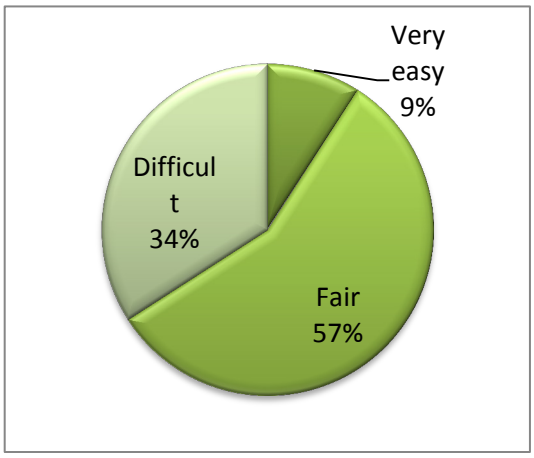


Figure 3.1-15 Work of taking slurry to compost hut

Moreover, based on survey data, the majority of the users were informed by NBP programme to build the compost hut to maximize their saving by reducing chemical fertilizer use. However, as seen in figure 3.1-15, only 24% of users had compost hut built properly, while the other 76% did not. The four main reasons of plant owners that did not construct the compost hut were: "No Money" (44%), "No Labor"(23%), "Busy" (19%), "Broken"(12%) and "Take to the field directly"(2%) as stated in figure 3.1-17.

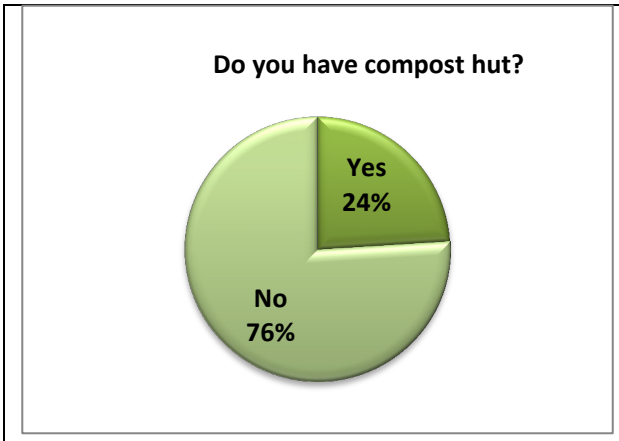


Figure 3.1-16 Percentage of household having compost hut

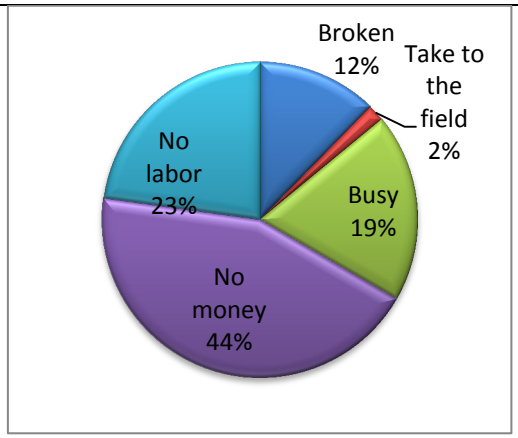
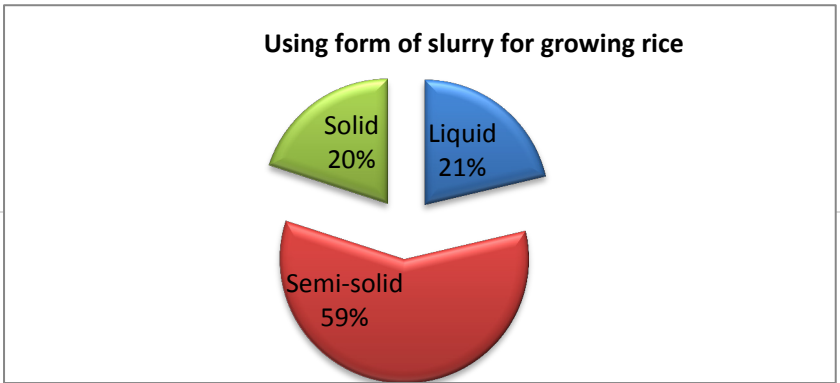


Figure 3.1-17 Reasons of not constructing compost hut

2) Bio-slurry use

Based on the survey data, the biodigester users save in average about **7tons** per year of bio-slurry compost that are used widely and especially for the rice field. Regarding the form of using it, semi-solid form in which bio-slurry was mixed with agricultural waste such as rice straw, leaves of the trees around the houses and the kitchen waste to form compost took almost 60%, while solid form in which bio-slurry or bio-slurry compost is exposed to the sun or the air to dry up and liquid form in which bio-slurry



is used directly on the field shared the same portion at around 20% each.

Figure 3.1-18 Form of bio-slurry use for growing rice

3) Impact of using bio-slurry

The majority of the biodigester users use in average 200kg of chemical fertilizer (4 bags) for growing rice of an average 1.1 ha per season per family before owning a biodigester plant, however after having the plant constructed, the amount of using chemical fertilizer is reduced haft (100kg) which is equal to USD50.00, except two families. They just completely stopped using chemical fertilizer by depending only on bio-slurry compost.

4) **Commercialization of Bio-slurry**

The majority of the farmers didn't want to sell the fertilizer. They want to keep it for use in their own rice field. However, they didn't manage those bio-slurries well, only 24% of users had compost hut. Based on the group discussion with Bio-slurry Coordinator from five provinces of NBP's targeted areas, to make the biodigester users manage their bio- slurry well, on top of what NBP is working on such as training, awareness raising, exchange visit ...etc, it required a visible value meaning that the bio-slurry can be sold with reasonable price. If that can happen, the issue of managing bio-slurry will be automatically solved.

3.1.5 Initial Environmental Examination (IEE)

The potential impacts and the impacts that could arise from biodigester project and that come from biodigester use have been assessed. The impact assessment and the development of mitigation measures focus on the significant issues, screening out the activities that have no potential to cause a significant environmental impact.

According to the results of the screening process, there would be no potential impacts on the ecological resources or physical and cultural heritage in community. However, improper animal manure and bio-slurry management have negative impacts on environment and human health at household level. The key impacts identified are air pollution, water pollution and human health-related diseases caused by improper management of animal manure and bio-slurry associated with both pre- and post-construction of the biodigesters. Issues associated with biodigester construction also identified as being potentially significant.

1) Soils and Materials

Biodigester Construction Period: Earthmoving will be required during bio-digester construction. Negative impacts on the environment that could occur during the construction of bio-digester include soil contamination caused by earthmoving and water pollution resulting from runoff of soil pile from earthmoving. In order to minimize the impact, soil from earthmoving should be kept in a proper place and covered in case of raining.

The construction materials such as cement, brick, sand and other materials may cause the environmental impacts if not managed properly.

2) Air Quality and GHG Emissions

Operation Period: According to the results of the survey, not all the fresh animal manure are fed into biodigester because the manure that are mixed with soil or rice straw caused by animal stamping on it are not advised to put into biodigester due to its creation of scummed layer in the digester, therefore those left animal waste is collected and put in a compost pit.

With 76% of biogas users do not have slurry hut to store bio-slurry for composting and it is kept openly in composite pit (no roof) until it is transported to rice field or vegetable plantation for applying as fertilizer. Without proper storage of bio-slurry, the potential impacts on environment could occur, especially air quality.

In order to minimize the impact, it is recommended to make the roof of all the compost pits meaning making compost hut (not just composite pit).

3) Water Quality

Biodigester Construction Period: The construction of biodigester is required the earthmoving. The earthmoving could cause the negative impacts on the environment, especially water quality, if not managed properly in rainy season. Without proper management of the sources of construction materials, the potential impacts on water quality could also occur in rainy season.

Operation Period: The improper management and storage of animal manure and bio-slurry could adversely affect surface water if biodigester is constructed nearby water source. However, the impact on water quality is minimal because usually biodigester is constructed far away from water source. Bio-slurry hut should be constructed to store bio-slurry and reduce the impact on water sources.

4) Health and Hygiene

Animal stable location usually is constructed under or nearby local people house. Therefore, animal manure is scattered under or nearby their house. The excreta from warm blooded animals have countless micro-organisms, including bacteria, viruses, parasites, and fungi. Some of the organisms are pathogenic (disease causing), and many of the disease carried by animals are transmittable to humans, and vice versa. Stabling cattle or pig under or close to the house has the potential impacts on human health, especially vulnerable group such as women and children. To minimize the impact, stabling area should be cleaned up every day and animal waste should be collected and stored in proper place, especially composting hut with roof locating a bit far from the house.

According the environmental screening, bio-slurry storage in bio-slurry pit could not have significant impact on human health because bio-slurry pit is usually constructed outside the house. However, bio-slurry hut should be constructed to store bio-slurry and minimize the impact.

3.2 Non biogas users

3.2.1 Socio economic

1) **Type of house**

The majority of surveyed households live in wooden houses with a tile or zinc roof accounting for 77% while the remaining live in half brick (20%) and brick house (3%)

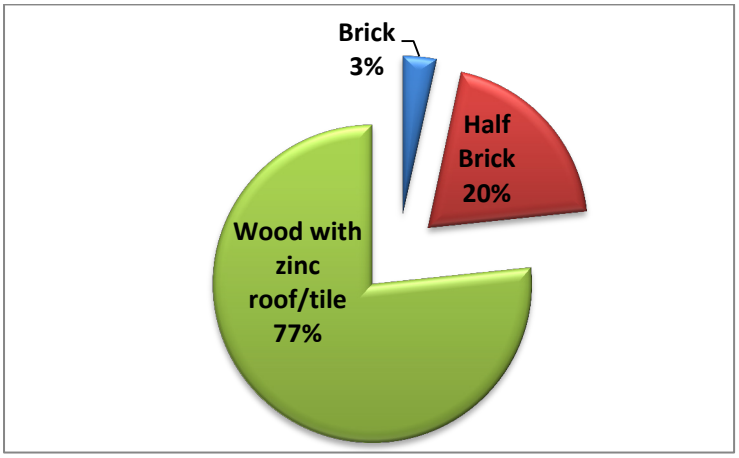


Figure 3.2-1 Type of houses of non-biogas users

2) Household characteristics

The average household size is 5.41 people including (grand) parents and children. The families have an average of 2.72 children, 87.4% are below 18 years old. The education level of the household head was higher than their spouse in primary school however was lower in junior high school and similar in high school completion.

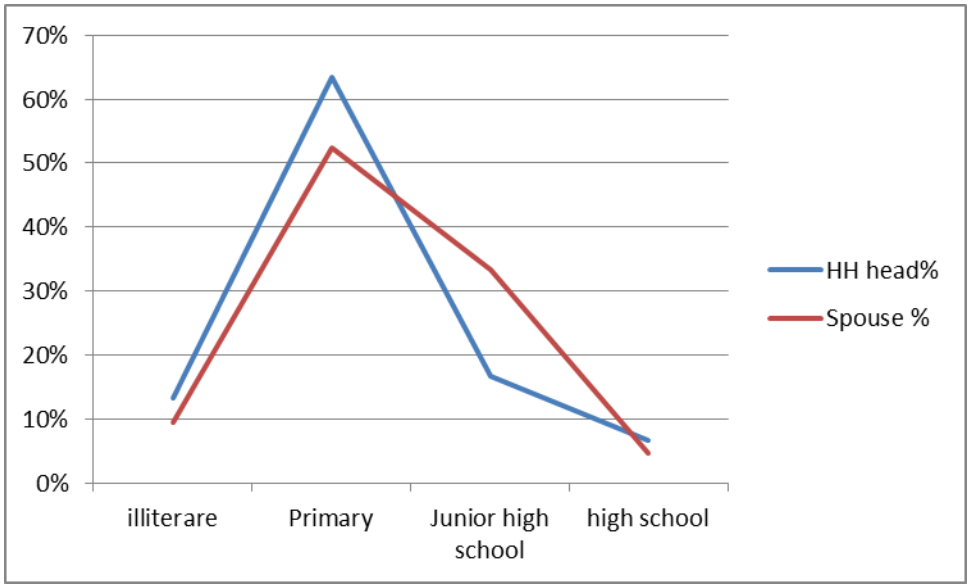


Figure 3.2-2 Level of education of non-biogas users in percentage

3) Income and expenditure

The combined income of monthly salaries such as government employee, teacher or NGO worker and the farm income from selling rice or pigs (costs are deducted) is calculated at US$166.33 per month or US$5.54 per day.
On average, households spend about US$ 4.91 per day or US$147.30 per month on food, transport, education, socialization and other small expenditures. The data also indicated that household spent US$11.25 per month on fuel wood.

4) Gender Perspective

The husband and wife always discussed each other for decision-making in term of financial and managerial aspect (70%). The chart below shows the percentage of decision-making between men and women.

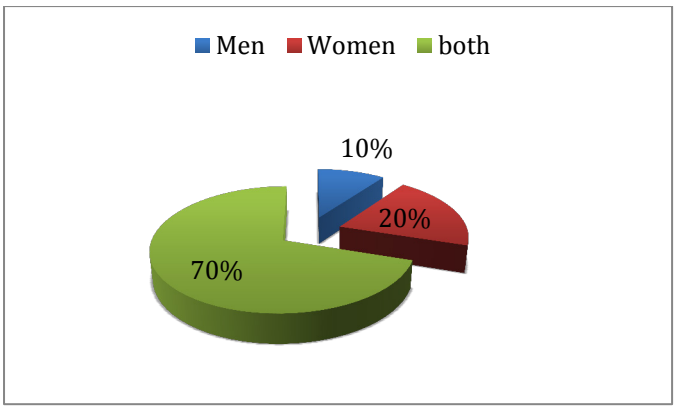


Figure 3.2-3 Gender perspective on decision making in the non-biogas users' families

5) Perspective on Range of Poverty Level

The data showed that in a score range-- with the very poor scoring 59-60; the poor scoring 45-58 and the non-poor scoring from 0-44, most beneficiaries of the project place themselves at a mean poverty score of 93.30%. This meant that many see themselves as non-poor.

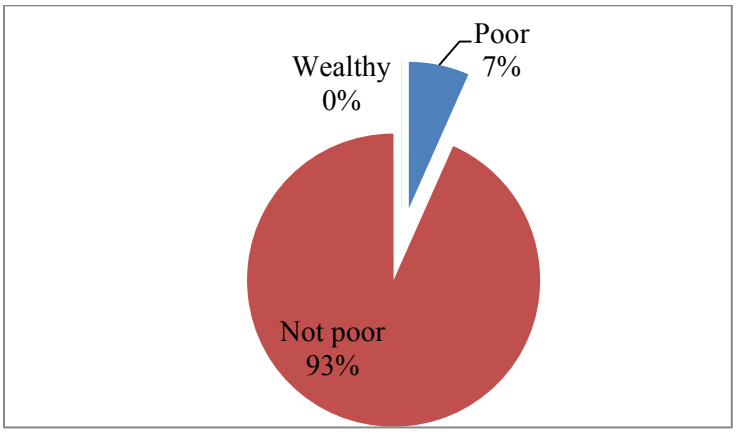


Figure 3.2-4 range of poverty level of non-biogas users

3.2.2 Knowledge on biodigester technology

All non-biogas users know only NBP's biodigester model. When showing a list of five biodigester plants model and asking about their preferences, most of them prefer NBP's model (77%) while composite accounts for 17%. This was because of the well-established NBP's model reputation. However, some of the interviewers preferred the composite because it looks modern, durable and can be built fast.

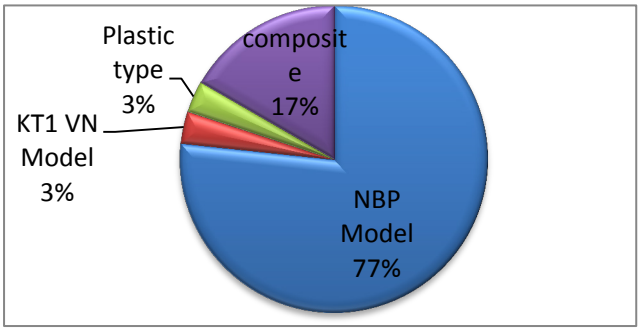


Figure 3.2-5 Non user's preference of biodigester model

3.2.3 Use of fuel for cooking

In average the interview household used about 3.8 kg of fuel wood per day which comparable to the result of the Kitchen performance survey by NBP in early 2013, 3.1kg per family. The family spent in average about $11.00 per month on fuel wood for cooking. Regarding the wood collection, all the member were involved but most were husband (77%), wife (73%) and son (30%) as seen in the figure 3.2-6.

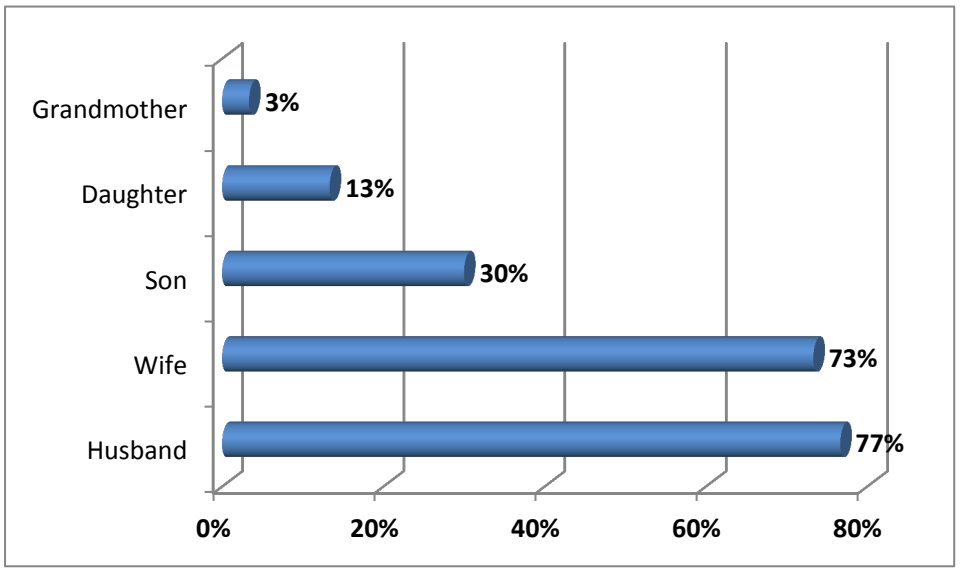


Figure 3.2-6 Member of the families who collect fire food for cooking

3.2.4 Animal handling and keeping

In Cambodian rural society, farmers raise traditionally cattle for dragging force and keeping them as the saving property, while pig raising is less popular due to the unstable market.

1) Average number of animal per family

The average number of animals per household is one head for young cow and 2.8 heads for adult cow. However, the share per household is not equal, with 100% of users owns adult cow while only 50% have young cow. The pigs were not included in the survey

because it was not reliable source for biodigester feeding due to its seasonal and short raising animal.

Description	Cow	
	Youngster	Adult
Average animal per household	1	2.85
Percentage of household that has animal	50%	100%

Table 3.2-1 Average number of animal per non biogas users' household

2) **Animal stable hours**

3) The number of hours that cattle are stable in rainy season is at around 18.7 h, four hours longer than that of dry season. In average, the cattle were stable about 16.80 hours per day which was one hour less than the case of biogas users' cattle.

Description	Hours of stable (h)
Cattle stable in rainy season	18.70
Cattle Stable in dry season	14.88
Average	16.80

Table 3.2-2 Average number of hours stable the animal

3.2.5 Use of fertilizer

All of the interviewed household use chemical fertilizer in which 53% of them mixed with animal manure compost. They do know about the bio-slurry as a good fertilizer. 57% are willing to pay for it while the 43% are not. They don't want to pay for it just because simply they used to get it for free and people sometimes share it in the rural area.

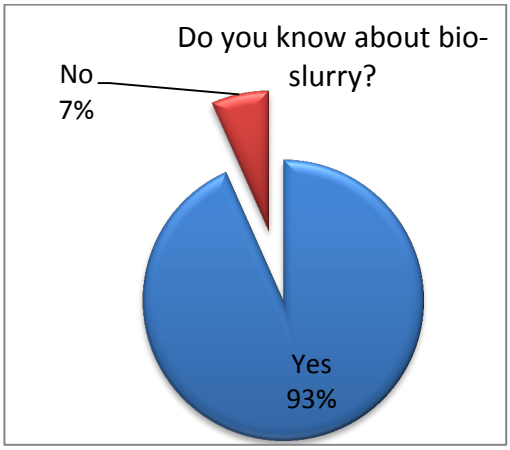


Figure 3.2-7Awareness of bio-slurry

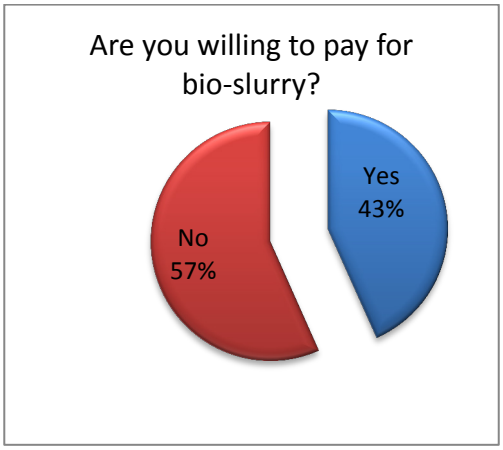


Figure 3.2-8 Willingness to pay for bio-slurry

3.2.6 Initial Environmental Examination (IEE)

The impacts that could arise from animal manure management of non-biogas users have been assessed. The impact assessment and the development of mitigation measures focus on the significant issues, screening out the activities that have no potential to cause a significant environmental impact.

According to the results of the screening process, there would be no potential impacts on the ecological resources or physical and cultural heritage in community. However, improper animal manure management has negative impacts on environment and human health at household level. The key impacts identified are air pollution, water pollution and human health-related diseases caused by improper animal manure management.

1) Air Quality and GHG Emission

According to the survey, most household collect the animal manure and store it in a solid storage which normally seen as a pile of animal dung near by the house without proper protected. As the result, chickens mostly prefer to find their foods in that pile by scratching the manure and spreading it around and diffusing the smell. The study also observes that some households don't collect the cow dung regularly, so they leave them at the stable place which usually located under or nearby the house of people. Animal manure can be the source of gases, aerosols, vapors and dust that, individually or in combination, can create air quality problems such as nuisance odors, health problems for animals, corrosion of materials and the generation of deadly gases that can affect animals and humans. Other gases produced by animal waste are methane (CH_4), carbon dioxide (CO_2), ammonia (NH_3), nitrous oxide (N_2O) and hydrogen sulfide (H_2S). In order to minimize the impact, the animal manure should be collected properly and kept in composting hut.

2) Water Quality

The improper management and storage of animal manure could adversely affect surface water if cattle stable place is located nearby water source. However, the impact on water quality is minimal because usually animal stable place is located far away from water source.

3) Health and Hygiene

Animal stable location usually is constructed under or nearby local people house. Therefore, animal manure is scattered under or nearby their house. The excreta from warm blooded animals have countless micro-organisms, including bacteria, viruses, parasites, and fungi. Some of the organisms are pathogenic (disease causing), and many of the disease carried by animals are transmittable to humans, and vice versa. Stabling cattle or pig under or close to the house has the potential impacts on human health, especially vulnerable group such as women and children. To minimize the impact, stabling area should be cleaned up every day and animal waste should be collected and stored in proper place, especially composting hut with roof locating a bit far from the house.

4. PILOT PLAN

4.1 New biodigester design

Recently, NBP has been working on a pro-poor biodigester's model with the size of 2 m^3, 3 m^3 and 4 m^3, under the PADEE project supported by IFAD. The purpose of this project is to develop a cheaper model for the PADEE's household group. Under this project, there are more than five biodigester models being studied and tested in the field since August 2013. By

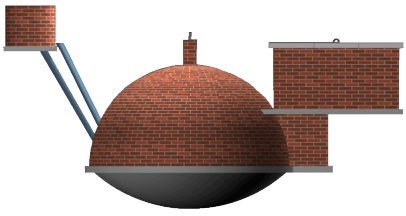
mid- 2014, one or two promising models will be rolled out for implementation with the size ranging from $2m^3$, $3m^3$ and 4 m^3 and the cost starting from 300 to 450USD.

On the other hand, under this study, the PADEE's design models were not included because it was under the testing stage; and to avoid duplication work, this study was trying to look at the new design with the same capacity or more as the existing NBP's model.

During the survey a list of five common biogas plants model was presented. Based on the result of the survey, NBP's biogas model (farmer's friend biodigester plant)was the most popular among all the five presented model because of its proven performance among exiting users; and it was also the only model that have been introduced by NBP for more than seven years. On the other hand, the prefabricated biogas plant (composite plant) shown a marginal sign of interest by existing biogas users who have had experience some difficulties to get their plants done due to long time of construction and service of the masons. They showed their preference to build the quicker once, although the cost would be higher. Interestingly, from view point of local authority, most of them preferred composite's model because they wanted to see the modern biogas plants constructed in their villages. However, for non-biogas users, they felt reluctant to invest in the new model where they are not yet sure about its performance. As the result, they opted for the NBP's model. Finally, when combining the view of three groups together, 24% of them preferred installing composite plant while 72% stuck to existing NBP's model.

Description	Users	Non-users	Authority	Total	Percentage %
NBP's model	56	23	2	81	72%
Plastic model	1	1	0	2	2%
Prefabricated model (Composite)	17	5	5	27	24%
Fixed domed VN's model	1	1	0	2	2%
Total	75	30	7	112	100%

Table 4.1-1Perception of biodigester plant model users,

Type of biogas plant	Cost	Construction time	Lasting time	O&M	Resource
 Farmer's friend biodigester (NBP's model)	550$	10 days	>20 years	Easy+	Has skill to do
 Composite model	650$	1 day	>20 years	Easy+	Not yet Need to be imported

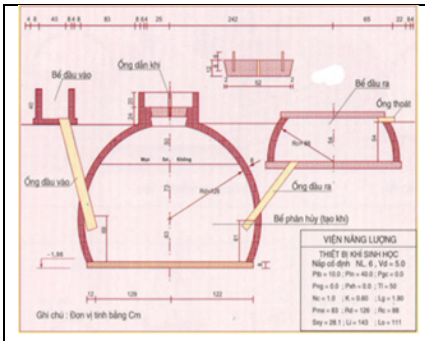
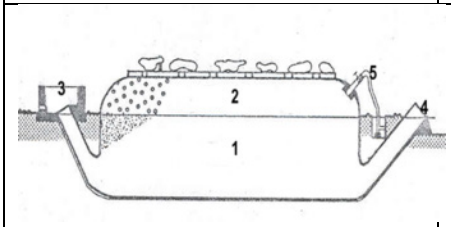
 KT1 Vietnamese model	550$	5 days	>20 years	Easy-	Not yet
 Plastic model	150$	1day	3 years	Regular maintenance and need to protect it well	Have
 Floating drum's model	550$	5 days	20 years	Regular maintenance after every 5 years by repaint the floating gas storage	No yet

Table 4.1-2 Comparison of 4 m^3- selected plants model for evaluation

Composite before burying in the ground

Composite plant in operation in Vietnam

Figure 4.1-1 Composite plant

Plant size (m^3)	Padee's design model cost in Cambodia	NBP's farmer friend pant cost in Cambodia	Composite model cost in Vietnam[1]
2	USD 300		
3	USD 350		
4	USD 450	USD 550	

[1] This composite plant cost was given from Moi Truong Xanh Company in Vietnam in Aug 2013

4.5			USD 550
6		USD620	
7.5			USD 600
8		USD 720	USD 650
10		USD 800	
11			USD 680
15		USD 1100	

Table 4.1-3Present cost comparison among biogas model

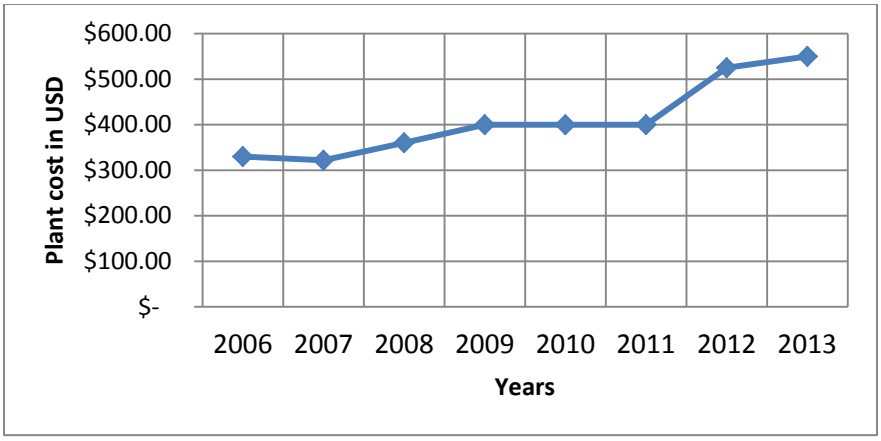


Figure 4.1-2 Cost evolution over the years of a 4 m^3NBP's current model plant

The cost of composite plant in Vietnam is comparable and even cheaper with that of NBP's design in Cambodia. However, the cost will increase if we import them to install in Cambodia. This need to be further studied in the pilot project whether it is practical to localize the product or imported with big quantities every year. With the trend of biogas technology and economic development, the labor cost for skill mason and construction material will keep increasing. As seen in the figure 4.1-2 of the cost evolution over the period of 8 years starting from 2006 to 2013, the cost of NBP's farmer friend model increases almost twice of that in 2006, while in general, the cost trend of composite will be in opposite direction because the nylon and glue[2]will gradually get cheaper and cheaper due to the technology development. This will eventually bring down the composite plant cost to meet with current NBP's model in the short coming years in Cambodia.

Another argument was also presented in the report on evaluating composite digesters in Vietnam by Dr. Bui Van Chinh conducted in 2011.In Vietnam, composite model plant has become gradually popular in recent years after its introduction in 2006. Over the last three years, three companies could sell almost 30,000 plants showing a high demand from the users. It is noted that these companies were running their business on a completely private basis without any support from government or the donor agencies.

Finally, based on the above survey result and judging from technical point of view as well as the development trend, composite model plant has the potential to be introduced in Cambodia due to (1) fast installation time, (2) space saving, (3) gas tight and (4) movable plant, although its higher cost (no local workshop can produce it yet) and short cut digested slurry

[2] The nylon and glue are the main component of making composite

remain the challenges for this model. In addition, with the constraint of labor shortage, the high dropout rate of NBP certified mason (65%) and the increasing cost of NBP's current model, composite model is in the better position to cope with these issues. To confirm on the above finding and assumption, this model should be tested in the pilot project and if it proved to be successful it should be integrated into NBP design which will give NBP a full option for the clients with different models PADEE's model, NBP's farmer's friend model and composite's model.

4.2 Bio-slurry management and improvement

Based on the desk reviewing and interviewing NBP and PBPO, it was found that bio-slurry managements were mostly well recommended and informed to biodigester users. Slurry pit, compost hut and composting method have been designed and recommended in the hand book on Bio-slurry Management and Application of NBP. To promote bio-slurry management and application, NBP has done a lot of work such as organize model farms for demonstrations, organize exchange visits, individual visits via the Extension Workers, and organize provincial workshops.

Figure 4.2-1 NBP bio-slurry management's model

However, the adaptation of farmers is still limited due to some difficulty as stated below:

- Difficult to carry the slurry from slurry pit to the compost hut
- No labor to build compost hut
- No time to build compost hut
- Not enough money to build a solid structure and a long last use of compost hut
- The compost hut was eventually damaged after using for a while

Bio-slurry left in the slurry pit without taking for making compost

Bio-slurry flow to the field without proper management

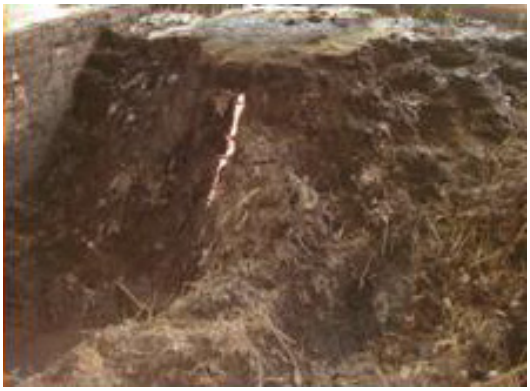
To improve bio-slurry management, it would be very important to make the bio-slurry value more visible to biodigester users by creating the demand, meaning bio-slurry can be sold with reasonable price. If that can be happened, the issue of managing bio-slurry will be automatically solved. Looking this proposed idea from commercial point of view, there is a possibility to make it come true through bio-slurry fertilizer business. The rice millers who have excess of bio-char would be interested in investing in a supplementary business on top of their core business of rice milling and expert, if it proves to be feasible.

During the field survey, two rice millers have been visited, Sok Keo rice miller and Golden Daun Keo Rice Mill. Only Sok Keo equipped its rice mill (10tons of rice per hour) with gasification system with the capacity of 1 600kva. It should be noted that Sok Keo rice mill facilities was granted by New Energy and Industry Technology Development Organization (NEDO) and the Ministry of Industry, Mines and Energy (MIME) under "the demonstrative project for rice husk power generation system by utilizing energy and environmental technology". After the meeting with the management team of Sok Keo rice mill, they have expressed their strong interest and willingness to accept the proposed pilot project and they even acknowledge that such kind of business is not a profit oriented business but a supporting one to their main business (milled rice production). They are very interested in this proposed pilot plan and are ready to invest in building the workshop to produce pellet bio-char behind their rice mill compound. Moreover, they have the ability to expand this business if it is proved to be successful after the end of the pilot project, said the director of the company.

How to make bio-slurry fertilizer and sell it in the market? we have visited a community based pellet fertilizer producer in Takreut village, Samraong commune, Prey Chhor district, Kampong Cham province wherethe Institute of Environment Rehabilitation and Conservation (ERECON)and Japan International Cooperation Agency (JICA)has supported 100 compost huts to both biodigester users and non biodigester users; and a pellet fertilizer equipment. Farmers living in the community can bring their composts to the pellet fertilizer facility and use the machine to produce pellet bio-fertilizer by themselves by just paying the basic fee 1.125 USD per hour for diesel and maintenance cost to the manager of the facility. However, after putting in operation in May 2013 for pilot only 15 farmers come to make pellet compost because farmers find it difficult to transport compost from their houses to the facility. It suggested that farmer would prefer a good package of fertilizer rather than transport and making by themselves.

To carry out the above work, it requires the expertise in making compost. As a result, Cambodian Education and Waste Management Organization (COMPED) has been contacted for technical support in implementing the pilot project. COMPED is a non-governmental organization that has proven background in dealing with waste through composting approach. They have operated their composting plant in Battambang since 2009 to present.

Bio-char



Compost from bio-slurry and agricultural waste

Equipment to produce pellet bio-fertilizer

Pellet bio-fertilizer after passing through the process

Back to the original idea behind making pellet bio fertilizer is the need to provide a visible value of compost from bio-slurry so that biodigester user will manage their bio-slurry very well. However, to get good bio-slurry compost, it requires some improvement work on the current NBP bio-slurry management system.

Based on the survey data, there is a difficulty in handling the bio-slurry from slurry pit to compost hut as a result three techniques has been proposed and evaluated during the pilot phase. They are the exiting model, gravity flow model and pumping model. At the end of the pilot project, the practical better technique will be recommended for future use.

	Existing model meaning, users have to carry the bio-slurry from slurry pit to compost hut manually. It is quite taught to do this work based on the survey.

 *Bio-slurry flow by gravity into compote hut*	This is the easiest way but it limits the storage volume of compost pit because the level of compost pit needs to be lower than that of over flow from outlet tank. Moreover, it is difficult to make good compost because the process to place different layers of bio-slurry and that of agricultural waste cannot be done easily. However, it should be open for further study in the pilot project if any improvement can be made.
	 Instead of taking slurry from slurry pit to compost hut by bucket, a pump is used to ease the process. This has been put in place by some of the biodigester users.

Another point for improvement is the bio-slurry compost. The compost which arebought from farmers should be standardized especially the composting process. Two composting pit should be built in one compost hut(its size is double ofthat of digester) and the concrete pit should be recommended. Moreover, in order to improve the NBP existing composting method, 4 PVC (Ø100mm) tubes with holes around should be poled in the compost pit to make decomposition process faster. The organic waste materials should be collected and stored in the compost pits which are constructed near the outlet tank. Some of organic waste material is put at the bottom of the pit and covered with a layer of bio-slurry. A small amount of ash and/or top soil is put on top of the bio-slurry to prevent the loss of nitrogen. This process is repeated until the pit is filled at the top. Once the first pit is full, the bio-slurry has to be diverted to fill the second pit.

4.3 Scope of pilot project and its implementation

4.3.1 Summary of the project frame work

Based on the results of the survey and the discussion with key informant as well as the result of consultative workshop, the study team has drafted the basic design of the pilot project. The draft of Project Design Matrix (PDM) is shown in Annex4 and the organizational chart of the project inAnnex 5.

1) Implementing agency

National BiodigesterProgramme (NBP) and Cambodian Education and Waste Management organization (Comped), local NGO).

2) Duration of the project

The project is schedule to be implemented for 12 (twelve) months from the commencement of the project.

3) Scope of the project

3.1 Overall goal

The biodigester technology in Cambodia will be up scaled with more diversity in plant design and slurry management

3.2 Project purpose

To test (1) the new biodigester model and (2) bio-slurry management for up scaling biogas technology in Cambodia.

3.3 Outputs

(6) Five composite plants will be installed and evaluated
(7) The prefabricated plants will be locally produce and installed
(8) Technical document and promotion material will be produced and integrated into the NBP exiting document and material
(9) Bio-slurry handling from outlet tank to slurry hut will be improved
(10) Composting technique will be improved
(11) Composting production will be set up and tested
(12) Field testing using pellet of mix bio-char compost fertilizer will be put in place
(13) Training and promotion will be carried out

3.4 Project activities

The Project Activities will be implemented in close collaboration between NBP and Comped as follows:

(1) Activities for output (1)
1. Installation of the five composite
1.1 Purchasing five composite plants for installing
1.2 Selecting five families for pilot plant installation
1.3 Installation the five plants by external technician and on job training to NBP trained masons
1.4 Monitoring on the performance of the plants (1) daily operation and maintenance (2) daily gas production vs feeding, (3) lab testing on TS, VS at different parts of the plant to see the efficiency of the plant.

(2) Activities for output (2)
2. Localization of composite plant
2.1 Selecting local workshop to be trained on producing composite plant
2.2 Training of trainer to local technician on installation and operation and maintenance

(3) Activities for output (3)

3. Technical and promotional documentation
   - 3.1 Developing construction manual, installation manual and user manual
   - 3.2 Integrating this model to promotion material of NBP

(4) Activities for output (4)

4. Improvement of bio-slurry handling from outlet to compost hut
   - 4.1 Testing with new design (1) manually taking slurry from slurry pit to compost hut (existing design), (2) using water pump to bring the water from compost pit to compost hut and (3) make the slurry flow directly to compost hut.
   - 4.2 Monitoring and evaluating the application and adaptation of the of those techniques

(5) Activities for output (5)

5. Improvement of composting technique
   - 5.1 Improving designed of the storage and composting hut with specific technique to make good compost
   - 5.2 Applying the improved design of storage and composting hut

(6) Activities for output (6)

6. Institutional set up
   - 6.1 Selecting a group of 50 biogas users to form model farm that participate in this pilot project
   - 6.2 Selecting rice miller to join the pilot as the pellet producer
   - 6.3 Setting up small scale facilities to produce pellet bio-fertilizer

(7) Activities for output (7)

7. Field testing by using pellet of bio-fertilizer
   - 7.1 Supporting the 50 model farm to apply pellet bio-fertilizer on their crops and vegetable
   - 7.2 Coaching and monitoring to selected farms
   - 7.3 Evaluation the effectiveness of pellet fertilizer

(8) Activities for output (8)

8. Training and promotion
   - 8.1 Developing training materials (construction, operation and maintenance manual,…etc)
   - 8.2 Training of trainer to NBP, PBPO's involved staffs on (1) improving bio-slurry storage (2) improving composting technique, (3) use of pellet bio-fertilizer
   - 8.3 Training 50 farmers by ToT and exchange visit
   - 8.4 Training the pellet bio- fertilizer producer on how to make it properly
   - 8.5 Developing promotion and marketing material

4.3.2 Budget, plan of operation and financial analysis

a) Budgeting for pilot project

The total budget for implementing this project is estimated to be **USD 93, 720.00** as detail described in the following table

No	Description	Total budget
Human resources		
2	NBP staffs involment	$ 11,500.00
3	PBPO staff involment	$ 2,520.00
4	Comped NGO staffs involment	$ 5,000.00
Cost of activities		
1	New biodigester model will be installed, tested, evaluated and rolled out	$ 19,000.00
2	Proper bio-slurry management and bio-fertilizer application	$ 50,700.00
Logistics		
1	Transport	$ 4,000.00
2	Communication	$ 1,000.00
	Total annual budget	$ 93,720.00

Table 4.3-1 Total budgeting for pilot project

b) Investment on composting plant

The composting plant will produce approximately 231 bags (50kg) of pellet bio-fertilizer per month with the operation cost of 2307.11 USD**.**

No	Description	Unit		Cost per Unit (USD)	Total (USD)
Operational cost per month					
1	Manager	person	1	200	200.00
2	Transporter driver from biogas plant	person	1	100	100.00
3	Wheel loader driver	person	1	80	80.00
4	Workers	person	2	70	140.00
5	Diesel for operating at compost plant	L	208	1.2	249.60
6	Diesel for transportation (1.5T Korea)	L	182	1.2	218.40
7	Packaging bags (tons of compost)	bag	231	0.40	92.44
8	Maintenance		1	100	100.00
9	Slurry cost	Tone	52	15	780.00
10	NPK addition (Urea, DAP, KCL fertilizer)	Bag	11.55	30	346.67
Subtotal					**2,307.11**

Table 4.3-2 Operational cost of composting plant per month

Investment cost and Depreciation

The total investment of the composting plant is 67,750.00 USD in which 38,750.00 USD is covered by rice miller and 29,000.00 USD is covered by pilot project

No	Description	Unit	Dimension		Total Cost (USD)	Depreciation		
						Month	Monthly cost (USD)	
1	Concrete 20*30m	m²	600	20	12,000.00	120	100.00	To be covered by rice miller
2	Roof	m²	900	20	18,000.00	180	100.00	
3	Wall	m²	50	15	750.00	120	6.25	
4	Truck for transport slurry	Set		1	8,000.00	84	95.23	
5	Machine mixer	Set		1	6,000.00	84	71.43	To be covered by project
6	Machine granoloader	Set		1	8,000.00	84	95.24	
7	Wheeloader	Set		1	15,000.00	84	178.57	
Subtotal					**67,750.00**		**646.73**	

Table 4.3-3 Investment cost and depreciation of composting plant

Based on the above table, the financial analysis could be made through the below calculation in which the selling price per bag is 14.00USD with the 10% top up on expenses per bag.

No	Description	Unit	Cost in USD
1	Operation cost	month	2307.11
2	Depreciation cost per month	month	646.73
3	Total expenses per month	month	2953.84
4	Total produced fertilizer	bag (50kg)	231.11
5	Expenses per bag	bag (50kg)	12.78
6	Selling price per bag (plus 10% of expenses)	bag (50kg)	14.06

Table 4.3-4 Calculation of selling price

Plan of Operation (PO)

Objective To test (1) the new biodigester model and (2) bio-slurry management for up scaling biogas technology in Cambodia

Output
1. Five composite plants will be installed and
2. The prefabricated plants will be locally produced
3. Technical document and promotion material will be produce or integrated into the NBP exiting
4. Improving bio-slurry handling from outlet tank to
5. Improving composting technique
6. Institutional set up
7. Field testing using pellet of mix biochar compost fertiliser
8. Training & promotion

No	Activities	2014											
		1	2	3	4	5	6	7	8	9	10	11	12
Output 1	1.1 Imported 5 model plants for testing												
	1.2 Selecting five families and installation the five plants by external technician and on job training to												
	1.3 Monitoring on the performance of the plants (1) daily O&M, (2) gas producing vs dung input, (3) lab testing on TS, VS at different parts of the plant												
Output 2	2.1 Selecting and training local workshops on producing composite plant												
	2.2 TOT training to local technician on installation and operation												
Output 3	3.1 Developing and printing construction manual, installation manual, user manual												
	3.2 Integrating this modle to promotion material of												
Output 4	4.1 Testing with new technique (1) scoping (existing practice)												
	4.2 Monitoring and evaluating the application and adoptation of those techniques												
Output 5	5.1 Improving design of storage and composting hut with specific tehnique to												
	5.2 Supporting the implication of the improved design												
Output 6	6.1 Selecting 50 model farms												
	6.2 Selecting rice miller to be a granule or pellet bio-fertilizer producers												
	6.3 Setting up small scale facilities to produce pellet												
Output 7	7.1 Supporting the 50 model farms apply pellet bio-fertilizer on their crops and vegetable												
	7.2 Coaching and monitoring to selected farmers												
	7.3 Evaluation the effectiveness of pellet fertiliser application												
Output 8	8.1 Developing training materials (construction, operation and maintenance manual…etc)												
	8.2 ToT training to NBP, exchange visit, PBPO's involved staffs on (1) improving bio-slurry storage (2) improving composting technique, (3) use of bio-char fertilizer												
	8.3 Training 50 farmers by TOT, exchange visit												
	8.4 Training rice miller to produce good organic fertilizer												
	8.5 Developing promotion and marketing material												

4.3.3 Risk-Uncertainty- Assumption of pilot project

It is advisable to consider risk, uncertainty and assumption on this pilot project because its success is very much dependent on them. The details are described in the following part.

3.3.3.1 Risk

The pilot project risk can be divided into three phases: planning, construction and operation. Typically the donor will only commence in depth financing for such pilot project once the planning phase is completed and the project has the necessary permits and license authorization to construct the compost plant and to operate it.

1- Planning phase risk

a) Feasibility Study

There is no much risk that feasibility studies will find for such pilot project. but this will have no coherent integration of different components such as the new bio-digester technology (Fabricated Fiber Glass), bio-slurry management and bio char toward to achieving commercialization of composted bio-slurry/bio char.

b) Permit/license risk

The risk that permits or licenses essential for importation of new bio digester technology and for compost plant is not high, but we should take time to coordinate with relevant authority and institutions to obtain those documents.

2- Construction phase risk

a) Capital cost over-run risk**:**
The risk that the costs involved in the construction and installation of equipment could be higher than the budget allocated

3- Operation phase risk

a) Technology risk
The risk is that the equipment/plant installed could not be responded to the expected specifications and output standard.

b) Market risk

- As this a new local product, the risk of sale price of the outputs is too low in comparison of their production costs. The sale volume may be lower than expected due to lower demand.
- The price of organic fertilizer Products and chemical fertilizer Products from abroad are sometime cheaper than the new bio fertilizer products.

c) Operation risk

- At the beginning operation, the costs of goods sold is too high which include transport cost, marketing fees, depreciation of equipment, advisor, expert and professional fees and administration fees.

d) Legal and Regulatory risks

- Too large open for chemical fertilizer would be hard for the bio-slurry compost in term of competition.

e) **Natural Disaster**
   - It causes flooding or drought to the rice crop, so bio-char production would be limited.
   - Some area where the NBP biogas plants located is affected by flooding could damage the production of slurry.

3.3.3.2 Uncertainty:

a) **Cost of production and consumption**:
   - Long distance between biogas plants and composting plant and the high cost of fuel consumption could lead to high production cost too
   - Long transportation and high cost of fuel would frustrate the customers in buying compost product as it is an extra cost for them as well.

b) **People motivation**:
   - Consuming organic food has dropped out due to various factors, so there is no demand for bio-slurry compost.
   - The biogas users is no longer selling slurry for compost production and turn to make compost or use cow manure directly onsite for agriculture.

c) **Product price**:
   - The estimated price of the bio-slurry is expected to sell at USD 14/bag, which quite comparable with chemical fertilizer of about at least USD 25/bag. The NPK in the bio-slurry compost have to be quite comparable with the quality of NPK in the chemical fertilizer, otherwise it can a market barrier for the compost product.

d) **Mindset**
   - The people may have constraints in labor supply for agricultural or there might be some motivation that most of the people use machines instead of using cows for supporting agriculture cultivation.

e) **Animal disease**
   - The animal dies due to the widespread of disease in the project area.

3.3.3.3 Assumption:

a) There is no natural disaster in the project location.
b) It is possible that the compost plant should locate in the rice mill boundary as they have a gasified plant to generate the energy and other facilities
c) The cooperation among the key stakeholders is getting well among each other.
d) The rice miller is able to keep on this rice mill and compost business.
e) There is no land use change in the project area.
f) The bio-slurry compost is quite comparable with chemical fertilizers and other organic fertilizers in terms of quality and price. The bio slurry fertilizer production should be considered reducing their costs
g) The affordable number of labor in the project location is not the major constraint.

h) The price of fuel and the distance of biogas plants to the compost plant are not much increased.
i) People are willing and keep on selling their slurry to the compost plant of the rice miller.
j) Now in Cambodia there is a high motivation to increase the consuming of organic food from day to day.
k) People keep on using cows to support their agricultural activity and feed increasingly cow manure for bio digester plants.
l) The animal is healthy and no widespread disease in the project area.
m) In 2015 the Royal Government of Cambodia set up a plan to export milled rice about 1.5 million tons, therefore the production of bio char will be high, thus contributing in production of compost.

4.4 Mitigation on environmental issues

Environmental Issues	Degree of Impact	Mitigation/Enhancement Measure
Biogas User		
Biodigester Construction Period		
• Soil contamination and water pollution by earthmoving	MS	• Removal of soil from construction site • Keeping soil in proper place and cover
• Environmental impact caused by construction materials such as cement, brick, sand and others.	MS	• Contain and store the construction materials properly • Dispose the waste from the construction materials at the nearest landfill.
Biodigester Operation Period		
Air quality and GHG emission *(Improper animal waste and bio-slurry management)*	MS	• Proper animal waste and bio-slurry collection • Construction of composting hut or bio-slurry hut with roof outside the house • Storage of animal waste and bio-slurry in composting hut or bio-slurry hut with roof • Collect and transport wastes to fields or bag the material for sale elsewhere • Compost the waste to reduce the availability of N.
Water quality *(Improper animal waste and bio-slurry management)*	MS	• Composting hut constructed far away from water sources. • Storage of animal waste and bio-slurry in composting hut or bio-slurry hut with roof • Proper animal waste and bio-slurry collection
Health and Hygiene *(Improper animal waste management, stabling animals*	MS	• Proper animal waste collection • Storage of animal waste and bio-slurry in composting hut or bio-slurry hut with roof

under or close to the house)		• Animals should be stabilized outside the house • Protection of children from animal waste • Cleaning up stabling area everyday
Biogas User		
Air quality and GHG emission *(Improper animal waste management)*	MS	• Proper animal waste collection • Construction of biodigester to produce gas and reduce environmental impacts • Construction of composting hut with roof outside the house • Storage of animal waste in composting hut with roof • Collect and transport wastes to fields or bag the material for sale elsewhere • Compost the waste to reduce the availability of N.
Water quality *(Improper animal waste management)*	MS	• Proper animal waste collection • Composting hut constructed far away from water sources. • Storage of animal waste in composting hut with roof
Health and Hygiene *(Improper animal waste management, stabling animals under or close to the house)*	MS	• Proper animal waste and bio-slurry collection • Storage of animal waste in composting hut with roof • Animals should be stabilized outside the house • Protection of children from animal waste • Cleaning up stabling area everyday

5. CONCLUSION

The study shows that biodigester provide a lot of benefits to the users by improving situation of the family in term of economy, social, financial health and environment. It can be seen clearly that biodigester users can save money from using biogas at around 10USD per month and save on chemical fertilizer by reducing 2 bags (USD50) of them. In addition, the improvement of health condition and environmental around the house were also observed. Furthermore, the users save about 1h20mn per day from collecting firewood and cooking with biogas. As far as gender perspective is concerned, farmers have extra time for social activities and reduce workload, especially for women. Almost all women using biogas express great satisfaction with the cooking aspects of biogas. In general, biodigester reduce smoke and indoor air pollution for women.

Regarding non biodigester users, they spend about 11USD per day on firewood which is similar to the amount of saving by biodigester users on replacement of firewood with biogas usage. The majority of the farmers are happy with their plant performance because of its provided convenience.

On the other hand, although a lot of benefits can be seen, some challenges need to be addressed to improve the current biodigester system. In term of product, NBP currently offer only one model namely farmer's friend biodigester which make from brick, cement and concrete. It takes at least ten days for completing a biodigester excluding soil excavation. This cause some inconveniences to the farmer while they are busy they need faster construction time but NBP cannot provide it yet. Although, a study under PADEE may partly contribute to solve this problem, it is only for the small size. To address the above issues, a pilot project to introduce a new biodigester model namely composite is proposed. This new type of plant is getting more popularity recently in Vietnam while they are far advance in China and India. In the pilot project, five composite plants will be imported, installed and evaluated. If it is proved to be successful in term of both performance and cost, NBP should consider including this model to its products list. So, they will have the diversified type of biodigester products for clients to select.

Another challenge of the current NBP's biodigester system is the slurry management, it is surprised that most of the user acknowledged the benefit of fertilizer use but only 24% of them have managed the slurry properly by constructing a compost hut while the others did not. It is understood that NBP has been actively promoting the bio-slurry management via trainings, awareness raising, exchange visits, setting up model farms…etc. However, this just doesn't work for most of the target province.

Therefore, there is a need to improve the current system. Through the study, it is pointed out that farmers need to see the value of their bio-slurry in a more visible way and that will provide the incentive for them to manage it well. Hence, this study proposes a pilot project that will eventually become the win-win strategy for all. In

collaboration with rice miller (SokKeo import expert co. ltd.) in Takeo province, the project will help to set up a bio-fertilizer production plant in the rice mill compound by using bio-char and bio-slurry compost. It is not a profitable oriented business for them but it is a supplementary business to the rice milling one. Based on this framework, it will give a strong link between the farmers and the rice miller through exchange approach of buying the bio-slurry from the biodigester use- based farmers and selling back (or advance) the bio-fertilizer to them. This activity will not only solve the facing problem of inappropriate managing for bio-slurry but also help the rice miller and the farmer to become closer through this supplementary business and in turn to increase the milled rice production.

6. BIBLIOGRAPHY

1. NBP 2013. Carbon Monitoring and User Survey 2012
2. NBP 2012. Biodigester User Survey 2012 Report
3. NBP 2012. Bio-slurry user manual
4. SNV Cambodia, 2005. Evaluation Study for Biogas Plant Designs
5. Dr. Bui Van Chinh, 2011. Report on Evaluating composite digesters in Vietnam
6. http://www.ncdd.gov.kh/en/

7. ANNEX

ANNEX 1Thequestionnaires for the survey

Questionnaire for Biogas User

Upscale new bio-digester technology with Bio-slurry management

INTRODUCTION

Hello, I am [name], with Mekong Carbon Ltd, an independent research company based in Phnom Penh and we're working on behalf of Landell Mills Ltd. They are conducting feasibility study on which a pilot investment project for up scaling new biogas technology with bio-slurry management demonstrated in Cambodia with supporting due diligence. This project is to implement ADB Capacity Building Technical Assistance (TA) 7833: REG Capacity Building for Efficient Utilization of Biomass for Bioenergy and Food Security in the GMS.

The interview will take approximately **60** minutes to complete. Your participation in this study is completely voluntary. You do not have to answer any questions that you do not want to answer and you may end the interview at any time. Your opinion is very important, however, and we hope you take the time to respond to all questions in this survey.

We will keep all of your answers to this survey confidential. You will not be personally identified. Survey data and findings will be reported only in an aggregate form and you will not be identified by name in any reports.
Please introduce yourself and the project to the respondent. Please note that respondent have right NOT to join this survey if they are not interested. If a qualified respondent is not available, please proceed to the next household on your list. ***(The qualified respondents are household head and spouse of household head only)***

Questionnaire ID:	**Date interview: __ __/__ __/ 2013**
Name of interviewer:……	**Time started:__ __ hr__ __mnEnd time: :__ __ hr __ __mn**

From survey list provided of sample selection

1.	PlantID: / / /_____ (xx/xx/xx/xxxx)		
2.	Plant size:……..m3(from NBP database)		
3.	Does the plant ID code and size match with the papers of the respondent?	Yes	No (please check if you have the right household)

SECTION A –GENERAL QUESTIONS

1)	Name of Respondent		
2)	Telephone number or number where they can be reached		
3)	Sex	1. Male	2. Female
4)	Age	……..years old	
5)	Number of household	……..people	

	member				
6)	How many children below 18 ?				
7)	Do all children go to school?	1. Yes 2. No, reason why_____			
8)	What is your ethnic background/nationality?	1. Khmer 2. Chinese 3. Vietnamese 4. Cham 5. Indigenous (Phnong,……) 4. Other (specify): ……..			
9)	Status of respondent	1. Household head	2. Spouse	3. Son/ daughter	4. Other (specify)
10)	Status of the house	1. Brick	2. Half brick	3. Wood with zinc roof/title	4. Wood with palm leave
11)	Land	1. Areas around the house ……m x…m=…..m2	2. Rice field ……..ha	3. Chamkar ……ha	

SECTION B –BIODIGESTER

1.	What was total cost of plant?	_____ U.S. Dollars 8. Don't know/refuse
2.	How do you think about this cost?	1. [ ] Expensive 2. [ ] Acceptable 3. [ ] Cheap 8. [ ] Don't know
3.	How was the plant financed (not considering subsidy from program):	1. [ ] Own cash savings only 2. [ ] All bank / microfinance 3. [ ] Some own some Microfinance 4. [ ]Local money lender 5. [ ] relatives and/or friends 6. [ ] savings group 7. [ ] other (specify):
4.	If borrowed from which bank and how much?	1. [ ] Prasac Amount in US$ . . . . . . 2. [ ] Amret Amount in US$ . . . . . . 3. Other: Amount in US$ . . . . .
5.	If loan: Loan repayment situation?	[ ] 1. Repaying in instalments, no late or overdue [ ] 2. Repaid the whole loan already [ ] 3. Still repaying some overdue instalments [ ] 4. Default

1) Is the Biodigester working?

1.	Is the plant currently producing gas	1. [ ] Yes 2. [ ] No → Number of days not working now: _____ days

2. If biodigester is not in operation: (Detail very specific):

_____

IF THE BIODIGESTER IS NOT WORKING, INFORM BCC/MASON/PBPO TECHNICAL SUPERVISOR WHOSE CONTACT IS LISTED AT THE GUARANTEE CERTIFICATE OR USER MANUAL AND MOVE TO THE NEXT HOUSEHOLDS ON YOUR LIST

2) Biodigester feeding?

1.	What do you put in digester?	1. [ ]Manure(cow and buffalo): ……kg/day 2. [ ] Manure (Pig) :… ……...kg/day 3. [ ] Food waste :… ……kg/day 4. [ ] Other: ……kg/day	
		1. [ ] Solid storage	Solid storage in piles or stacks
2.	If manure, How did you store or use it before?	2. [ ] Lagoon	In a water body (manure is submerged with water)
3.		3. [ ] Slurry	Kept in slurry condition (like porridge)
4.		4. [ ] Composting	Composting (manure is regularly turned over)
5.		5. [ ] Daily spread	Daily spread (brought to the field within 1 day)
6.		6. [ ] Burned as fuel	Burned dung as fuel
7.		7. [ ] Drying in sun	Drying in the sun (for selling)
8.		8. [ ] Fishpond	Fishpond
9.		9. [ ] Other:……	
10.	Is the biodigester connected with toilet?	1. [ ] Yes 2. [ ] Provision pipe is connected 3. [ ] No	

3) Use of Biogas

1.	If you use biogas: What do you use it for (multiple answers possible)	1. [ ] Cooking and boiling 2. [ ] Lighting. 3. [ ] Animal feed preparation 4. [ ] Electricity generation 6. [ ] Other (specify):
2.	If you use biogas: Is gas production normally sufficient for cooking?*(choose one)*	1.[ ] More than sufficient 2. [ ] Sufficient 3. [ ] Not sufficient. → Reason: . . . . . 8.[ ] Don't know

4) Benefit of biogas use

1.	What are the benefits of the biogas?	1. [ ] Cooking and boiling 2 [ ] Lighting 3. [ ] Fertilizer 4. [ ] Animal feeding 5. [ ] Improved hygiene 6. [ ] Improved health 7. [ ]Other . . .	
2.	If you use for cooking: Number of biogas stoves and type.	1. [ ] One NBP single burner 2 [ ] Two NBP single burners 3. [ ] One Imported single burner 4. [ ] Two imported single burners 5. [ ] Imported double burner 6. [ ] Biogas rice cooker 7. [ ] Other	
3.	If you use biogas stoves: Hours of biogas used for cooking per day (Average)?	1. Minutes in the morning . . . . . . 2. Minutes at noon (lunch) . . . . . . 3. Minutes in the Evening . . . . . . 8. Don't know	
4.	Are you satisfied with the biogas stove?	1. [ ] Yes 2. [ ] No → Reason . . . . 8. [ ] Don't know	
5.	How many minutes do you save with cooking with the biogas ?	Minutes saved per day: 8. Don't know	
6.	How much time to you save on fuel wood collection	Minutes saved per day: 8. Don't know	
7.	How much more or less time do you spend on manure management (compare before and after having the biogas plant)	1. More Minutes ….. ……..per day 2. Less Minute……per day 8. Don't know	
8.	*What do you do with your extra time?**(Interviewer: provide enough time for respondent to reply, and probe him for anything else?)*** **……** **……**.		
9.	If you use biogas lamps: How many do you have?	#of biogas lamps in use . . . . . . #of biogas lamps not in use ……	
10.	How many total biogas lighting hours per day? Add all hours up….	Lamp 1: . . . . . .hr/day Lamp 2: . . . . . .hr/day Lamp 3: . . . . . hr/day Lamp 4: . . . . . .hr/day 8. Don't know	Total hours per day:
11.	Are you satisfied with the biogas lamps?	1. [ ] Yes 2. [ ]No → Reason …….. 8. [ ] Don't know	

5) How do you like your biodigester?

1.	Are you satisfied with its performance?	1. [ ] Yes 2. [ ] No 8. [ ] Don't know
	If yes, Why?	1. [ ] Easy to use 2. [ ] Very strong and last long 3. [ ] Other: 8. [ ] Don't know
	If no, Why?	1. [ ] Not enough gas

		2. [ ] Often broken 3. [ ] Other: 8. [ ] Don't know
2.	How about its shape and general look, do you like it?	1. [ ] Yes 2. [ ] No→ Reason . . . 8. [ ] Don't know
3.	Do you know any other type of biogas plant model?	1. [ ] Yes 2. [ ] No
	If yes, what are they? ***(showing the pictures of those plants to respondents)***	1.[ ] Floating drum 2.[ ]Plastic type 3.[ ] Prefabricated plant : fibre glass 4.[ ] Fixed dome other than NBP:…… 8.[ ] Don't know
4.	Which onedo you like the best including NBP designed?	0 [….] NBP design 1.[ ] Floating drum 2.[ ] Plastic type 3.[ ] Prefabricated plant : fibre glass 4.[ ] Other: 8.[ ] Don't know
	Why?	

6) Fuels used by the household for cooking next to biogas (ASK AND *OBSERVE*, 0 = I DON'T USE THIS FUEL)

#	Fuel	Estimated amount (kg/day)	How many months do you use this amount (1-12) (12=all year)												How much in the other months?
1	Firewood (kg)		1	2	3	4	5	6	7	8	9	10	11	12	Kg/day
2	Charcoal (kg)		1	2	3	4	5	6	7	8	9	10	11	12	Kg/day
3	Agricultural residues (i.e rice husk) (kg)		1	2	3	4	5	6	7	8	9	10	11	12	Kg/day
4	Dung		1	2	3	4	5	6	7	8	9	10	11	12	Kg/day

SURVEYOR: MAKE BASED ON Q6 THIS FOLLOWING ASSESSMENT

5. The fuel use of the respondent is (one answer possible!):	[ ] Same during the whole year
	[ ] Higher in rainy season (~May to October)
	[ ] Lower in Rainy season (~ November to April)

LPG USAGE

#	Fuel	Size of bottle (A)	Number of days that the bottle lasts (B)	Price of the bottle (in USD)
6	LPG (kg)	……..kg	…….days	USD

7.	How much money do you save per month on cooking and boiling with biogas compared to the situation without the biodigester?	……..USD/month (typically in the range of $4 to $12)

8.	Which household member collects wood:	1. [ ] Husband 2. [ ] Wife 3. [ ] Son 4. [ ] Daughter 5. [ ] Grand father 6. [ ] Grand mother 7. [ ] Other specify

9.	How much money do you save per months on lighting with biogas compared to the situation without the biodigester	……..USD/month
10.	What are your other sources for household Lighting?	1. [ ]Battery 2. [ ] Kerosene 3. [ ] Grid electricity 4. [ ] Grid electricity from a local supplier 5. [ ] Solar lantern 6. [ ] Other……

SECTION C - ANIMAL HOLINGS AND KEEPING

Please walk around the farm to understand better how and where the animals are kept!

7) Do you own cattle or buffalo's?(Surveyor: please observe, count and not only ask!)

#	Livestock	Number of livestock by size present at the farm	
		Youngster (small)	Adult (big)
1	Cattle		
2	Buffalo		

8) Do you own pigs?(Surveyor: please observe, count and not only ask!)

#	Type of pig	Current population	Average weight
1	Sow		kg/pig
2	Other (i.e boar)		kg/pig
3	Piglet		kg/pig

9) How many hours are your animals stabled at your house?

#	Animal	Hours per day stabled	How many months like this												Number of hours stabled in the other months
1	Cows/Buffalo	h/day	1	2	3	4	5	6	7	8	9	10	11	12	hour/day
2	Pigs	h/day	1	2	3	4	5	6	7	8	9	10	11	12	hour/day

10) Measure the amount of <u>manure</u> that ends up in each system

#	Cattle Manure system	Description	Measure kg/day
1	Biodigester		
2	Lagoon	In a water body (manure is submerged with water)	

3	Slurry	Kept in slurry condition (like porridge)	
4	Solid storage	Solid storage in piles or stacks	
5	Composting	Composting (manure is regularly turned over)	
6	daily spread	Daily spread (brought to the field within 1 day)	
7	Burned as fuel	Burned dung as fuel	
8	Drying in the sun	Drying in the sun (for selling)	
9	Fishpond	Fishpond	
10	Other	Other (please specify)……..	
11		**Calculate the total**	

10A, In case some manure is not fed into the biogas plant, what is the reason for that

……

11) Bio-slurry stock and management,

11A. How much the bio-slurry is produced per day (flow out of biogas plant)

?.....kg/day

12B. **OBSERVE and DISCUSS! How do you store or use the bio-slurry** (bio-slurry is effluent from the biodigester)

1	Does your plant have slurry pit?	1.[ ] Yes	V=…..…..m3, (…….mx ……..mx…….m)	
		2.[ ] No	Why?	
2	Does your plant have slurry hut?	1.[ ] Yes	V=…..…..m3, (…….mx ……..mx…….m)	
		2.[ ] No	Why?:	
	If yes, what kind of roof?	1.[ ] Zinc 2.[ ] Leaf 3.[ ] Tent 4.[ ]Climbing plant 5.[ ] Others		
5	Do you take out the slurry from the slurry pit for composting?	1.[ ] Yes	1.[ ] every day 2.[ ] 3 days 3.[ ] 1 week 4.[ ] > 1 week	How many minute per each time?:……mn
		2.[ ] No	Why?.....	
6	Does your bio-slurry fertilizer mix with other organic material?	1.[ ] Yes	1.[] Dry material:…… 2.[] Wet material:…… 3.[] Animal dung:…… 4.[] Other:…….	
		2.[ ] No	Why?....	
	If yes, how often?		**Rainy season** 1.[ ] every day 2.[ ] 3 days 3.[ ] 1 week 4.[ ] > 1 week	**Dry season** 1.[ ] every day 2.[ ] 3 days 3.[ ] 1 week 4.[ ] > 1 week
7	How many tons of fertilizer is produced per year?	…….tons per year		
8	How often do you use the	1.[ ] every 3 months		

	compost?	2.[ ] every 3 months 3.[ ] 1 per year 4.[ ] Other:…….			
9	Please evaluate the use of following system				
	Bio-slurry stock and management	1.Very easy	2. Fair	3. Difficult	Remark
	Construction of slurry pit				
	Construction of compost hut				For slurry hut
	Take the slurry to compost hut				For slurry hut
	Mixing other organic material with slurry				For slurry hut
10	In your opinion,do you have any idea to store or manage the slurry better? …… …… …… ……				

12) Usage of Bio-slurry

1.	Do you use the bio-slurry?	1 [ ] Yes 2[ ] No				
2.	→ If no, what is the reason?	…….				
3.	→ If yes, what you use it for and in what form?					
Use for	Form of slurry	Average use of fertilizer		Evaluation		
		Total fertilized land use	Amount of fer./ harvest	Easy	Fair	Difficult
1.Rice	1. [ ] Liquid	……Ha	……Kg			
	2. [ ] Semi-solid		.....kg			
	3. [ ] Solid		……kg			
2.Vegetable	1. [ ] Liquid	.....Ha	.....Kg			
	2. [ ] Semi-solid		……kg			
	3. [ ] Solid		.....kg			
3.Fruit tree	1. [ ] Liquid	……trees	……Kg			
	2. [ ] Semi-solid		.....kg			
	3. [ ] Solid		……kg			
4.Fish	1. [ ] Liquid	.....m^2	.....Kg			
	2. [ ] Semi-solid		……kg			
	3. [ ] Solid		.....kg			
5.Earth	1. [ ] Liquid	……m^2	……Kg			
	2. [ ] Semi-solid		.....kg			
	3. [ ] Solid		……kg			
6.Others	1. [ ] Liquid		.....Kg			

	2. [ ] Semi-solid		……kg			
	3. [ ] Solid		……kg			

13) Impact of bio-slurry

1	Do you use chemical fertilizer before?	1: [ ] Yes . . . . . .per year 2: [ ] No→No4
2	Do you still use chemical fertilizer?	1: [ ] Yes, Why?. . . . . . 2: [ ] No
3	Do you save on chemical fertilizer because of the biodigester?	1. [ ] Use same amount,.... kg/year 2. [ ] Use more, ...kg/year 3. [ ] Use less, how much less per year .....kg and . . . . ….US$ 8. [ ] Don't know
4	How do you compare the quality of bio-slurry with composted manure? If you used it before.	1. [ ] Better 2. [ ] Same 3. [ ] less good 4. [ ] other …….. 8. [ ] Don't know
5	What are the difficulties and bad effect in using bio-slurry, if any?	1. [ ] No any →No7 2. [ ] Yes:……
6	How those problems can be solved?	1. [ ] 2. [ ] 8. [ ] Don't know
7	Would you recommend others to use bio-slurry?	1. [ ] Yes 2. [ ] No, →reason:…….. 8. [ ] Don't know
8	Do you have any concern about bio-slurry used in the future?	1. [ ] Yes→ reason:…… 2. [ ] No 8. [ ] Don't know
9	What are the impacts of the bio-slurry use? (asking per each answere)	1. [ ] Yield increase 2. [ ] Less insect pest 3. [ ] Less disease 4. [ ] Less weeds 5. [ ] Reduce chemical fertilizer use 6. [ ] Improve soil structure 7. [ ] Others 8.[ ] Don't know

14) Bio-slurry usage training

1.	Have you received any training from the programme so far?	1. [ ] Yes 2. [ ] No

	If yes, what kind of training	1. [ ] Exchange visit 2. [ ] Individual training 3. [ ] Group training 4. [ ] other……..
2	Do you feel there should be more training/information on bio-slurry use?	1. [ ] Yes 2. [ ] No, →reason:…….. 8. [ ] Don't know
	If yes, what are they?	1. [ ] 2. [ ] 3. [ ]

15) Bio-slurry (commercial side)

1	Have you ever sold the bio-slurry?	1. [ ] Yes 2. [ ] No
2	If no, would you sell it, if someone wants to buy?	1. [ ] Yes 2. [ ] No, why?.....
3	If yes, what is your expected price?	1. [ ] Solid :……USD/kg 2. [ ] Semi-solid: ……USD/kg
4	Are you willing to follow some storage method for making compost if it is required by the buyer?	1. [ ] Yes 2. [ ] No

SECTION D–SOCIO ECONOMIC

1. Household head: (0: illiterate / 1: primary / 2: junior high school / 3: high school / 4: University degree

2. Spouse (0: illiterate / 1: primary / 2: junior high school / 3: high school / 4: University degree

3. Daily expenditure. How much do you spend per day, on food, education, travel, etc? ……USD

Description	Per day	Per month	Per year
1. Food	……$	……$	……$
2. Education	……$	……$	……$
3. Health	……$	……$	……$
4. Socialize	……$	……$	……$
5. Other	……$	……$	……$
6. Total	……$	……$	……$

4. What other main expenditures did you have last year? ……USD

5. Land Title? 1. Yes 0. No

6. What are **monthly** incomes sources: (Government, NGO, shop etc)?.....USD

1	**Salary of parents**	**…….$**
2	Salary from job in city (garment factory, construction works	…….$
3		…….$
4	Others (	…….$
5	Total	…….$

7. What are **yearly** incomes from farming activities: (Rice growing, pigs, cows)?.....USD

1	**Rice**	**…….$**
2	Selling Pig	…….$
3	Selling cow	…….$
5	Selling chicken	…….$
5	Others	…….$
6	Total	…….$

GENDER:

8. How do you think about the project, is it suitable for women in operation and maintenance?
   1. Yes 2. No
9. What Kind of work or assistance that women are involved in the project activities?

   1 [ ] Decision for buying the plant
   2 [ ] Manure collection and mixing
   3 [ ] Use of biogas (cooking)
   4 [ ] Maintenance
   5 [ ] Others
10. In your household, who will be the decision maker for building bio-digester, in terms of financial and managerial aspects? 1. Men 2. Women 3. Both

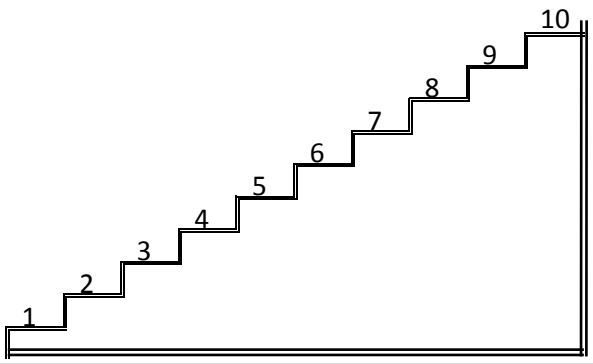
POVERTY PERCEPTIONS

How do you rank your household compared to others in this village?

1. Extremely poor 2. Poor3. Not poor4. Wealthy

Here is a picture of a 10-step ladder (well-being). Imagine that at the bottom, on the first step, stand the poorest people, and on the highest step, the tenth, stand the rich.

Figure1. 10-Step Ladder



11. On which step of this ladder are you today 2013?  

12. On which step were you located before having biogas plant

13. (If there was a positive change) What are the important factors that helped you move up? (Record in term of level of significance)
……..

14. (If there was a negative change) What are the factors that could not helped you move up? (Record in term of level of significance)……..

15. (If there is no change) What are the factors that could not helped you move up? (Record in term of level of significance)

Thank the respondent

Once you finish, make sure all questions are answered in a clear and understandable way!

The surveyordeclares that all questions were answered reliable:

Surveyor name	
Date	
Signature	
End time	
Total time	
Checked by	

Questionnaire for NoneBiogas User

Upscale new bio-digester technology with Bio-slurry management

(Check and make sure that the household owner don't have biodigester)

INTRODUCTION

Hello, I am [name], with Mekong Carbon Ltd, an independent research company based in Phnom Penh and we're working on behalf of Landell Mills Ltd. They are conducting feasibility study on which a pilot investment project for upscaling new biogas technology with bio-slurry management demonstrated in Cambodia with supporting due diligence. This project is to implement ADB Capacity Building Technical Assistance (TA) 7833: REG Capacity Building for Efficient Utilization of Biomass for Bioenergy and Food Security in the GMS.

The interview will take approximately 45 minutes to complete. Your participation in this study is completely voluntary. You do not have to answer any questions that you do not want to answer and you may end the interview at any time. Your opinion is very important, however, and we hope you take the time to respond to all questions in this survey.

We will keep all of your answers to this survey confidential. You will not be personally identified. Survey data and findings will be reported only in an aggregate form and you will not be identified by name in any reports.

Please introduce yourself and the project to the respondent. Please note that respondent have right NOT to join this survey if they are not interested. If a qualified respondent is not available, please proceed to the next household on your list. ***(The qualified respondents are household head and spouse of household head only)***

Questionnaire ID:	**Date interview: __ __/__ __/ 2013**
Name of interviewer:……	**Time started: __ __ hr __ __mn End time: :__ __ hr __ __mn**

SECTION A –GENERAL QUESTIONS

1)	Name of Respondent				
2)	Telephone number or number where they can be reached				
3)	Sex	1. Male		2. Female	
4)	Age	……..years old			
5)	Number of household member	……..people			
6)	How many children below 18				
7)	Do all children go to school?	1. Yes 0. No, reason why_____			
8)	What is your ethnic background/nationality?	1. Khmer 2. Chinese 3. Vietnamese 4. Cham 5. Indigenous (Phnong,……) 4. Other (specify): ……..			
9)	Status of respondent	1. Household head	2. Spouse	3. Son/ daughter	4. Other (specify)
10)	Status of the house	1. Brick	2. Half brick	3. Wood with zinc roof/tile	4. Wood with palm leave
11)	Land	1. Areas around the	2. Rice field	3. Chamkar	

		house….m x.…m=…..m2	……..ha	……ha	

SECTION B –KNOWLEDGE RELATED TO BIODIGESTER

5.	Have you ever heard about biodigester?	1. [ ] Yes 2. [ ] No→Go to question **No2 Fuel use**
1.	If yes, What kind of biogas plant do you know? (show the picture of those plant model)	1.[ ] NBP model 2.[ ] Floating drum 3.[ ] Plastic type 4.[ ] Prefabricated plant : fibre glass 5.[ ] Don't know 5.[ ] Other:
2.	If you buy a biodigester and you have the option to choose, what will be the model you choose?	1.[ ] NBP model 2 [….] Fixed dome other than NBP: VN 3.[ ] Floating drum 4.[ ] Plastic type 5.[ ] Prefabricated plant : fibre glass 6.[ ] Don't know 7.[ ] Other:
3.	Why?	1.[ ] 2.[ ] 3.[ ] 4.[ ] 5.[ ] Don't know
4.	Do you know what it is used for?	1. [ ] Cooking 2. [ ] Lighting 3. [ ] Fertilizer 4. [ ] Animal feeding 5. [ ] Don't know 6. [ ] Other
5.	Do you like it?	1.[ ] Yes 2.[ ] No→ go to question No5
	If Yes, why don't you install it?	1. [ ] cannot afford 2. [ ] Nolabor 3. [ ] Other:……
	If no, why?	1. [ ] cannot afford 2. [ ] Don't believe 3. [ ] Other:……..
6.	If cannot afford it, how much can you afford it? (don't show the cost to the respondent, let they say about it)	1.[ ] >500 USD:…… 2.[ ] <500 USD:…… 3.[ ] <400USD:…… 4.[ ] <300 USD:……

Fuels used by the household for cooking (ASK AND *OBSERVE*, 0 = I DON'T USE THIS FUEL)

#	Fuel	Estimated amount (kg/day)	How many months do you use this amount (1-12) (12=all year)												How much in the other months?
1	Firewood (kg)		1	2	3	4	5	6	7	8	9	10	11	12	Kg/day
2	Charcoal (kg)		1	2	3	4	5	6	7	8	9	10	11	12	Kg/day
3	Agricultural residues (i.e rice husk) (kg)		1	2	3	4	5	6	7	8	9	10	11	12	Kg/day
4	Dung		1	2	3	4	5	6	7	8	9	10	11	12	Kg/day

LPG USAGE

#	Fuel	Size of bottle (A)	Number of days that the bottle lasts (B)	Price of the bottle (in riel)
6	LPG (kg)	……..kg	……..days	Riel

11.	How much money do you spend per month on cooking	……..riel/month (typically in the range of $4 to $12)
12.	Which household member collects wood:	1. [ ] Husband 2. [ ] Wife 3. [ ] Son 4. [ ] Daughter 5. [ ] Grandmother 6. [ ] Grandfather
13.	What are the sources for household **Lighting**?	1.[ ]Battery 2. [ ] Kerosene 3. [ ] Grid electricity 4. [ ] Grid electricity from a local supplier 5. [ ] Solar lantern 6. [ ] Other……

SECTION C - ANIMAL HOLINGS AND KEEPING

Please walk around the farm to understand better how and where the animals are kept!

16) Do you own cattle or buffalo's?(Surveyor: please observe, count and not only ask!)

#	Livestock	Number of livestock by size present at the farm		Amount of livestock 1 year ago in total (number)
		Youngster (small)	Adult (big)	
1	Cattle			
2	Buffalo			

17) How many hours are your animals stabled at your house?

#	Animal	Hours per day stabled	How many months like this												Number of hours stabled in the other months
1	Cows	h/day	1	2	3	4	5	6	7	8	9	10	11	12	hour/day
2	Pigs	h/day	1	2	3	4	5	6	7	8	9	10	11	12	hour/day
3	Buffalo	h/day	1	2	3	4	5	6	7	8	9	10	11	12	hour/day

18) Measure the amount of <u>manure</u> that ends up in each system per day

#	Cattle Manure system	Description	Measure kg/day
1	Solid storage	Solid storage in piles or stacks	
2	Lagoon	In a water body (manure is submerged with water)	
3	Slurry	Kept in slurry condition (like porridge)	
4	Composting	Composting (manure is regularly turned over)	
5	Daily spread	Daily spread (brought to the field within 1 day)	
6	Burned as fuel	Burned dung as fuel	
7	Drying in the sun	Drying in the sun (for selling)	
8	Fishpond	Fishpond	
9	Other	Other (please specify)……..	
10	**Calculate the total per animal (should be *<u>100% for method B)</u>***		

SECTION D–BIOSLURRY (COMERCE)

4.	Do you grow crop?	1 [ ] Yes → 2 [ ] No →Go to End
	If yes, what do you grow?	1. [ ] Rice 2. [ ] Morning glory 3. [ ] Tomato 4. [ ] Plant egg 5. [ ] Cabbage 6. [ ] Others:
5.	Do you use fertilizer?	1 [ ] Yes 2[ ] No →2c
2a	If yes, What kind of fertilizer?	1 [ ] Chemical fertilizer: 2[ ] Compost from animal manure 3 [ ] Mix both chemical and compost 4 [ ] Other
2b	If mix both, how do you compare the quality of compost fertilizer with Chemical fertilizer?	1. [ ] Better 2. [ ] Same 3. [ ] less good 4. [ ] other ……..
2c	If No, what is the reason?	…….
3	What have you heard about bio-slurry?	1. [ ] Yes 2. [ ] No 3. [ ] Don't know
5	Are you willing to pay for bio-slurry?	1: [ ] Yes, How much per bag (50kg) ……Riel 2: [ ] No, Why?. . . . .

Socio Economic:

16. Household head:(0: illiterate / 1: primary / 2: junior high school / 3: high school / 4: University degree

17. Spouse:(0: illiterate / 1: primary / 2: junior high school / 3: high school / 4: University degree

18. Expenditure, how much do you spend on food, education, health, etc? ……USD

Description	Per day	Per month	Per year
Food	……..$	……..$	……..$
Education	…….$	…….$	…….$
Health	…….$	…….$	…….$
Socialize	…….$	…….$	…….$
Other	…….$	…….$	…….$
Total	…….$	…….$	…….$

19. What other main expenditures did you have last year? ……..USD

20. Land Title? 1. Yes 0. No

21. What are monthly incomes sources: (Government, NGO, shop etc)?……..USD

1	**Salary of parents**	**…….$**
2	Salary from job in city (garment factory, construction works	…….$
4	Others (	…….$
5	Total	…….$

22. What are yearly incomes from farming activities: (Rice growing, pigs, cows)?……..USD

1	**Rice**	**……..$**
2	Selling Pig	…….$
3	Selling cow	…….$
5	Selling cheken	…….$
5	Others	…….$
6	Total	…….$

GENDER:

23. How do you think about the project, will the bio-digester project besuitable for women in operation and maintenance?
1. Yes 2. No

24. What Kind of work or assistance that women are involved in the project activities?……..

1 [ ] Decision for buying the plant
2 [ ] Manure collection and mixing
3 [ ] Use of biogas (cooking)
4 [ ] Maintenance
5 [ ] Others

25. In your household, who is the decision maker, in terms of financial and managerial aspects? 1. Men 2. Women 3. Both

POVERTY PERCEPTIONS

26. How do you rank your household compared to others in this village?

1. Extremely poor 2. Poor 3. Not poor 4. Wealthy

Here is a picture of a 10-step ladder (well-being). Imagine that at the bottom, on the first step, stand the poorest people, and on the highest step, the tenth, stand the rich.

Figure1. 10-Step Ladder

27. On which step of this ladder are you located today 2013?

Thank the respondent

Once you finish, make sure all questions are answered in a clear and understandable way!

The surveyordeclares that all questions were answered reliable:

Surveyor name	
Date	
Signature	
End time	
Total time	
Check by	

ANNEX 2 List of biogas users

No	Plant ID	Biodigester Name	Name of respondent	Plant Size	Village	Commune	District Name	Province	Telephone
1	2109070245	Ourn Srey Tuch	Sin Yan	6	Trapeang Chak	Tram Kak	Tram Kak	Takeo	972071959
2	2109070182	Un Oeun	Och Tuch	6	Trapeang Chak	Tram Kak	Tram Kak	Takeo	92286093
3	2109081159	Baet Ngan	Baet Ngan	6	Trapeang Chak	Tram Kak	Tram Kak	Takeo	077618073
4	2109091191	Chhun Seng	Chhun Seng	6	Trapeang Chak	Tram Kak	Tram Kak	Takeo	0883879838
5	2109080611	Nob Phon	Mang Oun	6	Trapeang Chak	Tram Kak	Tram Kak	Takeo	092762534
6	2109123027	Toy Sarath	Her Pon	4	Ta Tai	Nhaeng Nhang	Tram Kak	Takeo	016426975
7	2109080637	Nget Nak	Nget Nak	4	Ta Tai	Nhaeng Nhang	Tram Kak	Takeo	092270249
8	2109123049	Yon Neath	Toy Sarath	4	Ta Tai	Nhaeng Nhang	Tram Kak	Takeo	078344753
9	2109080784	Vorng Ly	Vorng Ly	4	Ta Tai	Nhaeng Nhang	Tram Kak	Takeo	081646809
10	2109123402	Tem Khen	Tem Khen	4	Ta Tai	Nhaeng Nhang	Tram Kak	Takeo	
11	2109112215	Norn Nach	Norn Nach	4	Ta Tai	Nhaeng Nhang	Tram Kak	Takeo	092954397
12	2109123402	Nhet Nav	Nhet Nav	4	Ta Tai	Nhaeng Nhang	Tram Kak	Takeo	0979754445
13	2109122995	Nhet Ny	Nhet Ny	4	Ta Tai	Nhaeng Nhang	Tram Kak	Takeo	
14	2109112499	Bou Pet	Yong Sareurn	6	Angk Kralanh	Cheang Tong	Tram Kak	Takeo	
15	2109112498	Haem Sam Ol	Um Run	6	Angk Kralanh	Cheang Tong	Tram Kak	Takeo	
16	2109101841	Kret Soemg	Seng Sok	6	Angk Kralanh	Cheang Tong	Tram Kak	Takeo	0121793647
17	2109101846	Tei Sothear	Tem Sothea	6	Angk Kralanh	Cheang Tong	Tram Kak	Takeo	092822324
18	2109112498	Bou Sakum	Bou Sakum	6	Angk Kralanh	Cheang Tong	Tram Kak	Takeo	092492524
19	2109123168	Kim Samoeun	Kim Samoeun	6	Kol Kom	Tram Kak	Tram Kak	Takeo	092797098
20	2109123138	Prak Phal	Prak Phal	6	Kol Kom	Tram Kak	Tram Kak	Takeo	0976377327
21	2109070228	Sam Sarith	Kim Oun	6	Kol Kom	Tram Kak	Tram Kak	Takeo	0326400049
22	2109123082	Bun Vy	Bun Vy	6	Kol Kom	Tram Kak	Tram Kak	Takeo	0973227948
23	2109112391	San Bunthai	San Sina	6	Trapeang Kralanh	Ou Saray	Tram Kak	Takeo	012627689
24	2109123029	Chan Noeun	Phim Chantra	6	Trapeang Kralanh	Ou Saray	Tram Kak	Takeo	012764530
25	2109112400	Morm Sopheap	Morm Sopheap	6	Trapeang Kralanh	Ou Saray	Tram Kak	Takeo	092977984
26	2109123483	Um Chanthou	Um Chanthou	4	Trapeang Kralanh	Ou Saray	Tram Kak	Takeo	
27	2109123405	Lam Sreywit	Sos Sarom	6	Trapeang Kralanh	Ou Saray	Tram Kak	Takeo	0978780880
28	2109122891	Dy Vit	Moeun Ny	4	Peak Bang'aong	Trapeang Thum Khar	Tram Kak	Takeo	078345718
29	2109122865	Moeun Na	Moeun Na	4	Peak Bang'aong	Trapeang Thum Khar	Tram Kak	Takeo	0972899859
30	2109070350	Sao Chuon	Sao Chuon	4	Peak Bang'aong	Trapeang Thum Khar	Tram Kak	Takeo	017876909
31	2109070348	Suos Sovannarith	Suos Sovannarith	4	Peak Bang'aong	Trapeang Thum Khar	Tram Kak	Takeo	017882719
32	2109070351	Nou Porb	Nou Porb	4	Peak Bang'aong	Trapeang Thum Khar	Tram Kak	Takeo	0979335490
33	2109122837	Chey Sorn	Chey Sorn	4	Peak Bang'aong	Trapeang Thum Khar	Tram Kak	Takeo	097203305
34	2109122890	Un Aem	Un Aem	4	Peak Bang'aong	Trapeang Thum Khar	Tram Kak	Takeo	

35	2107101811	Nub Lach	Chong Ry	4	Angk Reang	Boeng Tranh Khang C	Samraong	Takeo	0975803736
36	2107101858	Keo Chantra	Keo Chantra	6	Angk Reang	Boeng Tranh Khang C	Samraong	Takeo	017847545
37	2107123111	Hang Hearn	Hang Hearn	4	Angk Reang	Boeng Tranh Khang C	Samraong	Takeo	088 9015194
38	2107101744	Soam Kem	Sorm Kem	6	Angk Reang	Boeng Tranh Khang C	Samraong	Takeo	0979875716
39	2107101859	Ung Sophak	Ung Sophak	6	Angk Reang	Boeng Tranh Khang C	Samraong	Takeo	0888135896
40	2107091494	Aeam Kea	Ket Narom	4	Srei Bandit	Sla	Samraong	Takeo	0886945994
41	2107102003	Soun Vet	Bouch Kim	4	Srei Bandit	Sla	Samraong	Takeo	0973309563
42	2107070164	Cheang Von	Cheang Sokhem	4	Srei Bandit	Sla	Samraong	Takeo	092862248
43	2107070165	Men Mouy	Men Mouy	4	Srei Bandit	Sla	Samraong	Takeo	017389264
44	2107123133	Van Nary	Van Kam	4	Srei Bandit	Sla	Samraong	Takeo	
45	2107112822	Sim hourn	Sim hoirn	4	Trapeang Vihear	Cheung Kuon	Samraong	Takeo	0976366377
46	2107112635	Pov Chhorn	Nob hon	4	Trapeang Vihear	Cheung Kuon	Samraong	Takeo	012418358
47	2107123306	Kim mern	Chea sokny	4	Trapeang Vihear	Cheung Kuon	Samraong	Takeo	
48	2107112620	Sang phai	Mork soy	4	Trapeang Vihear	Cheung Kuon	Samraong	Takeo	0889595966
49	2107070079	Khem phat	Therng sim	4	Trapeang Vihear	Cheung Kuon	Samraong	Takeo	0976605132
50	2107070281	Luy hak	Kao oun	4	Trapeang Vihear	Cheung Kuon	Samraong	Takeo	012201664
51	2107122853	Poeng sokhom	Poeng sokhom	4	Trapeang Vihear	Cheung Kuon	Samraong	Takeo	012846617
52	2107112856	Ven sok	Him sitha	4	Trapeang Vihear	Cheung Kuon	Samraong	Takeo	077332808
53	2107122855	Dy tha	Dy tha	4	Trapeang Vihear	Cheung Kuon	Samraong	Takeo	0886467785
54	2107112444	Touch chea	Touch chea	4	Trapeang Vihear	Cheung Kuon	Samraong	Takeo	089804280
55	2107080618	Dol kheang	Dol kheang	6	Hang Heng	Boeng Tranh Khang T	Samraong	Takeo	0974771755
56	2107112431	Long ngoun	Long ngoun	4	Hang Heng	Boeng Tranh Khang T	Samraong	Takeo	0888903391
57	2107112297	So saroeun	Mey reoun	4	Hang Heng	Boeng Tranh Khang T	Samraong	Takeo	092515765
58	2107112328	Mey oun	Ney sopheap	4	Hang Heng	Boeng Tranh Khang T	Samraong	Takeo	081 987272
59	2107101797	Um phorn	Um phorn	6	Hang Heng	Boeng Tranh Khang T	Samraong	Takeo	012560597
60	2107080513	Prak touch	Prak touch	6	Hang Heng	Boeng Tranh Khang T	Samraong	Takeo	095774689
61	2107112386	Heng kimsrouy	Heng kimsrouy	4	Hang Heng	Boeng Tranh Khang T	Samraong	Takeo	0883618218
62	2107080639	Nob Prum	Vann Sokom	6	Angkor Phdik	Chumreah Pen	Samraong	Takeo	092 92 31 30
63	2107122922	Yet song leng	Yet Song Leng	6	Angkor Phdik	Chumreah Pen	Samraong	Takeo	0884757781
64	2107122915	chhit sim	Vut Seng	6	Angkor Phdik	Chumreah Pen	Samraong	Takeo	089670982
65	2107122913	Cheam Mara	Chea Chantha	6	Angkor Phdik	Chumreah Pen	Samraong	Takeo	
66	2107101954	Ngen Saov	Vicheka	6	Angkor Phdik	Chumreah Pen	Samraong	Takeo	
67	2107123070	Lach saroun	Lach saroun	4	Romon	Boeng Tranh Khang C	Samraong	Takeo	0974801980
68	2107112668	Min sokhon	Min sokhon	4	Romon	Boeng Tranh Khang C	Samraong	Takeo	0978251788
69	2107112738	Phath Don	Phath Don	6	Romon	Boeng Tranh Khang C	Samraong	Takeo	
70	2107101822	Sam Sambo	Sam Bo	6	Romon	Boeng Tranh Khang C	Samraong	Takeo	012687172
71	2107080632	Sam Chanthou	Sam Chanthou	6	Romon	Boeng Tranh Khang C	Samraong	Takeo	0887382318
72	2107080648	Oung Khorn	Sok Soeun	6	Romon	Boeng Tranh Khang C	Samraong	Takeo	012919306
73	2107091293	Khiev Soeng	Khiev Soeng	4	Romon	Boeng Tranh Khang C	Samraong	Takeo	0889521316
74	2107123019	Kung Theoun	Kung Theoun	4	Romon	Boeng Tranh Khang C	Samraong	Takeo	
75	2107112799	Pen Rith	Chho Chanthy	6	Romon	Boeng Tranh Khang C	Samraong	Takeo	

ANNEX 3 List of non-biogas users

No	Name of Respondent	Village	Commune	District Name	Province	Telephone Number
1	Brak Phat	Angk Reang	Boeng Tranh Khang Cheung	Samraong	Takeo	
2	Seab Chanty	Angk Reang	Boeng Tranh Khang Cheung	Samraong	Takeo	
3	Khat Horn	Angk Reang	Boeng Tranh Khang Cheung	Samraong	Takeo	972610992
4	Eng Yeng	Angkor Phdik	Chumreah Pen	Samraong	Takeo	096 296 2828
5	Kum Keurn	Angkor Phdik	Chumreah Pen	Samraong	Takeo	12475227
6	Am Tit	Srei Bandit	Sla	Samraong	Takeo	032 640 35 93
7	Nget Srouy	Srei Bandit	Sla	Samraong	Takeo	978030188
8	Tep Mat	Srei Bandit	Sla	Samraong	Takeo	
9	Nob Toun	Trapeang Vihear	Cheung Kuon	Samraong	Takeo	889727981
10	Sok Se	Trapeang Vihear	Cheung Kuon	Samraong	Takeo	974750406
11	Mork rin	Trapeang Vihear	Cheung Kuon	Samraong	Takeo	60783307
12	Lunh soam	Hang Heng	Boeng Tranh Khang Tboung	Samraong	Takeo	888056342
13	Nov sin	Hang Heng	Boeng Tranh Khang Tboung	Samraong	Takeo	883191670
14	Pram borin	Hang Heng	Boeng Tranh Khang Tboung	Samraong	Takeo	17507795
15	Hou norn	Hang Heng	Boeng Tranh Khang Tboung	Samraong	Takeo	973811483
16	Deap Meo	Romon	Boeng Tranh Khang Cheung	Samraong	Takeo	89740486
17	Mok Chim	Romon	Boeng Tranh Khang Cheung	Samraong	Takeo	12204287
18	Soun Heam	Trapeang Chak	Tram Kak	Tram Kak	Takeo	
19	Keak Lon	Trapeang Chak	Tram Kak	Tram Kak	Takeo	
20	Doung Rorng	Trapeang Chak	Tram Kak	Tram Kak	Takeo	973838078
21	Bu Touch	Ta Tai	Nhaeng Nhang	Tram Kak	Takeo	
22	Ben Phach	Ta Tai	Nhaeng Nhang	Tram Kak	Takeo	
23	Kim Yeoun	Kol Kom	Tram Kak	Tram Kak	Takeo	886297726
24	Nuth Sarong	Trapeang Kralanh	Ou Saray	Tram Kak	Takeo	86606653
25	Mam Sokha	Trapeang Kralanh	Ou Saray	Tram Kak	Takeo	92415873
26	Bun Vanna	Trapeang Kralanh	Ou Saray	Tram Kak	Takeo	9241573
27	Nak Porng	Peak Bang'aong	Trapeang Thum Khang Cheung	Tram Kak	Takeo	78577986
28	Bou Sarun	Peak Bang'aong	Trapeang Thum Khang Cheung	Tram Kak	Takeo	973736125
29	Phann Oun	Peak Bang'aong	Trapeang Thum Khang Cheung	Tram Kak	Takeo	
30	Um Morn	Angk Kralanh	Cheang Tong	Tram Kak	Takeo	975403622

ANNEX 4 Project Design Matrix (PDM)

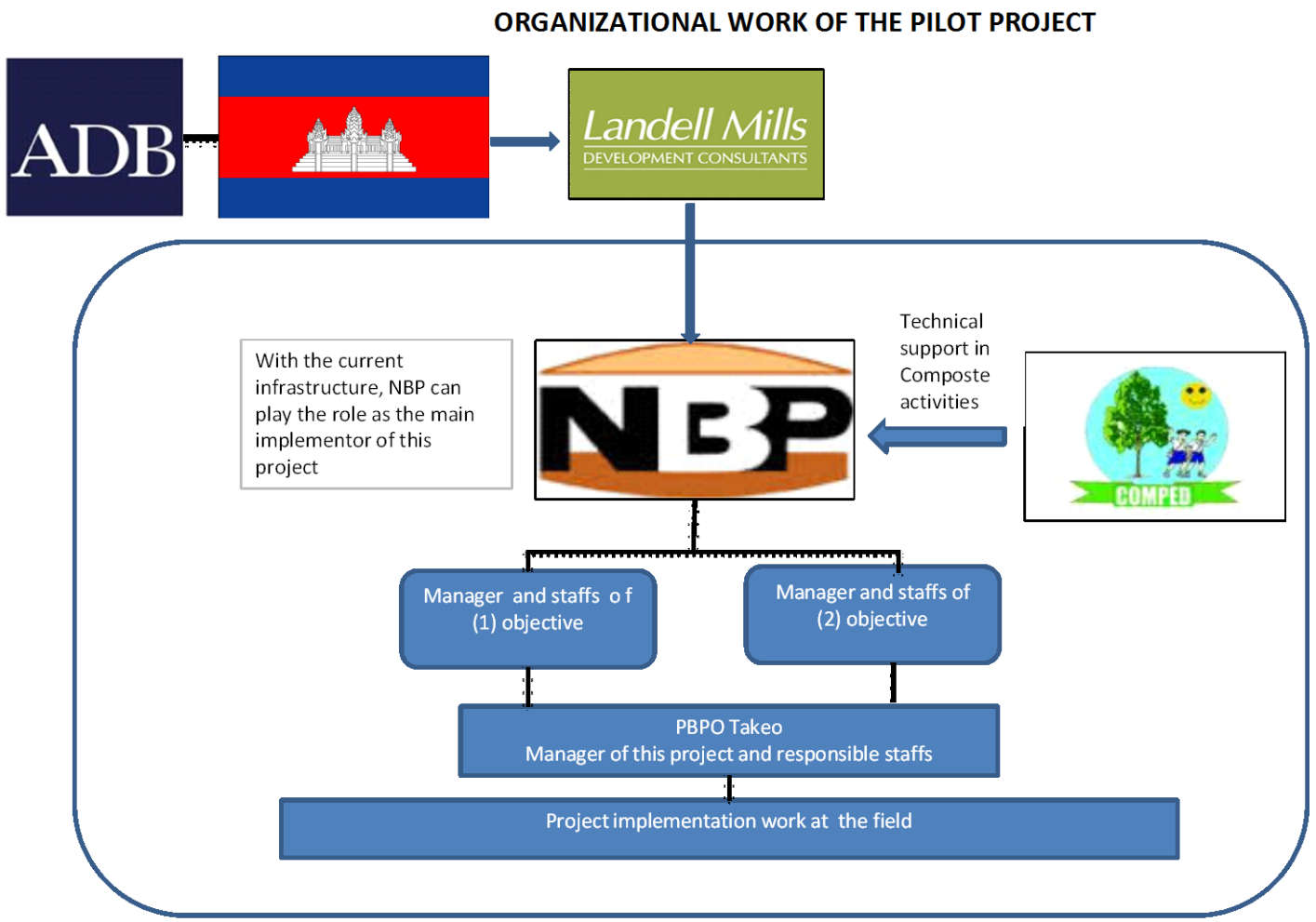
Project Design Matrix

The biodigester technology in Cambodia will be up scaled with more diversity in plant design and slurry management

No	Objective	Output	Activities	Pre-condition
I. New biodigester model				
	New biodigester model will be installed, tested, evaluated and rolled out	1. Five composite plants will be installed and monitored	1.1 Imported 5 model plants for testing	1. The Cambodia economic is maintained at present level 2. No any force measure such as flood, drought that can affect to the production of biogas during the implementing years
			1.2 Selecting five families and installation the five plants by external technician and on job training to NBP trained masons	
			1.3 Monitoring on the performance of the plants (1) daily O&M, (2) gas producing vs dung input, (3) lab testing on TS, VS at different parts of the plant	
		2. The prefabricated plants will be locally produced and intalled	2.1 Selecting and training local workshops on producing composite plant	
			2.2 TOT training to local technician on installation and operation	
		3. Technical document and promotion material will be produce or integrated into the NBP exiting document and material	3.1 Developing and printing construction manual, installation manual, user manual	
			3.2 Integrating this modle to promotion material of NBP	
II. Bio-slurry management				
	Proper bio-slurry management and bio-fertilizer application	4. Improving bio-slurry handling from outlet tank to slurry hut	4.1 Testing with new technique (1) scoping (existing practice) (2) using water pump, (3) gravity flow	
			4.2 Monitoring and evaluating the application and adoptation of those techniques	
		5. Improving composting technique	5.1 Improving design of storage and composting hut with specific tehnique to make good compost	
			5.2 Supporting the implication of the improved design of storage and composting hut	
		6. Institutional set up	6.1 Selecting 50 model farms	
			6.2 Selecting rice miller to be a granule or pellet bio-fertilizer producers	
			6.3 Setting up small scale facilities to produce pellet bio-ferlilizer	

		7. Field testing using pellet of mix biochar compost fertiliser	7.1 Supporting the 50 model farms apply pellet bio-fertilizer on their crops and vegetable	1. The Cambodia economic is maintained at present level 2. No any force measure such as flood, drought that can affect to the production of biogas during the implementing years
			7.2 Coaching and monitoring to selected farmers	
			7.3 Evaluation the effectiveness of pellet fertiliser application	
		8. Training & promotion	8.1 Developing training materials (construction, operation and maintenance manual…etc)	
			8.2 ToT training to NBP, exchange visit, PBPO's involved staffs on (1) improving bio-slurry storage (2) improving composting technique, (3) use of bio-char fertilizer	
			8.3 Training 50 farmers by TOT, exchange visit	
			8.4 Training rice miller to produce good organic fertilizer (pellet bio-char fertilizer)	
			8.5 Developing promotion and marketing material	

ANNEX 5 Organizational chart of the pilot project



ANNEX 6 Activities in this study

Outputs	Tasks	Activities
(i) Feasibility of the introducing new bio=digester technology in Cambodia	1. Meeting with stakeholders	1.1 Meeting with SNV to explain about the project and getting feedback or suggestion from them. 1.2 Meeting DAHP, NBP, PBPO to explain the objective and the outputs of the study. Then, requesting for their cooperation in supporting this study. Several points need to be discussed with the three organizations such as: (1) which are the two recommended districts in Takeo province for the study, (2) what is the current bio-slurry management system? (3) What are their suggestions regarding the new biogas technology and slurry management system. This is a kick off meeting and there will be follow up meeting during the period of the study.
	2. Desk study on existing and available bio-digester plant technology will be conducted	2.1 Reviewing the available prefabricated biogas plant designs via internet and NBP's documentary. A number of prefabricated biogas plant models from China, Thailand and Vietnam will be compiled for further study on cost and other technical specification.
	3. Checking the availability of prefabricated bio-digester models from China, Thailand and Vietnam and do comparison with the current model	3.1 Through ADB, NBP and SNV network, the team will contact the selected prefabricated bio-digester producers in China, Thailand and Vietnam to search for the possibility to introduce those prefabricated biogas plants in Cambodia by comparing with the current NBP model in term of cost, process to installation, durability and plant shape.
	4. Technical and social field survey on both biogas users and non- biogas user	4.1 After consulting with DAPH, NBP and PBPO on the selection of two districts for studying and piloting. 100 households, with 75 having bio-digester plants and 25 does not, will be selected. For selecting the 75 households, NBP database will be used while the other 25 will be selected at the actual site based on technical, financial and social criteria which measure the ability to install biogas plant such as number of cows, land space; condition of the house, transport means…etc. The

		detail criteria will be elaborated in the questionnaires. 4.2 A draft of questionnaire will be done by all concerned experts, then, it will be sent to Landell Mills Ltd (LML) for comment and approval. There will be two sets of questionnaire, one for biogas users and the other one for non-biogas users. With biogas users, the questionnaire consist of (a) technical part related to preference of the current biogas design, operation of the plant, level of satisfactory with the plant performance, (b) slurry management system and sludge management and (c) socio-economic and environmental part. While non- biogas users, it will compose of (a) technical potential for biogas installation and their preference biogas type, (b) management of existing agricultural waste, and (c) socio-economic and environmental aspect. 4.3 After approval on the questionnaire, two survey teams composed of 2 members each will be set up and a one day training including field testing will be arranged for the surveyors before going to the field. 4.4 The field survey and focus group discussion will be done within 2 weeks. At the first's day of the survey the related experts need to be present at the field to observe and monitor the process of the survey while daily monitoring will be done by team leader. 4.5 Four group discussions with chiefs of commune and chiefs of village will be conducted by team leader and concerned experts for qualitative interviews. These meeting will be done at commune office to get a better understanding of how local authority involves in this sector, what are their suggestion and intentions for the future implementation of the pilot project in their communes. 4.6 One focus group discussion with NBP's mason and Biodigester construction companies to learn about their preference of the current model and the suggestion for improving it or propose new plant design based on their experiences. This will be done by team leader
	5. Data entry and analysis, and Compiling report	5.1 After the survey, the data will be entered using SPSS and it will be crossed check by surveyors.

		5.2 Each expert will analyze the data and compile the report 5.3 If it is feasible for introducing a new biodigester plant design, about 5 demonstration plants which compose of 2 or 3 models will be proposed to install for assessing their performance. 5.3.1 Demo pilot plans for setting up those proposed biogas plants will be made with clear the detail of budget, technical assessment methodology, implementer and work plan 5.4 The draft report will be presented to stakeholders such as DAHP, NBP, PBPO and SNV for consultation. Based on their comments, the revision of the report will be done and then it will be sent to LML for further comment.
(ii) Feasibility of slurry management on existing and future biodigester plants	1. Meeting with stakeholders	1.1 The same meeting as stated in (i)-1.1 1.2 The same meeting as stated in (i) -1.2
	2. Desk study on existing available bio-slurry management	2.1 Reviewing the available bio-slurry management system's study via internet and NBP's documentary, and then proposed several options by making comparison based on technical, financial and social criteria of each model.
	3. Field survey and group discussion on bio-slurry management with existing biogas user and none biogas user	3.1 The same description as stated in (i)-4.1,4.2, 4.3, 4.4, 4.5
	4. Field survey with existing rice mill owner	4.1 Meeting and interviewing with rice mill owners to search for their interest in adding the organic fertilizer business to their current one. If they are interested, how much would they intend to invest and what are the needed capacity developments? What should be the business chain look like? Are they willing to buy the slurry from the biogas user to add

		up on the fertilizer?. A guiding questionnaire will be drafted and circulated for comment from LML.
	5. Data analysis, development of bio-slurry business model and report writing	5.1 The same activities as described in (i)- 5.1, 5.2, 5.2 A proposed business model for improving bio-slurry system will be made 5.2.1 At least two slurry management options will be proposed: (a) Slurry management system and its design for household use, (b) Slurry management system and its design for selling to local organic fertilizer producer. 5.2.2 In any option, training needs assessment and a capacity building program will be made 5.2.3 Implementing agency for carrying out this pilot work will be identified and the detail work plans, activities including the design and management of field demonstration plots will be prepared. 5.3 The draft report will be presented to stakeholder such as DAHP, NBP, PBPO, SNV for consultation. Based on their comments, the revision of the report will be done and then sent to LML for further comment.