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Alternative Energy Program
ASTAE**



Cambodia

**Supporting Self-Sustaining
Commercial Markets for
Improved Cookstoves and
Household Biogas**

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Cambodia: Supporting Self-Sustaining Commercial Markets for Improved Cookstoves and Household Biodigesters

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Acronyms

ASTAE	Asia Sustainable and Alternative Energy Program Program	KHR	Cambodian Riel
BCC	Biodigester Construction Company	MAFF	Ministry of Agriculture, Forests and Fisheries of Cambodia
CIEDC	Cambodia-India Entrepreneurship Development Centre	MFI	Microfinance Institution
DfID	U.K Department for International Development	MIME	Ministry of Industry, Mines, and Energy
DGIS	Directorate General International Cooperation of the Netherlands Ministry of Foreign Affairs	MPF	Model Production Facility (for NKS)
DIME	Department of Industry, Mines and Energy	NBP	National Biodigester Program
ESMAP	The World Bank Energy Sector Management Assistance Program	NGO	Nongovernmental organization
GERES	Groupe Energies Renouvelables, Environnement et Solidarités-Cambodia	NKS	Neang Kongrey Stove
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit	NLS	New Lao Stove
ICS	Improved cookstove	PBPO	Provincial Biodigester Program Office
ISC	Industrial Standards of Cambodia	PCF	Project Control Folder
ITC	Institute of Technology of Cambodia, Department of Civil Engineering	PDA	Provincial Department of Agriculture, Cambodia
		PSD	Private Sector Development
		QCC	Quality Control Checklist
		SNV	Netherlands Development Organization
		TLS	Traditional Lao Stove

As the US\$/KHR exchange rate fluctuated between KHR 4,000–US\$4,200 while these projects were underway, values in this report are approximate.

Introduction

In Cambodia, as elsewhere, reducing rural poverty, achieving economic, social, and environmental benefits, and meeting development goals require improved access to clean and affordable energy services. Especially in rural households beyond the reach of the electricity grid, the use of energy-efficient and renewable energy technologies could significantly reduce the large share of household expenses currently required for cooking and lighting (estimated to represent 10 percent of all expenditures), allowing poorer people to devote more money and time to food production, education, and health services.

In rural Cambodia, more than 90 percent of total household energy used comes from wood and charcoal, which will remain the primary energy source for many years to come. Rural families consume approximately 5 kilograms of firewood per day for cooking—in total about 5 million tons per year—contributing to deforestation, black carbon and other emissions from incomplete combustion of biomass, and their attendant health problems. Energy-related activities such as gathering wood, boiling water, and cooking take the poor as much as 3–4 hours a day.

With support from the public and private sectors, including technical assistance from the Asia Sustainable and Alternative Energy Program (ASTAE), the World Bank Energy Sector Management Assistance Program (ESMAP), and active involvement of NGOs, small and medium-sized enterprises are working to develop creative business models and payment schemes so that poorer households can access these energy-efficient, renewable technologies and improve their livelihoods.

This document highlights the technical reports of two such programs, briefly below and more fully in their respective sections:

1. Pilot Project on Improving Manufacturing of Efficient Rural Cookstoves
2. Private Sector Development Technical Assistance Activities to the Cambodian National Biodigester Program

At the heart of each is a primary focus on creating sustainable businesses that produce more affordable, more energy-efficient products for local use, with provisions to

train participants in the skills they require to participate in planning, working in, and managing those enterprises. The programs are consistent with Cambodia's national efforts to encourage decentralization by means of private enterprise development.

Support to the Production and Dissemination of the Neang Kongrey Stove

In the late 1990s, the NGO Groupe Energies Renouvelables, Environnement et Solidarités (GERES–Cambodia) introduced the efficient New Lao Stove (NLS) in Cambodia. Produced in about 20 facilities in Cambodia's main populated provinces, it uses 22 percent less charcoal than traditional models and is used by more than 40 percent of urban households. However, its relatively high price and the lack of a wide distribution network kept penetration in rural villages very low.

In 2001, to respond to the need for an affordable improved cook stove (ICS) in Cambodia's rural areas, GERES–Cambodia developed the Neang Kongrey Stove (NKS). In addition to the energy-efficiency features found in the popular, but largely unaffordable New Lao Stove, the NKS

- can use either charcoal or firewood,
- can be made using (mainly) fine and coarse clay, the same raw materials as for traditional stoves in rural areas,
- requires the same skills traditional stove producers already use, and
- is transportable in the stove carriers used by traditional stove distributors.

In 2007–08, the World Bank Energy Sector Management Assistance Program (ESMAP), with funding from the U.K. Department for International Development (DFID), provided support to pilot the introduction of the NKS in rural areas. The pilot activity was implemented by GERES–Cambodia. Some 8,000 NKS created by home-based potters were sold in rural villages. These were of less than uniform quality and produced in insufficient numbers to meet demand.

In response, the Asia Sustainable and Alternative Energy Program (ASTAE) Program provided technical assistance to create The Model Production Facility for the Efficient Neang Kongrey Stove in Bahn Shhkoul Village, Kampong Chhnang province. Kampong Chhnang is the main pottery- and stove-producing province in Cambodia; Bahn Shhkoul is the province's main stove and pottery production and distribution center. The facility serves as one business model to be replicated throughout Cambodia to achieve effective dissemination of an affordable, uniformly high-quality stove. This would simultaneously accomplish some of the government's objective to decentralize Cambodia's economy by creating private enterprises throughout the country.

The Model Production Facility was charged with achieving six key activities:

1. Develop and test production technologies and techniques to increase productivity and rate of NKS production;
2. Develop standards for production and kiln firing;
3. Pilot-test the new production facility;
4. Train producers to become self-sufficient in management and marketing;
5. Evaluate options for introducing improved manufacturing processes; and
6. Prepare a plan for scale-up of production.

The facility will provide a future for women producers in Bhan Shhkoul, as the improved cookstoves are taking a larger market share, and the need for traditional stoves in Bhan Shhkoul will slowly decline in the future. The facility will train several groups of women producers throughout its lifetime. With ASTAE funding, the first group of 10 women producers were trained to produce the NKS and helped to organize into a collaborative enterprise. The facility allowed these potters, who would otherwise be working on their own, to

- share larger, more efficient, and more energy-efficient production facilities (mechanical mixer, kiln) than those available when working at home,
- set up a microfinance mechanism providing a small daily income,
- learn, then produce, proper production documentation,
- learn production management, and
- learn to negotiate more effectively with middlemen—as a collective, rather than as vulnerable individuals.

The Model Production Facility began operations in August 2008. By August 2009, one year out, the 10 women

potters that were trained were producing a total of over 2,000 stoves per month.

Based on lessons learned from the pilot activity, a plan to implement a National Efficient Cook Stove Program has been formulated by the Ministry of Industry, Mines, and Energy (MIME) with assistance from the World Bank–ESMAP. The national program would bring the NKS—and a model of decentralized enterprise creation—to Cambodia's rural households.

Support to the Implementation of the Cambodian National Biodigester Program

The Cambodian National Biodigester Program (NBP) is a joint project of Cambodia's Ministry of Agriculture, Forests and Fisheries and SNV Netherlands Development Organization. It was launched in 2006 with cofunding from the Directorate General International Cooperation (DGIS) of the Netherlands Ministry of Foreign Affairs. The NBP's primary goal is enterprise development—specifically, the creation of a sustainable program for efficient private sector delivery of high-quality biodigester plants known as the Farmer's Friend.

The NBP is informed by lessons learned from SNV's biogas experience in Nepal and Vietnam, where it was clearly demonstrated that biodigester construction companies must be embedded in local communities to ensure success. Accordingly, NBP focused on developing pilot private sector contractor enterprises called Biodigester Construction Companies—and on supporting the entrepreneurs who lead these enterprises.

Pursuant to this objective, the NBP, with the support of the World Bank ASTAE and with cofunding from SNV for supplemental activities, engaged a private sector and value chain development consultant team to initiate a system to pilot and support the development of Biodigester Construction Companies. The team's work began with World Bank assistance from October 2008 through June 2009 and continued under direct funding from SNV from July through September 2009.

The NBP has established operations in eight provinces, where Provincial Biodigester Program Offices supervise the construction of household biodigesters by NBP-trained biodigester masons. In addition to surpassing the main milestone-linked project indicator (number of businesses registered), the program achieved three

important outcomes that support private sector and value chain development in Cambodia and provide a model for decentralized provision of biodigester services and other product-focused social enterprise initiatives:

1. Following an initially apprehensive reception, the project built strong support among NBP provincial stakeholders for private sector development, and for rural private enterprise development in general.
2. Despite multiple obstacles to training masons to become Biodigester Construction Company business owners, the private sector and value chain development team devised a microfranchise system that made replication of the effort much easier.
3. Customized training for semiskilled rural laborers resulted in a highly tailored and targeted business skills training program developed in collaboration with Cambodia India Entrepreneurship Development Centre (CIEDC).

The private sector and value chain development process resulted in the legal registration, NBP authorization, and business launch of 15 Biodigester Construction Companies in 3 provinces, each of which operates as a franchisee of NBP in a three-party contract between the NBP, Construction Companies, and Provincial Program Offices. The NBP's operating plan prescribes that all Farmer's Friend biodigester products and services in Cambodia will be delivered by private sector Construction Companies by the end of 2011.

Results for the Neang Kongrey Stove Program

The lesson from the program's 2007–08 pilot dissemination of 8,000 stoves was that local producers were unable to create stoves of uniform quality or in sufficient numbers to meet demand. The response, in 2009, was ASTAE funding to create the Model Production Facility, with improved production techniques (mechanized clay mixing, improved molding techniques, and modern kiln firing) and management practices that could be replicated by small and medium enterprises. The facility also trained its workers in production techniques, monitoring of

standards, and basic management skills. The 10 women potters who were trained during the pilot were able to dramatically increase production to over 2,000 stoves a month. In cooperation with the Ministry of Industry, Mines, and Energy, lessons learned will later be incorporated into uniform production standards.

The planned scaling-up phase aims to train additional traditional stove makers to become improved cookstove producers; to open new facilities nationwide modeled on the model production facility; and to strengthen existing distribution channels and create new ones.

Each improved cookstove prevents 0.3 to 0.5 tons of carbon dioxide emissions per year. When disseminated in their hundreds of thousands, they will make an important contribution to the fight against climate change.

Results for the Cambodia National Biodigester Program

The first years of the program, 2006–08, provided valuable learning. Installation of 750 Farmer's Friend biodigesters in 5 provinces revealed that mason-installers lacked the basic skills required to create a self-sustaining business—one of the program's key goals.

ASTAE support was provided in fiscal 2009 to develop a service delivery model that included the required training. It was implemented in four test provinces by establishing and training private Biodigester Contracting Companies, and creating a trade association that would relay business experiences and standards improvements.

By the end of fiscal 2009, 21 Biodigester Construction Companies had been created (100 percent over target) in 4 provinces, responsible for 5,600 installations—a 600 percent increase.

Each biodigester avoids burning about two tons of wood and kerosene annually and is estimated to reduce CO₂ emissions by 4–6 tons—about the equivalent of eliminating a U.S. car's typical annual emissions (5.5 tons per year, according to the U.S. Environmental Protection Agency).

Pilot Project on Improving Manufacturing of Efficient Rural Cookstoves

Introduction

In the late 1990s, the NGO Groupe Energies Renouvelables, Environnement et Solidarites (GERES–Cambodia) introduced the efficient New Lao Stove (NLS). NLS technology is based on a stove from Thailand that uses 22 percent less charcoal than the Traditional Lao Stove (TLS) in wide use at the time. Now produced in around 31 production centers in Cambodia’s main populated provinces, the NLS is durable, attractive, and generally considered the best in its class.

In 2002, GERES–Cambodia, with the support of the EU, trained TLS producers to manufacture the efficient NLS and launched a publicity and sales campaign that helped drive gradual adoption of the stove in urban markets, despite its higher cost (around US\$3.50) compared to the TLS (US\$1.50). The NLS is now used by an estimated 160,000 households.

The relatively high cost of the NLS and the lack of a distribution network into rural villages, however, have kept NLS penetration in these villages very low. The development of the Neang Kongrey Stove (NKS) in 2001 was a response to the need to supply an affordable, improved cookstove (ICS) to these rural areas.

The NKS incorporates the energy-efficiency features of the TLS and the additional benefits that

- it can use either charcoal or firewood as fuel,
- the main raw materials for production are fine clay and coarse clay, the same as the material used to produce traditional stoves,

- the skills of traditional stove producers are more than sufficient to produce it, and
- it is transportable by the common stove carriers operated by traditional distributors.

The World Bank Energy Sector Management Assistance Program (ESMAP), with funding from the U.K Department for International Development (DfID), provided support to pilot trial the introduction of the NKS in rural Cambodia. A strategy for a National Efficient Cookstove Program for rural Cambodia was formulated as a result.

During the pilot phase, implemented by GERES-Cambodia (April 2007–08) 8,000 NKS created by home-based potters were sold in rural villages. Users understood and appreciated the savings in fuel and cooking time and the reduction in cooking smoke. Women who sold the stove in village shops expressed interest in continuing to do so. The stoves, however, were of less than uniform quality and produced in insufficient numbers to meet the considerable demand.

In response, the Asia Sustainable and Alternative Energy Program (ASTAE) Program provided technical assistance to develop The Model Production Facility for the Efficient Neang Kongrey Stove (hereinafter both Model Production Facility and MPF) in Bahn Chkool Village, Kampong Chhnang province. If successful, it would serve as one business model to be replicated throughout rural Cambodia to achieve effective dissemination of an affordable, uniformly high-quality stove. The facility would also play a role in Cambodia’s national efforts to decentralize its economy by creating private enterprises.

The Model Production Facility was charged with achieving six key activities:

1. Develop and test production technologies and techniques to increase productivity and rate of NKS production;
2. Develop standards for production and kiln firing;
3. Pilot-test the new production facility;
4. Train producers to become self-sufficient in management and marketing;
5. Evaluate options for introduction of the improved manufacture of the NKS; and
6. Prepare a plan for scaled-up production.

The village-level goal was to find 30 potters interested in producing the NKS and help them organize into a collaborative enterprise. The facility would then allow these potters, who would otherwise be working on their own, to

- share larger, more efficient, and more energy-efficient production facilities (mechanical mixer, kiln) than those available when working at home,
- set up a microfinance mechanism providing a small daily income,
- learn, then produce, proper production documentation,
- learn production management; and
- learn to negotiate more effectively with middlemen—as a collective, rather than as vulnerable individuals.

In accordance with the mandate that the MPF must accommodate the larger social needs of participating villagers, women were given the option to use the more efficient pilot technologies to prepare clay that they could then take back to work in their homes. This let them more easily combine their production and their domestic duties—child care, meal preparation, and so on.

The activities required to prove the MPF a viable model are discussed in the following sections.

Activity 1: Develop and Test Production Technologies and Techniques to Increase Productivity and Rate of Stove Production

To address the quality and uniformity problems found during the NKS pilot, and to increase production, alternative forming technology and modern kilns were introduced.

Clay Mixing

The traditional potting method begins with clay, collected from its source (a hill or riverbank) or delivered by a supplier, then soaked in a pit to allow uniform absorption of water. Potters then knead the wet clay together with coarse clay or a nonclay material (usually fine sand from riverbank). These act as a filler to reduce plasticity and shrinkage. In some cases, fillers may also lower the bulk density and increase the porosity of the fired piece, depending on the firing temperature.



A mechanized clay mixer

After kneading, the mixture is kept for a few more days to reach a certain plasticity. Kneading 1 cubic meter of clay requires six hours at a labor cost of US\$5.

At the Model Production facility, mixing was done by a mechanical clay mixer that ensures a homogenous mixture and reduces the time and effort required by kneading. Each mixer kneaded 1 cubic meter per hour, at a labor cost of US\$0.50 and 1 liter of diesel fuel (US\$0.75) for a total cost of US\$1.25 per cubic meter. For the US\$5 cost of hand-kneading 1 cubic meter, the mechanical mixer produced 2 cubic meters.

The clay mixer consists of a frame with two shafts, one with five blades that sinks into the cylindrical metal tank and is fixed by five bearings and a pulley. The other shaft is fixed by three bearings with two pulleys. The diesel engine is fixed and is connected to the mixing shafts by pulleys. Detailed drawings are in appendix 1.2.

Stove Body Molding

The typical way to form stoves in Kampong Chhnang is by hand: a lump of clay mixture is placed on a fixed pole and pulled up from the center into a hollow shape. Once the walls are the right thickness, coils of clay are added (when necessary) to the top to build up the form to the correct size. To finalize the form, the walls are beaten from outside using a wooden bat while a round flat stone inside the form helps hold the proper shape. The final product is a cylinder with a bottom.

An important note: traditionally, Kampong Chhnang potters do not use a pottery wheel to throw the clay; instead,

the potter moves in a circle around a fixed pole while pulling or beating the clay. This technique cannot consistently produce an NKS of uniform quality and dimensions. To achieve this standard, in 2004, GERES-Cambodia introduced an external mold and a set of rotating trimming blades called a “jigger-jolly.” The reasons for choosing this technology were:

- It is hand-powered—no external power source is required.
- The US\$25 cost is quite affordable.
- It requires minimum maintenance: can be washed with water, coated with used engine oil to prevent rust.
- Local workshops with basic technical skills can produce it.
- All parts can be easily calibrated at an affordable cost.

There was interest in using a hydraulic press mold to make the stove body, but this was deemed a less desirable alternative for the following reasons.

- It requires external power (electricity).
- The cost is quite high (more than US\$300).
- It is not suitable for family-scale production.
- It requires a sophisticated workshop with precision tools to produce, and special training to operate.
- It needs special skills to maintain the parts—oil pump, hose, joints and connectors, hydraulic shaft, and so on.

A previous study found that molding a stove body using a hydraulic press requires an average of 1 minute and using the jigger-jolly requires 2.6 minutes. Although the hydraulic press is more productive, that is only one consideration at only one point in the NKS production cycle.



A potter throwing clay with a simple pottery wheel

Carving and First-Step Drying

After molding, the stove body is dried in the shade until it is firm, but soft enough to be cut with a carving knife. This is called “first-step drying.” In the dry season, this takes 6–8 hours; in the rainy season, it can take up to 24 hours.

The rim of the body is then carved to make three pot-rests. The next steps are to cut the rim for the fuel inlet and then cut the lower part of the body for the primary air inlet. No special tools are used in carving; those commonly used in making the Traditional Lao Stove are sufficient.

The per-unit production speed achieved by newly trained potters in the MPF after 3 months of training was comparable to that of a skilled NKS producer using traditional techniques in Kdey Tnaot village (see table 1.1).

Therefore, the determining factor in production capacity is the carving, which requires nearly 17 minutes. Molding the final NKS body requires a special molding technique—ordinary press molds or extruding techniques cannot achieve the NKS’s proper inside shape or proper thickness.

GERES tried to find an appropriate compression and blow-molding technique but none supported stove molding because

- the texture of the clay is too rough,
- its plasticity and elasticity are too low,
- it cannot be easily cured and stabilized (polymer, rubber, resin, or other composite materials that can be stabilized by heat); and
- the internal shape of the NKS is complex—hollow with outward bulging on the inside walls.

TABLE 1.1: PRODUCTION SPEED—TRAINED POTTERS

Production Steps	Newly Trained	Skilled Potter
Molding the stove body	10.14 mins	2.6 mins
Carving	23.12 mins	16.57 mins
Cutting	2.39 mins	1.79 mins
Grate molding	0.48 mins	n/a
Grate punching	6.60 mins	n/a

Source: GERES-Cambodia.

One other possibility was to apply a combination of compression molding and collapsible mold. This technology can be costly and requires additional work to finish the molding process.

Second-Step Drying

The body of the NKS is thicker than that of traditional stoves (Siam Stove, Lao Kampong Chhnang, for example). It therefore needs considerably more time to dry.

The second-step drying process is critical, as most shrinkage takes place at this step—not later, during firing. If the stove body dries unevenly, stresses are created that can lead to cracks forming in the stove body either immediately or after firing. It is therefore important to dry the stoves slowly, over several days.

Potters in Kampong Chhnang usually dry the stove body under their houses. In the dry season, the ground is uniformly very dry and quickly absorbs the moisture from all of the stove bodies. In the rainy season, those stoves in the middle beneath the house are less exposed to air and dry less effectively.

To facilitate the second drying properly, the Model Production Facility introduced a new technique: a drying pallet and a three-row drying shelf.

Two stove bodies are placed on each pallet; the pallets are then stacked on the shelf. A typical 6 meter by 6 meter (36 square meters) house can accommodate 300 stove units underneath, occupying less than a half of the space beneath a house.

Drying the stove bodies on shelves under houses in the shade provides these advantages:

- Drying can be easily controlled by installing draperies made of used rice bags to protect against direct sunlight and wind.
- Each stove body is exposed to the same humidity and temperature.
- The drying is not affected by ground moisture; drying speed is uniform.
- Stove bodies are protected against damage by animals (chicken, dogs, pigs).



Stacking the stoves for bonfire (L), igniting the fire (R)

Before firing, all stove bodies are exposed to direct sunlight, usually for two hours, to ensure they are dry enough to be fired.

Firing

Firing, like drying, must be done slowly, steadily, and for the proper amount of time. As the NKS body is thicker than traditional stoves, firing time is longer, to allow water content to slowly leave the center of the clay. If this stage proceeds too quickly, the water can turn into steam and create enough pressure to break or crack the stove body.

Traditionally, the stoves are fired in an open space in the yard of the potter's house. A layer of wood is placed on the ground, then the stoves are piled up and covered with biomass—rice straw, palm leaves, and the like. The fire is ignited from the four sides of the pile and more biomass is added gradually from all sides. The process, known as “bonfire,” usually takes 4–5 hours. Several factors, for example, the temperature differential between the center and the edges of the fire and the uncertain duration of the fire's hottest moments, make bonfire a less than predictable firing technique (see appendix 1.3).

To ensure better temperature control, potters in the Model Production Facility were given a simple kiln to replace firing by bonfire. The kiln is made of brick, 4 meters wide by 2 meters long by 1.3 meters high. It can accommodate 312 NKS units, costs US\$300, and lasts for 10 years with minimal maintenance. See appendix 1.3 for more details.

Tests performed by The Institute of Technology of Cambodia (ITC), Department of Civil Engineering, showed that stoves fired in the kiln are slightly stronger than the stoves fired in the bonfire (table 1.2).

TABLE 1.2: COMPARISON OF PRESSURE STRENGTH

Fired in the bonfire			Fired in the kiln		
Sample no.	Breaking point		Sample no.	Breaking Point	
	in kN	in kg		in kN	in kg
A1	13.00	1,325.2	B1	25.60	2,609.6
A2	22.50	2,293.6	B2	32.50	3,312.9
A3	20.00	2,038.7	B3	34.50	3,516.8
A4	28.70	2,925.6	B4	14.10	1,437.3
A5	20.40	2,079.5	B5	24.50	2,497.5
A6	32.90	3,353.7	B6	28.80	2,935.8
A7	20.00	2,038.7	B7	17.50	1,783.9
A8	21.00	2,140.7	B8	25.00	2,548.4
A9	30.00	3,058.1	B9	19.60	1,998.0
A10	24.00	2,446.5	B10	34.00	3,465.9
Min	13.00	1,325.2	Min	14.10	1,437.3
Max	32.90	3,353.7	Max	34.50	3,516.8
Average	23.25	2,370.0	Average	25.61	2,610.6

Source: GERES-Cambodia.

Activity 2: Development of Standards for Production of the NKS and Kiln Firing

The NKS came to market in 2003–04. Many home-based potters produced the stove, but modified or otherwise failed to follow the original design.

Although GERES-Cambodia trained potters to produce the NKS according to set design standards, at the time of this report, there are no nationally recognized quality standards that NKS potters must meet and no monitoring of potters' compliance. As a result, the NKS available in the market is smaller than the original dimensions (table 1.3 below). The incorrect dimensions of the NKS affected its performance by preventing the proper mixture of air and fuel to produce optimum combustion—with the result that the smaller NKS disappointed users because it could not generate the heat expected.

GERES will propose NKS standards to the Council of Ministers for ratification, then publish and disseminate a standards manual with the support of the Office of

Industrial Standards of Cambodia of the Ministry of Industry, Mines, and Energy (MIME). Standards for production and procedures will be included.

The report Gender Assessment: Gender Mainstreaming Energy Planning Project (World Bank–GAP Fund, 2009) recommends that a larger NKS is needed to cook rice for families with more than five members and a smaller NKS is needed for families of fewer than five. GERES determined the optimum dimensions for these new versions, which were validated in mid-2009. The sizes will be included in the published standards manual.

The concept of standard dimensions is not easily understood by traditional potters, who learn pottery techniques from their parents and have no experience making products with low dimensional and quality tolerances. The traditional view that the shape is the most important consideration had to be corrected. To ensure adherence to the GERES standards throughout the production process, MPF potters are trained to understand them and to read relevant technical drawings and use templates and molds.

TABLE 1.3: NKS DIMENSIONS—ORIGINAL, SMALLER, AND LARGER SIZES

	Parameter	Dimension of the NKS (mm)		
		Original	Smaller	Larger
1	External Ø of top rim	260	253	280
2	Internal Ø of top rim	210	202	245
3	Pot rest width	50	40	60
4	Pot rest height (from the rim)	10	16	11
5	Ø of the combustion chamber	180	160	184
6	Ø of the grate hole	16	15	18
7	Grate thickness	40	18	38
8	Width of the firewood door (top)	140	143	150
9	Width of the firewood door (bottom)	110	130	145
10	Height of the firewood door	70	48	55
11	Height of the primary air inlet	50	43	55
12	Width of the primary air inlet	120	110	112

Source: GERES-Cambodia.

The NKS standards were presented as simply as possible in the MPF training program; potters were shown a technical drawing and a sample NKS was created as they watched. Training also mentioned the importance of the molds set (outer body mold, inner body, and grate) as tools that ensure potters work to the standard dimensions shown in appendix 1.

The potters were also shown the draft of the NKS standards guidebook, which includes proper stove dimensions, production procedures, and quality control tests.

Standards Finalization

The standards for the NKS were submitted to the MIME Office of Industrial Standards of Cambodia (ISC) in October 2008. They have been assessed by the director of ISC and discussed thoroughly in two rounds by a working team of GERES technicians and ISC officers. The draft standards will eventually be submitted to the Council of Ministers for ratification.

Some key points must be considered before creating the standards:

- A standards monitoring and enforcement infrastructure must be established at the national level.
- Licensing and authorization mechanisms must be developed along with a technology transfer plan.

- Traditional stove producers must be identified and benchmarks for program targets must be created.

Standards Implementation and Monitoring

The preliminary conclusion reached by the working team is that adherence to the standards by producers should be voluntary, with producer and product performance reviewed annually to decide when to amend the standards and when to declare adherence mandatory.

To monitor adherence, GERES will collaborate with the Office of ISC of the MIME Department of Industry to set up a monitoring system. The monitoring and standards implementation plan is as follows.

- Initially, over four months, GERES will train Department of Industry, Mines, and Energy (DIME) staff on ICS dissemination, NKS standards (NLS included) and standards monitoring protocol.
- Over the following eight months, DIME will monitor production in the provinces, accompanied by GERES technicians.
- After 12 months, DIME is expected to be fully responsible for monitoring and standards implementation. GERES will continue to provide technical support.

Coordination meetings with DIME provincial officers were planned for March 2009 (after two previous

reschedulings) but were postponed by the ISC to April 1, 2009. The agenda was to set a plan to identify and inventory potters in 17 provinces (number of microenterprises, types of stove produced, capacity, and so on) and develop a map of stove producers in Kampong Cham, Kampong Thom, Kampong Speu, Kampong Chhhang, Pursat, Battambang, Siem Riep, Banteay Meanchey, Takeo, Kampot, Kep, Sihanoukville, Prey Veng, Svay Rieng, Kandal, Kratie, and Stung Treng.



Size of cooking pot compared to size of NKS. NKS too small for the pot (L), and suitable for the pot (R). User added a rim to adapt to the small cooking pot.

The map will inform development of the monitoring system and standards implementation plan based on the concentration of potters in each province and among provinces.

Activity 3: Model Production Facility

The Model Production Facility for the Efficient Production of the Neang Kongrey Stove was established in Bahn Chkool Village, Kampong Chhnang province, in August 2008, as a center where individual NKS producers could access information, technical support, facilities, a warehouse, and necessary assistance with any difficulties.

The facility was established by GERES and managed by a technician, a facilitator, and an assistant technician. The objective was to identify 30 local potters interested in producing the NKS and help them organize themselves to work together to

- share production facilities (clay mixer, firing kiln, and warehouse) that improve production quality and reduce the labor required,
- create a microfinance mechanism that regularly provides potters a small daily income based on completion of agreed production steps (molding, carving, cutting, grate production, and assembling),
- provide proper production documentation to allow disbursement of the production-based daily income,
- learn production management by voluntarily serving as the administrator for two weeks (with a partner), taking care of raw materials, production, finance, salary disbursement, stocking of finished products, and NKS sales, and

- build awareness and capacity for better bargaining power with middlemen.

While learning NKS production in the MPF, the potters are also learning simple, practical management skills. They are expected to use these as part of the rotating organizational structure to manage the facility.

The potters are mainly women, who do not enjoy status or decision-making power equal to that of men in traditional Cambodian society. Organizing them as an association gives each of them an equal opportunity to receive peer support, to create a subculture based on a common interest, and to help increase the social status and perceived value of women in Cambodia. From the social development point of view, the presence of a productive, well-managed potters' organization should create positive perceptions of the potters themselves—and of the larger notions of decentralized enterprise development.

The Model Production Facility consists of the facilities in table 1.4.

Currently, GERES manages the MPF and will do so until the potters in the area are ready to take over and manage it properly. Continuous accompaniment for a period of two years will still be necessary.

In implementing the long-term NKS production strategy, additional production facilities based on the MPF will be similar in terms of building layout and equipment, but need not be identical. Locally available material and labor costs will be taken into account in design and construction.

TABLE 1.4: LIST OF MODEL PRODUCTION FACILITY BUILDINGS AND FLOOR SIZES

No.	Building	Size in m	Cost (US\$)
1	Clay stock, including two soaking pits	4 X 5	350
2	Coarse clay stock	4 X 5	350
3	Clay mixer platform (in the corner of building 5)	1,5 X 2.5	300
4	Grate punching shelter	4 X 7	1,500
5	Molding and carving shelter	14 X 7	3,400
6	First-step drying platform and stock platform for dried unfired stove	12 X 5	2,700
7	Shelter to assemble stove body and grate	12 X 5	2,700
8	Kiln	6 X 6	2,600
9	Rice husk warehouse	10 X 5	2,750
10	Warden house	5 X 4	1,200
11	Toilet	2.4 X 2.4	950
	Total Cost		18,800

Source: GERES-Cambodia.

Activity 4: Train Producers in Management and Marketing

MPF training began by gathering interested potters and helping them assess their current methods of NKS production. The assessment indicated that participating potters wanted to improve their production practices and earn a better income.

Baseline NKS Production Prior to the MFP

In the original NKS pilot, GERES-Cambodia trained 24 NKS producers (11 in May 2003 and 13 in February 2004); as of 2008 only 11 were actively producing the NKS. Together, their average monthly production capacity was 500 units (in 2008). Their production capacity was insufficient to meet market demand. The potters produced the NKS based on orders received from middlemen. The pace and volume of these orders did not utilize their full production capacity.

The common daily activities pattern of NKS production at that time (pre-MPF) is shown in table 1.5. The average cycle of 11 days (sometimes 12–13 days) as above was usually repeated twice a month, making the maximum production capacity 100–120 units for a family working at home. The profit margin is shown in table 1.6.

The net profit was considered monthly income, about US\$1.55 per day. The potters' average production and

cash flow were discouraging; many potters (except larger families) considered giving up NKS production temporarily to produce other products. The Model Production Facility offered these families an alternative—a new way to produce stoves that would increase production speed

TABLE 1.5: COMMON NKS PRODUCTION PATTERN PRE-MPF

Day	Activity
0	Assumption: received payment from the NKS sales of 60 units @ KHR2,200=KHR132,000 (approx US\$33)
1	Purchase raw material—clay (or coarse clay), sand, rice husk, straw—then soak in pit
2	Knead clay and sand, then keep lump covered
3	Mold stove body (20–30 units)
4	Mould stove body (20–30 units)
5	Carve stove (15–20 units) and make grate (30)
6	Carve stove (15–20 units) and make grate (30)
7	Carve stove (15–20 units)
8	Dry stove
9	Dry stove
10	Fire stove (morning) and assemble (afternoon) (60 units)
11	Complete assembly and sell stove

Source: GERES-Cambodia.

TABLE 1.6: PROFIT FOR TYPICAL FAMILY PRODUCING NKS

Investment	KHR	US\$
1 m ³ clay and coarse clay	8,000	2.0
Labor cost for kneading of 1 m ³	10,000	2.5
Fuel for firing (wood and straw)	60,000	15.0
Total Investment	78,000	19.5
Income		
From selling the 120 NKS @ 2,200 KHR	264,000	66.0
Profit in one month	186,000	46.5

Source: GERES-Cambodia.

and volume, reduce the labor required, and increase cash flow and income.

Participatory Assessment for Planning and Introduction of the MPF Scenario

To launch the new plan, all potters interested in producing the NKS met in a facilitated meeting. At the end of the meeting, and based on the information provided, all potters agreed to participate in the Model Production Facility.

The most important new practice was that the program was allocated “seed money” to help pay potters for their labor on a regular basis—while also engaging them to share some production risks. This was done by breaking the NKS production process into several production steps and agreeing on a valuation of each step.

Identify and Assign Values to Steps in Production

In the MPF, instead of being paid for each produced batch of stoves, the production of the NKS was divided into eight working steps with clear, quantifiable deliverables. Each step was valued based on time, skills, and labor intensity (table 1.7).

Daily Payment Based on Production Quantity

The aim of the valuation was to allow each potter in the program to be paid based on her or his output, verified by the administrator at the end of the working day (see Activity 3, Model Production Facility). The potter would receive different amounts of pay from day to day, depending on production.

The average daily income of the 10 trained potters (after three months training) at the NKS Facility was US\$0.73 to US\$1.05, and the highest income was US\$3.37.

Potters' Savings

The average production cost of the NKS in the MPF (after 3 months' training) was US\$0.47 per unit, with a selling price of US\$0.54 per unit. The margin of US\$0.07 for each unit belonged to the potter, who received it the day the stoves are sold—not in cash, however, but as savings in a savings account in the potter's name. The savings could be withdrawn only after a year on deposit, and were in addition to wages potters received for their labor.

Selling the Stove from One Warehouse

All of the NKS units produced during the day were documented by the administrator in charge and stored in a warehouse, following the first-in-first-out principal. The administrator organized the sale of the NKS to the middlemen. Instead of dealing with several individual producers, the middlemen dealt with only the warehouse. This system ensured proper recording of the sale and certainty about the number of NKS units sold on any given day.

Potter Training

To select the first group for training, GERES decided that all meeting attendees would draw straws because the MPF could accommodate only 10 of the more than 20 interested potters. Depending on their needs and abilities, the potters received training in the skills described below.

Production Techniques

All potters learned how to mold the NKS body using a jigger-jolly, to use a pallet to dry the stove, and to arrange the pallet on a shelf for drying. They also learned the requisite skills for carving, drying, making the grate, and assembling. Though all of the potters knew these techniques quite well, it was necessary to teach them in the

TABLE 1.7: LIST OF AGREED STEPS AND VALUES IN NKS PRODUCTION

No.	Product or Process	Payment (US\$/unit)	Note
1	Mix clay and sand (or coarse clay) and firing costs	0.17	Cost includes <ul style="list-style-type: none"> • raw material • diesel fuel • mixing operator cost • fuel for firing • firing operator cost
2	Mold stove body	0.5	Based on number of molded stoves at the end of work day
3	Mold grate	0.01	Based on number of molded grates verified at the end of work day
4	Punch holes in grate	0.04	Based on number of punched grates verified at the end of work day
5	Carve and install pot-rests	0.10	Based on number of stove bodies carved and verified at the end of work day
6	Cut firewood gate and primary air inlet and dry	0.02	Based on number of carved stove bodies cut
8	Assemble stove body and grate into final product	0.07	Based on number of assembled stoves into final product

Source: GERES-Cambodia.

new context of the Model Production Facility, where operations would be collaborative and focused on maximizing productivity and income.

Bookkeeping

Bookkeeping training was delivered through “learning by doing.” Two potters worked together as “administrator” for one week, recording daily NKS production. Then one was replaced by another for the following week, doing the same thing. This gave each of the potters an

opportunity work with each of their peers, building group knowledge, unity, and trust.

The day’s production record was the baseline to calculate the profit to be received in the afternoon and the costs to be paid to the group.

Finance Management

Training in finance management took place along with bookkeeping training, with the two administrator potters made responsible for paying their peers. This required collecting the money to be deposited in each individual’s savings account and paying for the services provided by the production center (mixing clay and firing). Each individual potter was responsible for paying the production center based on the quantity of produced and sold NKS units.

Stock Management

The two administrators also learned how to determine how much clay to mix to meet the needs of their peers and how to place the order for rice husk, fine clay, and coarse clay. The administrator of the week also was charged with informing distributors of NKS availability at any give time. On days when distributor picked up stoves, the assigned pair was also responsible for recording the number of units that left the warehouse.

TABLE 1.8: EXAMPLES OF POTTER PRODUCTIVITY AND INCOME

Example 1—in a day a potter:	US\$
Molds stove body 40 pcs @ 0.05	2.0
Molds grate 40 pcs @ 0,01	0.5
Total income for the day	2.5
Example 2—in a day a potter:	
Carves stove body 20 pcs @ 0.10	2.0
Cuts stove 20 pcs @ 0.05	1.0
Punches grate 20 pcs @ 0.04	0.75
Total income for the day	3.75

Source: GERES-Cambodia.

The three months of training enabled the potters to do paperwork for the first time in their lives. The additional benefits were many:

- The potters (all women) were encouraged and regained their confidence; they no longer felt inferior to their neighbors because now they were able to write, fill in forms, and perform simple administrative tasks.
- “Team spirit” grew among the participating potters, who began to take care of and help each other.
- Concern that other families producing NKS units in the village were competitors faded away; potters began to consider partnership and collaboration with those families.
- The potters were able to do work that was familiar to them, but with the all-important additional motivation of earning daily income.

Activity 5: Evaluating Options for Introducing Improved Manufacturing of the NKS

The NKS is currently produced in Kampong Chhnang province on a household scale and (in a few instances) on a microenterprise scale as a result of the Model Production Facility. The overall production capacity ranges from 100 units to 500 units per month. In addition to production capacity, other aspects characterize family-scale and microenterprise-scale production (table 1.9).

Improving Microenterprise Productivity

Microenterprise productivity can be improved in the following ways.

- **Labor skill improvement:** Technical training to improve the potters’ and other workers’ understanding of and compliance with standards and to learn to operate semi-mechanized equipment;
- **Supervision and control systems:** Quality control training to ensure that control systems are introduced to minimize product defaults and ensure all products comply with standards;
- **Production chain management:** Business training in production optimization to ensure that production steps and workloads are proportional, to avoid overloading or underloading workers;
- **Workshop and facilities:** Similar to those in the Model Production Facility (see table 1.4), and following the same principals;
- **Safety and sanitation:** A workplace that is well ventilated, well-lighted, and protected against animals intruding, with a floor free of sharp objects and the surrounding area neat and free of stagnant water (especially during the rainy season);
- **Financial management:** Introducing simple bookkeeping that includes records of production management (raw material, labor, maintenance, final product, sales, and so on) will ensure a clear picture of the enterprise’s financial status. Proper bookkeeping facilitates access to additional capital (when needed) from a bank or MFI. Training to improve those aspects requires active participation of the owner/manager for at least six months.

TABLE 1.9: FACTORS INFLUENCING MICROENTERPRISE AND FAMILY NKS PRODUCTION

No.	Production Factors	Microenterprises	Family
1	Capacity per month	Minimum 500 units	50–100 units
2	Labor	Employ paid labor	Unpaid labor, mostly women
3	Production facility	Specially constructed, often separate from the house	Within house plot
4	Production flexibility	Can be extended and scaled up	Limited and highly dependent on family size
5	Capital investment	Bankable, most get loan from MFI	Limited, mostly loan from money lender
6	Raw materials	Supplied by providers	Partly supplied but mostly collected
7	Production	Regular and reliable, usually able to fulfil the order on time	Less regular and reliable in fulfilling the order
8	Applied production technology	Intermediate technology, systematic	Traditional technology, mostly unsystematic

Source: GERES-Cambodia.

Microenterprises that want to produce the NKS can use their current facilities to produce traditional stoves or construct new facilities as in the Model Production Facility, using low-cost materials. Construction costs of about US\$5–\$8 per square meter should be expected. To produce 2,000–2,500 NKS units per month requires about 400 square meters, a clay mixer (US\$850), and a kiln of 4 meters by 2 meters by 1.3 meters (US\$250).

Improving Family-Scale Production

For family-based production, the most important factors in optimizing production are the following.

- **Ready-mixed clay stock:** To assure continuous supply of mixed clay (20 square meters),
- **Molding platform:** Spacious enough for the potters to mold the stove body and the grate (20 square meters),
- **Drying area:** Allows stove body drying (first and second drying) on shelves as well as on the drying floor (30 square meters), and
- **Assembly platform and temporary stocking space:** To facilitate installation of the grate and store the final product before the sale (30 square meters).

Those facilities can be located in the space under the house. If the space is not available, such facilities will require a US\$500–US\$800 investment in low-cost materials such as bamboo poles, leaf roofing, and hardened dirt floors. Such a facility can support the production of 600 to 800 units per month.

The clay mixing machine and kiln should be procured and managed by an association or group of potters, such as in the Model Production Facility, to reduce each family's investment costs.

As a production unit, a family has some limitations (see table 1.9 above) that cannot be easily remedied. However, families producing cookstoves usually live in areas where many other potters are doing similar work—in sufficient numbers to support setting up a pilot production facility or a center where interested potters can learn to improve their production practices as mentioned in Activity 3 (Model Production Facility) and Activity 4 (Train Producers in Management and Marketing). Given sufficient numbers and promotion, this is the best way to improve family-scale production.

Projected Production Capacity

The Model Production Facility, in operation from August 2008, produces about 600 units of NKS per month (as of March 2009). At the end of year one, the expected 40 potters from surrounding villages, trained by the MPF, are expected to produce at least 2,400 stoves per month.

More than 1,200 potters produce various pottery wares in Kampong Chhnang province. There are at least three more clusters of potters there who are interested in producing the NKS—in Khsam, Kdey Tnaot, and Andong Russey. Establishing three more MPF-based production facilities in those clusters could add more than 7,000 units per month to the province's total NKS production.

Combining family scale production—supported by the MPF, three new MPF-type facilities, and three new microenterprises—can increase Kampong Chhnang province's total NKS output to around 13,000 units per month—a conservative estimate. Projected production (table 1.10) for all provinces is based on the 17 provinces where there are currently potters and traditional stove microenterprises.

Total projected NKS production for all provinces after three months of training is 44,300 units and is expected to reach about 90,000 units per month by the end of year four.

Activity 6: Plan to Scale Up Production

A plan to implement a National Improved Cook Stove Program has been formulated by the MIME with assistance by the World Bank-ESMAP and GERES-Cambodia. The overall objective of the program is to scale-up dissemination of improved cookstoves, including the NKS, as a cleaner, more energy-efficient and cost-effective cooking device, through the development of a commercial, market-oriented improved cookstove sector in selected provinces of Cambodia.

The national program would lead the efforts to bring improved cookstoves to all 2.1 million rural households and make major contributions to reducing the negative impact of smoke on the health of women and children and reducing the time and cost of using firewood. The proposed target is to disseminate one million improved cookstoves over a four-year project period—equivalent

TABLE 1.10: PROVINCES, POTENTIAL NKS PRODUCTION PER MONTH (IN NKS UNITS PER MONTH) ONE YEAR AFTER COMPLETION OF TRAINING

No.	Province	Production Facilities		Microenterprises	
		#	cap/mo	#	cap/mo
1	Kg Chhnang	4	8,000	4	8,000
2	Kg Speu	2	4,000	1	1,000
3	Kg Cham	2	4,000	1	1,000
4	Kg Thom	1	1,000		
5	Pursat	1	1,000		
6	Battambang			2	2,000
7	B Meanchey	1	1,000	1	500
8	Siem Reap	1	1,000	1	500
9	Prey veng	1	1,000	1	500
10	Svay Rieng	1	1,000	1	300
11	Kracheh	1	2,000	1	500
12	Stung Treng	1	500	1	500
13	Takeo	1	1,000	1	500
14	Kampot	1	1,000		
15	Kandal	1	1,000	1	500
16	Kep	1	500		
17	Sihanoukville	1	500		
Potential production capacity		21	28,500	16	15,800

Source: GERES-Cambodia.

to 50 percent of all rural households. Reduction in the use of fuel wood through year four is estimated to be 500,000 tons. Reduction of CO₂ emissions is estimated at 250,000 tons.

In order to achieve the objectives, the program would aim to (i) increase market share of improved cookstoves

in the existing market for traditional stoves by converting traditional stove producers to improved cookstove producers; and (ii) access new market segments, which may require new production centers such as those similar to the Model Production Facility, new distribution markets, and new points of sale in rural areas (villages and communes).

Appendix 1.1: About the Neang Kongrey Stove

The Neang Kongrey Stove (NKS) is a simple ceramic cookstove that sells for about US\$1.25 and lasts for 1–2 years. The other efficient stove in wide distribution—but mostly in urban areas—is the New Lao Stove, which has metal cladding and insulation that extend stove life by at least two years but increase its cost to about US\$4.00.

The NKS is more efficient than the widely used Traditional Lao Stove because of three main design improvements:

1. The space between the pot and the pot-rest is reduced.
2. The grate has smaller holes.
3. The combustion chamber is smaller.

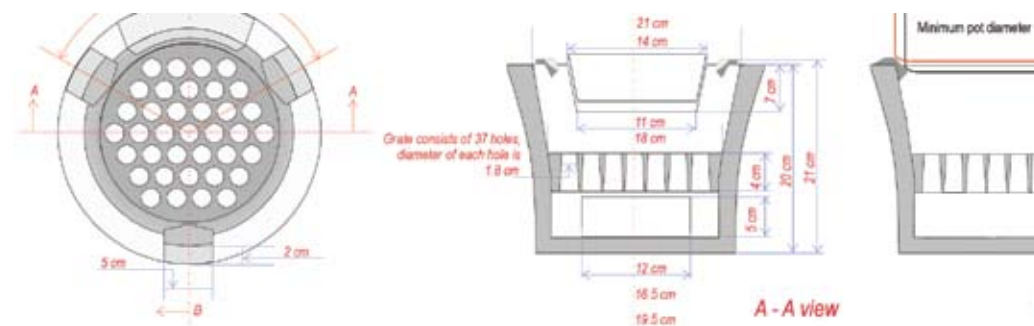
These improvements combine to deliver increased combustion, reduced heat loss, and reduced smoke. Because the NKS holds heat well and thus requires less attention

to ensure sufficient fuel is always burning, cooks gain a certain amount of free time to perform other tasks. Users also say the NKS saves time because food cooks faster.

The stove delivers about 30 percent overall energy efficiency and uses approximately 21 percent less wood or charcoal than a Traditional Lao Stove and a significant 64 percent less than the traditional “three-stone” stove. Families that collect and cut their own wood can then devote that time to other household tasks or livelihoods.

Because of the significant savings on charcoal and wood, payback time for the NKS is around 1 month. Significant further benefits of the NKS are that it reduces emissions by approximately 0.3 to 0.5 tons of carbon dioxide per stove per year and reduces deforestation—both important contributions to the fight against climate change.

FIGURE 1.1: NEANG KONGREY STOVE

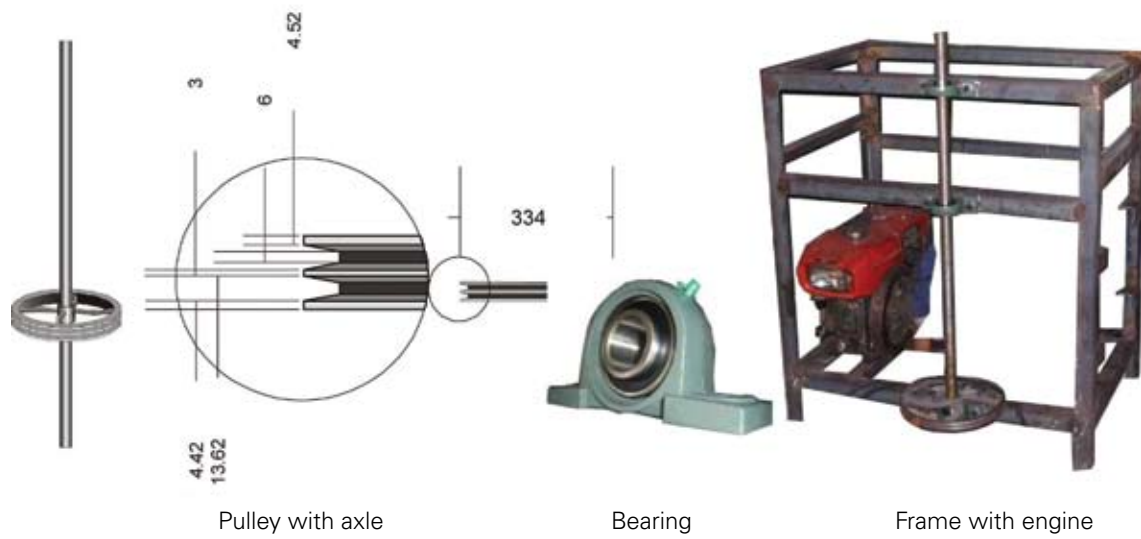
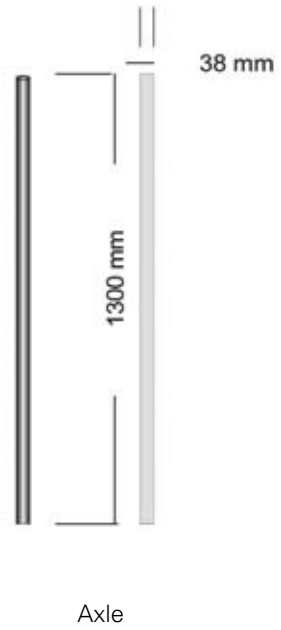
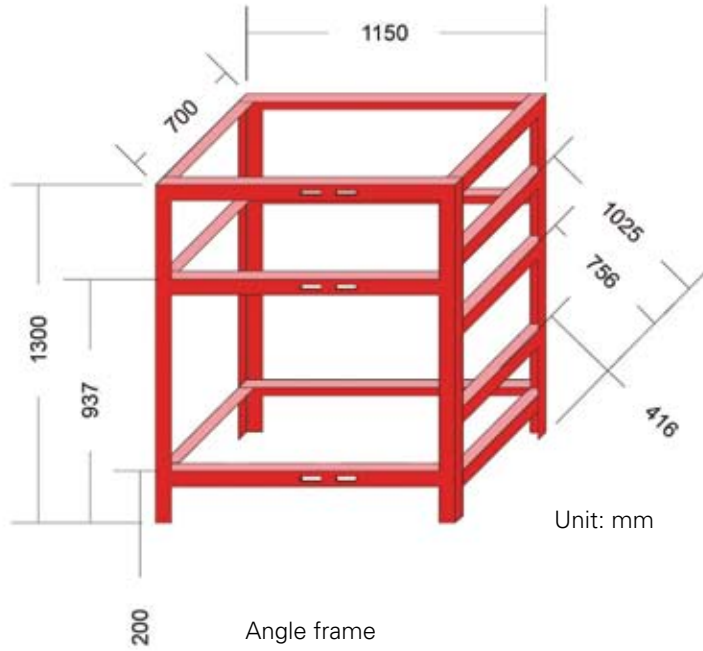


Characteristics

Material: Baked clay
 Size: 21.7 cm height 26 cm diameter
 Specification: Portable (weight approx. 5 kg)
 Price at retailer level: KHR 5,000 (US\$1.25)
 families
 Fuel: Commercial firewood
 Dissemination: Commercialization

Production: Stove artisans
 Optimized pot size: 21 cm to 24 cm or diameter
 Price at producer level: KHR 2,200 (US\$0.55)
 Main uses: Targeted for rural and peri-urban
 Fuel savings: 22% (with fuelwood)

Appendix 1.2: NKS Production Facility Components

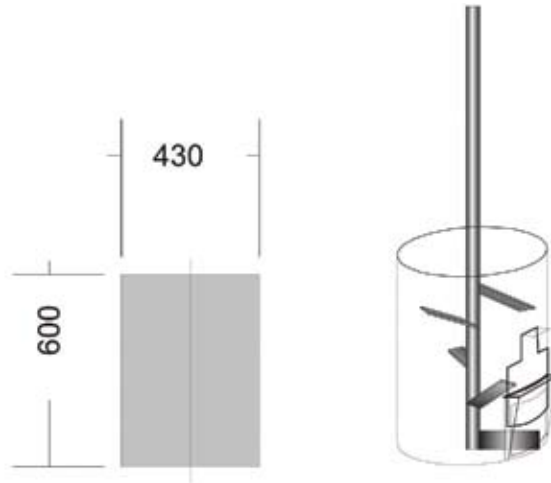


Pulley with axle

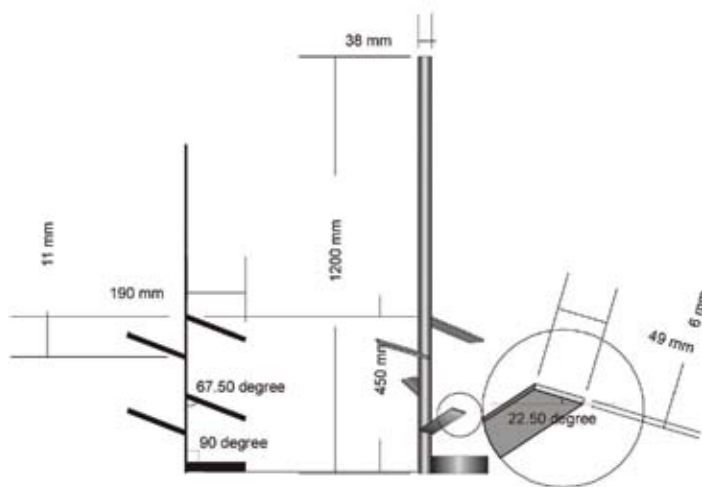
Bearing

Frame with engine

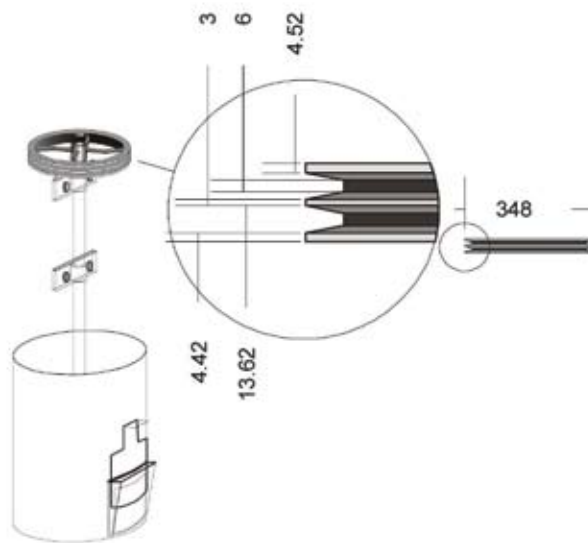
Appendix 1.2: NKS Production Facility Components, Cont.



Mixing tank

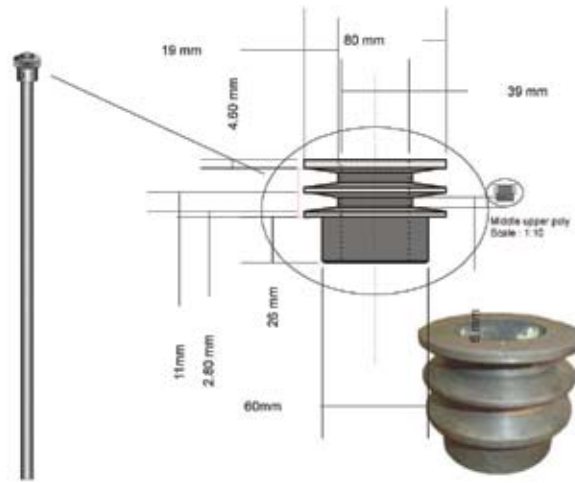


Axle with blades

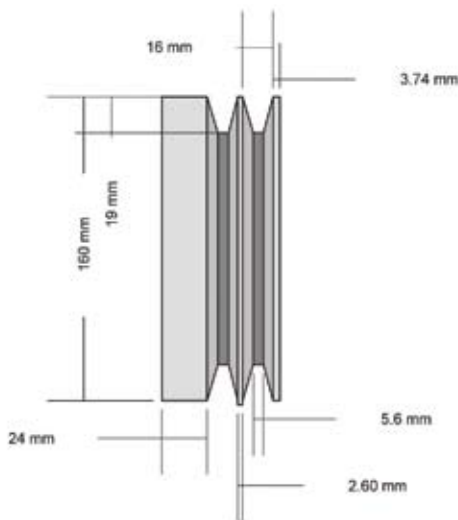


Pulley fixed with axle

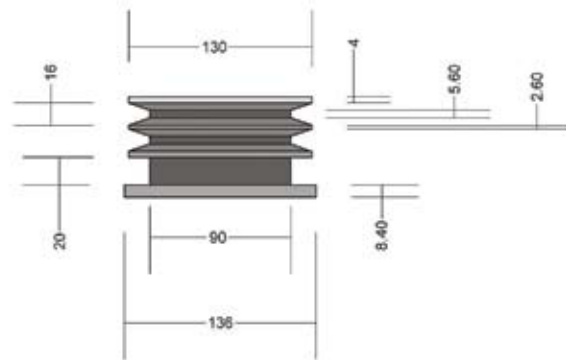
Appendix 1.2: NKS Production Facility Components, Cont.



Pulley fixed to axle



Pulley fixed to differential box



Pulley fixed to differential box

Appendix 1.3: Firing the NKS

The temperature in the middle of the bonfire (A_0) can reach up to 851°C, which is quite sufficient. At this temperature, vitrification (when silica, then clay particles melt) begins, though with clay containing a large amount of iron and in a reducing atmosphere. When melting, silica and clay bond together to form a strong, brittle material. A gentle, gradual temperature increase throughout the process is crucial. This can be difficult to achieve, however; the highest temperature in the heart of the bonfire lasts only for about 90 minutes and is not sufficient to completely vitrify the thick body of the NKS. The temperature on the sides of the pile (B_0), (C_0) and (D_0) is too low to reach the vitrification point (see below for the position of the thermocouple probes).

All probes to measure the temperature in the bonfire were positioned at half the height of the bonfire pile, 60 cm from the ground. Probe A_0 is exactly in the center of the pile. Probes B_0 , C_0 , and D_0 were installed 15 cm from the side of the bonfire.

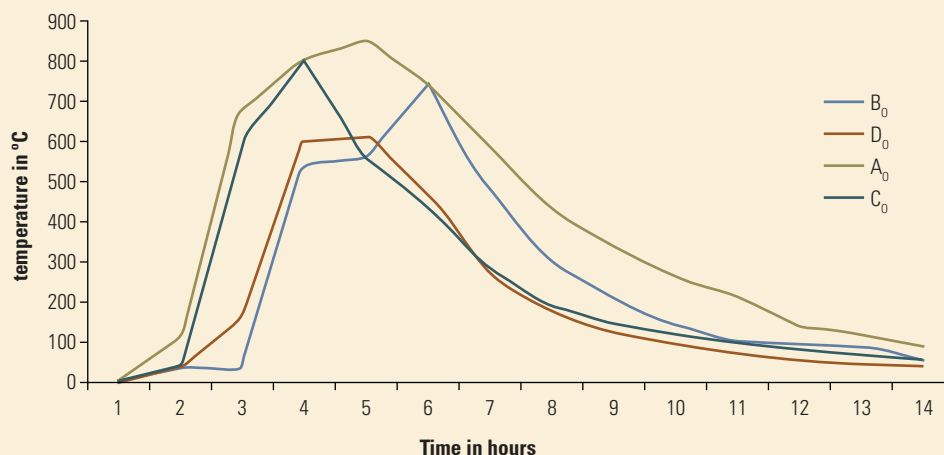
Temperature was recorded every 30 minutes, starting 10 minutes after ignition.

The temperature in the center of the kiln (A1) reached above 800°C after 25 hours of firing and stayed above 800°C for 3.5 hours with the highest temperature 871°C. On the points close to the kiln walls, the temperature did not reach 800°C but stayed at above 700°C for at least 6 hours.

Figure 1.5 shows the placement of thermocouple probes to measure the temperature in the kiln. All probes are positioned at half of kiln height, 65 cm from the kiln floor. Probe A1 is exactly in the kiln center. Probes B1, C1, and D1 are installed 10 cm from the wall.

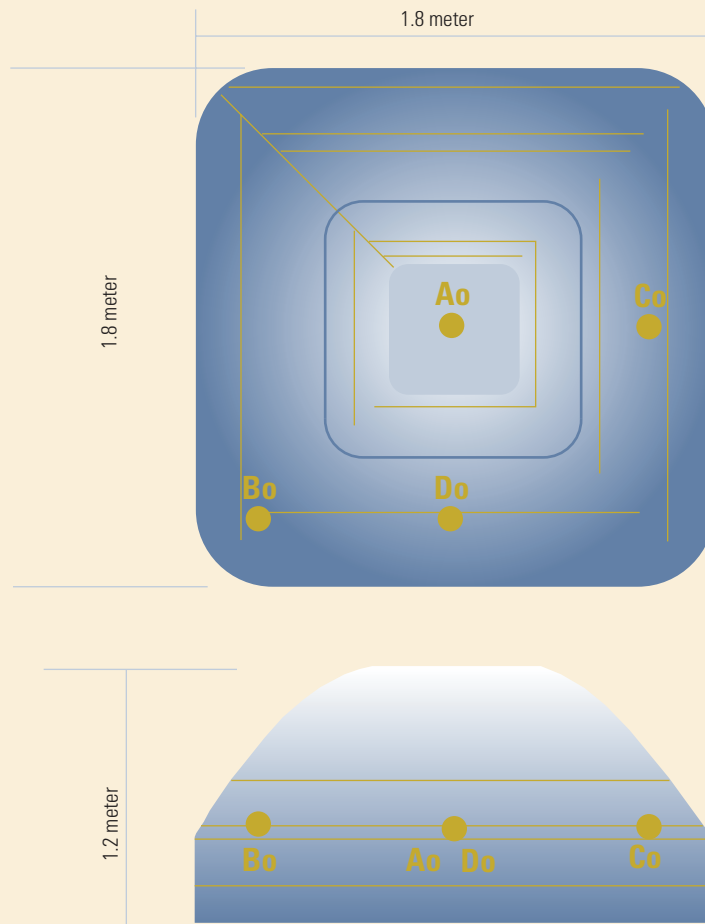
Temperature is recorded every 30 minutes. Different firing temperatures and temperature increments in the bonfire and the kiln affect the strength of the stove body to resist pressure.

FIGURE 1.2: TEMPERATURE IN A BONFIRE



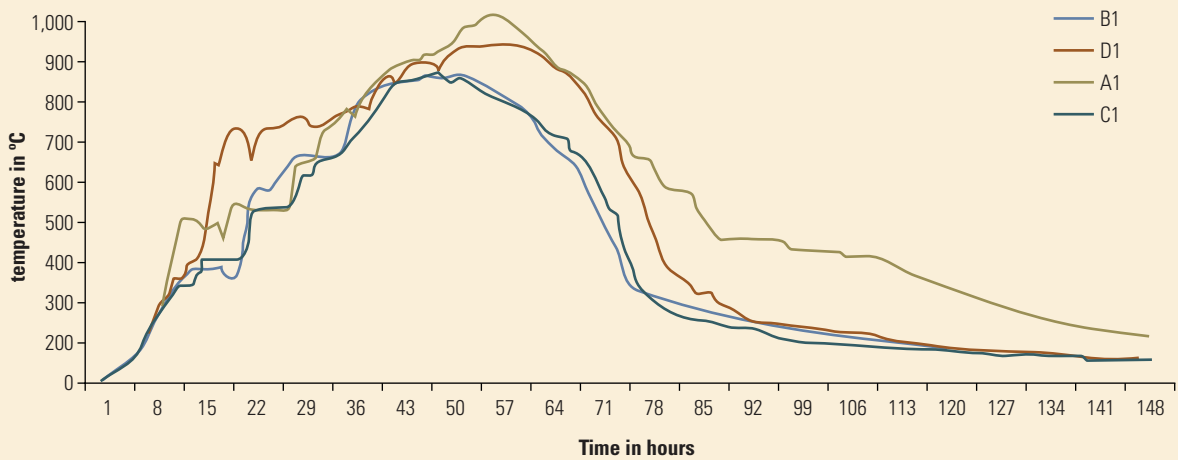
Source: GERES-Cambodia.

FIGURE 1.3: POSITION OF THE PROBES IN THE BONFIRE



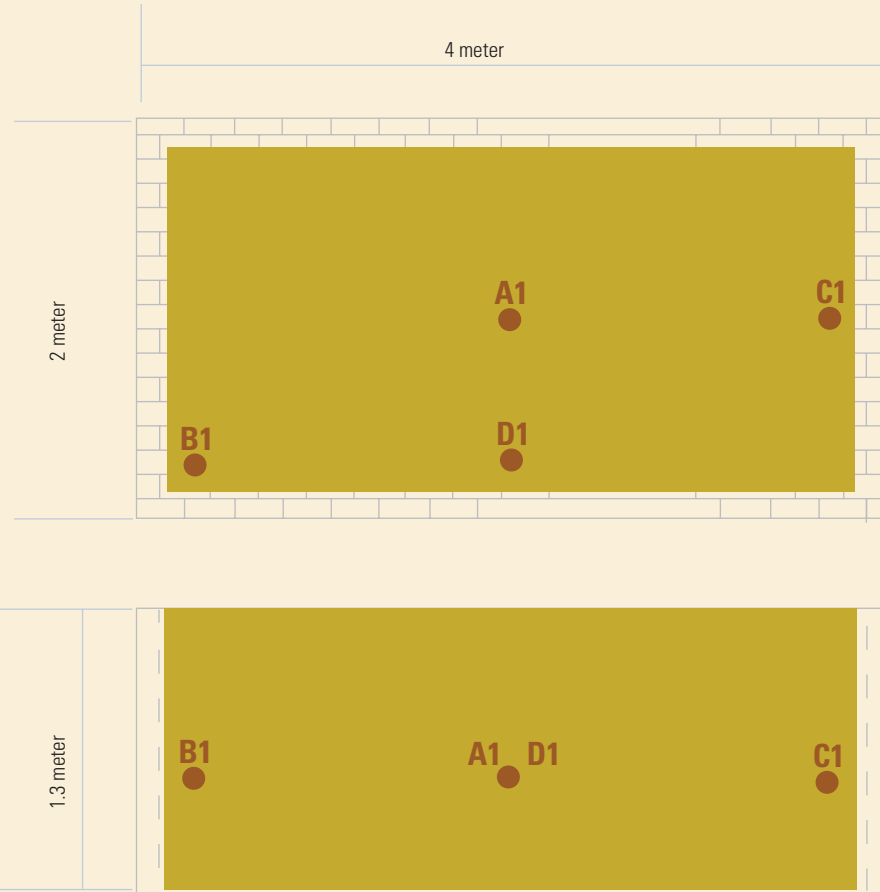
Source: GERES-Cambodia.

FIGURE 1.4: TEMPERATURE IN THE KILN



Source: GERES-Cambodia.

FIGURE 1.5: POSITION OF THE PROBES IN THE KILN



Source: GERES-Cambodia.

Final Report to the Cambodian National Biodigester Program of Private Sector Development Technical Assistance Activities

Introduction

From July 2008 to June 2009, a Private Sector Development (PSD) consulting team, supported (sequentially) by Netherlands Development Organization (SNV) and the World Bank, developed and piloted an innovative and replicable microfranchise model for the creation of biodigester construction companies (BCCs) providing household biodigester services to rural Cambodians. This project was undertaken to advance the development of a permanent, private biodigester construction and service sector as envisioned by the Cambodian National Biodigester Program (NBP), a joint project of the Ministry of Agriculture, Forests and Fisheries (MAFF) and SNV.

The project undertook

- selection of appropriate province and district market areas to pilot private provision of the biodigester known as The Farmer's Friend,
- management of provincial counterpart relationships,
- analysis of the NBP business model, including codification of NBP operating procedures and development of a viable microfranchise business model, and development of the *Operations Manual for Privately Provided Biodigester Services* (the *Operations Manual*),
- selection and management of a local capacity builder to co-develop and implement a mason selection process and an intensive business skills training and mentoring (business coaching) program,
- design and implementation of a process to identify and select high-potential delivery of intensive business skills training programs for selected masons,
- providing assistance for official business registration to permit companies to enter legal contracts with customers,
- finalization of three-party Franchise Agreements among the NBP, the BCCs, and the Provincial Biodigester Program offices (PBPOs)
- the launch of 15 BCCs in 3 provinces, and
- post-training needs assessment and initiation of business coaching program.

These results exceeded the PSD project's main performance indicators (10–12 BCCs registered) and are anticipated to significantly accelerate the NBP's PSD development in 2009–11.

Key innovations included

- a marked increase in support for rural private enterprise among provincial government leaders, particularly among NBP leadership,
- development of a replicable model for microfranchising decentralized biodigester construction services that compensates for gaps in skills and resources among rural entrepreneurs, and
- effective development and implementation of customized entrepreneurship training and business coaching for marginally skilled rural business owners in partnership with a local training institution.

The system's sustainability will depend on

- business capacity development supported by ongoing business coaching and development of BCC owners,
- NBP development of additional capacity in managing franchise operations,
- the economic stability of the Cambodian agricultural sector,
- absence of donor distortion of market incentives for private provision, and
- further development of business-friendly sector regulation and supervision at the provincial level.

Project Background and Objectives

Background

The Cambodian National Biodigester Program (NBP) is a joint project of the Ministry of Agriculture, Forests and Fisheries (MAFF) and SNV Netherlands Development Organization, initiated in 2006 with cofunding from the Directorate General International Cooperation (DGIS) of the Netherlands Ministry of Foreign Affairs.

Since 2006, NBP has established operations in eight provinces of southern and central Cambodia through cooperation with province-level agriculture departments (PDAs) and nongovernmental actors, consistent with Cambodia's current decentralized governance model. In these provinces, Provincial Biodigester Program Offices (PBPOs) supervise the construction of Farmer's Friend household biodigesters by NBP-trained biodigester masons.

NBP's program objectives for 2008–09 included support for the development of a professionalized biogas contractor system in Cambodia that could drive significant penetration of biodigester systems among rural farming families in targeted provinces. Program success depends on the continued exposure of potential buyers (farm families/customers) to working biodigesters, to peer families who are satisfied with their biodigester plants, and the ability of the NBP marketing system to convert interest into sales and successful installations performed by qualified, NBP-certified masons.

The NBP's operating plan prescribes that all biodigester products and services in Cambodia will be delivered by private-sector BCCs by the end of 2011. Other value-chain-related development activities are underway or planned in related elements of the NBP's 2009 and 2010 operating plans.

Project Initiation

The focus of the NBP project is its enterprise development component, which is situated within the NBP's overall private sector and value chain development (PSD) activities. Accordingly, it emphasized developing pilot private-sector contractor enterprises—(BCCs)—and developing and supporting the entrepreneurs who lead these enterprises, in anticipation of a fully privately-provided contracting sector.

Pursuant to this objective, the NBP, with the support of the World Bank ASTAE and with cofunding from SNV for supplemental activities, engaged a PSD consultant team to initiate a system to pilot and support the development of BCCs. The team's work began under direct funding from NBP program partner SNV for the period of July 1 to September 31, 2008 and continued with World Bank assistance from October 3, 2008 to June, 2009.

The overarching goal of the NBP is private sector delivery of high-quality biodigester plants through the most efficient means available. The NBP initiated this process to pilot and test the most promising options for private sector development, in addition to assessing the masons' capacities and needs for this task.

Microenterprise Focus

The NBP's preferred option was to draw the BCC entrepreneurs from the pool of trained, certified NBP biogas masons. This reflected the organization's preference for projects that support both economic and social development in rural Cambodia—and its desire to increase the presence of value-added private enterprises and to maintain and improve high standards of quality control in biodigester provision. It also reflected lessons learned from SNV's biogas experience in Nepal, which demonstrated that to ensure high quality construction, after-sales service, maintenance, and availability of spare parts, BCCs must be embedded in local communities.

A key project risk was that the available pool of NBP masons would lack adequate business skills to ensure their success as microbusiness owners and managers. They were skilled or semiskilled manual laborers, generally with low levels of formal education and minimal (if any) business exposure or experience. The NBP planned to address these limitations by training promising masons in managerial skills, credit and finance, sales and marketing, and developing and enhancing foundational entrepreneurial skills.

Workplan and Milestones

The PSD project team developed a workplan defined around seven key activities and milestones (see appendix 1). The milestones are:

1. **Business Model Recommendations:** Recommendations on adjusting the business delivery model for biodigesters in Cambodia;
2. **Province Selection:** Selection by the consultant and NBP leadership of three provinces for privatization, based on criteria to be determined in collaboration with the NBP and memoranda of understanding between the NBP and each selected PBPO outlining cooperation in the privatization process;
3. **Training Partners:** Identifying and contracting with training partners for needs assessment and mason selection, with the consultant submitting a report on contractual arrangements with selected partner(s);
4. **Mason Selection:** Identifying three to six highest-potential masons for placement in Farmer's Friend biodigester construction companies in selected provinces, and their immediate training needs, or on other steps to develop private biogas contractor firms in selected provinces;
5. **Training Development and Delivery:** Organization and completion of appropriate SNV-funded managerial, entrepreneurial, and other training deemed necessary for selected masons by the NBP, delivered by qualified national training providers or partners, with the consultant submitting a report detailing training provided and the results of a post-training needs assessment conducted in collaboration with training providers or partners;
6. **Business Registration:** Establishment of 10–12 biodigester construction companies in selected provinces and their registration as companies with district authorities, with the consultant submitting a report on company formation and registration and supporting documentation; and
7. **Contractor Support Plan:** Submission of contractor business development and support plan for incorporation into the NBP's operating plan (included in this report).

Monitoring and Evaluation Framework

Output and outcome measures defined for the project are related to the viability and sustainability of privately provided biodigester construction services in rural Cambodia. The project's M&E framework is presented in appendix 2.

The limited duration of this project, and its focus on targeted objectives related to business capacity building and company launch, as well as the construction of business support structures through the NBP franchise system, all point to further required M&E activities to comprehensively assess progress toward sustainability-based indicators.

Summary of Project Activities

In accordance with the workplan, the project undertook the following nine activities to accomplish the objectives above.

1. Selection of appropriate provinces and district market areas for private provision;
2. Management of provincial counterpart relationships (PBPO);
3. Analysis of the NBP business model and development of viable microfranchise business models, including codification of NBP operating procedures and development of the *Operations Manual for Privately Provided Biodigester Services*;
4. Selection and management of a local capacity builder to co-develop and implement a mason selection process and an intensive business skills training and mentoring (business coaching) program;
5. Design and implementation of a process to select high-potential entrepreneurs from among NBP biodigester masons;
6. Delivery of intensive business skills training program for selected masons;
7. Assistance with official business registration to permit companies to enter legal contracts with customers;
8. Finalization of three-party Franchise Agreements among the NBP, BCC, and Provincial Biodigester Program offices (PBPOs) and launch of 15 BCCs in 3 provinces; and
9. Post-training needs assessment and initiation of business coaching program.

Summary of Project Results

The PSD process resulted in the legal registration, NBP authorization, and business launch of 15 Farmer's Friend BCCs in 3 provinces, each of which operates as a franchisee of the NBP in a three-party contract between the NBP, BCC, and PBPOs. This entailed achieving the following nine outcomes.

1. Districts privatized in three provinces: Kampot, Kampong Cham, and Svay Rieng. Six Takeo Province districts were in the process of privatizing at the time of project completion in June 2009.
2. Fifteen BCCs established in three provinces. Anticipated that 5–6 additional BCCs will be registered in Takeo province in the 2 months following project completion, resulting in formation 21 BCCs attributable to the project by the third quarter of 2009;
3. Systematic and replicable mason selection process developed, documented, and implemented exclusively by Cambodian staff and program support partners (in later phases of the project);
4. Adjustment of business model for private sector delivery, including codification of procedures and incorporation of overheads sufficient to support ongoing commercial development of the sector;
5. Microfranchise model created for BCC development and expansion, including franchisee *Operations Manual*, simplified project management tools and technical procedures, and business management forms;
6. Development of customized training appropriate for condensed, six-day program for rural entrepreneurs, and system of continuous improvement of training to meet revealed needs through the SNV–Cambodia-India Entrepreneurship Development Centre (CIEDC) partnership;
7. Mentoring/business coaching system implemented with local partner CIEDC and supported by SNV national staff, combining one-to-one mentoring and needs-based group training with a peer-learning component;
8. Progress in migrating provincial PBPOs to a regulatory and sector support role and familiarization with regulation of private activities;
9. Significant increase in acceptance of and support for private sector provision of household-level energy services among national and provincial government partners, including significant buy-in for private delivery of biodigester construction among technical supervisors.

Key Project Innovations, Accomplishments, and Lessons Learned

In addition to surpassing the main milestone-linked project indicator (number of businesses registered), the NBP PSD project has achieved three important outcomes that support PSD outcomes in Cambodia and provide a model for decentralized provision of biodigester services and other product-focused social enterprise initiatives. This

section provides a summary of key innovations, accomplishments, and lessons learned, some of which are drawn from the project narrative section in this report.

Building Support for Private Sector Development among Provincial Government Leadership and Technical Supervisors

Following an initially apprehensive reception to the concept of privatization, the project has built strong support for private sector development among NBP provincial stakeholders, and for rural private enterprise development in general. This includes support among PBPO directors (who are typically directors or deputy directors of the provincial agricultural departments) and, more recently, a base of support among provincial coordinators and technical supervisors who now understand private provision as a more efficient and labor-saving division of labor.

To overcome initial apprehension about PSD among national and provincial program leaders, the PSD team conducted extensive outreach in July and August of 2008. Subsequently, SNV led a learning mission to Nepal for the directors of four PBPOs and national program leaders, where they were shown the advantages and operational details of commercially provided biodigester services. Following the trip, the PSD team immediately captured the impressions and lessons learned that the directors believed could be applied to the Cambodia NBP. These were used to structure specific PSD program activities and training plans for the remainder of the project.

After this experience, a near-consensus emerged in favor of the PSD process, with provincial leaders extremely (and directly) supportive of PSD program goals and activities. PBPO technical supervisors, who are government employees, also offered some initial resistance to the privatization process, particularly in Svay Rieng province, where they were openly hostile to the new system. Supervisors there feared loss of control over masons, whom they had considered their “employees,” and loss of prestige and status as the orchestrators of the program in their respective districts.

The PSD team engaged in intensive education and outreach to demonstrate that the privatization process stood to increase the efficiency of the program, directly benefiting technical supervisors in terms of earning potential and work efficiency. Recognizing that supervisor outreach would be critical to the success of the program, PSD team leaders and coordinators held meetings with PBPO coordinators and supervisors in January, February, and March, 2009. In these meetings, supervisors

indicated that customer identification and sales efforts provided the lowest financial returns to their efforts, with 1–3 days of work yielding only US\$5 in promotion fees in most provinces, with technical quality inspections yielding more, for a smaller and more predictable investment of time and effort. When asked “Which would you rather do full-time—quality supervision or customer identification and sales?” technical supervisors unanimously chose quality supervision. When the PSD team explained that the principal change PSD would entail would be full dedication to quality supervision and (near) elimination of customer identification and sales responsibilities, the supervisors recognized the logic of commercial provision and became highly receptive to the PSD process.

The PSD efforts and auxiliary efforts by SNV effectively neutralized opposition to privatization and built the foundation for a pro-commercial constituency among provincial stakeholders. Still, sustaining support among provincial stakeholders will require clearly and visibly successful BCCs, and sustained efforts by all actors to make the privatized system yield the expected benefits—faster growth in plant construction and overall improvements in plant quality.

Replicable Microfranchise Business Model

Early in the process, the PSD team recognized that local NBP masons faced multiple constraints to becoming BCC business owners, including lack of necessary business skills, lack of familiarity with administrative compliance procedures, and low tolerance for the risks traditionally associated with business startup. In initial meetings with masons, it was clear that they lacked many of the hoped-for skills and aptitudes required to support microenterprise-driven privatization. In addition, the responsibilities of new mason-entrepreneurs envisioned by NBP leadership continued to grow, highlighting a severe supply-demand mismatch and a need for adjustment of the PSD delivery model. The PBPO directors and coordinators also expressed significant concern about masons’ financial capabilities and management skills, staff and operations management abilities, and foundational entrepreneurial skills.

The PSD team adjusted its approach accordingly, settling upon the development of a microfranchise system, with specific operating arrangements and business procedures developed through a BCC *Operations Manual*, simplified project management tools, and a three-party Franchise Agreement.

The microfranchise system emulates successful commercial franchise systems in the sense that the franchisor,

the NBP, centralizes the most skill-intensive business activities of the business, including brand, product, system and business process development, and delegates franchisees with lesser skills and resources (BCCs) to contribute technical skill, direct sales networks, and direct personnel management. The risks and costs of business entry for franchisees are reduced because (as they lack previous exposure to effective business processes and operating procedures) they receive turnkey procedures developed by more highly skilled personnel (the PSD team and NBP technical management). Once implemented, the franchise system becomes an ongoing dialogue between franchisor and franchisee, based on a shared interest in expanding market penetration. In addition, because the franchisor can revoke a franchise in the case of noncompliance with operating procedures, the franchisor can exert significant control over procedures with a more credible sanction than in the case of dealing with fully independent businesses.

This model required detailed codification (and in some cases, modification) of NBP operating procedures to ensure predictability and clarity for low-skilled Farmer’s Friend entrepreneurs. Development of this system, in the end, facilitated replication of the privatization effort in subsequent districts, as the basis for business systems had been developed. The key tools of this system are the *Operations Manual for Private Biodigester Companies* and the Project Control Folder (PCF) (see chapter 3) and the Franchise Agreement (see this chapter’s appendix 3).

Effective Business and Entrepreneurship Training for Semiskilled Rural Laborers

Development of Customized Training Focused on Concrete Business Outcomes

The training development process resulted in a highly tailored and targeted business skills training program, which was developed over the period of November 2008 to February 2009. The PSD team worked with CIEDC, the training partner and local capacity builder, to produce a six-day Entrepreneurship for Biodigester Construction Companies (BCCs) training course. The main objective was to teach the skills that BCC owners would need to build and operate a successful business as a NBP franchisee.

CIEDC was selected as the only full-service entrepreneurship training provider able to provide diversified training and ongoing support services to Cambodian rural entrepreneurs, and the most appropriate for working with rural nonagricultural businesspersons with low formal skill levels (low literacy and numeracy). The PSD

team found over time, however, that CIEDC's ability to provide ongoing mentoring required further upgrading to meet NBP sector development needs. SNV then hired a National Advisor for Rural Private Sector Development to improve CIEDC's capacity to deliver ongoing customized training and business coaching services. (SNV intends to continue building the capacity of CIEDC and other local institutions to provide mentoring and business coaching to low- and moderately-skilled rural entrepreneurs.)

While the development process was not without obstacles, the final training program effectively overcame many of the limiting features of "generic" business training programs by attending specifically to the unique situation of rural entrepreneurs in Cambodia and the specific activities required of new BCC business owners.

In November 2008, the PSD team worked with the CIEDC training team to familiarize them with NBP, to prepare them for a field visit to meet with masons and for the mason capacity assessment and entrepreneur selection process. Preparation included customization of assessment tools based on projected company structure, in order to ensure appropriate training for future BCC owners.

During the week of November 17, 2008, the team was briefed and conducted visits to Svay Rieng and Kampot Provinces. The PSD team developed a functional map of BCC operational processes and implications for mason assessment and training, forerunner of the BCC *Operations Manual*. This early version was used as the basis for targeting business training approaches to the specific needs of new BCC owners.

During the week of November 24, the training team presented their findings and consultants held three workshop sessions to clarify the BCCs' functional requirements using the process map referenced above and to map required skills and competencies to each projected BCC's activities. The main training-related results of this process were a number of additions to the CIEDC, a mason capacity-assessment tool used in Farmer's Friend mason selection and training design, and a succinct map of key business skills around which training would focus.

Several iterations of the training process were required to fine-tune and target training to the level and skills appropriate to new BCC owners. The parallel development of the *Operations Manual* and codification of associated BCC business processes (many of which had not been previously codified by the NBP) helped to focus the final training on immediately useful skills and activities.

The business skills training program was structured as contextual learning, within the cognitive abilities of highly motivated learners with limited formal education. It is unlikely that the initially selected group of BCC owners would have absorbed training related to developing business procedures in which significant business learning was embedded. This suggests an additional benefit of the franchise development model, in that it provides potential entrepreneurs with concrete learning contexts in which to develop basic business and entrepreneurial skills.

Business Coaching and Mentoring for BCC Owners

It is a given in the entrepreneurship support community that initial or sporadic training is insufficient to improve survival rates for startup businesses, even within a tightly managed franchise system. The NBP project adopted international best practices in providing ongoing training support, professional coaching, and peer support through the local capacity builder, CIEDC, supported by the SNV national advisor.

Mentoring and business coaching activities were initiated by CIEDC in late May 2009 and performed in the last week of June 2009, coordinated by the PSD coordinator and assisted by the SNV National Advisor for Rural Private Enterprise Development.

CIEDC will ensure that masons receive the required support for company registration. To the extent required for sustainability, CIEDC trainers will

- hold one monthly mentoring meeting with each selected mason–contractor group or individual (see below),
- provide explanation and introductions to service providers for additional services required by BCC owners,
- provide telephone support to monitor masons' progress and answer questions in a timely way, and
- in limited cases, travel to target provinces on an as-needed basis for additional direct mentoring. CIEDC personnel will also provide NBP and SNV leadership a brief report on current needs and status of each BCC owner after each bi-monthly individual mentoring session. Results will be shared with PBPOs as necessary and appropriate to improve PBPO back-stopping activities.

To achieve efficiencies in costs and coaching delivery, mentoring sessions, which began in July 2009, alternate between group and individual sessions. During the first month of business mentoring, all BCC owners received one-to-one mentoring by a CIEDC trainer. Following this meeting, the CIEDC team met with the SNV PSD

advisor and NBP personnel to discuss common BCC owner needs. The following month's mentoring session was held in the provincial capital and focused on a small number of training topics (one or two issues) that are common BCC owner needs. This creates a fertile environment for peer-to-peer learning among BCC owners, which the PSD team believes will be an essential basis for cooperation among BCCs in future business associations or federations.

This structure also enables better coordination among technical training enrichment activities conducted by NBP technical supervisors, for example, on appliance estimating and product improvement, as well as providing a centralized distribution opportunity for *Operations Manual* updates and information about province-level changes in PBPO operations.

Recommendations to the NBP

This section provides recommendations for NBP to extend the PSD process within and beyond the current NBP program context.

An Elevated NBP PSD Objective

Based on the experience of the pilot PSD process, the PSD team articulates the medium-term vision of privately provided biodigester services in Cambodia as follows.

In all Cambodian provinces, commercially provided household biodigester construction and maintenance services and spare parts are available to meet growing demand from livestock raisers (farmers/customers) who recognize the multiple benefits of ownership. Competition among NBP franchisees to provide these services ensures that potential customers can choose among BCCs based on their quality and service reputation. Destructive price competition is minimized by effective sector regulation and an optimal franchisee density, maintained by the NBP and provincial partners. Because franchisees are rewarded for professionalizing their businesses by higher revenues and increasing status as business owners in their communities, they participate actively in the development of a sustainable commercial biodigester sector, and provide input to the NBP on continuous, sector-wide improvement and upgrading.

To achieve this bold vision, the NBP can explore the following recommendations on replicating and expanding the PSD process to all current NBP provinces, and expanding into new provinces with a PSD-friendly model of program initiation.

Recommendations for PSD Replication in Current NBP Provinces

Objective: Biodigester construction and maintenance (warranty) services in all eight existing NBP provinces are conducted by private NBP-authorized or recognized franchisee businesses by the end of 2011.

NBP Organization, Management, and Administration

Franchise management is a complex task requiring a number of related business skills and a high level of dedication to the brand being franchised.

The NBP may not currently have the capacity to manage the appliance supply chain, enforce company agreements and procedures, or monitor BCC performance and apply appropriate sanctions within the franchise system. There is a further risk that BCCs may not hire or appropriately manage NBP-certified masons, limiting sector growth. Finally, PBPOs may attempt to micromanage the sector, resulting in a difficult business climate and eventual BCC exit or abandonment. Careful monitoring will be required within the context of the franchise system.

As a result, no later than mid-2010, the NBP should establish a Franchise Operations Manager position, reporting to the national coordinator and parallel or horizontal to the technical manager and director of administration. This position should take over the responsibilities of the private sector development coordinator position, since the privatization process should be nearly complete by this time.

The principal responsibility of the Franchise Operations Manager should be to oversee, manage, and implement

- ongoing revisions to the BCC Franchise Agreement and BCC *Operations Manual*,
- negotiation, consultation, and communication with BCCs and PBPOs regarding changes to the BCC Franchise Agreement and BCC *Operations Manual*,
- monitoring and improvement of the appliance credit system and supply chain, with the primary goal of continued sector expansion,
- negotiation of preferred Farmer's Friend materials supplier arrangements with construction material supply companies in each NBP province, with the objective of materials quality control and program compliance,
- development of a market-focused consultative process for sector promotion activities, with BCC owners' ideas and needs driving brand development, marketing, and communications activities,
- establishment and operational supervision of a national federation or association of BCC owners

to provide ongoing input to NBP and PBPO procedures and operations and to provide an efficient delivery mechanism for ongoing training and communication,

- monitoring of company's use of NBP-trained masons,
- selective auditing of BCCs' financial, sales, and marketing operations, and of PBPO appliance credit accounts,
- development and enforcement of clearly articulated and appropriate sanctions for BCCs violating the franchisee agreement or other policies outlined in the *BCC Operations Manual*, and
- assistance in province-level planning for new company authorization and new NBP mason training.

Human Resources and Training

There remains some risk that new BCC owners may be unprepared for the responsibilities of business ownership, particularly those related to new paperwork and administrative requirements, and may abandon BCC operations. Of course, business survival is not guaranteed, and the NBP should aim for realistic business survival and growth rates. Nonetheless, to address these risks, the NBP should undertake the following.

PSD Training for All New Masons. For all new Farmer's Friend masons, the NBP should add to existing technical training activities a two-day PSD training component, providing an overview of the possibilities of business ownership (franchisee status) in the NBP system, of the responsibilities of ownership, and of quality control.

Integration of Quality Control Checklist (QCC) Training into Initial Mason and Supervisor Training. This is an essential element of BCC operation for all masons in the NBP system. In anticipation of PSD in all NBP provinces, the QCC should be introduced as a normal part of biodigester construction.

- The NBP should provide training in the QCC and other PSD procedures (for example, the Project Control Folder) to all supervisors in all participating provinces. This should be conducted by the NBP technical manager (who co-designed the tool) or NBP technical supervisors in the third and fourth quarters of 2009. By the end of 2009, all NBP and PBPO personnel should be familiar with the QCC and able to instruct masons in its proper use.
- The NBP, in coordination with the PBOs, should train all participating masons in the use of the QCC, which should be introduced in all new mason training to

stimulate awareness of and commitment to internal quality control.

- Beginning on January 1, 2010, the QCC should become mandatory in all biodigester construction projects, both BCC and PBPO. It should be used as a tool for supervision in PBPO-run operations, and NBP masons in PBPO-run districts should be required to submit the QCC in order to be paid by PBPOs.
- The NBP technical department should provide new or refresher training to all BCC owners, and possibly to participating NBP masons, in the following skills.
 - *Estimating appliance costs to give customers precise cost estimates, using forms and guidelines produced by the NBP.* Precise cost estimates for appliance systems are somewhat difficult, but are an essential skill. The PSD team, in collaboration with the NBP technical manager, has developed relatively precise estimation routines (forms) for use by BCC owners or sales representatives. Intensive training should be provided in their correct use to ensure that incorrect estimates do not generate resentment or negative publicity among buyers.
 - *Enrichment training in evaluating the potential of farm families to benefit from biodigesters.* In accordance with the revised PRASAC-NBP agreement, BCC owners and masons require additional training in determining the technical feasibility of biodigester construction. Training should be focused on helping BCC owners improve basic evaluation of appropriateness and technical potential, and explain to families the potential cost savings on firewood and cooking fuel. In addition, the NBP should clearly articulate sanctions against franchisee BCCs who sell biodigester installations to nonqualifying families, as this represents a significant potential risk to the ongoing success of the NBP.

The NBP, through CIEDC, should also provide training for families of BCC owners in accounting and inventory procedures. The basic systems developed present challenges to most BCC owners. In addition, the assumption of the PSD team from the outset has been that BCC owners will initially depend on family labor to staff their offices and handle basic administration, inventory, and financial management. Since the majority of such supporting family members are likely to be women, the NBP should produce and deliver gender-sensitive training covering the inventory management system, receivables and payments, cash book, and basic filing and records management. This training should be delivered as soon

as possible to BCC owners' spouses, daughters, and other appropriate family members.

Financial System/Regulation

To facilitate the system-wide transition to private provision of biogas services in Cambodia, the NBP should do the following.

- **Add company overhead to the official bill of quantities in the third quarter of 2010 for all BCCs and PBPOs.** This will help limit the NBP's costs and prepare BCCs for a fully privatized system. Ultimately, to create a self-sustaining household biogas construction sector, company overheads must be borne by customers (farmers). Furthermore, though the current US\$150 subsidy level is no longer justified by materials prices, which peaked in 2007–08, reducing the subsidy may be extremely difficult. At the same time, the NBP cannot (and should not) bear all overhead costs in a privatized system. In districts that are not privatized by mid-2010, this additional overhead cost should be recaptured by the NBP to offset subsidies and overhead payments previously provided.
- **Revisit company overhead charges annually.** At the end of 2009, and at the end of each subsequent year, NBP staff should revisit the overhead percentage (currently around 7 percent) in light of the previous year's business operations, progress toward targets, and BCC failures. The current US\$30 overhead plus US\$5 promotion fee is actually US\$5 lower than the originally recommended US\$35 overhead, but it should not be raised unless needed to stimulate sector growth.

Marketing/Promotion/Communications

The NBP remains the "brand owner" of Farmer's Friend biogas in Cambodia. Within the objective of sector and brand promotion, the NBP should do the following.

- **Step up sector promotion activities, through local media and public advertisements, to raise awareness of BCCs and the NBP brand.** Province-specific marketing materials should include the names and telephone numbers of masons serving specific districts and be updated on a regular basis. The NBP should consider facilitating radio (and possibly television) exposure for more articulate BCC owners as an outreach and brand promotion strategy, in concert, where possible, with other agricultural extension efforts that use radio and television to reach agricultural audiences.
- **In collaboration with BCCs, develop a consultative process for developing sector promotion activities based on BCC experience.** Household incentives for biogas

deployment are varied, and BCC owners will soon have the best information regarding the disposition of customers to biogas. The NBP should carefully listen for and extract information about common customer concerns, objections, and motivations, and develop sector-wide promotion activities and marketing materials to raise awareness of these concerns and help BCCs sell to new customer groups. It is important that the social goals of sponsoring NGOs are complemented by an acute understanding of the drivers of customer interest, which may be (broadly) financial, sanitary, social, hedonistic (more time to relax), or others. While there is no need for the NBP to compromise its social mission, effective marketing activities must be developed in a way that respects all possible motivations for biogas ownership.

- **Broaden the target market and reduce the intensity of promoter training.** Under the pre-PSD system, promoters were principally responsible for evaluating technical feasibility using Form 02-P. In the privatized system, Form 02-P will normally be completed by the BCC owner or sales representative. At the same time, remuneration for promoters is also being privatized, and, though auditable by the NBP, should be primarily the responsibility of BCC owners. As a result, the primary goal of NBP promoter training should be to engage a broader range of community and commercial actors and stakeholders, and to empower the personal and professional networks of BCC owners to effectively communicate the benefits of biogas ownership. Reducing the intensity of technical feasibility training should be accompanied by co-recruitment of promoters by BCC owners (including farmer promoters, feed dealers, veterinarians, and other agriculture sector stakeholders). For greatest effect, NBP technical supervisors might be deployed monthly over the next year for half-day scheduled meetings with newly identified promoters to ensure that an informed promoter network continues to grow in PSD districts.

NBP Expansion into Four Additional Provinces with Accelerated PSD

A second objective is the expansion of the NBP into additional provinces, which may be supported by additional donor funds beginning in 2010.

Objective: Beginning in 2010, expand the NBP into four additional provinces, fully leveraging the experience of the NBP PSD pilots to accelerate the formation of a sustainable commercial biogas construction sector.

Recommendations for Expansion into Additional Provinces with Accelerated PSD

All of the recommendations for Farmer's Friend contractor support and enrichment outlined in the previous section, if rigorously implemented, will support program expansion. However, additional actions to configure provincial programs so that they are "primed" for a quick transition to commercial operation should be considered by NBP and its implementing partners.

PSD-Ready

It is the recommendation of the PSD team leader that new provinces be introduced into the NBP system in a manner that reduces obstacles to privatization. The team's recommendations for adding new provinces follow.

- **Upon establishment of PBPOs, fully inform and train PBPO directors, coordinators, and supervisors on their principal role as sector regulator, the limited duration of their direct supervision of construction activities, and their responsibility to create PSD-ready Farmer's Friend masons.** If necessary, facilitate field exposure visits to participating PSD districts for new coordinators and supervisors to help them clearly understand the program objective: a sustainable commercial sector.
- **Establish one or two demonstration districts in each new province for one year.** The demonstration district should be run by the PBPO with intensive supervision.
- **Train 10–20 masons from all districts in the province to serve only their own districts during the first year.** Masons should be chosen based on geographic distribution and willingness and ability to travel to demonstration districts (demonstrating commitment, mobility, and future service area coverage).
- **Introduce the BCC franchise system and basic sales and marketing in a two-day addition to basic mason training.** The PSD concept should become familiar and expected for masons and supervisors alike.
- **Establish a plan for introducing new districts in each new province through PSD only, after masons have "matured" in their technical skills and have a basic understanding of the concept and practices.** This can help the NBP avoid issues with provincial supervisors' territoriality and should allow the demonstration district in each province to achieve economy of scale and serve as a marketing tool for training promoters in new districts.
- **Use a promoter identification competition and new mason recruitment as part of the process to select masons as BCC owner/NBP franchisee.** Assuming masons have been appropriately trained in PSD, incorporating a BCC-centered promoter system into the program structure should improve BCCs' initial sales performance

and provide for more rapid privatization. Recruitment of new masons is also an important attitudinal test for potential BCC owners: masons who are willing to refer their peers and helpers for NBP certification should be favored for BCC ownership.

- **Plan for a second class of masons.** The NBP should plan a second round of mason training at approximately 9–10 months in order to ensure a supply of trained and skilled masons sufficient to cover the entire province. Trainees referred by existing masons with high potential for BCC ownership should be favored, given that they are likely to support sector development post-privatization. This approach will also help the PBPO role develop more consistently with the overall and long-term objective of the project, with supervisors regarding masons as essential to program success and to their own financial well-being.

Human Resources and Training

If the NBP wishes to rapidly introduce a commercial biodigester sector, new mason training should incorporate the necessary skills and understanding to facilitate this introduction. This requires additions to NBP mason training to "prime" masons for a PSD role.

- **PSD training for new masons.** For all new masons trained by the NBP, provide a one- or two-day PSD training component providing an overview of possibilities for BCC ownership (franchisee status) in the NBP system, responsibilities of business ownership, and quality control.
- **Introduce the Quality Control Checklist (QCC) in initial mason training.** This will stimulate awareness of and commitment to internal quality control. Use the QCC as a supervision tool for new masons and require QCC submission for payment by PBPOs from the outset.
- **Train supervisors and masons in appliance cost estimating.** Appliance cost estimating should be incorporated into initial training for new supervisors. For masons, this should occur during the first refresher training (perhaps at six months) in preparation for BCC owners' sales and contracting roles. Accurate cost estimating could also be incorporated as a BCC-owner selection criterion, as it demonstrates ability to perform the planning and applied calculations that are essential to the BCC owner role.

Financial

Include company overhead in the official bill of quantities in all new provinces. Company overhead charges should be included in the bill of quantities for all new provinces at standard levels. These additional charges should be retained by the NBP (not by PBPOs) and used to fund

the NBP contribution to PBPO operating costs prior to privatization. In this manner, company overhead charges will more smoothly migrate into a fully private system, while PBPO compensation for quality control and program management activities will never be visibly linked to overhead charges.

Marketing, Promotion, and Communications

- **Demonstration districts.** Develop the promoter system using demonstration districts to highlight both the individual and community benefits of Farmer's Friend biogas systems. Begin promoter system development in additional provinces approximately six months after program initiation in new provinces. Conduct exposure visits to demonstration districts for new promoters.
- **Develop a BCC-linked promoter system.** In newly initiated districts, link new promoters to new BCCs at the onset of operations. The NBP can migrate toward a commercially oriented promotion network by directly involving BCCs in newly served districts from the outset in the network's development.

Operations and Materials Management

There is a risk that PBPOs may not understand or support the BCC franchise system, and problems with management of credit accounts, appliance provision, or both could lead BCC owners to abandon operations. The NBP should work to:

- **Monitor appliance supply and inventory credit with BCCs.** The PSD coordinator or his successor (franchise manager, for example) should conduct a bimonthly telephone call with each BCC owner to ensure that PBPO supply operations are effectively meeting the demand for materials, and that the system remains free of abuse or demand for informal payments related to the appliance credit system.
- **Conduct spare parts spot checks.** NBP technical supervisors should conduct approximately one spot check per month on each BCC to ensure they are maintaining appropriate spare parts inventories. The NBP should articulate and enforce appropriate tiered sanctions against BCC owners who fail to maintain the required inventory. For example, first offense: warning; second offense: suspension of one startup bonus payment of US\$15; third offense: suspension of overhead payment of US\$30; fourth offense: revocation of Franchise Agreement.
- **Negotiate preferred construction materials supplier arrangements.** NBP technical supervisors, working with BCC owners, should identify reputable materials suppliers who are willing to meet NBP quality standards in each PSD province, and work to incorporate

these suppliers into the NBP system. Preferred suppliers could be informed of plant construction projections on an annual or semiannual basis to ensure availability of supplies, and could negotiate further arrangements with BCCs for package discounts, delivery of materials to customer homes, and other ways coordinate basic supply operations.

Sequential Narrative of Project Activities

This section presents a narrative of major project activities, presented in sequence according to the date of initiation of sub-activities.

Selection of Appropriate Province and District Market Areas for Private Provision

Project activities were initiated on July 1, 2008 in preparation for the July PBPO directors meeting, during which the concept of the pilot PSD program was presented in detail. The meeting successfully led NBP and PBPO directors to think about sector sustainability, but some initial resistance to the PSD concept was encountered. As a result, the PSD proposal was translated to Khmer and circulated to NBP and PBPO directors, and in consultation with the national coordinator and international advisor, a PSD steering committee was formed to oversee PSD activities, provide input, and validate PSD team decision making.

The NBP directors arrived at the decision to select three provinces for initial PSD pilot activities beginning in 2008, and at the behest of the NBP coordinator, a fourth province was selected for incorporation into the PSD program in early 2009.

Management of Provincial Counterpart Relationships

Stakeholder engagement was conducted with PBPO directors and PBPO coordinators and supervisors during August and September of 2008, and was a necessary ongoing part of project activities throughout. The following sections outline the process of stakeholder engagement and key findings.

The stakeholder engagement process also elicited feedback and input from PBPO directors, coordinators, and supervisors on their suggestions of appropriate districts for PSD pilots. District selection was also discussed, though ultimately it was decided that final selection

TABLE 2.1: PROVINCE SELECTION FOR PILOT PSD ACTIVITIES AND RATIONALE

Province	Rationale	Start Date
Kampong Cham	Adequate performance with some strong districts and reasonably committed leadership in PBPO.	2008
Kampot	CEDAC PBPO, success in organizing NBP start-up, and strong performance during initial period.	2008
Svay Rieng	Strong leadership of PBPO Director and rapid growth in past year.	2008
Takeo	Need for restructuring and improved performance.	2009

would be conducted as a function of Farmer's Friend mason selection in potential districts. This process was conducted in collaboration with training partner CIEDC to ensure adequate coverage of selected districts by skilled and well-prepared masons.

Engagement of PBPO Directors

On August 8–14, the PSD team held meetings with directors of each PBPO and with supervisors or coordinators from Kampot and Kampong Cham. This section outlines issues common to all provinces, specific findings on key points of discussion with each province (summarized in a table on subsequent pages), and directions indicated by these meetings that were expanded upon by the NBP.

Issues Common to All Provinces

In all provinces, there was clear agreement on the following issues.

- Enthusiasm for PSD.** All PBPO directors expressed enthusiasm for PSD activities as a means of expanding the NBP. No serious concerns were raised by any director.
- Masons' construction capacity.** Each province director or coordinator identified a limited number of outstanding masons. Unfortunately, their geographic distribution and capacity for plant production (approximately two per mason in a single village) does not necessarily provide the combination of geographic coverage and competition required by the NBP for expansion.
- Masons' skills.** All province directors expressed concern about the business and financial management skills of available masons—even those identified as outstanding. Directors have so far been flexible in addressing these deficiencies, though the two provincial PBPOs anticipate a PBPO role in financial management, which may be incompatible with the NBP PSD roadmap.
- Promoter system.** In all provinces, the success of the program rests on effective promotion at the local and district level, either by district officials, village vets, or other district- or commune-level promoters. According to directors and supervisors, masons are not ready to handle these activities on their own in a single district of the surveyed provinces. Yet, the most intuitive option—pairing promoters with masons as the basis of companies—does not provide for competition within communes, and does not match the well-considered geographic structure of the current promotion system. PSD activities must accommodate or incorporate this system, as failure to do so would seriously curtail demand growth and threaten overall NBP goals.
- Noncompetitive assumptions.** PBPO directors' initial ideas on PSD do not provide for the level of competition among mason-companies that is assumed in the NBP PSD roadmap. The PSD team will need to explore these issues further to ensure competitive outcomes in selected districts, and to determine the level of "monopoly control" acceptable as an interim situation while the PSD system is under development.
- Financial structure.** The PSD team leader is very concerned that the current financial structure of plant construction leaves insufficient funds to account for company overheads, marketing and promoter costs, supervision costs, rising labor costs, and materials costs in a privatized system while maintaining competitive pricing. This issue needs to be resolved in order to give potential masons a clear idea of the benefits of starting and registering a business, and to assure other participants of their continued financial stake in the process. The PSD team and project advisor need to construct and analyze a biodigester value chain in the immediate future to clarify options and viability.

Analysis of Provincial Biodigester Program Performance and Rationale for Selection of Appropriate Districts for PSD Activities

The PSD team undertook analysis of the potential districts for the pilot PSD, both independently and with the PBPO directors and coordinators. Initial PSD analysis yielded findings that were consistent with provincial stakeholders' suggested target areas, suggesting that there is a high degree of agreement on successful districts in each province. The PSD coordinator also held in-depth meetings with each province's PBPO coordinator in late August 2008 to ensure project ownership and to elicit concerns and suggestions regarding target districts and challenges to masons.

Ultimately, however, final district selection was deferred until completion of the mason selection process. It was decided that the local network and service capacity of outstanding masons would be the most important guide to appropriate selection of districts. To this end, measures of mason "embeddedness" in their home districts (as indicated by the intensity of their past work in the district and success in identifying customers with appropriate technical potential in these districts) were added to the mason selection process.

Building Support for Private Sector Development among Provincial Government Leadership and Technical Supervisors

Following an initially apprehensive response to the concept of privatization, the project built strong support among NBP provincial stakeholders for private sector development, and for rural private enterprise development in general. This includes support among PBPO directors (who are typically directors or deputy directors of the provincial agricultural departments) and, more recently, a base of support among provincial coordinators and technical supervisors who now agree that private provision is a more efficient and labor-saving division of labor.

To overcome initial apprehension about PSD among national and provincial program leaders, the PSD team conducted extensive outreach in July and August of 2008. Subsequently, SNV led a learning mission for the directors of four PBPOs and national program leaders to Nepal, where they saw the advantages and operational details of commercially provided biodigester services. After the trip, the PSD team immediately captured the directors' impressions and the lessons learned that they believed could be applied to the Cambodia NBP. These were used to structure specific PSD program activities and training plans for the remainder of the project.

After this experience, a near consensus emerged in favor of the PSD process, and provincial leaders were extremely (and directly) supportive of PSD program goals and activities. PBPO technical supervisors, who are government employees, also initially offered some resistance to the privatization process, particularly in Svay Rieng Province, where they were openly hostile to the new system. Supervisors feared loss of control over masons, whom they had considered their employees, and loss of prestige and status as the orchestrators of the program in their respective districts.

The PSD team engaged in intensive education and outreach to demonstrate that the privatization process stood to increase the efficiency of the program, directly benefiting technical supervisors in terms of earning potential and efficiency of work.

Recognizing that supervisor outreach would be critical to the success of the program, the PSD team leader and coordinator held meetings with PBPO coordinators and supervisors in January, February, and March, 2009. In these meetings, supervisors indicated that the customer identification and sales effort provided the lowest financial returns to their efforts, with 1–3 days of work yielding only US\$5.00 in promotion fees in most provinces, in contrast to technical quality inspections yielding higher compensation for a smaller and more certain investment of time and effort. When asked "which would you rather do full-time, quality supervision or customer identification and sales?" technical supervisors were unanimous in choosing quality supervision.

When the PSD team explained that the principal change for supervisors would be full dedication to Farmer's Friend quality supervision and (near) elimination of customer identification and sales responsibilities, they became highly receptive to the PSD process and recognized the logic of commercial provision.

The PSD efforts and auxiliary efforts by SNV have effectively neutralized opposition to privatization and built the foundation for a pro-commercial constituency among provincial stakeholders. Nonetheless, sustaining support among provincial stakeholders will require successful BCCs and sustained efforts on the part of all actors to make the privatized system yield the expected benefits of faster growth in plant construction and overall improvements in plant quality.

Business Model Analysis and Development of a Viable Microfranchise Business Model, Including Codification of NBP Operating Procedures and Development of the Operations Manual for Privately Provided Biodigester Services

The business model analysis task of the consultant terms of reference was ongoing throughout the project, with the bulk of analysis conducted in September and October, 2008. In accordance with the terms of reference, this section outlines analysis of and recommendations for selecting appropriate business models for implementation of PSD in selected districts, accounting for market, economic, financial, labor, geographic, technical, and key success and failure factors of each potential model.

The PSD team and NBP leadership agreed that the Farmer's Friend biodigester pricing model or models would have consequences for both program and contractor enterprise sustainability, and ultimately for the sustainability of the entire PSD effort. Key observations, preliminary analysis, and some recommendations from this analysis are presented in this section.

Observations on the Pricing Model

Administrative and overhead costs excluded from present model. The current pricing model assumes that administrative overheads of all kinds are covered by NBP compensation to the PBPOs. Because PBPO supervisors in effect serve as project marketers and managers, the current pricing model (cost estimation) excludes these costs. In a privately provided system, these overheads, including the entrepreneur's time and direct costs for marketing, client contact, contracting, and after-sales service, must be compensated. In the longer run, pricing structures must also provide for BCC administrative and overhead expenses.

Standard construction pricing models. In most developed countries, company overheads are covered by a markup on construction materials and direct labor expenses. In Malaysia, these rates may be 35–40 percent of total construction costs, while in Europe and the United States the markups are commonly 25–50 percent of costs or more. This system has several advantages:

- Overheads and firm support are linked to overall inflation rates in the materials and labor markets. As firms consume (administrative and marketing) labor, materials, and technology, their overhead costs are likely to grow in tandem with other costs across the economy.

- The firm's profit margin is usually captured in the overheads, providing entrepreneurs with the space to negotiate price and delivery terms and reduce profits as appropriate to win contracts.
- As material and labor costs are somewhat transparent in these markets, clients can compare bids and determine what is an acceptable rate of compensation for the firm based on comparative estimates.
- The system rewards entrepreneurial and innovative management, as good management practices can reduce overall overhead costs and a larger share of the markup can be captured by the entrepreneur.

Rising construction labor costs. Cambodian construction labor costs have risen sharply since the NBP biodigesters were constructed in 2006, as the domestic construction sector has been saturated by foreign-investment-driven projects. PSD team members conducted a spot check on labor costs in September 2008, and found that the rates for skilled labor in most NBP provinces exceeded the current compensation rates for biogas masons. The National Committee of Sub-National Democratic Development (NCDD) provincial and national stakeholders reported that many commune-level projects were cancelled or postponed in 2008 because both labor and materials costs exceeded the ceiling prices set by NCDD.

It is very likely that the September 2008 findings reflected a temporary construction boom that began to subside with the financial crisis of October 2008 and a seasonal increase in construction labor rates tied to the rice-planting season. Nonetheless, the long-term trends in construction labor costs, and their distribution throughout Cambodia (not confined to Phnom Penh) must be taken into account in designing pricing models that promote PSD pilot sustainability.

The SEILA (poverty reduction program) system in Cambodia has operated with only a 5 percent markup on costs, though several informants suggest that, in the context of Cambodia's construction boom, this low rate of compensation threatens project sustainability and does not encourage or reward contractors to adopt good or innovative management practices.

Competition for skilled labor. The NBP leadership is aware that the pricing model adopted must be sufficiently lucrative for mason-contractor entrepreneurs and skilled laborers (masons) to remain interested and active in the sector for the long term. In part, this will depend on the NBP's commitment to enhanced sector promotion in PSD provinces. More importantly, individual entrepreneurs' skills levels in customer identification, marketing, and closing the sale will determine contractor-firm profitability.

Unfortunately, no data are available on the amount of marketing and sales an entrepreneur must do to ensure company maintenance and growth, making precise activity-based costing very difficult. Furthermore, existing biodigester penetration and PBPO sector promotion support influence how easy or difficult the mason-entrepreneurs' sales efforts are likely to be. As it is unlikely to be equal across provinces, sales may be harder to close in some districts or provinces than others. This conflicts with the NBP agenda, which requires relatively uniform pricing across districts and provinces.

Sales and marketing skills development. Mason-entrepreneurs' skill levels in sales and marketing should improve over time and with training, but it is essential to program sustainability that they maintain income during the startup period, as failing to ensure this could jeopardize commitment to the program.

The cost analysis on the following pages presents a set of pricing and cost scenarios that illustrate the gaps in capital finance and income that must be met by the program to address these issues, and analyzes potential pricing structures in light of the labor conditions observed in September 2008.

Results of Preliminary Cost Structure Analysis

Tables 2.2–2.8 present potential pricing structures in light of labor conditions in September 2008. They illustrate—as the NBP model (left column) versus per-province costs—the gaps in capital finance and income that must be addressed to achieve relatively uniform pricing across provinces.

Business Model Findings and Recommendations

Drawing heavily on the analysis of the previous PSD consultant with respect to required startup costs for pilot biogas contractor firms, and based on very rough estimates of time and expenses involved in scaling up operations in such firms, the foregoing analysis points to some preliminary conclusions and recommendations. Validation of these assumptions is also needed in discussions with key NBP personnel.

- Approximately 7.5 percent overhead rate on biogas construction and labor should be sufficient to permit PSD sector growth. Calculations for a number of overhead scenarios were performed using a simplified version of the bill of quantities provided by the NBP. A variety of overhead scenarios were

calculated for reference, based on a percentage of construction materials and labor costs, but excluding guarantee and participation fees. The increase in cost for the following plant sizes is presented in the table below, based on the current NBP labor and construction materials estimates.

- NBP sustainability depends on maintaining mason-contractor income in the first six months following privatization. Income maintenance is calculated as US\$90 per month for skilled masons, based on a minimum 10 working days per month as a skilled mason at the approved US\$4.50 rate. This figure was used as a reference (minimum required) income for existing masons.
- Anticipated expenses far surpass anticipated revenues in the first four months of PSD company operation. Depending on the speed with which mason-entrepreneurs gain skills related to sales, marketing, and team management, it is estimated that all firms will incur losses during the first four months of operation. These can be expected even with highly subsidized loan interest rates of 18 percent for motorbike, trailer, and short-lived capital equipment.
- Profitability is possible from month four onward. Based on these assumptions, companies may be able to reach profitability after four months while maintaining baseline income.
- If mason training effectively communicates the enhanced profitability of completing installations in a clustered fashion, and if promotion and marketing efforts bring this goal to fruition, it is possible that after the fourth month (in this scenario), companies can begin to generate relatively significant profits.
- Net pretax income in this scenario in year 1 for mason-entrepreneurs of US\$1,458 (US\$121.49 per month) is projected. Year 2 pretax income, at a level of 18 plants per company per month, is projected as US\$3,374. These estimates do not include additional potential revenues from efficiencies generated in clustered construction. In the case of clustered construction, year 1 income could rise by US\$576 to US\$2,034 and year 2 income could rise to as much as US\$4,670 for BCCs.
- Direct subsidy requirement (cash, in-kind, or loan deferral): The foregoing company growth scenario requires a total subsidy of US\$419 per mason-entrepreneur to ensure income stability in the first four months of operation, in addition to indirect subsidies on interest rates for equipment purchases.

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TABLE 2.2: KEY ISSUES RAISED BY PBPO DIRECTORS

Issue	Kampong Cham	Kampot	Svay Rieng
1. General disposition on PSD	Strongly positive	CEDAC moving ahead quickly with PSD. PSD aligned with CEDAC priorities	Strongly positive: believes that PSD system could remedy low motivation of Prov/District staff
2. Current challenges to biodigester program	<ul style="list-style-type: none"> • Soil issues near Mekong • Low demand in forested areas and near Mekong (flooding) • Slow expansion of demand due to cost of biodigesters 	<ul style="list-style-type: none"> • Brick supply • Rocky soil makes digging more expensive and time consuming • Groundwater and rain impede expansion 	Limited PDA staff exposure in communities limits promotion efforts
3. Capacity and suggested districts	Director identified masons in most successful districts of region 3, including Banthea, Cheung Prey, Prey Chor, and Kang Meas. Possibly Ou Reng Ov	Dang Tong, Kampong Trach, and Banteay Meas are possible candidate districts, Kampot also possible; not enough capacity to cover all districts	Director suggested Svay Teab, Romeas Haek, Svay Chrum, and possibly Rumdol. Excluded well-performing district of Kampong Rou
4. Mason assessment	<ul style="list-style-type: none"> • 41 masons • 28 good masons • 15 outstanding masons (candidates) • Concern about new mason interest in program due to limited effective demand expressed by supervisors 	<ul style="list-style-type: none"> • 30 masons • 4 ready to engage for PSD • Identified key capacity limit: • 1 mason can supervise 2 plants in a single village 	<ul style="list-style-type: none"> • 29 total • 12 active • 3–4 outstanding candidates • Most masons still very weak in finding new customers • NBP mason fee above current market rate of US\$3.25/day for skilled labor (positive)
5. Key mason challenges in PSD	<ul style="list-style-type: none"> • Financial management • Business management 	<ul style="list-style-type: none"> • Brick supply • Business skills • Work rules vs contract format • Code of conduct and controls 	<ul style="list-style-type: none"> • 80% of good masons want PSD • Weakness in finding customers; masons requested continued help in customer identification • Financial management • General business skills
6. PBPO and supervision issues	Supervisors concerned about <ul style="list-style-type: none"> • Placement of plants • Guarantee certification • Cement quality 	None identified; discussions with supervisors in next phase of work	None identified; discussions with supervisors in next phase of work
7. Promotion and marketing systems	<ul style="list-style-type: none"> • Suggested farmer associations as promotion partners • PDA has village vets who are key promoters. Must include in PSD 	1 commune, 1 promoter system is working effectively; need to maintain in PSD structure	Network of district-level promoters needs to be maintained
8. Preference for PSD structure/business model	No strong preference expressed	<ul style="list-style-type: none"> • Suggested individual and cooperative model options • Some resistance to concept of competition 	Strong preference to start with 1 company formed by strongest masons (effective monopoly)
9. Opinion of outside capacity builders	Generally positive. Little discussion	None. CEDAC serves as key outside capacity builder	No resistance to outside business capacity builders, but none identified in Svay Rieng
10. Key issues to address	Expectation of PBPO control of mason finances PSD needs to be addressed	CEDAC actively thinking about two structures: <ol style="list-style-type: none"> (1) partnerships between masons and promoters; (2) Co-op company including masons, possibly providing brick and other supplies 	Preference for single company

TABLE 2.3: SEPTEMBER 2009 CONSTRUCTION LABOR RATES IN SELECTED CAMBODIAN PROVINCES

No.	Ranges of labor rates (US\$/day)								Company type	Comments
	Supervisor		Skilled		Semi-skilled	Unskilled				
	Low	High	Low	High		Low	High			
1	Phnom Penh									
	10.00	12.00	7.00	8.00		3.00	3.75	Contractor	Rate increased in rainy season when construction laborers are planting and plowing rice fields	
	9.00	10.00	5.00	10.00	3.75	2.50	3.25	Contractor-skilled mason	Rate has changed this year by US\$0.50 to US\$0.75, est.	
	7.00	8.00	5.00	6.00		2.50	3.50	Contractor	Informant stopped bidding on house construction projects because labor rates have risen quickly this year	
	N/A		6.00	7.00	N/A	3.00	4.00	GS and construction co.	Estimate	
2	Kampong Cham									
	11.00	11.00	6.25	7.50	5.00	2.25	2.75	Construction material supplier	Unskilled labor is currently hard to hire	
	10.00	12.00	7.00	7.00		2.25	3.75	Contractor	Many laborers have shifted to farming in response to high commodity prices	
			6.25					NCDD-SPPA		
3	Kandal									
	10.00	15.00	5.00	10.00	5.00	2.50	3.25	Mr. Sreang Chantha, Technical Officer, Public Transportation Office		
4	Takeo									
	12.00	15.00	10.00		5.00	2.50		Contractor	After April 2008, labor rates increased around US\$0.75 to US\$1/day	
5	Kampot									
			5.75	6.25	4.00	3.00	3.25	NCDD-SPPA		
			5.00	8.00	5.00	3.00	3.25	Contractor	International seaport and hydro-power are under construction, both need labor	
6	Svay Rieng									
			5.00	5.00	3.50	2.50	2.50	NCDD-SPPA		
	7.00	8.00	3.75	5.00	3.75	2.00	2.75	Contractor		
7	Prey Veng									
			5.00	5.00	3.00	2.00		NCDD-SPPA	Updated to May 2008. No current update available	
	6.00	7.00	4.50	5.00	3.75	2.00	2.50	Contractor		
						1.75	2.25	Private information from independent researcher	Informant indicates that skilled labor nearer PV Town	

TABLE 2.4: ESTIMATED CURRENT COSTS FOR 4m³ BIODIGESTER AND COST AND OVERHEAD ANALYSIS

	NBP as of 4/08			KCH as of 9/08		KPT as of 9/08		SVR as of 9/08		TAK as of 9/08	
	Rate (US\$)	Days	Total	Rate (US\$)	Total	Rate (US\$)	Total	Rate (US\$)	Total	Rate (US\$)	Total
I			26765		26765		26765		26765		26765
Construction materials			26765		26765		26765		26765		26765
II			56.53		56.53		56.53		56.53		56.53
Appliances			56.53		56.53		56.53		56.53		56.53
III			80.00		107.50		102.50		90.00		140.00
Labor			80.00		107.50		102.50		90.00		140.00
Skilled labor	4.5	10.0	45.00	6.25	62.50	5.75	57.50	5.00	50.00	10.00	100.00
Unskilled labor	2.0	10.0	20.00	3.00	30.00	3.00	30.00	2.50	25.00	2.50	25.00
Excavation of soil	1.5	10.0	15.00	1.50	15.00	1.50	15.00	1.50	15.00	1.50	15.00
IV			10.00		10.00		10.00		10.00		10.00
Guarantee			10.00		10.00		10.00		10.00		10.00
V			15.00		15.00		15.00		15.00		15.00
Participation fee			15.00		15.00		15.00		15.00		15.00
			429.18		456.68		451.68		439.18		489.18
Labor as % total cost			19		24		23		20		29
Materials as % total cost			62		59		59		61		55
5% of non-administrative costs			20		22		21		21		23
7.5% of non-administrative costs			30		32		32		31		35
10% of non-administrative costs			40		43		43		41		46
15% of non-administrative costs			61		65		64		62		70
20% of non-administrative costs			81		86		85		83		93
25% of non-administrative costs			101		108		107		104		116

TABLE 2.5: ESTIMATED CURRENT COSTS FOR 6m³ BIODIGESTER AND COST AND OVERHEAD ANALYSIS

		NBPP as of 4/08		KCH as of 4/08		KPT as of 4/08		SVR as of 4/08		TAK as of 4/08		
		Rate (US\$)	Days	Total	Rate (US\$)	Total	Rate (US\$)	Total	Rate (US\$)	Total	Rate (US\$)	Total
I	Construction materials			330.45		330.45		330.45		330.45		330.45
II	Appliances			56.53		56.53		56.53		56.53		56.53
III	Labor			89.50		114.25		100.50		155.50		155.50
	Skilled labor	4.5	11.0	49.50	6.25	62.50	5.75	57.50	5.00	50.00	10.00	110.00
	Unskilled labor	2.0	11.0	22.00	3.00	30.00	3.00	30.00	2.50	25.00	2.50	27.50
	Excavation of soil	1.5	12.0	18.00	1.50	15.00	1.50	15.00	1.50	15.00	1.50	18.00
IV	Guarantee			10.00		10.00		10.00		10.00		10.00
V	Participation fee			15.00		15.00		15.00		15.00		15.00
				501.48		531.73		526.23		512.48		567.48
	Labor as % total cost			18		23		22		20		27
	Materials as % total cost			66		62		63		64		58
	5% of non-administrative costs			24		25		25		24		27
	7.5% of non-administrative costs			36		38		38		37		41
	10% of non-administrative costs			48		51		50		49		54
	15% of non-administrative costs			71		76		75		73		81
	20% of non-administrative costs			95		101		100		97		108
	25% of non-administrative costs			119		127		125		122		136

TABLE 2.6: ESTIMATED CURRENT COSTS FOR 8m³ BIODIGESTER AND COST AND OVERHEAD ANALYSIS

	NBP as of 4/08			KCH as of 9/08		KPT as of 9/08		SVR as of 9/08		TAK as of 9/08	
	Rate (US\$)	Days	Total	Rate (US\$)	Total	Rate (US\$)	Total	Rate (US\$)	Total	Rate (US\$)	Total
I			387.75		387.75		387.75		387.75		387.75
	Construction materials	Total									
II			56.53		56.53		56.53		56.53		56.53
	Appliances	Total									
III			107.00		142.75		136.25		120.00		185.00
	Labor										
	Skilled labor	No.	4.5	6.25	81.25	5.75	74.75	5.00	65.00	10.00	130.00
	Unskilled labor	No.	2.0	3.00	39.00	3.00	39.00	2.50	32.50	2.50	32.50
	Excavation of soil	m ³	1.5	1.50	22.50	1.50	22.50	1.50	22.50	1.50	22.50
IV			10.00		10.00		10.00		10.00		10.00
	Guarantee	Given									
V			15.00		15.00		15.00		15.00		15.00
	Participation fee	Given									
			576.28		612.03		605.53		589.28		654.28
	Labor as % total cost		19	23	23	23	23	20	20	28	28
	Materials as % total cost		67	63	64	64	66	59	59	59	59
	5% of non-administrative costs		28	29	29	29	28	31	31	31	31
	7.5% of non-administrative costs		41	44	44	44	42	47	47	47	47
	10% of non-administrative costs		55	59	58	58	56	63	63	63	63
	15% of non-administrative costs		83	88	87	87	85	94	94	94	94
	20% of non-administrative costs		110	117	116	116	113	126	126	126	126
	25% of non-administrative costs		138	147	145	145	141	157	157	157	157

TABLE 2.7: ESTIMATED CURRENT COSTS FOR 12m³ BIODIGESTER AND COST AND OVERHEAD ANALYSIS

	NBP as of 4/08			KCH as of 9/08		KPT as of 9/08		SVR as of 9/08		TAK as of 9/08	
	Rate (US\$)	Days	Total	Rate (US\$)	Total	Rate (US\$)	Total	Rate (US\$)	Total	Rate (US\$)	Total
I			387.75		387.75		387.75		387.75		387.75
		Total	387.75		387.75		387.75		387.75		387.75
II			56.53		56.53		56.53		56.53		56.53
		Total	56.53		56.53		56.53		56.53		56.53
III			107.00		142.75		136.25		120.00		185.00
		Labor	107.00		142.75		136.25		120.00		185.00
	4.5	No.	58.50	6.25	81.25	5.75	74.75	5.00	65.00	10.00	130.00
	2.0	No.	26.00	3.00	39.00	3.00	39.00	2.50	32.50	2.50	32.50
	1.5	m ³	22.50	1.50	22.50	1.50	22.50	1.50	22.50	1.50	22.50
IV		Given	10.00		10.00		10.00		10.00		10.00
		Given	15.00		15.00		15.00		15.00		15.00
V			576.28		612.03		605.53		589.28		654.28
			576.28		612.03		605.53		589.28		654.28
		Labor as % total cost	19		23		23		20		28
		Materials as % total cost	67		63		64		66		59
		5% of non-administrative costs	28		29		29		28		31
		7.5% of non-administrative costs	41		44		44		42		47
		10% of non-administrative costs	55		59		58		56		63
		15% of non-administrative costs	83		88		87		85		94
		20% of non-administrative costs	110		117		116		113		126
		25% of non-administrative costs	138		147		145		141		157

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Based on these recommendations, an overhead and startup bonus structure was developed that provided US\$30 per plant overhead payments, a US\$5 promoter fee to be transferred by BCCs to referring promoters, and a US\$15 per plant startup bonus for the first 30 plants completed by BCCs (total of US\$450 subsidy per company).

Overhead Payment Through Offsetting Credits in the Appliance Account

The next task was to determine how to create a reliable system for BCCs to receive overhead payments and startup bonuses without depending on cash transactions

from the PBPO, which were determined to invite demands for commissions or other informal payments.

NBP leadership decided to use the appliance credit system to offset Farmer's Friend BCC liabilities for NBP-provided appliances with credits for plant completion in the amount of the overhead payment, promoter fee, and startup bonus. Each time a plant completion report was to be submitted, the BCC's account payable to the NBP would be reduced by the corresponding amount, and the NBP receivable account reduced by the same amount. In this way, the actual cash payment flow from BCC–PBPO

TABLE 2.8: ESTIMATED STARTUP COSTS FOR BIODIGESTER COMPANIES AND FIRST-YEAR BUSINESS EXPENSES (PRO FORMA)

	Month/US\$											
	1	2	3	4	5	6	7	8	9	10	11	12
Production Assumptions												
Number of teams managed	1	1	1	1	2	2	2	2	3	3	3	3
Plants completed	3	3	6	6	9	9	12	12	15	15	18	18
Mason income @ \$30/plant	90	90	180	180	270	270	360	360	450	450	540	540
Entrepreneur baseline income	90	90	90	90	90	90	90	90	90	90	90	90
Expenses												
Motorbike and trailer*		46	46	46	46	46	46	46	46	46	46	46
Tools and equipment**		56	56	56	56	56	56	56	56	56	56	56
Petrol	25	28	30	33	37	40	44	49	54	59	65	71
Communications	20	22	24	27	29	32	35	39	43	47	52	57
Service expense(s)	10	11	12	13	15	16	18	19	21	24	26	29
Business registration	25											
Tax (no date)												
Estimated total company expense	80	162	168	175	182	190	199	209	220	232	245	259
Profit margin	10	(72)	12	5	88	80	161	151	230	218	295	281
Required direct subsidy or loan to maintain	80	162	78	85	2	10	(71)	(61)	(140)	(128)	(205)	(191)
Clustered construction management scenario												
Labor saving from clustered construction	–	–	–	–	36	36	72	72	72	72	108	108
Profit margin with clustered construction	10	(72)	12	5	124	116	233	223	302	290	403	389
Required direct subsidy or loan to maintain	80	162	78	85	(34)	(26)	(143)	(133)	(212)	(200)	(313)	(299)

*Assumes equipment account finance @ 18% p.a. simple interest, repayment in 11 installments.

**Assumes tool and equipment finance @ 18% pa, simple interest, repayment in 11 installments.

TABLE 2.9: COST INCREASE WITH PLANT SIZE

Plant Size	Overhead @ 7.5% (US\$)
4m ³	30
6m ³	36
8m ³	41

TABLE 2.10: TIME TO PROFIT WHILE MAINTAINING BASELINE INCOME (US\$)

	Year 1	Year 2
Plants completed	126	216
Mason income @ \$30/plant	3,780	6,480
Estimated total company expenses	2,322	3,106
Net profit	1,458	3,374
Return on investment (ROI, simple)	63%	109%
First four-month subsidy required	419	–

TABLE 2.11: CLUSTERED CONSTRUCTION BENEFITS (US\$)

Clustered construction case	Year 1	Year 2
Labor saving from clustered construction	576	1,296
Net profit with clustered construction	2,034	4,670
Return on investment with clustered construction	88%	150%
First four-month subsidy required	406	–

for appliances would be greatly reduced, as would BCCs' reliance on direct payments from the PBPOs.

Figures 2.1 and 2.2 outline the flow of funds in the revised system. The first diagram outlines the proposed flow of “payment entitlements” related to BCCs; the second illustrates the devised mechanism of offsetting payments.

Development of a Replicable Microfranchise Business Model

Early in the PSD process, the PSD team recognized that local NBP masons faced multiple constraints to becoming BCC business owners, including lack of several necessary business skills, lack of familiarity with administrative compliance procedures, and low tolerance for the

risks traditionally associated with business startup. In initial meetings with masons, it was clear that they lacked many of the hoped-for skills and aptitudes required to support microenterprise-driven privatization. In addition, the anticipated responsibilities of new mason-entrepreneurs envisioned by NBP leadership continued to grow, highlighting a severe supply-demand mismatch and a need to adjust the PSD delivery model. Furthermore, the PBPO directors and coordinators expressed significant concern about masons' financial capacity and management skills, staff and operations management abilities, and foundational entrepreneurial skills.

The PSD team adjusted its PSD approach accordingly, settling upon the development of a microfranchise system, with specific operating arrangements and business procedures developed through a *BCC Operations Manual*, simplified project management tools, and a three-party Franchise Agreement.

A microfranchise system emulates successful commercial franchise systems in the sense that the franchisor, the NBP, centralizes the most skill-intensive activities of the business, including brand, product, system and business process development, and delegates franchisees with lesser skills and resources (in this case, BCCs) to contribute technical skill, direct sales networks, and direct personnel management. The risks and costs of business entry for Farmer's Friend franchisees are reduced because—lacking previous exposure to effective business processes and operating procedures—they receive turnkey procedures developed by more highly skilled personnel (the PSD team and NBP technical management).

Once implemented, the franchise system becomes an ongoing dialogue between franchisor and franchisee, with shared interest in expanding market penetration. In addition, because the franchisor can revoke a franchise in the case of noncompliance with operating procedures, the franchisor can exert significant control over procedures with a more credible sanction than would be the case dealing with fully independent businesses.

This model required the detailed codification (and in some cases, modification) of NBP operating procedures to ensure predictability and clarity for low-skilled entrepreneurs. This system made replication of the privatization effort in subsequent districts much easier, as the basis for business systems had been developed.

The key tools of the system are the *Operations Manual*, the Project Control Folder, and the Franchise Agreement,

FIGURE 2.1: FLOW OF PAYMENT ENTITLEMENTS IN PRIVATE BIODIGESTER CONSTRUCTION SYSTEM (US\$)

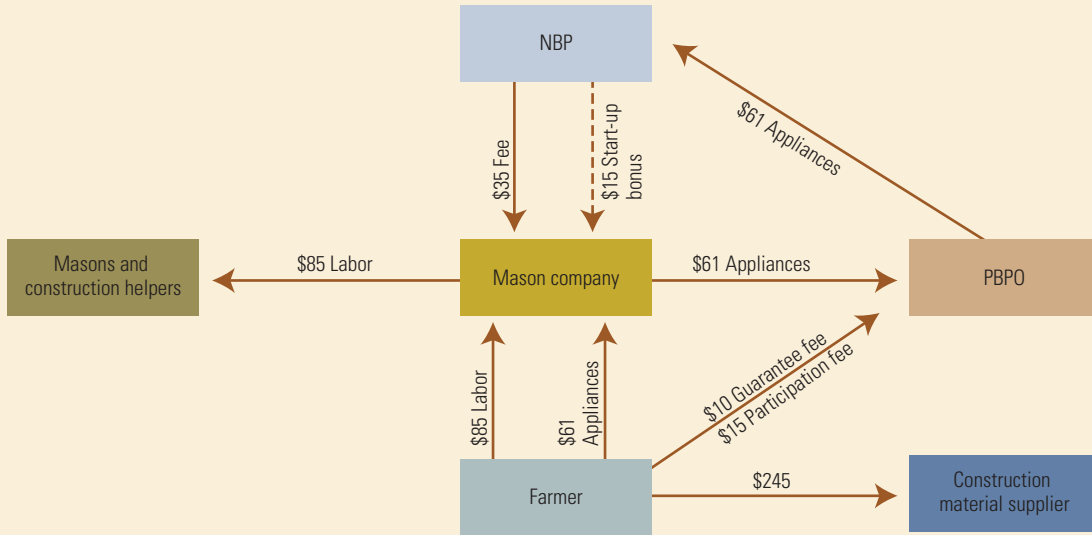
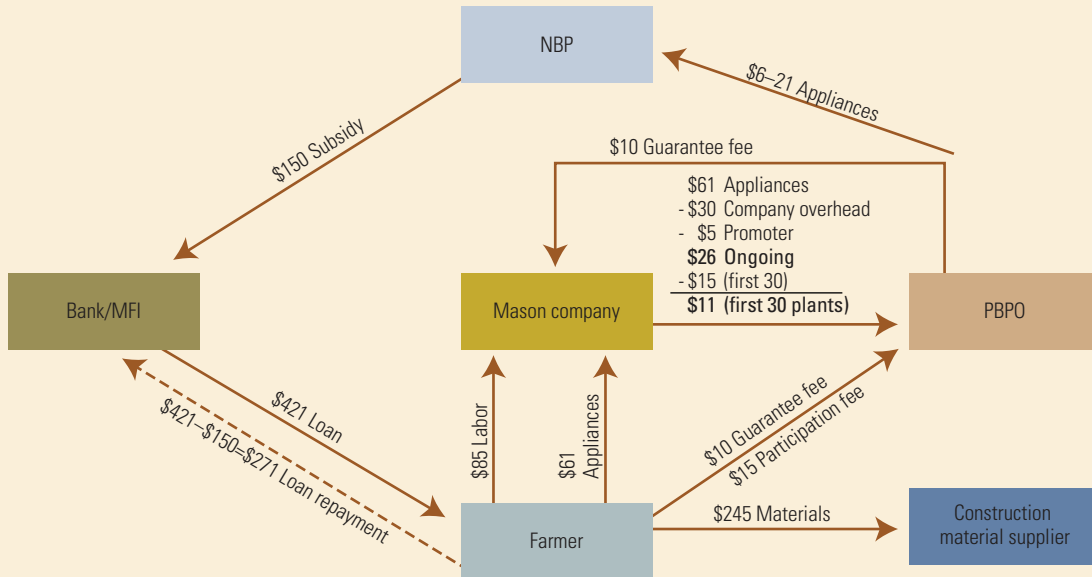


FIGURE 2.2: OFFSETTING PAYMENTS UTILIZING THE APPLIANCE CREDIT SYSTEM

Example: flow of funds for 4m³ plant (US\$415 total cost)



described briefly here and included in their entirety (English translation of Khmer original) in chapter 3.

Operations Manual

In response to concerns about the clarity, transparency, and ease of replication of NBP operating procedures, the PSD team produced the *Operations Manual for Private Biodigester Construction Companies*, which presents and formalizes all known required business procedures corresponding to the business process map for private biodigester construction companies. The *Operations Manual* assumed a central role in training development, as it ultimately contained an authoritative statement of expected company procedures. Developing the manual also revealed and clarified the feasibility of a microfranchise approach to BCC development.

Selecting and Managing a Local Capacity Builder

With the objectives of co-developing and implementing mason skills evaluation and a business skills training and mentoring (business coaching) program, the following steps were taken.

Selection of Training Partner (CIEDC)

The NBP engaged the entrepreneurship development training team of the Cambodia India Entrepreneurship Development Center (CIEDC) to co-develop and implement training. CIEDC's main objective is to provide entrepreneurship skills, mentoring, and coaching to rural businesses in Cambodia.

Before contracting CIEDC, the NBP PSD team shortlisted several experienced potential training centers and organizations to provide required assessment and training services. Development community leaders were consulted in the research process, including Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) and project staff of USAID efforts.

Referring organizations were also asked about viable private-sector training organizations, to ensure that for-profit partners were given adequate consideration. Their answers, confirmed by PSD team research, indicated that most such organizations are tightly focused on the urban Phnom Penh marketplace, and offer training programs focused on advanced business skills development that would not be appropriate for NBP masons.

Furthermore, their reliance on part-time trainers who are employed elsewhere was seen as a disadvantage. These findings confirmed the lack of an active sector of private providers of rural business development services in Cambodia.

Further inquiries in the donor and development community pointed to Cambodian-Indian Entrepreneurship Development Center (CIEDC) as the only full-service entrepreneurship training provider capable of providing diversified training and ongoing support services to Cambodian rural entrepreneurs, and the most appropriate for working with rural nonagricultural businesspersons with potentially low formal skill levels (that is, low literacy and numeracy).

Based on this research, CIEDC was selected as the key partner in the Farmer's Friend mason selection process and as a partner in delivering pre-training and training in entrepreneurial skill and business management directly to mason-contractors. This recommendation was based on the general reliance on CIEDC by other reputable organizations involved in training, and by the lack of another suitable alternative.

However, further assessment of CIEDC's capabilities and ability to provide ongoing mentoring outside of business and entrepreneurial skills was required. This stimulated SNV to hire a National Advisor for Rural Private Sector Development to improve CIEDC's capacity to deliver customized training and business coaching services.

Training Development Process

The PSD team held partnership meetings with CIEDC on October 6 and October 28, 2008. The PSD team also worked with CIEDC's international advisor to plan and program November 2008 CIEDC training team activities, including team briefing, field visits, and mason capacity and mason needs assessment and selection—precursors to mason-entrepreneur training activities.

In November, 2009, consultants worked with the training team from CIEDC to familiarize them with the NBP, to prepare for a field exposure visit and engagement with masons, and to conduct the mason capacity assessment and entrepreneur selection process—including customization of assessment tools based on projected company structure, in order to secure customized and appropriate training for future BCC owners. During the week of November 17, the team was briefed and conducted field visits to Svay Rieng and Kampot.

Functional and Process Mapping of BCCs to Guide Training Development

During the week of November 24, 2008, the training team presented their findings and consultants held three workshop sessions to clarify the BCCs' functional requirements (using the process map cited above) and to map required skills and competencies to each activity of projected Farmer's Friend BCCs. The main result of this process was a number of additions to the CIEDC mason capacity assessment tool used in mason selection and training design.

A functional map of BCC processes and their implications for mason assessment, training, and the *Operations Manual* appears in appendix 4 of this report.

Customization, Testing, and Review

The training development process required close collaboration between the PSD team and CIEDC and ultimately, a six-day training package (in Khmer) was satisfactorily submitted to the PSD team and reviewed by the PSD team leader and PSD coordinator and final refinements were implemented.

SNV's National Advisor for Rural Enterprise Development, who joined SNV shortly after the first training, continued to work with CIEDC and the NBP to improve CIEDC's capacity to continuously improve the training process and materials. These activities are ongoing at the time of this report.

Design and Implementation of a Process to Select High-Potential Entrepreneurs from among NBP Biodigester Masons

The NBP PSD collaborated with training partner CIEDC to develop a selection process for masons. Before beginning the process, the team analyzed district-level biodigester performance to identify the districts with the most promising masons—those who had built large numbers of plants. PBPOs were engaged to provide additional input on districts with established promotion networks and those with masons who already were taking responsibility for customer identification, promotion, and marketing.

The mason and district selection processes were indivisible, as the selection of a district for privatization depended on district performance, and masons' interest in being part of the first "class" of private BCC owners.

Some high-performing districts (particularly in Kampong Cham), where masons did not have adequate interest to permit privatization, were omitted from the first round of district selection.

Steps in Mason Selection Process

The formal selection process entailed eight steps:

1. Development of application forms by NBP PSD

Application forms were developed to elicit information about the real interest, asset position, personal stability, family status and obligations, personal and business network, and other factors potentially relevant to performance as biodigester company owners (see appendix 5: Application Form).

2. Announcement meeting

All of the province's masons were brought together to learn about the process and the opportunities it presented, and to receive application forms that were to be completed in the week following.

3. Independent completion of applications by interested masons

Masons were encouraged to solicit help from their families and communities in developing a well thought out application.

TABLE 2.12: EVALUATION POINTS IN SELF-ASSESSMENT ADMINISTERED BY CIEDC

Self-Assessment Dimension	Possible Score
Initiative	1–25
Sees and Acts on Opportunities	1–25
Persistence	1–25
Information Seeking	1–25
Concern for High Quality Work	1–25
Commitment to Work Contract	1–25
Efficiency Orientation	1–25
Systematic Planning	1–25
Problem Solving	1–25
Self-Confidence	1–25
Assertiveness	1–25
Persuasion	1–25
Use of Influence Strategies	1–25
Total Possible Score	325

4. Selection Meeting I (written self-assessment of entrepreneurial readiness)

This document was prepared by CIEDC to learn about the personal and professional qualities noted below. The scoring formula for the written self-assessment was normalized to account for possible distortions by docking points for unrealistically positive ratings in certain key question areas. “Trigger” questions were used to identify those respondents whose answers were likely to reflect unrealistically positive self-assessment.

5. Selection Meeting II (oral interview)

CIEDC team members conducted an oral review of the masons’ applications and administered an interview protocol designed to gauge entrepreneurs’ skill level, capacity, and readiness to assume specific responsibilities related to BCC entrepreneurship. The areas of capacity assessed are presented in table 2.13. In addition, CIEDC and NBP PSD coordinator provided comments on each interviewed mason’s interview performance, demeanor, and attitude, and reported questions and concerns the applicants raised during interviews.

6. Analysis of Mason Performance in the NBP Program and Related Measures

The NBP PSD team analyzed each applicant’s biodigester construction history, using NBP records and focusing on the factors below.

In consultation with NBP leadership and SNV advisors, it was decided that measures of construction quality (faults identified in quality control) would not be included in the evaluation process because of variations among PBPO supervisors in the frequency of fault reporting. BCCs were generally licensed to operate in a specific district that the NBP determined had sufficient business potential to sustainably ensure NBP masons’ participation (rather than returning to, for example, farming). If a district lacked sufficient business potential, a mason could be licensed in an additional district.

7. Consultation with NBP Technical Supervisors and PBPO Coordinators

The NBP PSD interviewed NBP technical supervisors in each of the three provinces in order to gain more qualitative information about finalist applicants, particularly where more than one mason in a district was considered. Specific areas of discussion included NBP technical supervisors’ experience with and assessment of the quality of the plants constructed by the mason, the mason’s personal maturity and capacity for business

TABLE 2.13: SKILLS ASSESSED IN ORAL INTERVIEW

Skill Area in Oral Interview	Rating Scale
Marketing and (product) Explanation	0–5
Calculation	0–5
Communication	0–5
Loans and Finance (MFI)	0–5
Time Management	0–5
Management and Supervision	0–5
Payment and Record-Keeping	0–5
Materials Management	0–5
Business Contracts	0–5
Administrative	0–5
Total Possible Score	50

mobilization (especially marketing and promotion), the mason’s supervision and management skills, and overall supervisor recommendation (rated 1–5).

In addition, the selection(s) were reviewed with PBPO coordinators prior to finalization to ensure that any concerns about mason selections were addressed. No major issues were raised in these consultations, except in Kampot, where the PBPO was concerned about excessive competition among masons who would operate in the same district(s).

8. Approval of PBPO Directors

The PSD submitted a final list of its recommendations for mason selection to the PBPO directors, solicited concerns and questions, and offered to discuss final

TABLE 2.14: NBP DATA ANALYZED IN MASON SELECTION PROCESS

NBP Data Points
Date of First Plant Completion Report
Months Since First Plant Completion Report
Total Number of Plants Constructed
Plants Constructed in 2008
Plants/Month
% Plants in Home District

selections. No concerns were raised in these meetings, though with CEDAC (Kampot), a productive discussion arose on competition among mason companies, service territory, and opportunities for CEDAC to participate in construction materials supply activities.

Masons Selected for Business and Entrepreneurship Training in Kampong Cham

Final mason selection for Kampong Cham included four outstanding masons in three districts (Prey Chor, Cheung Prey, and O Raing Ov). Because two outstanding masons applied for the O Raing Ov designation, both were selected for training. Upon successful completion of training and business registration, each was authorized to work in O Raing Ov and one of the adjacent districts (either Tboung Khmum or Ponhea Kraek).

In addition, one mason, Pav Paoheng of Bathay district, applied and scored very well in the process, but had not completed the required minimum number of plants to secure designation. The PSD team's recommendation was to allow Mr. Paoheng to participate in the first round of entrepreneurship training, and to agree that he be allowed to launch a company after having completed an NBP-designated minimum number of plants (20) at a satisfactory quality level. As of May 2009, Mr. Paoheng is a registered BCC operating in Bathay district.

Masons Selected in Kampot

In Kampot, six masons were selected to form five companies serving three districts. Each district will be served by two companies under this arrangement. Two masons who are brothers—Em Vin and Em Soteha—will form a company to serve two districts in which each has a significant profile. All masons were in agreement with this arrangement in a meeting with the NBP PSD and the Kampot CEDAC coordinator.

Masons Selected in Svay Rieng

Five masons representing four districts were selected for training in Svay Rieng.

In the district of Romeas Hek, two very similarly qualified masons applied for training. Though their strengths differed somewhat, no objective criteria were found to favor one over the other. In addition, the opinions of CIEDC interviewers and PBPO coordinators were split on which mason was more qualified. The masons were consulted, and it was decided that both will be invited to attend. They agreed to decide, after completing training, whether to form a company together, to compete against each other, or if one should work for the other.

One of the selected masons, Ngoun Sam Ann, was considered a relatively risky choice. His strengths included marketing ability (he finds 70 percent of his own clients) and a history of satisfied customers with well-functioning plants. He was also known to effectively manage his (one) helper. Risks, however, included plants that were of below average appearance (despite functioning well), and possible personal issues that could interfere with his work. While these are risk factors, personal issues are entirely subjective and impossible to verify. Therefore, the PSD team suggested that he be trained and given a chance to demonstrate his level of commitment.

Additional Province Mason Selection: Takeo

Mason selection for a fourth province, Takeo, added to the workplan as an extended activity, began following the completion of initial training and business launch of masons in the initial three provinces. This process was finalized in July, 2009. Mason selection was performed by NBP and SNV staff with minimal supervision and input by the PSD team leader.

TABLE 2.15: MASONS SELECTED IN KAMPONG CHAM

Mason Name	District	No. Plants Built	Self-Assessment Score	Skills Score	NBP Supervisor Rating
Soam Thy	Prey Chor	81	81%	68%	Excellent (5)
By Pheap	Cheung Prey	57	81%	70%	Excellent (5)
Korng Sokhon	O Raing Ov	52	69%	66%	Very Good (4.5)
Yim Sopourn	O Raing Ov	76	70%	60%	Very Good (4.5)
Pav Paoheng	Bathay	9	82%	68%	Unknown

TABLE 2.16: MASONS SELECTED IN KAMPOT

Mason Name	District	No. Plants Built	Self-Assessment Score	Skills Score	NBP Supervisor Rating
Toun Sambo	Kampong Trach	12	84%	78%	Very Good
Huot Sengly	Banthay Meas	45	84%	60%	Very Good
Hin Chankhemrith	Banthay Meas	25	85%	75%	Unknown
Nouch Sophon	Dang Tong	18	83%	73%	Unknown
Em Vin	Dang Tong, Kampong Trach	17	85%	74%	Very Good
Em Sothea	Dang Tong, Kampong Trach	17	87%	58%	Very Good

Commentary and Obstacles Encountered During Mason Selection Process

During the week of December 15, 2009, the National PSD coordinator accompanied the training partner team (CIEDC) to Svay Rieng, Kampong Cham, and Kampot provinces to accept applications, administer a written test on entrepreneurial readiness, and conduct oral interviews with applicant masons. In Kampot province, 10 candidates presented themselves for assessment. Attendance in the other two provinces, Svay Rieng and Kampong Cham, was inexplicably low, with only one mason presenting himself in Svay Rieng and only two in Kampong Cham, leading to an investigation by the PSD team.

In Svay Rieng, the team discovered that NBP provincial officials (supervisors) had actively and systematically discouraged several qualified masons from attending the previous week's announcement meeting, causing them to also miss the application process and the capacity assessment. This situation was immediately reported to the NBP and remedial measures taken in collaboration with the province's director. Followup in Svay Rieng took place in January, 2009. The process was re-implemented

after an educational outreach meeting with PBPO supervisors and the reassertion of support for the PSD process by the PBPO director.

In Kampong Cham, low attendance was attributable to a wider range of reasons. Masons lacked confidence, felt that outreach had been inadequate, and believed they lacked the financial resources to start businesses of their own. The PSD coordinator found no evidence of systematic or deliberate efforts to discourage masons from applying for the process. Followup outreach was performed in January, 2009 by the PSD coordinator, who personally visited the homes and worksites of outstanding Kampong Cham masons to encourage them to apply for BCC leader designation.

Delivery of Intensive Business Skills Training Program for Selected Masons

Kampot Province Mason Training, March 9–14, 2009, held in Kep Municipality

The NBP PSD and training partner CIEDC conducted a six-day training for the six Kampot masons selected as

TABLE 2.17: MASONS SELECTED IN SVAY RIENG

Mason Name	District	No. Plants Built	Self-Assessment Score	Skills Score	NBP Supervisor Rating
Ngoun Sam Ann	Svay Teab	72	74%	62%	Good 3
Prac Lei	Rumdoul	52	51%	62%	Good + 3.5
Am Deun	Romeas Hek	40	75%	65%	Very Good 4
Mov Bork	Romeas Hek	31	67%	71%	Very Good 4
Lor Sam Eun	Svay Chrum	43	75%	72%	Very Good 4

business owners. The training was held in Kep, Cambodia March 9–14. All but one participant (whose father passed away on day five) completed the training course to the trainers' satisfaction. The training team reported that the masons maintained a consistently high level of engagement with technical, financial, and administrative themes throughout the training process.

Training Agenda for Kampot Province BCC Owners (Masons)

1. Participant Registration
2. Welcome Speech
3. Case study: "Biography of Mr. Chin"
4. Success Factors in Establishment of the Biodigester Construction Company
5. "Entrepreneur as Leader"
6. Biodigester Construction Plant Sales Contract
7. Implementation of Sales and Promotion
8. Customer Visits (Customer Relations)
9. Gathering Marketing Information
10. Forms for Marketing Planning
11. Goods Customer Service
12. Cost of Goods Sold and Selling Price
13. Assistance from Microfinance Institution on Loan Application
14. Time Management
15. Staff Recruitment and Hiring
16. Motivation
17. Planning
18. Production Planning
19. Accounting System
20. Financial Management (PC Folder)
21. Inventory Control
22. Training Assessment
23. Closing

Training Strategy

In order to achieve the cited objectives, training techniques focused on the fundamentals of entrepreneurship, leadership, marketing and sales, hiring staff, time management, accounting, finance, and production topics. Each topic was also designed utilizing resources from the *Operations Manual*. Trainees were required to work in groups so that they could share knowledge and experiences, and demonstrate their skills and understanding by working on a small business case study. Trainees successfully achieved objectives, learning how to set up a business, develop their market, and manage their time and workforce to service a specific target customer group and market.

Trainees' Assessment of Kampot Mason Training

At the end of the training course, a training assessment was conducted by trainers in order to assess trainees' level of satisfaction and understanding. Trainees were generally pleased and satisfied with the training course; the trainers' tactics and efforts, and especially the training topics, exceeded trainees' expectations. However, when asked about timing and level of learning, trainees responded that the program was short, given the number of topics to cover. All trainees proposed that there be additional training.

Feedback by Trainers on Kampot Mason Training

Trainers believed that trainees still had limited communication experience and average levels of education. However, trainees showed very strong commitment and interest in learning the training topics. They shared experiences and ideas in coping with business problems. Some trainees had creative business ideas and others sought further illustration on topics such as business management, especially marketing and accounting.

TABLE 2.18: KAMPOT PROVINCE MASONS TRAINED

Mason Name	District	No. Plants Built	Self-Assessment Score	Skills Score	NBP Supervisor Rating
Toun Sambo	Kampong Trach	12	84%	78%	Very Good
Huot Sengly	Banthay Meas	45	84%	60%	Very Good
Hin Chankhemrith	Banthay Meas	25	85%	75%	Unknown
Nouch Sophon	Dang Tong	18	83%	73%	Unknown
Em Vin	Dang Tong, Kampong Trach	17	85%	74%	Very Good
Em Sothea	Dang Tong, Kampong Trach	17	87%	58%	Very Good

TABLE 2.19: KAMPONG CHAM PROVINCE MASONS TRAINED

Mason Name	District	No. Plants Built	Self-Assessment Score	Skills Score	NBP Supervisor Rating
Ngoun Sam Ann	Svay Teab	72	74%	62%	Good 3
Prac Lei	Rumdoul	52	51%	62%	Good + 3.5
Am Deun	Romeas Hek	40	75%	65%	Very Good 4
Mov Bork	Romeas Hek	31	67%	71%	Very Good 4
Lor Sam Eun	Svay Chrum	43	75%	72%	Very Good 4

Recommendations Based on Kampot Training

It was recommended that further trainings be customized and shortened to better meet BCCs' needs, taking into account training time limitations and the trainee's ability to study on their own for each topic. It was also recommended that there be more training in business planning, accounting systems, and inventory management and control.

Combined Kampong Cham–Svay Rieng Mason Training

The training course "Entrepreneurship for Biodigester Construction Companies" was conducted from March 30 to April 4, 2009 in Phnom Pros Hotel, Kampong Cham province, under the PSD component of the NBP. The 10 trainees were the BCC owners in Kampong Cham and Svay Rieng provinces.

The training was led by CIEDC, an NBP partner whose main objective is to provide entrepreneurship skills, mentoring and coaching to rural businesses.

Training Materials

The training material was improved by CIEDC with input from the NBP PSD team, following an evaluation of the Kampot BCC owners' training experience.

Training Strategy

In order to achieve the course objectives, training techniques focused on the fundamentals of entrepreneurship, leadership, marketing and sales, hiring staff, time management, accounting, finance, and production. Each section was designed to utilize the resources from the *Operations Manual*. Trainees were required to work in groups so that they could share knowledge and experiences and demonstrate their skills and understanding by working on a small business case study.

As a result, trainees successfully achieved training objectives, learning how to set up a business, develop their market, and manage their time and workforce to service a specific target customer group and market.

Trainee's Assessment of Combined Kampong Cham, Svay Rieng Training

At the end of the training course, trainers assessed trainees' level of satisfaction and understanding. Trainees were also generally pleased and satisfied with the training course and the trainers' tactics and efforts. However, the majority of the trainees replied "medium" (less than good) to a question assessing the amount of learning they gained ("What did you get from this training?")

TABLE 2.20: SVAY RIENG PROVINCE MASONS TRAINED

Mason Name	District	No. Plants Built	Self-Assessment Score	Skills Score	NBP Supervisor Rating
Soam Thy	Prey Chor	81	81%	68%	Excellent (5)
By Pheap	Cheung Prey	57	81%	70%	Excellent (5)
Korng Sokhon	O Raing Ov	52	69%	66%	Very Good (4.5)
Yim Sopourn	O Raing Ov	76	70%	60%	Very Good (4.5)
Pav Paoheng	Bathay	9	82%	68%	Unknown

The average amount of learning among the ten trainees was 72 percent; three of them learned only 60 percent from the course, that is, they missed 40 percent of the content. Nevertheless, trainees requested more of such training through the survey.

Feedback by Trainers

Trainers believed that trainees still had limited communication experience and an average level of education. Trainees showed very strong commitment to and interest in learning. They shared different experiences and ideas in coping with business problems. Some trainees had creative business ideas and others sought further instruction in topics such as accounting and inventory control.

Recommendations Based on Combined Training

The assessments and the trainers' feedback indicate that limited training time, with many topics to learn, probably most affected trainee's learning and catching up. The complexity of the accounting and inventory control processes in the *Operations Manual* was also an obstacle to trainees' comprehension of the topics. These conclusions were addressed in recommendations delivered in early May 2009 on preparing and delivering further training on accounting and inventory control. Further practical exercises and process guidance were presented along with other business operations and marketing topics.

Providing Assistance for Official Business Registration to Permit Companies to Enter Legal Contracts with Customers

Official registration is required to permit companies to enter into binding two-party contracts with customers (farmers purchasing biodigesters). It also permits them to establish BCC business premises according to local laws and regulation and to display commercial signs indicating that they provide NBP-authorized services, and to enter into legal employment agreements with employees and financial institutions.

In March and April, 2009, the NBP PSD team and training partner CIEDC successfully assisted in the official, district-level registration of a total of 15 private BCCs in the provinces of Kampong Cham, Kampot, and Svay Rieng. This surpassed the PSD team's main project indicator, which prescribed registration of 10–12 BCCs during the project.

The process received consistently strong support from the NBP, PBPO directors, and the provincial departments

of agriculture (in which two of the PBPOs were located). The registration process involved only minimal requirements for unexpected administrative payments, and only in one province (Kampot). While the process required some investigation into local rules for business registration, its relative simplicity suggested that the model for microenterprise and microfranchise development was viable, expandable, replicable, and efficient—provided PBPOs and Provincial Departments of Agriculture maintain an ownership stake in the process.

Registration Strategy

The NBP's business registration strategy was established by the previous PSD consultant in 2007. The consultant investigated similar construction-related programs for rural and small-town microenterprise development, most prominently the SEILA program (now NCDD). In this system, small construction companies are required to register at the district or provincial level only, not at the national level. They are required to register only after they have been awarded a live construction contract as the lowest bidder. Registration constitutes payment of the license tax (Patong) of approximately US\$25.

Additional Requirements

The PSD team's research found that additional requirements would be needed for BCC owners to register:

- **Authorization from the Provincial Department of Agriculture.** A letter indicating that the biodigester construction business is officially authorized to exist under the authority of the department. This appears to be a custom according to continental legal systems in which a specific company type must be defined through legislation or directive(s) by a government agency before it can be registered.
- **Registration with the District Governor.** For BCCs to establish an official business premise and display commercial signs, the permission or certification of the district governor must be acquired. The fee for this registration did not appear to be established by statute, but was effectively approximately US\$20 per incident of registration. Companies may operate outside of their home district (in which they are registered) but may not establish commercial premises nor display commercial signs. Only one BCC was in this category in the initial registration period.
- **Patong not required.** Because the license tax (Patong) is collected annually, based on estimated previous year's revenue, BCCs were not required to pay it prior to initiating operations.

Narrative of Registration Process

Complying with these requirements required additional engagement with the NBP and PBPOs. In Kampong Cham and Svay Rieng, PBPO directors assumed responsibility for official communications with the provincial department of agriculture, and for preparing a letter to each district governor on behalf of the BCCs, explaining the program and requesting assistance or permission or both to register.

In Kampot province, CEDAC, a large Cambodian NGO, serves as the NBP PBPO. In this case, the necessary relationships among NBP, the PBPO, and the provincial department of agriculture were not in place to facilitate the registration process, so the PSD team and training partner CIEDC were required to facilitate these relationships in order to register the five Kampot companies. This involved securing a letter from NBP and the MAFF-Office of Animal Health and Production introducing the NBP program and explaining the purpose of the BCC registration process. The process had the unintended benefit of providing the Kampot PDA with an introduction to the NBP and the BCCs, revealing the Kampot PDAs lack of knowledge of (or exposure to) the program and lack of enthusiasm for working with BCCs to promote dissemination of biogas in Kampot province.

It is expected that as a result, Kampot BCCs will benefit from a new set of marketing channels in the province, resulting from the required formalities of the process.

Analysis of Business Registration Process and Performance Time

On average, the time from application to approval by the district governor for business registration was 1.4 days in Kampot, 4 days in Kampong Cham, and 20.5 days in Svay Rieng.

Launch of 15 Companies in 3 Provinces

Signing of three-party Franchise Agreements by the NBP, BCC, and PBPOs marked the launch of 15 BCCs in 3 provinces. This took place in May 2009, with the PSD team organizing a formal business launch and signing ceremony to launch BCC operations in Kampong Cham and Svay Rieng provinces. Working with NBP leadership, the PSD team converted these events into public relations events to promote local awareness of the privatized system, and of the new BCCs and their roles in the future of the sector.

The PSD team also coordinated with the PBPO in inviting key participants and development partners, such as promoters from each province and staff from PRASAC MFI (the key local finance partner), and worked to ensure they attended. The participation of these numerous development partners enhanced the BCCs' credibility, increased awareness among all participants of their status in the privatized system, and earned recognition by key sector development partners.

The BCC agreement signing ceremony for Kampong Cham was held on May 5, 2009 at the Kampong Cham provincial department of agriculture. The BCC agreement signing ceremony in Svay Rieng was conducted on May 6, 2009 at the provincial department of agriculture's meeting hall. The PSD coordinator also assisted and advised BCC representatives in drafting appropriate speeches to present in these events.

Significant media coverage was arranged for these two ceremonies. The PSD team arranged the event schedule to accommodate local mass media (newspaper and local television). In Kampong Cham, newspaper *Rasmey Kampuchea* was invited to join and was given a press release prepared by the NBP and the PSD team. *Koh Santepheap*, another newspaper, was invited to the signing ceremony at Svay Rieng and provided with similar materials. Additionally, Bayon Television and Radio covered the event, capturing the signing ceremony event for broadcast.

In Kampot, the PSD team also provided materials and Franchise Agreements to BCC owners at CEDAC, and organized a signing with BCCs and the Kampot PBPO on May 17, 2009 at the CEDAC office at Chhouk district. A similar public ceremony was conducted on June 5 in Kampot, though companies were officially launched in May. This event also received local newspaper coverage.

Post-Training Needs Assessment and Initiation of Business Coaching Program

In the four weeks after completion of training, and during the process of business registration, the NBP PSD Coordinator conducted a post-training needs assessment to evaluate new BCC owners' most urgent followup training needs. This had been planned as part of the training program, but time constraints and the very full training schedule made combining the training and needs assessment impractical. In the end, however, the PSD team believed that they better understood the BCC owners' needs because of the delayed assessment.

TABLE 2.21: POST-TRAINING NEEDS OF KAMPOT BCC OWNERS

Mason Name	District	Business Training Issues	Technical Training Needs
Toun Sambo	Kampong Trach	Appliance credit payment and accounting system, especially money paid to PBPO	Overall quality aspect is clear, but process of PSD Quality Control Checklist not clear
Huot Sengly	Banthay Meas	Develop more methodology and marketing skills to identify more potential clients	Overall quality aspect is clear, but process of PSD Quality Control Checklist not clear
Hin Chankhemrith	Banthay Meas	Not clear on accounting and finance system	Overall quality aspect is clear, but process of PSD Quality Control Checklist not clear
Nouch Sophon	Dang Tong	Not clear on accounting and finance system	Overall quality aspect is clear, but process of PSD Quality Control Checklist not clear
Em Vin	Dang Tong, Kampong Trach	Not clear on sale contract and finance and accounting system	Quality control process: doesn't know how to start, end, and check
Em Sothea	Dang Tong, Kampong Trach	Not clear on sale contract and finance and accounting system	Quality control process: doesn't know how to start, end, and check

Summary of Post-Training Needs Identified

- The “Appliance Credit and Simple Accounting System” session was considered the most difficult by all BCC owners, and was the major concern among the new entrepreneurs. All BCC owners expressed enthusiasm about changing it to a new systematic credit management system. All BCC owners requested more training in this session to enhance their knowledge of accounting and inventory or stock control.
- BCC owners requested additional training in writing and finalizing the sale contract in order to increase the number of plants and to meet their sales projection. The sale contract requires structured calculations and is the first contractual agreement that many BCC owners have ever entered into. As a result, ongoing mentoring to increase their comfort level with these contracts is indicated.
- BCC owners indicated that the training provided on market surveys and marketing strategy by CIEDC trainers was excellent, but nearly all indicated that they required more assistance before they could design and implement their own marketing programs.
- BCC owners also raised concerns related to technical aspects of construction overall and some technical and quality control aspects designed by the NBP PSD team to ensure strong internal quality control. All owners indicated that they had limited capacity and understanding of the QC process generally, and in the Project Control Folder’s QC section specifically. They also indicated that they had not had opportunities to practice this process since the training, as the

transition to a privately operated system had been delayed until the beginning of May 2009 to allow a smooth transition in PSD districts.

- In all provinces, BCC owners have some concerns about promoter networks and other certified masons who might not be willing to work for the BCCs in the immediate term. These issues will need to be addressed by the NBP through coordination with PBPO leadership and supervisors.

Kampot BCC Owner Post-Training Needs

Business Training Issues

Kampot masons required the most followup on business issues related to accounting and finance, inventory control, and appliance credit. Only one BCC owner identified foundational marketing skills as a concern, though all requested assistance with effective market planning.

Technical Training Needs

Only the QC process and the use of the program-designed Quality Control Checklist were identified by Kampot BCC owners as technical challenges. In fact, this is a challenge arising from the transfer of responsibility for initial quality control from PBPO supervisors to BCC owners and their mason teams. It requires practice and support from the NBP PSD and technical management.

Kampong Cham BCC Owner Post-Training Needs

Business Training Issues

Kampong Cham BCC owners also required the most followup on business issues related to accounting and finance, inventory control, and appliance credit, as well

TABLE 2.22: POST-TRAINING NEEDS OF KAMPONG CHAM BCC OWNERS

Mason Name	District	Business Training Issues	Technical Training Needs
Soam Thy	Prey Chor	<ul style="list-style-type: none"> Needs training on NBP appliance credit and finance and accounting system Difficulty working with Form 02-P 	Clear on PSD Quality Control Checklist
By Pheap	Cheung Prey	Does not understand accounts receivable and payable with NBP and overall finance system	No problem on general quality control, but still unclear on PCF
Korng Sokhon	O Raing Ov	<ul style="list-style-type: none"> Still worries but understands principles of finance and accounting Needs training on sale contract and Form 02-P 	No problem on general quality control, but still unclear on PCF
Yim Sopourn	O Raing Ov	<ul style="list-style-type: none"> Needs to continue training on cash book, accounts receivable and payable Doesn't know how to check and fill 	Still some problem with quality control PC and keeping information in the back part of PCF
Pav Paoheng	Bathay	<ul style="list-style-type: none"> Does not understand simple account, finance and stock management Develop new training methods; training not retained after training Does not understand sale contract 	Technical part is fine, but requests to continue training on PCF and overall technical aspect
Em Sothea	Dang Tong, Kampong Trach	Not clear on sale contract and finance and accounting system	Quality control process: doesn't know how to start, end, and check

as the sales contract and Form 02-P (customer information). BCC owners also required assistance with the Project Control Folder. Marketing and sales skills were not raised as an important concern.

Technical Training Needs

Only the quality control process and the use of a program-designed Quality Control Checklist and Project Control Folder were identified by Kampong Cham BCC owners as technical challenges that required further training.

Svay Rieng BCC Owners' Post-Training Needs

Business Training Issues

Svay Rieng BCC owners uniformly requested assistance on business issues related to accounting and finance, inventory control, and appliance credit. This group had the lowest overall education levels, and may have ongoing difficulties with basic accounting and finance, requiring significant followup.

Technical Training Needs

Svay Rieng BCC owners identified fewer technical challenges. The QC process, and the use of the program-designed Quality Control Checklist and Project Control Folder were identified by some owners as technical challenges requiring further training and support, but most attributed this to a lack of practice. Because Svay Rieng

and Kampong Cham masons were trained together, it is unclear why Svay Rieng masons were, on the whole, more confident with this process.

Implementation of Mentoring and Training Activities

Mentoring and business coaching activities were conducted by CIEDC in late May and late June of 2009, coordinated by the PSD coordinator and assisted by the SNV National Advisor for Rural Private Enterprise Development.

In April and May, to prepare for the May 2009 BCC mentoring sessions, the PSD team managed the training partner's activities around a set of themes that emerged from the post-training needs assessment.

May mentoring sessions were held as group sessions because of the similar identified needs of new BCC owners, and focused on extended training in the use of business, accounting, and inventory forms, and helping BCCs prepare 2009 sales projections. Significant revisions and simplifications of the business forms were undertaken in April and May to ensure that the final distribution of these forms in the May mentoring sessions would

TABLE 2.23: POST-TRAINING NEEDS OF SVAY RIENG BCC OWNERS

Mason Name	District	Business Training Issues	Technical Training Needs
Ngoun Sam Ann	Svay Teab	Does not understand simple account and inventory management—requests help and practice with Form 02-P and sale contract	Needs to practice with PCF quality control folder
Prac Lei	Rumdoul	Difficulty with simple account and inventory management	PCF quality control folder is clear but feels complicated
Am Deun	Romeas Hek	Understands some but not all—can work with but worries about the ledger, finance and inventory stock	No problem with technical part
Mov Bork	Romeas Hek	Needs some help with simple account and inventory management and sale contract	No problem with technical part
Lor Sam Eun	Svay Chrum	Doesn't understand simple account and inventory management	Still has problems with PCF quality control folder because never practices
Em Sothea	Dang Tong, Kampong Trach	Not clear on sale contract and finance and accounting system	Quality control process: doesn't know how to start, end, and check

provide BCCs with the capability to effectively manage their basic financial and commercial operations.

The June 2009 mentoring/coaching sessions were held on an individual basis with each BCC owner in each privatized district. These sessions focused on review of the BCCs' status, to ensure that they had all necessary resources and preparation required for business operation; on further coaching in finance and inventory control, calculation of accounts receivable and payable, and general use of business forms; on establishment of individual company action plans to facilitate meeting sales projections submitted in May 2009; and on direct coaching, with trainers answering BCC owners' operational and business questions. These individual sessions also permitted a confidential review by CIEDC trainers of progress to date in basic business functions.

Going forward, to achieve efficiencies in costs and coaching delivery, mentoring sessions will alternate between group and individual sessions. In one month, all BCC

owners will receive one-to-one mentoring by a CIEDC training team member, after which the CIEDC training team will meet with the SNV PSD advisor and NBP personnel to discuss common and shared needs among BCC owners. The subsequent month's mentoring session will be conducted centrally (in the provincial capital) and will focus on a small number of training topics (one or two issues) that are common needs of BCC owners. This should also create a fertile environment for peer-to-peer learning among BCC owners, which the PSD team believes will be an essential basis for cooperation among BCCs in future business associations or federations.

This structure will also facilitate better coordination among technical training enrichment activities conducted by NBP technical supervisors, for example, in appliance estimating, product improvement, and providing a centralized distribution opportunity for *Operations Manual* updates and information about province-level changes in PBPO operations.

Appendix 1: Detailed Project Workplan, Completion Dates

No.	Activity	Date Completed
1	Project Planning and Review	
1.1	Review project goals and parameters	
1.2	Review existing reports and studies of NBP	
1.3	Review projected demand for biogas digesters and future sales by province and analyze geographic structure of biogas markets and construction service provision	
1.4	Review existing business delivery model—institutional arrangements with current NBP partners and resource/commitment assessment, technical and safety regulations, pricing mechanism	
1.5	Review NBP assumptions of characteristics of successful contractor businesses	
1.6	Gender issues review and planning in collaboration with World Bank Gender Mainstreaming Project	
	MILESTONE 1: Recommendation on adjustment of business delivery model for biogas digesters in Cambodia	Report to SNV, October 8, 2008
2	PBPO Coordination	
2.1	Develop presentation for PBPO directors on privatization plans <ul style="list-style-type: none"> • Outline PSD process • Outline mason-contractor selection • Outline information needs 	
2.2	Present to PBPO directors' meeting <ul style="list-style-type: none"> • Present PSD workplan • Gather input on key mason performance and readiness issues • Gather input on development of competitive process for mason selection • Identify potential non-mason contractor options for each province • Interview PBPO directors and select three provinces for privatization • Schedule coordination meeting with PBPO Technical Staff 	
	MILESTONE 2: Select 3 provinces for privatization based on PBPO revealed interest in meeting	Report to SNV, October 8, 2009
2.3	Coordination Meeting with PBPO technical staff/coordinators in selected provinces <ul style="list-style-type: none"> • Present PSD workplan • Gather input on key mason performance and readiness issues • Seek input on development of a competitive process of contractor selection • Identify potential non-mason contractor options for each province • Plan and schedule mason meetings 	Not required
3	Partner Identification and Coordination (funded by SNV)	
3.1	<ul style="list-style-type: none"> • Identify potential training partners • ESOs (entrepreneur support organizations) • Credit and finance partners • Other national and regional training organizations 	
3.2	Assess capacity and resources of potential training partners	
3.3	Develop partnership parameters and work plans	
3.4	MILESTONE 3: Issue initial (SNV) contract(s) to identified partners to provide needs assessment, including expenses and staff time	Contract issued October 30, 2008

(continued)

Appendix 1: Detailed Project Workplan, Completion Dates (Continued)

No.	Activity	Date Completed
4	Mason Selection	
4.1	Develop screening criteria and needs assessment in collaboration with training partners <ul style="list-style-type: none"> Identify criteria and/or characteristics of ideal enterprises Finalize competitive selection process (tasks) Develop objective success criteria in consultation with national technical manager of NBP program 	
4.2	Meeting Preparation <ul style="list-style-type: none"> Develop meeting agenda, locations and so on for mason meetings Coordination with partners and PBPOs 	
4.3	Mason Meetings (2 per province) <ul style="list-style-type: none"> Announce and explain PSD plans to NBP masons Partner presentations on what it takes to run a company Solicit indications of interest for becoming contractors (on-site) Interviews, pre-qualification, and needs assessment of interested masons Issue competitive assignment(s) to masons expressing interest in becoming contractors 	
4.4	Evaluation of interested masons' service records with PBPOs	
4.5	Review of competitive assignments for interested masons	
4.6	Review of selected masons based on objective potential success criteria	
4.7	Verification and follow-up interviews, possibly in collaboration with PBPOs	
4.8	Mason selection or re-direction of process based on needs assessment and verification	
4.9	Inform selected masons and PBPOs of selection	
4.10	MILESTONE 4: Submit report to NBP on selection of 3–6 masons per province for development as contractor-entrepreneurs	Selection report submitted March 2, 2009
5	Pilot Mason Training	
5.1	Identify and select Cambodian business mentor for post-training support of masons (either individual or local NGO)	
New	Develop Mason Business Operations Manual including business-related and technical materials to support company operation(s) for use in training activities	Completed February, 2009 Revisions ongoing
New	Develop and compile necessary mason business forms for training and distribution to eligible masons	Completed February, 2009 Revisions ongoing
5.2	Development and review of training plans in collaboration with training partners <ul style="list-style-type: none"> Review proposals/TOR from training partners Issue contracts for development of training for Masons 	
New	<ul style="list-style-type: none"> Supervise Partner development of appropriate training materials Review completed training programs 	
5.3	Schedule and coordinate pilot training(s)	
5.4	Conduct pilot training(s): Organize and supervise the delivery of approximately six days of training for selected masons to be delivered as a group, in approximately three skill areas identified as most critical needs	

(continued)

Appendix 1: Detailed Project Workplan, Completion Dates (Continued)

No.	Activity	Date Completed
5.5	Conduct post-training training and support needs assessment in collaboration with training partners. Assessment will include: <ul style="list-style-type: none"> • Financial capabilities of selected masons • Management capabilities of selected masons • Entrepreneurial and personal development of selected masons 	
5.6	Establish mentoring and support plan for subsequent phases	
5.7	MILESTONE 5: Consultant will submit a report detailing training provided and the results of a post-training needs assessment (PTNA)	Training completed April, 2009. PTNA May 2009. Milestone report submitted June 3
6	Company formation and registration, ongoing mentoring support	
6.1	Address identified needs of potential masons and partners <ul style="list-style-type: none"> • Assist masons with district-level company registration • Assist mason-entrepreneurs with acquisition of appropriate financial products from MFIs or other (appropriate) partners • Assist mason-entrepreneurs with establishing basic protocols for business operation • Assist mason-entrepreneurs with sales partnership development 	
6.2	Monthly meetings with mentor in provinces	
6.3	Provide ongoing business mentoring support	
6.4	MILESTONE 6: Consultant will submit a report on company formation and registration and supporting documentation of business registration	Business Registration concluded April 2009. Milestone Report Submitted June 5, 2009
7	Ongoing PBPO coordination and optimization of contractor support system	
7.1	Assess potential contribution to NBP and viability of regional contractor networks or federations	
7.2	Assess potential contribution to NBP and viability of ongoing entrepreneurial mentoring options	
7.3	Assess potential contribution to NBP and viability of commercial sales force management tools and sales force support	
7.4	Assess potential contribution to NBP and viability of additional required credit and finance tools	
7.5	Assess potential contribution to NBP and viability of partnerships with existing successful small contractors in target provinces	
8	Finalization and integration into NBP Operating Plan	
8.1	Draft contractor support program	
8.2	Review of contractor support program guidelines with NBP	
8.3	MILESTONE 7: Submission of final report outlining recommendations on adjustment of business delivery model and contractor support program for incorporation into NBP operating plan	Attached Final Report satisfies Milestone 7

Appendix 2: Project M&E Framework

Outcomes	Performance Indicators	Monitoring and Evaluation	Assumptions and Risks
In 3 provinces, 10–12 economically viable, well-managed biodigester companies are established	<ul style="list-style-type: none"> • Number of operational businesses • Number of registered businesses • Sales targets met by private businesses • Maintenance of business registration and records in line with NBP requirements 	NBP monitoring	
Competitive markets for biodigester provision in districts/provinces in which contractor services are privatized	<ul style="list-style-type: none"> • Sales growth in line with NBP projections in privatized areas. • Number of biodigester firms that are going concerns in each privatized district/province 	NBP monitoring	<p>Anti-competitive behavior (price fixing, collusion) among contractors</p> <p>Contractor bias toward larger installations could leave less profitable segments of biodigester market underserved</p>
Expanded partner sales network	<ul style="list-style-type: none"> • Increased sales credit awards to non-PBPO actors. • Increased sales credit awards to private firms 	NBP monitoring	PBPOs may resist sharing sales commissions with other partners, impeding partner sales network development
Mason-contractor businesses enter into contractor or employee relationships with masons who are not selected as contractors for selected districts	<ul style="list-style-type: none"> • Number of mason subcontracts per month/year • Number of mason firms with employees • Number of mason-employees per month/year (FTEs) 	NBP monitoring	<p>Masons' disposition toward employee status is unknown</p> <p>Seasonality of biodigester sales may limit the stability of employee relationships</p>
Mason-contractor businesses gain access to the financial, managerial, and technical resources to establish viable businesses	<ul style="list-style-type: none"> • Contractor utilization of private sector and NGO services 	NBP monitoring	Business services may not be available locally, requiring ongoing PBPO/NBP role in facilitating access to services
Mason-contractor businesses maintain or improve quality of biodigester installations	<ul style="list-style-type: none"> • Customer complaints level maintained or reduced in privatized provinces 	NBP monitoring	Inconsistent quality management by PBPO staff

(continued)

Appendix 2: Project M&E Framework (Continued)

Outputs	Performance Indicators	Monitoring and Evaluation	Assumptions and Risks
Selection of provinces and terms of cooperation with PBPOs established	PBPO participation in meetings Selected provinces	Memorandum of terms for ongoing collaboration between NBP and PBPO in each pilot province	
Identification and contracting of training partners for needs assessment and mason selection	Partners selection based on objective criteria Cost of engagement within budget	Consultant will submit a report on contractual arrangements with selected partner(s)	Ability of partners to customize training to mason needs must be assessed
Selection of 3–6 masons per pilot province for further development	<ul style="list-style-type: none"> Market coverage of selected masons Selected masons scored based on objective criteria Transparency of competition for contractor status 	Report identifying the 3–4 masons selected for development into biogas contractor firms in selected provinces, and their immediate training needs, or an alternative course of action for development of private biogas contractor firms in selected provinces	<p>Moderate to high risk that masons are unsuitable contractors (technical skill, financial resources, management skills) or unwilling to engage NBP</p> <p>Low to moderate risk that non-selected masons become discouraged by process and withdraw from NBP program</p>
Masons complete appropriate managerial, entrepreneurial, and other training	<ul style="list-style-type: none"> Number of masons completing training % of masons selected who complete training 	Report detailing training provided and the results of a post-training needs assessment conducted in collaboration with national training providers/partners	Moderate risk that 10% or more of selected masons will withdraw from training prior to completion
10–12 (total) biogas contractors established as businesses in target provinces and their registration as contractors with district authorities	Company establishment data and records	Report on company formation and registration and supporting documentation	High risk that business registration process will be impeded by administrative obstacles (outlined below)
Monthly mentoring meetings and ongoing telephone support	<p>Frequency of mentor contact with mason-contractors</p> <p>% of issues successfully resolved</p>	<p>Verified log contact record of mason-mentor meetings</p> <p>Submission of contact log and problem reports by national business mentor</p>	
Finalize NBP protocols for ongoing support of sector privatization	Adoption of consultant-developed protocols	Submission of draft and final support protocols to NBP and NBP approval	

(continued)

Appendix 2: Project M&E Framework (Continued)

Activities	Inputs	Monitoring and Evaluation	Assumptions and Risks
Selection of 3 NBP provinces for pilot privatization of biodigester services and establishment of PBPO role in supporting the process	World Bank funding of \$65,000	Activities will be verified through regular project monitoring by NBP	
Identification and contracting of training partners for needs assessment and mason selection	SNV Funding of \$18,000 to Cambodian partners for 2008 training activities		
Mason selection process resulting in Identification of 9–18 masons for development as contractors	International consultant input–55 days		Assumes the level of literacy, financial, technical and managerial capacity of current NBP masons is sufficient to permit successful training
Organization and completion of appropriate managerial, entrepreneurial, and other training deemed necessary by NBP for selected masons, delivered by qualified national training providers/partners	National coordinator input: 150 days		
Support and oversee establishment and district-level registration with district authorities of 10–12 biodigester contractor businesses in selected provinces	National business mentor input: 55 days		<ul style="list-style-type: none"> • Formal recognition of construction contractors is controlled by the Ministry of Land Management Urban Planning and Construction (MLMUPC) and its provincial departments • The requirement for formal registration/certification of enterprises may contribute toward solicitation of substantial informal facilitation' fees leading to reluctance to register • Similar issues exist with establishing commercial enterprise and obtaining the relevant certificates from different departments • PBPO participation and involvement necessary to ensure successful process
Mentoring and ongoing support of contractor-entrepreneurs in early stage of business operation			<ul style="list-style-type: none"> • Assumes identification of suitable national business mentor candidate with requisite skills and experience • A number of business/service networks have previously been established in country—their effectiveness is unclear
Develop SNV plan for contractor business support and development in additional provinces			<ul style="list-style-type: none"> • Microfranchise system serves as contractor business support system

Appendix 3: Three-Party Company Franchise Agreement

Private Biodigester Construction Company Agreement

BCC, NBP, PBPO

Agreement for Authorization of Biodigester Construction Company for Biodigester Construction Services:

Name of Company Owner: _____

National ID Number of Company Owner: _____

Telephone Number: _____

Business Premises (Office) Address: _____

District: _____

Province: _____

Company is Authorized to Provide Biodigester Construction Services only in the following District(s): _____

1. Biodigester Construction Company Leader Agrees to:

Company registration, administration, and operation:

1. Register his/her company with appropriate provincial/district authority in order to become eligible to enter into contracts with customers, and maintain business registration and payment of legally required taxes while operating as a Private Biodigester Construction Company recognized by NBP.
2. Open and maintain an account at a bank or registered microfinance institution (MFI) to facilitate professional business operations and reduce the risk of financial mismanagement.
3. Provide biodigester construction services to customers in _____ District(s) of _____ Province on a year-round basis in accordance with the procedures outlined in the NBP *Private Biodigester Construction Company Operations Manual*.
4. Establish and maintain a business premises that is clearly identifiable to customers and potential customers with appropriate NBP signage, either at the home of the owner or at a location in the district of his residence. The business premises will be open for the public during office hours. Changes in office address and unscheduled closing of offices shall be reported to the PBPO without delay.
5. Maintain NBP promotional information, appliance and spare parts inventory, at this business premise according to NBP procedures.
6. Properly maintain business records in a file at the business premise, including project control folder, sales contracts, bills related to the transaction with the buyer of a biodigester plant, plant completion report, guarantee card, and written complaints. Filing will be according to the unique plant code number as assigned by NBP. All files will be kept for a period of at least three years after date of construction. Employees of NBP and PBPO have the right to inspect the content of the files at any time during office hours.
7. Comply with all NBP administrative procedures as outlined in the NBP *Private Biodigester Construction Company Operations Manual*, including timely registration of contracts and submission of construction schedules to PBPO; appliance inventory management and payment; quality control procedures; after sales service and scheduled maintenance; and maintenance of records on customers and work performed.
8. Make timely payment to PBPO for biodigester appliances provided by the PBPO each time that the BCC has used/installed ten (10) appliance sets, or whenever spare parts inventory falls below the level defined by NBP.
9. Issue unique sales contracts to customers for the construction of a biodigester plant. The sales contract shall be filled out in duplicate before beginning the construction. One copy will remain with the company and another will remain with the client. The company will register each contract with the PBPO in a timely manner.
10. Submit to annual re-authorization based on NBP performance and management audits, and to improve areas of business operations that do not meet NBP requirements.
11. Submit to the binding decision of the NBP Coordinator or other NBP official designated by the Coordinator with respect to disputes or disagreements between the company and other NBP-related entities, including PBPOs, licensed biodigester masons, and NBP.

Construction and Sales Procedures

12. Adhere to the current official NBP pricing structure as provided by NBP in periodic updates. The general quotation on the cost of biogas plants will be according to the Bill of Quantities as provided in NBP *Private Biodigester Construction Company Operations Manual*.
13. Construct biodigester plants according strictly to the design, construction materials, and construction method stipulated in the NBP Biodigester Construction Manual and NBP *Private Biodigester Construction Company Operations Manual*.
14. Assist customers who wish to obtain credit for biodigester construction in obtaining such loans from NBP micro-finance partners in accordance with NBP procedures.
15. Participate in additional training on business and technical subjects related to the operation of a Private Biodigester Construction Company recognized by NBP.
16. Make all reasonable efforts to achieve annual biodigester sales targets in the districts in which the company is authorized to operate.

2. NBP Agrees to:

PBCC Compensation and Appliance Finance

1. Compensate private biodigester construction companies the sum of \$30 for each biodigester plant constructed during the period of this agreement, until such time in the future that company overhead charges are incorporated into the official NBP Bill of Quantities and paid by the customer.
2. Provide BCCs with \$5 promotion fee for each plant constructed, which BCCs are obligated to pay to the promoter who referred the purchaser (customer).
3. Compensate BCCs with an additional start-up bonus of \$15 per plant for the first 30 plants constructed in accordance with NBP procedures.
4. Provide subsidy payments to qualified customers who purchase biodigesters from BCCs recognized by NBP (and in good standing).
5. Provide BCCs with officially approved appliances on credit with zero interest as outlined in the NBP *Private Biodigester Construction Company Operations Manual*.

PBCC Training and Mentoring/Coaching

6. Provide BCC leaders with ongoing mentoring/coaching on business skills for a period of one year from the date of this agreement.
7. Conduct periodic training to improve the business and technical skills of BCC leaders and their staff.
8. Continue mason training activities so as to ensure an adequate supply of NBP-certified masons to permit the growth of BCCs and of the sector as a whole.
9. Regularly provide biodigester promoter training for new promoters identified by BCCs.

Promotion, Regulation, and Administration of the Sector

10. Regulate the sector and participation of new and existing BCCs to ensure that the territory in which BCCs are authorized to operate allows companies to grow in accordance with NBP goals.
11. Provide marketing and promotional materials and business cards to private biodigester construction companies.
12. Provide regular updates to the NBP *Private Biodigester Construction Company Operations Manual* apprising BCCs of changes to required operating and business procedures.
13. Provide updated price information to BCCs in a timely manner, once updates to the pricing structure have been established by the NBP Steering Committee.
14. Arbitrate (settle) any and all disputes or disagreements between the company and other NBP-related entities, including PBPOs, licensed biodigester masons, and NBP, where such disputes are not satisfactorily resolved by the PBPO.

3. The Provincial Biogas Promotion Office (PBPO) of _____ Province Agrees to:

Maintain an orderly provincial biogas construction market

1. Recognize private biogas construction companies as the exclusive providers of biogas construction services in the districts authorized by NBP.
2. Maintain and grow the official network of promoters in PSD districts through regular promoter training and development.
3. Regularly report to NBP on BCC performance and capacity.
4. Monitor production and sales performance of BCCs relative to NBP and PBPO goals and expansion plans.

Provide transparent and consistent administration of NBP processes and regulations

5. Maintain sufficient inventory of official NBP-approved biogas appliances to meet the requirements of BCCs, and provide these appliances to BCCs under the terms outlined in the NBP *Private Biogas Construction Company Operations Manual*.
6. Maintain records of BCC appliance accounts in accordance with NBP procedures.
7. Provide necessary business forms to BCCs when requested. All forms necessary for the proper administration of the programme and all promotion material for companies produced by NBP will be available from the PBPO.
8. Issue appliance account invoices and receipts for payment upon request of BCCs, and receive and channel payments to NBP on behalf of BCCs.
9. Register contracts and construction schedules presented by BCCs in a timely manner, and provide BCCs with plant codes promptly.
10. Inspect finished plants and issue plant completion reports in a timely manner.

Support PBCCs in enhancing the quality of biogas plants and customer access

11. Provide technical consulting to assist BCCs in resolving problems and issues with biogas plants during construction, at the time of the Plant Completion Report, and during the after-sales service period.
12. When required, participate in loan application verification processes with biogas lenders (MFIs) under the terms set out in official NBP policy.

4. Further, All Parties Agree:

1. Rights of NBP and PBPO to promote quality control

NBP and the PBPO have the right to control the quality of construction, maintenance, and after sales service as provided by the biogas plants whereby:

- a) NBP and PBPO staff will have the right to supervise and check the work of the company concerned to this agreement.
- b) The company shall give full cooperation to NBP or PBPO staff during execution of its duties.
- c) Control procedures for the quality of newly constructed plants or plants under construction; penalty, bonus calculations, construction quality standards and resulting penalties; and calculations of the performance index are according to the *Operations Manual*.
- d) Control procedures on the quality of maintenance and after sales service of existing plants, maintenance and after sales service procedures, quality standards and resulting penalties are according to the *Operations Manual*.

2. Closing of the company or its branch offices

Termination of this agreement from the side of the company or closing of one or more branch offices of that company will only be permitted when the following procedure is strictly adhered to:

- a) Listing of all plants for which responsibilities are transferred provided to the PBPO.
- b) Transfer of all pending responsibilities regarding guarantee, repair, and maintenance of biogas plants constructed by the company or branch office or to another BCC officially recognized by NBP.
- c) Transfer of the guarantee funds belonging to the biogas plants constructed by that branch office to another BCC officially recognized by NBP.
- d) Proof that all involved plant owners are properly informed.

3. Suspension or termination of the agreement

NBP retains the right to immediately suspend the cooperation with a company or company office in the cases as specified below in this article for a period of 1 month.

Further suspension or termination of this agreement from the side of NBP will be subject to the advice of the NBP Steering Committee. All correspondence regarding suspension of an agreement shall be copied to the NBP Steering Committee. In case of a suspension, the company will be invited for clarification of the issue. Depending on the company's reaction, the suspension may be lifted. It is the company's responsibility to react at its earliest convenience.

NBP will suspend cooperation in the case of:

- a) Gross irregularities, such as claiming of subsidy for plants not constructed, or unauthorized claiming or channeling of subsidy money.
- b) Non-observance of the terms and conditions of this agreement by the company.
- c) Ongoing neglect for quality of plant construction as agreed by both NBP and the PBPO after a quality warning from NBP has been issued.

In case this agreement between NBP, PBPO, and the company is terminated, the remaining balance of Guarantee Fee funds shall be fully at the PBPO's disposal, supervised by NBP. PBPO will relocate the pending guarantee obligations to other companies, and allocate the guarantee funds accordingly or return the outstanding guarantee amount to the customer.

Appendix 4: Training Development Framework Based on BCC Business Process Map

	Activity/Step	Existing Mason Skill	New Mason Responsibility	Capacity Assessment Topic	Training Topic	Operations Manual Content
Marketing and Sales						
1	Identify potential clients in collaboration with promoter network and other referrers	X	X	Survey	Market survey	Information on marketing network
2	Explain benefits of biogas to potential clients, indicative costs, and credit options	X	X	Communication and explanation	Communication skills	Existing marketing materials for use with farmer
3	Technical feasibility visit: site and size selection		X	N/A	N/A	Site selection guide
4	Provide cost estimate (BOQ) for biogas plant to potential clients		X	Good calculation	Cost estimate (quotation)	Pricing, BOQ, explaining prices
5	Explain and facilitate MFI financing for potential clients		X	How to take from MFI	Loan process	Step-by-step guide to obtaining finance, contact names, and numbers. Explanation of payment process and interest rate
6	Verify financing and make contract for construction		X	Making contracts	Business contract	Contract(ing) forms
Operations Management, Human Resources, Financial Management						
7	Make construction schedule and plan with farmer	X	X	Managing time	Time management	Schedule, planned and actual, in PCF
8	Instruct farmer on construction materials purchase (or acquire construction materials)	X	X	Communication and explanation	Communication skills	Checklists for farmer-purchased construction materials
9	Submit contract copy and construction schedule to PBPO		X	Document processing	Administration	Contract issues and procedures
10	Organize construction team, assign responsibilities	X	X	Skills for staff management	Skills for staff management	Guidelines for payment of construction teams
11	Inspect construction materials	X		Taking responsibility	N/A	Inspection guidelines
12	Draw/establish plant layout	X	X	Taking responsibility	N/A	None: technical content
13	Acquire and provide tools to construction team	X		N/A	N/A	None: technical content
14	Supervise excavation of soil	X		N/A	N/A	Excavation checklist
15	Supervise and inspect construction	X		Management	Quality control	Project Control Folder quality control guidelines
16	Provisioning of appliances		X	General admin	Finance, stock	Appliance system
17	Appliance and pipeline installation	X		N/A	N/A	None—technical content

(continued)

Appendix 4: Training Development Framework Based on BCC Business Process Map (Continued)

	Activity/Step	Existing Mason Skill	New Mason Responsibility	Capacity Assessment Topic	Training Topic	Operations Manual Content
Financial Management; Quality Control, After-Sales Service; NBP Administration						
18	Receive appliance and work payment from farmer		X	Material and payment management	Stock, book of accounts, I/S	Book of accounts, I/S format
19	Collect overhead payment		X	Financial management	Book of accounts	Book of accounts format
20	Completion report, final inspection, and collection of guarantee fee and participation fee (with PBPO)	X	X		Write report, collect and record revenue	Report format
21	Explain user manual, plant operation, guarantee, and maintenance		X			Small manual (operation, warranty)
22	Payment to construction team	X	X	Expenditure reports	Book of accounts	Book of accounts format
23	Payment/transfer of promotion fee to promoter		X	Expenditure reports	Book of accounts	Book of accounts format
24	Follow-up 3–7 days after feeding to ensure operation of plant		X	Taking responsibility	None	Procedures for follow-up
25	Extended user training		X	Customer care	Service quality	None
26	Follow-up every 6 months after completion inspection and user relation(s), and recording of situation(s)	X		Responsibility	Service quality	Warranty procedures and obligations
27	Provide after-sales service of client request	X		Responsibility	Service quality	After-sales service protocols
28	Submit end of guarantee Form (10) to PBPO	X	X	Submitting forms	Admin skill	Warranty format, procedures, and obligations
29	Collect guarantee fee—after 2 years	X	X	Expenditure reports	Book of accounts	After-sales service protocols
General Business Functions						
30	General operations planning		X	N/A	Scheduling materials, etc.	None
31	Accounting and tax payment		X	N/A	Bank account, records	None
32	Loan repayment		X	N/A	Understanding loans, finance, interest	None
33	Networking and promotion system	X	X	N/A	Working a sales network	Section in marketing
34	Administration	X	X	N/A	Working with the NBP system	Incorporated in inventory procedures and QC

Appendix 5: Application for NBP Masons Seeking BCC Owner Designation

Personal Information

Name _____

Address _____

Age _____ ID number _____

Advantages and Disadvantages of Company Ownership

List 3 of each: Advantages _____ Disadvantages _____

Personal Network

Who can help you with this business?

	Who	How	Skill(s)
Marketing and sales	_____	_____	_____
Record keeping	_____	_____	_____
Finance	_____	_____	_____
Inventory and Logistics	_____	_____	_____

Does anyone in your family currently own a business of any kind?

Who? _____

What kind? _____

Assets (Capital)

Do you or your immediate family own:

	Yes	No	
Motorbike	_____	_____	
Remork	_____	_____	
Land	_____	_____	
Livestock	_____	_____	_____ Cows _____ Pigs
Mobile telephone	_____	_____	
Bank account	_____	_____	Name of bank or MFI _____

Family Income Sources

	Agriculture	Business	Job
Me	_____	_____	_____
My wife	_____	_____	_____
Mother	_____	_____	_____
Father	_____	_____	_____
Child (1)	_____	_____	_____
Child (2)	_____	_____	_____
Child (3)	_____	_____	_____

Operations Manual for Private Biodigester Construction Companies

Introduction

As the National Biodigester Program (NBP) proceeded through its stages of implementation, it became clear to the Private Sector Development (PSD) team that local NBP masons lacked business skills, were unfamiliar with administrative compliance procedures, and had low tolerance for the risks traditionally associated with business startup. The Provincial Biodigester Program Office (PBPO) Directors and Coordinators also expressed significant concern about masons' financial capabilities and management skills, staff and operations management abilities, and foundational entrepreneurial skills.

The PSD team adjusted its approach accordingly, settling on the development of a microfranchise system, with specific operating arrangements and business procedures developed through a Biodigester Construction Company (BCC) *Operations Manual*, simplified project management tools, and a three-party Franchise Agreement.

This model required detailed codification (and in some cases, modification) of NBP operating procedures to ensure predictability and clarity for low-skilled entrepreneurs. The key tools of this system were the *Operations Manual for Private Biodigester Construction Companies* (included in its entirety here), the Project Control Folder (PCF), and the Franchise Agreement.

Operations Manual for Private Biodigester Construction Companies

In response to concerns about the clarity, transparency, and ease of replication of NBP operating procedures, the PSD team produced this *Operations Manual*, presenting and formalizing all known required business procedures corresponding to the business process map for BCCs. The manual played a key role in training development, as it contained the authoritative statement of expected company procedures.

Project Control Folder

Because the BCC owners lacked experience with project management, the PSD team created the Project Control Folder as the principal tool for team operations, scheduling, quality control, and basic financial management. The PCF also serves as the "project file" for each biodigester constructed, and comprises the framework of the business records BCCs are required to maintain. According to the Franchise Agreement, the PCF must remain at the customer's premises during construction and in the files of the BCC for three years after plant completion. It establishes a permanent record of the construction process that concurrently provides basic business skills training.

Franchise Agreement

A three-party agreement was formulated, outlining the responsibilities of BCCs, the NBP, and the PBPO of each province. The agreement is based on a hybrid of the existing Cambodia program structure and the company agreement in place in Nepal under the Nepal National Biogas Program. The complete agreement appears in chapter 2, appendix 3.

Operations Manual for Private Biodigester Construction Companies

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Section 1. Marketing, Sales, Finance, and Contracting

1. Finding Customers: The Promotion Network

All NBP masons know that the Farmer's Friend biodigester is a great product for farmers. But new Biodigester Construction Company owners (leaders) may wonder how exactly to find new customers who will be interested in installing a biodigester.

A sales (promotion) network is a group of people or companies that consistently introduce you to new customers.

Fortunately, NBP and your PBPO have worked hard to build a network of promoters who can help connect you to the right customers. You will have the tools and support of NBP in building this promotion network into your company's sales network.

These are some of the people in your area you should get to know as soon as your Biodigester Construction Company is started.

Who	Why
Village Livestock Agents/Village Animal Health Workers (VAHW)	They know the farmers in your area who own land and have enough livestock to operate a biodigester.
Commune Chiefs and Commune Council Members	They know the successful farmers in their commune who are interested in improving the commune environment.
Village Chiefs and Village Council Members	They know the most successful farmers in their village who are interested in improving the village environment.
Animal Feed and Agriculture Supply Dealers	They know the customers who buy a lot of animal feed and are likely to have enough livestock to operate a biodigester.
Local NGOs Interested in Agricultural Community Development	They are interested in the community's quality of life and in people having more productive, healthier lives by using resources more efficiently.
Satisfied Biodigester Users	They can tell others about the positive impact a biodigester has had on their family and finances.

As you move forward in your business, you will also identify other people who can be part of your sales network—this list is a starting point, not a final list.

NBP will also provide training to new promoters you identify. Having trained promoters is an advantage to you, because they will better understand the characteristics of good customers.

Good Relationships with the Promotion and Sales Network

One of the most important parts of your job as a company owner is developing good relationships with the people in your sales network. How?

Tips for Building Your Company's Sales Network

1. Personal visit

When you begin your company, pay a personal visit to each person you think could refer you to new Farmer's Friend customers.

- *Introduce yourself:* Introduce yourself as the NBP-licensed Biodigester Construction Company for the district.
- *Leave information:* Provide information about biodigesters and the NBP.
- *Offer an exposure visit:* Offer to take the person to visit the home of one of your customers who has a working Farmer's Friend biodigester. If they accept, inform your customer by telephone one day in advance of bringing the promoter to his/her home.
- *Promoter fee:* Explain that he or she will receive US\$5 for every customer that they refer to you who ends up hiring you to build a biodigester.
- *Official business card:* Leave your business card so the person knows how to contact you, and understands that you are the officially designated NBP Biodigester Construction Company in the district.
- *Make a next appointment:* Promise to visit again after two weeks to one month. Set an appointment for a specific day, if possible.

2. Follow up and build trust

If you do not hear from the promoter in the first few weeks after you visit him or her, don't get discouraged. Return to see them and remind them who you are and what you are offering. It may take some time for the promoter to understand what you are offering, and to trust you with their customers. That's normal—they need to trust that you are responsible before making referrals.

3. Provide new material

Each time you receive new promotional material from NBP, go to each member of your sales network and share it. If the promoter is a person who has a place of business that many people visit, offer to place posters and leaflets in their place of business.

4. Respond quickly

Try to visit potential customers within two days of the time that you receive a referral from the promoter.

5. Say “thank you”

If a promoter’s referral leads to a sale, call or visit the promoter in person. At this time, do two things: (1) Thank him/her for the referral; (2) Tell him/her when the construction is scheduled and when he can expect to receive his US\$5 promotion fee.

6. Pay promptly

As soon as you are paid by your customer (the same day, if possible), visit the promoter who provided the referral. Pay him the US\$5 promotion fee and thank him for helping you build your business. Over time, this will build trust and make the promoter more willing to help you find more customers.

2. Visiting Customers

Preparing to Visit a Prospective Customer for the First Time

1. **Appointment:** Ask the promoter who referred you to call the farmer and tell him/her you’d like to visit. Set an appointment if possible, so you know that the farmer will be free to talk with you when you arrive.
2. **Information:** Make sure you have the correct NBP promotion information (pamphlets and your business card) to bring with you.
3. **Relax!** You have a great product to sell. If you are relaxed, your customer will be relaxed. If you are nervous, your customer will also be nervous. Go into the first meeting to build a relationship with your prospective customer—but without expecting to make an immediate sale.

The first visit: Your goal is to determine whether this is a good customer.

When you are talking to a farmer who may want to buy a Farmer’s Friend biodigester, you should:

1. **Introduce yourself:** Introduce yourself as the NBP-licensed Biodigester Construction Company for the district. Immediately give the customer your business card identifying you and your company.
2. **Learn about the customer:** Keep notes on the customer information sheet (Form 02–P).
 - *Family:* How many people are in his/her family? Are they healthy?
 - *Economic condition:* What is the family’s economic status? Are they respected in the community? Are they busy working when you visit?
3. **Give information:** Provide information about biodigesters and the NBP Program. Use official NBP promotion materials to help explain the benefits of the biodigester. These are summarized below.
 - *Livestock:* How many cows and pigs does he/she have?
 - *Land:* Look at how much land the customer has.
 - *Water:* Does the customer have access to necessary water to run a biodigester?
 - *Firewood:* How much firewood does the family use every week for cooking? How much does it cost the family? How much time does the family spend collecting firewood?
 - *Save time and money on firewood:* Families with biodigesters spend less money on firewood for cooking. Use the customer information sheet to figure out the farmer’s potential savings from a biodigester.
 - *Healthy family environment:* Cooking with gas from a biodigester improves the family’s health because there is less smoke.
 - *Safer, better manure:* Manure that has been through a biodigester is called “slurry.” It does not smell bad or attract insects and is safer for the family. It is also a high-quality fertilizer that can improve the family’s crops.
 - *Clean environment:* Families with biodigesters have cleaner home environments because manure is put to good use.
4. **Explain price and subsidy:** Tell the farmer about the costs of a biodigester and the process for figuring out the right size of biodigester for his farm.
5. **Explain microfinance institution (MFI) financing:** Tell the farmer that the key local finance partner (PRASAC MFI) can provide special low-interest loans for biodigester construction, and that you can help the customer apply for this loan.
6. **Offer an exposure visit:** Offer to go with the farmer and his family to visit the home of one of your customers who has a working biodigester. If they accept, set a schedule and inform your old customer by telephone one day before bringing the promoter to his home.
7. **Offer to talk to an expert:** Some customers will want to find out for themselves about biodigesters. Give the customer the names, telephone numbers, and information of some knowledgeable people he can talk to about biodigesters, including the local Village Animal Health Worker, and your satisfied customers who live near the customer.
8. **Explain the construction process:** Explain the process of building a plant, the mason team that you will use, and the amount of time it will take to complete the plant.

National Biodigester Program – Form 02-P

Survey form for potential Farmer's Friend households

Code _____ Company Name: _____

General Information

Province: _____ District: _____ Commune: _____ Village: _____

Name of household head: _____ Telephone No: _____

Number of people in family: Adult: _____ Children (age <16): _____ Total: _____

Date of survey _____

Land information

Total land area: _____ m² Land area for biodigester: _____ m²

Groundwater level in dry season _____ m² Flooding problems in wet season: yes/no

WATER AND SANITATION INFORMATION

Sanitary works	Running water sources	General sanitary		
		Good	Fair	Bad
Simple pit latrine	River	Kitchen		
Improved latrine	Lake/pond	Latrine		
No latrine	Deep tube well	Water source		
Drainage system	Shallow tube well	Drainage system		
	Dug wells	Household wastes disposal		
	Piped water tap			
	Canal			

Animal husbandry development activities

NUMBER OF DOMESTIC ANIMALS:

Animal type	Pig	Cattle	Buffalo	Adult	Calf	Adult	Calf	Adult	Calf
Quantity									

Daily manure volume: _____ kg/day

	Firewood and Fuel Use	Firewood	Lighting oil/kerosene
13	Kilograms/week	KG/week	Liters/week
14	Cost per week	US\$/KHR	US\$/KHR
15	Annual cost of firewood (cost per week x 52)	US\$/KHR	US\$/KHR
16	Potential savings on firewood/fuel (Annual cost X .8)	US\$/KHR	US\$/KHR

Assessment

Plant construction recommended Y/N
 Recommended plant size _____ m³
 Approximate cost of recommended plant _____ US\$/KHR
 Credit required by customer _____ US\$/KHR

BIODIGESTER COMPANY REPRESENTATIVE

BIOGAS HOUSEHOLD HEAD

NAME

NAME

SIGNATURE

SIGNATURE

TELEPHONE NUMBER

TELEPHONE NUMBER

STAMP OF BCC GOES HERE BEFORE SUBMITTING TO PRASAC

The BCC leader can place promotional materials here.

9. **Offer to come back and answer questions:** A biodigester is a big purchase. Tell the customer that you understand he needs to think about it, and discuss it with his family. Make an appointment to come back in one week or less to answer more questions.
10. **Leave information:** Leave the farmer official NBP information about biodigesters and the NBP, PRASAC MFI, and slurry.
11. **Decide whether another visit is useful:** Not every family you visit is going to install a biodigester. If you feel the customer is not really motivated, maybe your time is better used finding another potential customer. You must decide this based on your experience with sales.

Following Up: (Second Visit)

1. **Keep your appointment:** Come back when you say you will.
2. **Provide more information and answer questions.**
3. **Explain the next step(s):**
 - Choosing the right size biodigester size and location (technical feasibility visit);
 - Arranging for financing with PRASAC (fill out loan forms);
 - Signing a contract and setting a schedule for construction;
 - Buying construction materials.
4. **Collect manure:** Ask the customer to collect manure for one day before your next visit to estimate the right size biodigester.
5. **Estimate customer's real level of interest:** You don't want to waste your time or your customer's time if they're not really interested.
6. **Close the sale or offer to follow up again.** If the customer is still not sure, offer to come back again. Set specific goals for your next visit, for example, the technical feasibility visit or filling out loan paperwork.

3. Technical Feasibility: Site and Size Selection

There are two goals for the technical feasibility visit: (1) to determine the right size biodigester for the customer, and (2) to determine if there is a suitable location (the most suitable location) for the plant on the farmer's property.

What Size Biodigester is Correct?

The best and most accurate way to choose the right biodigester is to weigh or measure the manure that the customer actually collects on a daily basis.

To decide the correct size of biodigester, ask the customer to collect the manure from his property that he usually collects for one day and set it aside in a pile or bucket for you to measure. You may need to call and

make sure he has done this before you make your next trip to his/her home.

When you return to the customer's property, weigh the manure if you have the right equipment, or estimate the quantity as best you can.

As a rule of thumb, most farmers can collect about 8.5 kilograms of manure per cow per day, when cows are roaming during half of the day.

Plant size	Fresh manure required every day (Kg)	Water required every day (liters)	Approximate number of cows required
4m ³	20–40	20–40	3–5
6m ³	40–60	40–60	4–6
8m ³	60–80	60–80	6–8
10m ³	80–100	80–100	8–10
15m ³	100+		11+

Is there a suitable location on the farmer's property?

In general, a biodigester site should be selected that:

- Minimizes construction materials costs;
- Ensures easy operation and maintenance activities like "feeding" the biodigester, turning the main gas valve on and off, composting and using slurry, checking for gas leakage, draining condensed water from pipeline, and so on;
- Guarantees plant safety; and
- Makes construction work easy.

Based upon these factors, plant locations should be selected based upon the following specific considerations.

- Location that receives sunlight, not in the shade or in a damp or cool area (to maintain operating temperature);
- On even (level) ground;
- Slightly higher elevation than the surroundings (for drainage and slurry outlet);
- As close as possible to the cattle shed or pig sty (to avoid wasting manure);
- No more than 100 meters from a source of water (to make transporting water easy);
- At least 10 meters away from well (to avoid ground-water contamination);
- As close as possible to kitchen or cooking area (to avoid leaks and reduce cost);
- Edge of plant at least two meters away from the foundation of house or any other structure;
- Enough space for compost-pit(s)—3x4 meters is a good guideline;

- At least two meters from big trees to avoid damage to biodigester by roots; and
- Soil hard enough to support biodigester (to avoid the biodigester sinking).

It may not always be possible to meet all of these requirements, but as many points as possible should be considered.

Note: When space is a problem, the pigsty can be constructed on top of the plant after proper backfilling.

4. Biodigester Costs: The Bill of Quantities

The simplified Bill of Quantities (in US\$) shown below can be used to explain biodigester costs to customers.

Detailed Bills of Quantities for each size biodigester appear on the following pages. These can be used to explain the cost to farmers who have more questions.

Calculating Appliance Costs

Each Farmer's Friend biodigester installation will have slightly different costs based on the appliances that the customer selects. You will need to calculate these costs every time you give a customer a quote for a biodigester.

In general, the following costs will be paid to your company by the customer for appliance installations.

Item	Cost (US\$)	Number per plant	Total cost (US\$)
Main gas pipe	5	1	5
Water drain	4	1	4
Pressure gauge	2	1	2
Stove kits (stove, burner, and gas tap)	18	1 or 2	Company must calculate
Lamp	5	1–5	Company must calculate
Total of appliance purchases by company			Company must calculate

Most customers will buy construction materials themselves, so you do not need to calculate these costs to make a contract, but you will need to advise customers on how much of each item to purchase in order to explain the total cost of the plant correctly. Use the following Bills of Quantities to help your customer understand his/her choices and costs.

SIMPLIFIED BILL OF QUANTITIES (US\$)		4 m ³	6 m ³	8 m ³	10 m ³	15 m ³
I	Construction Materials	229	285	335	390	632
II	Appliances	61	61	61	61	61
	Purchased locally	27	27	27	27	27
	Purchased from NBP	34	34	34	34	34
III	Labor	80	90	107	126	168
	Skilled labor	45	50	59	68	90
	Unskilled labor	20	22	26	30	40
	Excavation of soil	15	18	23	29	38
IV	Guarantee Fee	10	15	20	25	35
V	Participation Fee	15	15	15	15	15
	Total Cost	395	466	538	617	911
	NBP Subsidy	150	150	150	150	150
	Cost to Farmer	245	315	388	467	760

5. MFI Financing

PRASAC MFI is a partner of NBP. PRASAC provides special low-interest loans for biodigesters. Biodigester Construction Company leaders need to understand the PRASAC loan process so they can sell biodigesters to customers who want them but do not have the money available to pay in advance.

Key points that you can explain to customers are:

- PRASAC MFI offers loans for biodigesters for a special interest rate of 1.2 percent per month (14.4 percent per year). This is a much lower rate per month than regular MFI loans or local moneylenders' rates. It is a special rate for NBP customers only. Sample promotional materials are shown on page 83.
- The loan can be used to build a biodigester and for small improvements required to make the biodigester work better, for example, connecting it to stables or a kitchen.
- Customers can choose to pay back the loan in one year or two years.
- Customers can borrow from US\$150 up to US\$1,000 for biodigesters.
- Customers can choose to borrow all of the money required for a biodigester, or only part of the money, but the minimum loan is US\$150. They cannot borrow more than what is required for the plant construction.
- There are different payment plans available for customers, depending on how regular their income is.
 - There are plans that allow customers to pay equal amounts every month.
 - There are plans that allow customers to pay interest monthly and principal (the money borrowed) every two, three, or four months, (according to an agricultural income schedule).
- Customers may qualify for lower payments for the first two months. This is called a "grace period."
- If they borrow money from PRASAC to build their biodigester, the NBP subsidy will be used to pay back PRASAC first.
- Farmers with another loan from PRASAC are still eligible for biodigester loans, even if the other loan has not been fully paid.

BCCs are strongly advised to offer customers all necessary assistance in securing a loan. It is also a good idea to go with the customer to PRASAC MFI to help him apply for a biodigester loan, and to become familiar with the papers that he/she will need to show PRASAC to obtain the loan.

BCCs must submit Form 02-P to PRASAC for the customer.

It is also a good idea to develop a relationship with the PRASAC loan officer in your area who is in charge of biodigester loans. This will make it easier for him or her to help you make sales using these special loans.

6. Making the Contract

The NBP-approved Biodigester Sales Contract is a written agreement between a BCC and a customer that clearly outlines the costs, schedule, and obligations of both the BCC and the customer. This sales contract has been developed for BCCs to ensure that all questions that might come up are clearly answered. A biodigester is not eligible for the NBP subsidy unless a contract has been made correctly between the BCC and the customer.

Steps for Completing the Contract

1. Write the date and contract number at the top of the page.
2. Write your company's name and information and customer's name and information at the top of page 1.
3. *Line 1:* Write the size of the biodigester in m³ (4, 6, 8, 10, or 15) in the space provided.
4. *Line 2:* Write the number of days after the contract signing that you plan to start work (for example, if you will start in one week, write "7" for 7 days).
5. *Line 2:* Give a final completion date. Usually this should be one month from the date of the contract, unless you have made other arrangements with the client. For example, if today's date is June 1, 2009, the completion date should be July 1, 2009.
6. *Line 7:* Who will buy construction materials?

If the client will buy construction materials himself, put an "X" in box (a).

If you (the Company) will purchase the construction materials for the client, put an "X" in box (b) and fill in the amount in dollars or KHR that the customer has agreed to pay for these materials. If you will buy the construction materials, make sure to negotiate a fee for delivery of between US\$5 and US\$10, depending on the expenses that you will pay. You should add this to the construction materials cost in the contract.

continued on page 84

BILL OF QUANTITIES FOR 4m³ BIODIGESTER, JANUARY 1, 2009

No.	Item	Unit	Unit Cost US\$**	4m ³ Qty	Total Cost (US\$)
I	Construction materials (normally purchased by customer)				
1	Solid brick	piece	0.10	2000.0	100.00
2	Cement	bag	5.50	14.0	77.00
3	Gravel 1x2	m ³	26.00	0.5	13.00
4	Coarse sand	m ³	8.00	0.4	3.20
5	Fine sand	m ³	10.00	1.1	11.00
6	Inlet PVC pipe 10cm Ø	piece	4.50	2.0	9.00
7	Iron bars ø 6	kg	1.50	8.0	12.00
8	Binding wire	kg	1.30	0.5	0.70
9	Acrylic emulsion paint*	liter	3.00	1.0	3.00
	Subtotal I				229.00
Ila	Appliances/accessories (normally purchased by customer)				
10	GI nipple, Ø 0.5"	piece	0.70	1.0	0.70
11	Main gas valve Ø 0.5"	piece	3.00	1.0	3.00
12	Male-female socket Ø 0.5"	piece	0.70	1.0	0.70
13	PVC 90o elbow	piece	0.10	4.0	0.50
14	Tee Ø 0.5" (aluminum thread inside)	piece	1.00	3.0	3.00
15	Reduction nipple Ø 0.5"-9 mm	piece	1.00	2.0	2.00
16	Glue for PVC connection	bottle	0.70	1.0	0.70
17	Teflon tape	piece	0.30	1.0	0.30
18	PVC pipe Ø 0.5	meter	1.50	10.0	15.00
19	Gas hose pipe Ø 0.5"	meter	1.00	1.0	1.00
	Subtotal Ila				27.00
Ilb	Appliances purchased from NBP only				
20	G.I, Gas outlet pipe Ø 2", 0.6 m long	piece	5.00	1.0	5.00
21	Water drain valve	piece	4.00	1.0	4.00
22	Gas tap	piece	6.00	1.0	6.00
23	Stoves single burner	piece	12.00	1.0	12.00
24	Lamp	piece	5.00	1.0	5.00
25	Pressure gauge	unit	2.00	1.0	2.00
	Subtotal Ilb				34.00
III	Labor				
26	Skilled labor	no.	4.50	10.0	45.00
27	Unskilled labor	no.	2.00	10.0	20.00
28	Excavation of soil	m ³	1.50	10.0	15.00
	Subtotal III				80.00
	Total				369.70
	Guarantee				10.00
	Participation Fee				15.00
	Total (including guarantee and after sales services)				395.00

* Should be purchased by customer from Biodigester Construction Company

** Indicator price; actual price will vary depending on location and market developments, ±5 percent

BILL OF QUANTITIES FOR 6m³ BIODIGESTER, JANUARY 1, 2009

No.	Item	Unit	Unit Cost US\$**	4m ³ Qty	Total Cost (US\$)
I	Construction materials (normally purchased by customer)				
1	Solid brick	piece	0.05	2400.0	120.00
2	Cement	bag	5.50	18.0	99.00
3	Gravel 1x2	m ³	26.00	0.9	24.20
4	Coarse sand	m ³	8.00	0.6	4.80
5	Fine sand	m ³	10.00	1.2	12.00
6	Inlet PVC pipe 10cm Ø	piece	4.50	2.0	9.00
7	Iron bars ø 6	kg	1.50	10.0	15.00
8	Binding wire	kg	1.30	0.5	0.65
9	Acrylic emulsion paint*	liter	3.00	1.2	3.60
	Subtotal I				288.20
Ila	Appliances/accessories (normally purchased by customer)				
10	GI nipple, Ø 0.5"	piece	0.70	1.0	0.70
11	Main gas valve Ø 0.5"	piece	3.00	1.0	3.00
12	Male-female socket Ø 0.5"	piece	0.70	1.0	0.70
13	PVC 90o elbow	piece	0.12	4.0	0.48
14	Tee Ø 0.5" (aluminum thread inside)	piece	1.00	3.0	3.00
15	Reduction nipple Ø 0.5"-9 mm	piece	1.00	2.0	2.00
16	Glue for PVC connection	bottle	0.70	1.0	0.70
17	Teflon tape	piece	0.25	1.0	0.25
18	PVC pipe Ø 0.5	meter	1.50	10.0	15.00
19	Gas hose pipe Ø 0.5"	meter	1.00	1.0	1.00
	Subtotal Ila				26.80
Ilb	Appliances purchased from NBP only				
20	G.I, Gas outlet pipe Ø 2", 0.6 m long	piece	5.00	1.0	5.00
21	Water drain valve	piece	4.00	1.0	4.00
22	Gas tap	piece	6.00	1.0	6.00
23	Stoves single burner	piece	11.00	1.0	11.00
24	Lamp	piece	3.50	1.0	3.50
25	Pressure gauge	unit	2.00	1.0	2.00
	Subtotal Ilb				31.50
III	Labor				
26	Skilled labor	no.	4.50	11.0	49.50
27	Unskilled labor	No.	2.00	11.0	22.00
28	Excavation of soil	m ³	1.50	12.0	18.00
	Subtotal III				89.50
	Total				436.10
	Guarantee				15.00
	Participation Fee				15.00
	Total (including guarantee and after sales services)				466.10

* Should be purchased by customer from Biodigester Construction Company

** Indicator price; actual price will vary depending on location and market developments, ±5 percent

BILL OF QUANTITIES FOR 8m³ BIODIGESTER, JANUARY 1, 2009

No.	Item	Unit	Unit Cost US\$**	4m ³ Qty	Total Cost (US\$)
I	Construction materials (normally purchased by customer)				
1	Solid brick	piece	0.05	2800.0	140.00
2	Cement	bag	5.50	22.0	121.00
3	Gravel 1x2	m ³	26.00	1.3	34.58
4	Coarse sand	m ³	8.00	0.8	6.40
5	Fine sand	m ³	10.00	1.3	13.00
6	Inlet PVC pipe 10cm Ø	piece	4.50	2.0	9.00
7	Iron bars ø 6	kg	1.50	12.0	18.00
8	Binding wire	kg	1.30	0.5	0.65
9	Acrylic emulsion paint*	liter	3.00	1.3	3.90
	Subtotal I				346.50
Ila	Appliances/accessories (normally purchased by customer)				
10	GI nipple, Ø 0.5"	piece	0.70	1.0	0.70
11	Main gas valve Ø 0.5"	piece	3.00	1.0	3.00
12	Male-female socket Ø 0.5"	piece	0.70	1.0	0.70
13	PVC 90o elbow	piece	0.12	4.0	0.48
14	Tee Ø 0.5" (aluminum thread inside)	piece	1.00	3.0	3.00
15	Reduction nipple Ø 0.5"-9 mm	piece	1.00	2.0	2.00
16	Glue for PVC connection	bottle	0.70	1.0	0.70
17	Teflon tape	piece	0.25	1.0	0.25
18	PVC pipe Ø 0.5	meter	1.50	10.0	15.00
19	Gas hose pipe Ø 0.5"	meter	1.00	1.0	1.00
	Subtotal Ila				26.80
Ilb	Appliances purchased from NBP only				
20	G.I, Gas outlet pipe Ø 2", 0.6 m long	piece	5.00	1.0	5.00
21	Water drain valve	piece	4.00	1.0	4.00
22	Gas tap	piece	6.00	1.0	6.00
23	Stoves single burner	piece	11.00	1.0	11.00
24	Lamp	piece	3.50	1.0	3.50
25	Pressure gauge	unit	2.00	1.0	2.00
	Subtotal Ilb				31.50
III	Labor				
26	Skilled labor	no.	4.50	13.0	58.50
27	Unskilled labor	No.	2.00	13.0	26.00
28	Excavation of soil	m ³	1.50	15.0	22.50
	Subtotal III				107.00
	Total				511.90
	Guarantee				20.00
	Participation Fee				15.00
	Total (including guarantee and after sales services)				546.90

* Should be purchased by customer from Biodigester Construction Company

** Indicator price; actual price will vary depending on location and market developments, ±5 percent

BILL OF QUANTITIES FOR 10m³ BIODIGESTER, JANUARY 1, 2009

No.	Item	Unit	Unit Cost US\$**	4m ³ Qty	Total Cost (US\$)
I	Construction materials (normally purchased by customer)				
1	Solid brick	piece	0.05	3200.0	160.00
2	Cement	bag	5.50	26.0	143.00
3	Gravel 1x2	m ³	26.00	1.6	40.82
4	Coarse sand	m ³	8.00	1.0	8.00
5	Fine sand	m ³	10.00	1.4	14.00
6	Inlet PVC pipe 10cm Ø	piece	4.50	2.0	9.00
7	Iron bars ø 6	kg	1.50	13.0	19.50
8	Binding wire	kg	1.30	0.5	0.65
9	Acrylic emulsion paint*	liter	3.00	1.5	4.50
	Subtotal I				399.50
Ila	Appliances/accessories (normally purchased by customer)				
10	GI nipple, Ø 0.5"	piece	0.70	1.0	0.70
11	Main gas valve Ø 0.5"	piece	3.00	1.0	3.00
12	Male-female socket Ø 0.5"	piece	0.70	1.0	0.70
13	PVC 90o elbow	piece	0.12	4.0	0.48
14	Tee Ø 0.5" (aluminum thread inside)	piece	1.00	3.0	3.00
15	Reduction nipple Ø 0.5"-9 mm	piece	1.00	2.0	2.00
16	Glue for PVC connection	bottle	0.70	1.0	0.70
17	Teflon tape	piece	0.25	1.0	0.25
18	PVC pipe Ø 0.5	meter	1.50	10.0	15.00
19	Gas hose pipe Ø 0.5"	meter	1.00	1.0	1.00
	Subtotal Ila				26.80
Ilb	Appliances purchased from NBP only				
20	G.I, Gas outlet pipe Ø 2", 0.6 m long	piece	5.00	1.0	5.00
21	Water drain valve	piece	4.00	1.0	4.00
22	Gas tap	piece	6.00	1.0	6.00
23	Stoves single burner	piece	11.00	1.0	11.00
24	Lamp	piece	3.50	1.0	3.50
25	Pressure gauge	unit	2.00	1.0	2.00
	Subtotal Ilb				31.50
III	Labor				
26	Skilled labor	no.	4.50	15.0	67.50
27	Unskilled labor	No.	2.00	15.0	30.00
28	Excavation of soil	m ³	1.50	19.0	28.50
	Subtotal III				126.00
	Total				583.80
	Guarantee				25.00
	Participation Fee				15.00
	Total (including guarantee and after sales services)				623.80

* Should be purchased by customer from Biodigester Construction Company

** Indicator price; actual price will vary depending on location and market developments, ±5 percent

BILL OF QUANTITIES FOR 15m³ BIODIGESTER, JANUARY 1, 2009

No.	Item	Unit	Unit Cost US\$**	4m ³ Qty	Total Cost (US\$)
I	Construction materials (normally purchased by customer)				
1	Solid brick	piece	0.05	4500	225.00
2	Cement	bag	5.50	40	220.00
3	Gravel 1x2	m ³	26.00	2.3	59.80
4	Coarse sand	m ³	8.00	2.5	20.00
5	Fine sand	m ³	10.00	3	30.00
6	Inlet PVC pipe 10cm Ø	piece	4.50	2.5	11.25
7	Iron bars ø 6	kg	1.50	25	37.50
8	Binding wire	kg	1.30	1	1.30
9	Acrylic emulsion paint*	liter	3.00	3	9.00
	Subtotal I				613.90
Ila	Appliances/accessories (normally purchased by customer)				
10	GI nipple, Ø 0.5"	piece	0.70	1	0.70
11	Main gas valve Ø 0.5"	piece	3.00	1	3.00
12	Male-female socket Ø 0.5"	piece	0.70	1	0.70
13	PVC 90o elbow	piece	0.12	4	0.48
14	Tee Ø 0.5" (aluminum thread inside)	piece	1.00	3	3.00
15	Reduction nipple Ø 0.5"-9 mm	piece	1.00	2	2.00
16	Glue for PVC connection	bottle	0.70	1	0.70
17	Teflon tape	piece	0.25	1	0.25
18	PVC pipe Ø 0.5	meter	1.50	10	15.00
19	Gas hose pipe Ø 0.5"	meter	1.00	1	1.00
	Subtotal Ila				26.80
Ilb	Appliances purchased from NBP only				
20	G.I, Gas outlet pipe Ø 2", 0.6 m long	piece	5.00	1	5.00
21	Water drain valve	piece	4.00	1	4.00
22	Gas tap	piece	6.00	1	6.00
23	Stoves single burner	piece	11.00	1	11.00
24	Lamp	piece	3.50	1	3.50
25	Pressure gauge	unit	2.00	1	2.00
	Subtotal Ilb				31.50
III	Labor				
26	Skilled labor	no.	4.50	20	90.00
27	Unskilled labor	No.	2.00	20	40.00
28	Excavation of soil	m ³	1.50	25	37.50
	Subtotal III				167.50
	Total				839.70
	Guarantee				35.00
	Participation Fee				15.00
	Total (including guarantee and after sales services)				889.70

* Should be purchased by customer from Biodigester Construction Company

** Indicator price; actual price will vary depending on location and market developments, ±5 percent

Form 03-P

No.: _____, date _____ month _____ 200 _____

BIODIGESTER SALES CONTRACT

Between:

1. Customer: Biodigester Program Supported Household	2. Company: Licensed Biodigester Construction Company
Address:	Address:
Telephone:	Telephone:
Household Owner Name:	Representative Name and Position:

for the construction of biodigester plant under the NBP whereby:

The Company:

1. Shall construct a _____ m³ biogas plant for the client.
2. Shall commence construction within _____ days of client’s notification and will complete construction no later than Day _____ Month _____, Year 20_____.
3. Shall provide to the client all services regarding this biogas plant according to the agreement between NBP and the Company.
4. Shall be responsible for safety at work, and bear all expenses if any accident happens.
5. Shall warranty construction works for 24 months from the Acceptance Date if Party A operates and maintains the biodigesters correctly to program requirements.
6. Shall carry out four scheduled visits, one every 6 months, to provide Party A with maintenance of the biodigester and after-sales service.

The Client:

7. (a) _____ shall provide the construction materials (cement, bricks, stones, gravel, sand) as instructed by company within the period as stipulated in article 2. Construction materials shall be rejected by company if not as per NBP standards; or;
(b) _____ shall pay Company to obtain construction materials in the amount of US\$/KHR _____ including delivery charge;
8. (a) _____ shall provide unskilled labor for excavation of soil prior to the construction of this plant, or;
(b) _____ pay the company US\$/KHR _____ for excavation of soil.
9. Agrees to pay the Company US\$/KHR _____ for appliances provided by the company.
10. Agrees to pay the Company US\$/KHR _____ for labor to construct the biodigester plant.
11. Agrees to pay the Company a total of _____ US\$/KHR for construction of the plant, as outlined below:

Construction Materials provided by Company including delivery fee	KHR/Dollars
Labor Provided by Company	KHR/Dollars
Appliances Provided by Company	KHR/Dollars
Total to Pay Company	KHR/Dollars

12. Declares that he or any other member of his/her household has not taken subsidy for a biogas plant before and will not request subsidy twice for the same plant.
13. Declares that this plant is financed on cash/loan basis.
14. Shall not request or allow other companies to construct the biogas plant without the written permission of the Company.

(continued)

Form 03-P (Continued)

15. May allow other companies to construct plant if the Company does not commence construction within the time as mentioned in article 2.
16. Agrees to put the plant into operation and prepare for acceptance in 30 days at the latest after the completion date.
17. Agrees to pay to the PBPO a program participation fee of US\$15 and a guarantee fee of US\$ _____ in order to receive a plant completion report and subsidy payment of US\$150.

Both parties:

18. Agree to strictly follow the rules of NBP regarding the installation of the biogas plant and receipt of the subsidy for the plant.
19. Declare that this sales agreement is the first and only between the client and any biogas company.
20. Have agreed that in cases not specified above, they will follow the existing laws of Cambodia.

Unilateral termination of construction contract and compensation:

21. Both Company and Customer have the right to terminate the construction contract unilaterally and can request compensation when the other party violates contract provisions.
22. The responsible party has to compensate all expenses that the other party has paid for the loss, unless otherwise stated.

Complaints and dispute settlement:

23. All complaints and disputes will be considered and settled by both parties based on mutual interest. If both parties cannot reach final agreement then the matter will be brought before Civil Court for final judgment.

This agreement is signed on the _____ day of _____, _____ in two copies, one copy for each party.

FOR CUSTOMER:

(Full name + Signature)

FOR COMPANY:

(Full name + Signature)

7. Instructing the Customer on Buying Construction Materials

Your ability to construct a high-quality biodigester depends on the quality of the construction materials. If farmers decide to purchase their own construction materials, you should remind them of the characteristics of good construction materials.

When you sign the contract, you should give your customer a copy of the list of construction materials (shown on the next page), and draw a circle around the size of biodigester that the customer has purchased. This will help him buy the right materials of the right quality.

You should also explain the purchase list step-by-step to the customer. Be sure to explain each item.

Bricks

- Should be high-quality (No.1), usually the best quality available in the local market
- Should be well burned, straight, regular in shape and size and have no cracks or broken parts

Mild Steel Bars

- Bar should be free of heavy rust
- 8 mm diameter for plants of 4, 6, and 8 m³
- 10 mm diameter for plants of 10 m³ and 15 m³

Cement

- High quality Portland cement from a brand with a good reputation, fresh, free of lumps, and stored in dry place

Gravel

- Size: not very big or very small
- Maximum size about 2 cm
- Should be clean, hard, and of angular shape

Sand

- Should be clean, should not contain soil or other materials
- Coarse and granular sand for concrete
- Fine sand for plastering and mortar works

CONSTRUCTION MATERIALS PURCHASE LIST FOR BIODIGESTER CUSTOMERS TO BE GIVEN TO CUSTOMER WITH CONTRACT														
SN	Item	Unit	Unit cost (US\$)	4m ³ (Qty)	Total cost (US\$)	6m ³ (Qty)	Total cost (US\$)	8m ³ (Qty)	10m ³			15m ³ (Qty)	Total cost (US\$)	
									Total cost (US\$)	Qty	Total cost (US\$)			
I	Construction materials													
1	Solid brick	piece	0.1	2,000.0	100.0	2,400.0	120.0	2,800.0	140.0	3,200.0	160.0	4,500.0	225.0	
2	Cement	bag	5.5	14.0	77.0	18.0	99.0	22.0	121.0	26.0	143.00	40.0	220.0	
3	Gravel 1x2	m ³	26.0	0.5	13.0	0.8	20.8	0.9	23.4	1.2	31.20	3.0	78.0	
4	Coarse sand	m ³	8.0	0.4	3.2	0.6	4.8	0.8	6.4	1.0	8.00	2.5	20.0	
5	Fine sand	m ³	10.0	1.1	11.0	1.2	12.0	1.3	13.0	1.4	14.00	3.0	30.0	
6	Inlet PVC pipe 10 cm Ø	piece	4.5	2.0	9.0	2.0	9.0	2.0	9.0	2.0	9.00	2.5	113	
7	Iron bars ø 6	kg	1.5	8.0	12.0	10.0	15.0	12.0	18.0	13.0	19.50	25.0	375	
8	Binding wire	kg	1.3	0.5	0.7	0.5	0.7	0.5	0.7	0.5	0.65	1.0	13	
9	Acrylic emulsion paint	litre	3.0	1.0	3.0	1.2	3.6	1.5	3.9	1.5	4.50	3.0	9.0	
	Approximate cost				228.9		284.9		335.4		389.90		632.1	

Acrylic Emulsion Paint

- BCC should provide customers with Kaltex® brand acrylic emulsion paint because it is not available in the local markets
- BCC may charge customers US\$3 per liter under NBP procedures

Remember, the Biodigester Construction Company owner is responsible for inspecting the construction materials that farmers buy, so provide these instructions before farmers buy the materials, not after.

Section 2. Organizing and Managing the Construction Process

8. Get Organized: Fill out a Project Control Folder

The Project Control Folder (PCF) has four sections that you will need to use to effectively manage biodigester construction projects, and to verify that you have taken all the required actions to complete your obligations to your customers and your team, and your obligations to NBP.

This folder must be kept at the site of the biodigester construction project, and used throughout the project. When the biodigester is complete, it will serve as your record of the project, and should be kept at your business premises. NBP and PBPO employees have the right to inspect this folder at any time during the project at the construction site, or after the project is complete at your business premises during regular business hours. The four sections of the PCF are reproduced on the following pages.

Page 1: Basic Information

Page 1 is used to keep basic information about the project, the team, and your planned schedule for the project. Once you receive a plant code from the PBPO, you must also put this information in the Project Control Folder.

Pages 2–3: Company Quality Control Checklist

The Quality Control (QC) Checklist on pages 2–3 of the Project Control Folder should be used to ensure that your company is taking all the required steps to ensure high quality biodigesters are constructed. There are a number of QC points in each section of the checklist. Each QC point must be verified by a Certified NBP Mason in the Project Control Folder. The mason must sign his initials and the date of the inspection for each point in the numbered box corresponding to the QC point.

Page 4: Summary of Plant Financial Information

Page 4 of the Project Control Folder will help you keep accurate financial records for each biodigester you build. If you keep these records correctly, you will have all of the information you need in order to collect your overhead payments, pay for the appliances you have used, keep track of how much money you have made on each plant, and pay taxes at the end of the year. There are four sections in the financial information summary.

9. Setting the Construction Schedule

The construction schedule is the first page of the Project Control Folder. It should be filled out with the customer at the time you sign the contract. It must be submitted to the PBPO with the contract for biodigester construction. It contains basic information about when you expect to start and complete certain tasks, and who will be working on the job with you. The dates that you enter should be your best estimate of the dates at which each stage will be complete.

10. Submitting the Contract and Construction Schedule to the PBPO

You are required to register three documents with the PBPO when you have made a contract with a customer:

- Contract;
- Construction Schedule; and
- Form 02-P—Customer Information.

BCCs must do this in order to obtain a plant code and for customers to be eligible for the subsidy.

How to Register these Documents

To register a contract, the BCC must make a photocopy of each page of the biodigester sale contract, the front page of the project control folder showing the construction schedule, and Form 02-P, and submit them to the PBPO Coordinator during office hours. The PBPO Coordinator will assign a unique plant number at that time. You should keep the original copies for your records at your place of business.

Why Must these Documents be Registered with the PBPO?

Only registered contracts are eligible for overhead and subsidy payments. If you do not register your contract before you begin construction, your customer may not receive his subsidy, and you will not receive your overhead payment from NBP.

PROJECT CONTROL FOLDER:

Page 1—Basic Information and Construction Schedule

1. Basic information about your customer

Name of customer	
Street	
Village	
Commune	
Telephone	

2. Plant Code

Plant code	
------------	--

Team information	
Name of NBP mason responsible for construction	
Name(s) of helpers	

3. Information about your company's construction team

4. Your construction schedule that you plan to follow

Schedule	Planned date	Actual date
Date of contract		
Contract and schedule registered with PBPO		
Appliances received from PBPO		
Date to begin excavation		
Date excavation complete		
Date(s) of concreting foundation		
Date to begin plastering		
Date of appliance installation		
Date of user training		
Date of completion report		
Follow-up visit 1		
Follow-up visit 2		
Follow-up visit 3		
Follow-up visit 4: End of guarantee period		

PROJECT CONTROL FOLDER:

Pages 2–3—Company Quality Control Checklist

Checklist for Company Quality Control		Checked by/Date
1	Before excavation begins, check site selection and draw layout.	
1.1	Use site selection checklist (guidelines) in Section 3 of the <i>Operations Manual</i> .	1.1
2	When construction materials arrive, check their quality.	
2.1	Use construction materials checklist in Section 11 of the <i>Operations Manual</i> .	2.1
3	During pouring concrete for the plant foundation, inspect the biodigester's curvature and the quality of concreting.	
3.1	Center of the foundation's curvature is also the center of the pit.	3.1
3.2	Depth of the pit is as drawing before making the curvature.	3.2
3.3	Radius of curvature is as in the drawing.	3.3
3.4	Top of the curvature is leveled.	3.4
3.5	Concrete is composed of (1 cement, 2 sand, and 4 aggregate) with proper water/cement ratio.	
3.6	Concrete is 7.7 to 10 cm thick.	3.6
4	Before laying the inlet pipes, inspect the bricklaying of the plant wall.	
4.1	Brick is soaked with clean water for about 15 minutes before using.	4.1
4.1	Ratio of mortar: sand = 1:3 with clean water.	
4.3	Mortar joints in two adjacent brick layers never fall in a vertical line.	4.3
5	When laying the inlet pipe, inspect laying of the inlet pipe.	
5.1	Inlet pipe diameter is 10 cm.	5.1
5.2	Inlet pipe is placed at the heart-line.	5.6
5.3	Slope of the inlet pipe is at least 60° with the ground level.	5.3
5.4	Pipe's surface is cleaned at the contact surface between the pipe and the wall.	5.4
5.5	Pipe is properly fixed.	5.5
5.6	Toilet pipe (optional) is placed not farther than 30 cm from the heart-line.	5.6
6	After inspecting the inlet pipe, inspect the curvature of the outlet.	
6.1	Constructing the wall up to certain height, then making the curvature of first outlet.	6.1
6.2	Soil used as the mold is correct shape for making the curvature.	6.2
6.3	Position of brick at both sides of edges of the curvature: half of the brick stays on the wall and half stays on soil frame.	6.3
7	When the guide bamboo is 45° from horizontal, inspect outside plastering.	
7.1	Outer wall is plastered before starting the fresh layer each day.	7.1
7.2	Before plastering, the entire surface of the brick wall is cleaned with clean water and steel brush.	7.2
7.3	One (1) layer of 8 mm thick cement sand plaster is used, 1:4 mix.	7.3
8	After plastering, inspect the quality of bricklaying and the use of S-hooks.	
8.1	Right amount of mortar has been used to lay bricks.	8.1
8.2	Bricks are soaked with clean water.	8.2
8.3	Mortar joints in two adjacent brick layers never fall in a vertical line.	8.3
8.4	Approximately 100 S-hooks used.	8.4
8.5	Each S-hook attached to a brick.	8.5
8.6	S-hooks are proper shape.	8.6
8.7	Counterweight is 2 or 3 pieces of brick.	8.7

(continued)

PROJECT CONTROL FOLDER:

Pages 2–3—Company Quality Control Checklist, Cont.

Checklist for Company Quality Control		Checked by/Date
9	Before closing the dome, inspect dome construction, frameworks, gas pipe, and mortar.	
9.1	Diameter of the top dome is 50 to 90 cm before closing the dome.	9.1
9.2	Frameworks: scaffoldings correct, soil prepared as mold for laying bricks, and sand is sprinkled in mold.	9.2
9.3	Main gas pipe is placed at the center of the dome and faced toward the kitchen.	9.3
9.4	Mortar is well poured and compacted and left to dry for minimum 2 days before removing the framework.	9.4
10	Ensure quality during plastering of digester and gas chamber.	
10.1	Entire surface of the brick wall is cleaned with water and steel brush before starting the plastering.	10.1
10.2	Outside: Bricks are scrubbed and scratched.	10.2
10.3	Outside: 1 layer of 8 mm thick cement sand plaster, 1:4 mix.	10.3
10.4	Inside: Bricks are scrubbed and scratched.	10.4
10.5	Inside: Each plastering layer is smooth and fine.	10.5
10.6	Inside: 5 layers of dome treatment works applied on the proper schedule.	10.5
11	Ensure that the second outlet is correct during construction.	
11.1	Height of the manhole is as drawing.	11.1
11.2	Inspect the dimensions of the outlet against drawing.	11.2
11.3	Mix of concrete cement: sand: aggregate is 1:2:4.	11.3
11.4	Concrete floor is 7.5 cm thick.	11.4
11.5	Each plastering layer is smooth and fine.	11.5
11.6	Surface of the floor is horizontal and smooth.	11.6
11.7	Overflow opening is on the heart-line.	11.7
12	During construction of the inlet, ensure that inlet is correct.	
12.1	Foundation of the tank is well rammed and hard and the surface is level.	12.1
12.2	The floor of the inlet is at least 15 cm above the outlet overflow level.	12.2
12.3	Inlet pipe position: Pole or rod cam entered through inlet pipe without obstruction for de-blocking.	12.3
T	If toilet attachment to the plant	
T.1	No siphon or trap in toilet plan construction.	T1
T.2	Inlet pipe from toilet discharges less than 45° from the heart-line.	T2
T.3	Pan level of toilet is at least 15 cm above the overflow levels in the outlet.	T3

Notes on actions taken by Company to repair defects in quality check:

PBPO Supervisors will use the construction schedule to supervise your construction projects, to plan inspections, and to schedule plant completion reports in a timely manner.

Form 02-P must be submitted because PBPO and NBP Technical Supervisors need to be able to verify technical

feasibility to maintain the relationship between NBP and PRASAC MFI.

No Payments Required

There are no payments required of BCCs at the time of contract registration and construction schedule submission, unless the company is delinquent with payments

PROJECT CONTROL FOLDER:
PAGE 4: SUMMARY OF PLANT FINANCIAL INFORMATION

1. Summary of the contract you have made with the customer, and a record of payments that have been made.

Summary of Plant Financial Information

Contracted items	Amount	Date	Signature
Construction materials	\$		
Labor	\$		
Appliances	\$		
Total of contract	\$		
Payment 1	\$		
Balance	\$		
Payment 2	\$		
Balance	\$		

2. Appliance Accounting: Summary of the amounts that the customer pays you for appliances, and the amount you must pay to the PBPO for these after your project is complete.

Appliance Accounting

1. Customer's appliance payment to company	\$	KHR
2. Overhead retained by company	\$35	KHR
3. Company start-up bonus (\$15 for plants 1-30 only)	\$0 or \$15	KHR
4. Total amount due to company from NBP (2+3)	\$	KHR
5. Total owed to PBPO for appliances (1-4)	\$	KHR

Team Payment(s)

Mason in charge

Name of Mason in Charge Contract Amount Amount Paid Date Signature of Mason

Helper 1

Name of Helper 1 Contract Amount Amount Paid Date Signature of Helper

Helper 2

Name of Helper 2 Contract Amount Amount Paid Date Signature of Helper

Payment to Promoter

Name of Promoter Amount Owed Amount Paid Date Signature of Promoter

Other Project Expenses

	Description	Amount paid	Date
	Tools		
	Transportation		
	Other		
	Total		_____

4. Other expenses you have paid during this project.

3. Summary of payments you make to the construction team, and to the promoter who referred you to your customer.

for appliances. In this case, the PBPO may require you to pay the amount you owe NBP for appliances, but may not charge any fees or request any payments for contract registration or to receive a plant code.

If a PBPO official asks you for a payment to obtain a plant code or to register your contract, contact the Finance Officer [Name] at the NBP office in Phnom Penh, Telephone _____.

11. Inspecting Construction Materials

The form shown on page 94 provides guidelines for inspecting the construction materials that you or your customer buy. For each answer marked "NO," describe what must be corrected in the third column.

12. Drawing the Plant Layout

Construction work on the biodigester starts with laying out the plant. This is the activity carried out to mark the dimensions of the plant on the ground so you can start the digging work in the right place.

The following steps should be followed:

- *Stick a small peg in the ground at the center spot of the biodigester (to mark the spot).*
- *Level the ground and determine the center line of the biodigester, outlet tank, and inlet pit (generally called the heart-line).*
 - *Mark the area to dig for biodigester*
 - *Select the outer diameter of the pit (digester diameter plus wall thickness) as shown in the drawing and mark it with rope or cord.*
 - *Mark the area to dig:* Insert a stick or wooden peg in the leveled ground at the center of the proposed digester pit. With the help of the pole and cord prepared earlier, make a circle. This will indicate the area to dig.
- *Mark the dimensions of outlet (1) and outlet (2)*
 - *Mark the width of outlet (1) and outlet (2):* From the center point, where the central line meets with the perimeter line, draw a tangent and measure a length equal to half of the inner width of outlet plus wall thickness on either side of this tangent.
 - *Mark the length of outlet (1) and outlet (2):* Draw horizontal parallel lines from the points on either side in the tangent, which will meet the dome. From the center point where the central line meets the perimeter line, measure the length of outlet plus wall thickness to decide the outer dimension of outlet.

- *Check the size diagonally* to ensure that the corners are exactly at 90 degrees.
- *Decide the location of slurry pits* while laying out plant digester and outlet.

13. Obtaining the Tools Required for Construction

The following tools are required for different stages of the biodigester construction process.

BCC owners or lead masons should arrange tool responsibilities in advance with their teams to ensure that the correct tools are available at the construction site for the appropriate phase of construction. BCCs should be prepared to provide tools for the use of their construction teams if necessary, or to compensate masons and helpers (or share costs) for the use of their tools if this is appropriate.

Bricklaying (Masonry) Work

- Hoe
- Shovel
- Axe
- Hammer
- (Hand) saw
- Trowel
- Wooden brace for top of dome

Plastering

- Plastering trowel
- Wooden boards for smoothing
- Wood palate
- Plastic trowel
- Broom/sweeper
- Paint brush (#3)
- Mortar bucket
- Level-line ruler
- Rubber boots for all workers
- Metal shears (snips/scissors)
- S-Hooks (100)

Measuring Tools

- Tape measure
- T-square (steel)
- Nylon string
- Plumb bob
- Level
- Transparent water pipe for leveling

CONSTRUCTION MATERIAL INSPECTION GUIDELINES

Schedule	Yes	No	Correction required
Cement			
High quality Portland cement from a brand with a good reputation			
Fresh, free from lumps and stored in dry place			
Sand			
Clean and does not contain soil or other materials			
Coarse and granular sand for concrete			
Fine sand for plastering and mortar works			
Gravel			
Size: not very big or very small			
Maximum size 2 cm or ¼ of thickness of concrete layer			
Should be clean, hard, and of angular shape			
Dirty gravel must be washed properly before use			
Bricks			
Should be of high quality (No.1), usually the best quality available in the local market			
Should be well burned, straight, regular in shape and size with no cracks or broken parts			
Mild Steel Bars			
MS bar should be free from heavy rust			
8mm diameter for plants of 4, 6 and 8 m ³			
10mm diameter for plants of 10m ³ and 15m ³			
Acrylic Emulsion Paint			
NBP Strongly Recommends Kaltex® Brand Acrylic Emulsion Paint			

14. Supervising the Excavation of Soil

After completion of layout, the work of digging must begin. Tools—crowbar, picks, spades, shovels and baskets—should be available at the site.

Farmers will usually want to do the digging themselves. If this is the case, remind them that excavated earth should be deposited at least two meters away from the pit on each side to make construction work easier.

Dig the foundation for the manhole (first step of outlet tank) along with the foundation for the biodigester according to the dimensions determined during layout.

The following points have to be observed:

- As far as practical, digging should be straight down without creating a slope. If the soil is loose on the

sides and crumbles, scaffolding may be needed to keep the soil in place as digging continues.

- If the water table is high and digging to the required depth is difficult, a deeper pit must be constructed near the biodigester pit. Water from the biodigester pit has to drain to this second pit through underground pipes. Water should be pumped from this pit.
- Once the biodigester pit is of the proper depth, the work of fixing curvature at the pit's bottom has to be considered while digging.
- Now horizontal poles are placed on the ground crossing each other at 90 degrees in the center. Ensure that the poles rest on level ground.
- A rope or cord the length of the inner radius of the biodigester (as shown in the drawing) plus additional length needed to tie it to a pole and a wedge at each end is tied at the pole exactly at the center. A wedge is tied to the other side of the rope. The length from

the pole to the wedge should be equal to the inner radius of the biodigester plus plaster thickness.

- With the help of the rope or cord, decide the depth of the pit and the shape of its curvature. Never dig more than the depth as indicated in the drawing. If done so, earth has to be compacted firmly in this area to fill it.
- Be careful to avoid accidents while digging near the sides, as soil may collapse.

15. Supervising Construction to Ensure Quality

Quality control is the shared responsibility of the BCCs and the PBPO supervisors. The checklists on the next two pages appear on the Project Control Folder and should be used by BCC owners and team leaders to ensure that quality of biodigester construction is maintained for each customer, and in each phase of construction.

There are 12 phases in the construction process that are most important for BCCs to check, and several specific points that must be checked at each of these twelve times.

For each point, a Certified NBP Mason (either the company owner or a Certified NBP Mason who is working for him) must check and place his initials and the date of the check in the box on the project control sheet.

In the Quality Control Checklist in your PCF, every box with a number (for example, 1.1, 3.4, 5.5) must have the initials of a Certified NBP Mason and the date of the check.

16. Appliances and Spare Parts

Following the procedures for appliance payment is very important, because this is the mechanism that NBP uses to pay your company the US\$35 overhead fee that you are entitled to as a Biodigester Construction Company, the US\$5 promotion fee, and the US\$15 start-up bonus for your first 30 plants.

Procedure for Biodigester Construction Company Appliance and Spare Parts Provisions and Payment with PBPO

- BCC receives sufficient appliances and parts in advance from PBPO to complete 15 plant installations. BCC is issued an invoice for these materials and the invoice is recorded by the PBPO Coordinator.
- BCC is obligated to store these appliances at their premises or place of business.

- When the BCC has used 10 sets of appliances, BCC should obtain 10 new (replacement sets) from the PBPO and pay for the 10 sets it has used.
- The payment required by the BCC calculated as follows:

Cost of 10 appliance sets	Actual cost of 10 sets of appliances provided by PBPO
minus	–
Overhead	(US\$35 × Plant Completion Reports since last payment)
minus	–
Start-up bonus	(US\$15 × Number of Plant Completion Reports since last payment that are eligible for start-up bonus)
equals	=
Required payment	Payment from BCC to PBPO

If the BCC has (additionally) sold part of a complete appliance set, he should also replace those individual parts each time he/she receives an additional 10 appliance sets. NBP will not extend credit for items that BCCs have already sold to customers.

Example:

A new Biodigester Construction Company takes 15 sets of appliances and spare parts from the PBPO valued at US\$,1200 (US\$80 per set).

After completing its first 10 plants, the BCC must replenish its appliance and spare parts stocks for new jobs.

The cost of the 10 appliance sets is US\$800 (US\$80 per set × 10 sets)

PBPO then **subtracts** the overhead payment for ten plants (US\$35 overhead × 10 plants=US\$350) from the total due. **US\$800–US\$350=US\$450** total due after overheads.

PBPO then subtracts the start-up bonus (US\$15 startup bonus × 10 plants=US\$150) from the total due after overheads.

US\$450–US\$150=US\$300 final payment due.

The balance of the BCC’s Appliance Account with the PBPO after this payment is US\$1,200–US\$800=US\$400 **plus** the value of 10 additional appliance kits (US\$800) **and** any spare parts or other appliances that the BCC takes from the PBPO.

Spare Parts

The BCC is also required to hold additional spare parts in stock that are required for maintenance at the time of making payments for appliance purchases. The BCC should maintain the following spare parts stock at all times.

NBP SPARE PARTS STOCK REQUIREMENT FOR BCCs		
Item	Number to Keep in Stock	Cost (US\$)/unit
1. Mantles	10	0.01
2. Lamp glass	10	0.50
3. O-rings	10	0.00
4. Lamp reflectors and upper shell (kit)	10	1.00
5. Muddy shower	10	0.20

Keeping Track of Company Appliance and Spare Parts Inventory

BCCs should keep careful track of appliance and spare parts inventory, and the money that is owed to the PBPO for the appliances and spare parts they have used. There are two forms (following pages) that BCCs are required to maintain to keep track of appliances and spare parts. These are:

1. Appliance Inventory Form (Form A-1)

The appliance inventory form is used to keep track of the appliances and spare parts that come in to the BCC and the appliances and spare parts that are used by the BCC. It has a column for each item that is provided by NBP. BCCs should keep a continuous inventory of the parts that are received from the PBPO and the parts that are used for new biodigester construction, scheduled maintenance, and after-sales service.

The blank (white) lines are for recording transactions (items coming in or going out). Each transaction should be recorded in a separate white line. *You should always use a different line for items coming in and items going out.*

The dark (shaded) lines are for keeping a running total of the items in the BCC's stock.

Date: The date of parts coming in or going out of the BCC's place of business.

In/Out: If parts are coming in from PBPO, indicate "in." If parts are going out to a client's home or a new construction, write "out."

Activity: Are parts being used for a new Farmer's Friend biodigester construction? Are they spare parts or for after-sales service? Write this in the area under "activity." It is best to use the plant code to keep close track of the items that are used, both for new construction and for service.

Number of each item received or used: Under the heading of the appropriate item, write the number of parts that are coming in or going out.

The current inventory of each part should be calculated and entered in the dark shaded line every time parts come in from the PBPO or go out to be used with a customer. After each transaction, calculate the current inventory by adding parts coming "in" (on lines where you have entered "in") to the previous number of parts in stock, or subtracting items going "out" (on the lines where you have entered "out") from the previous number of parts in stock.

In this way, BCCs can keep track of parts that are in stock, and will know when they need to get more appliance kits or spare parts from the PBPO.

2. Form A-2: Appliance and Spare Parts Account

This is the second form that BCCs are required to maintain to keep track of appliances and spare parts. Accounting for the value of appliance kits and spare parts in stock and of the money you owe to the PBPO is the most important and difficult/complex accounting task for BCCs. Form A-2 provides a way to keep track of these two figures, and to make sure you receive the right amount of money from NBP for your overhead payments.

Recording Appliances and Spare Parts Received from the PBPO

First, when the company receives appliances and spare parts from the PBPO, the date of receipt and the value of these parts stated on the PBPO invoice should be entered on the first white line, and "Received from PBPO" should be written in the Description (Plant Code/Customer) column. Then, these totals should be transferred to the shaded line marked "Total," reflecting the inventory of parts on the date they were received.

Recording Appliances and Spare Parts Used

Next, whenever spare parts or appliances are taken out of the company's place of business, this should be recorded. The BCC should write on a white line: **Date;** **Plant code of customer for new appliance kits, (or customer's name for spare parts sales);** and **value of appliances and/or spare parts being taken from inventory;**

For New Plants Only: Calculate the amount of overhead payment (US\$35) and start-up bonus (US\$15 for the first 30 plants) and add the two together for the total amount due from NBP.

Calculate how much the BCC owes the PBPO for these appliances and spare parts.

- If these are spare parts only, the amount owed to the PBPO will be exactly the same as the value of the appliances.
- If these are appliances for a new biodigester, the amount owed to the PBPO is *Value of Appliances and Spare Parts MINUS Total Amount Due from NBP*.

Keeping Track of the Total

The shaded (dark) lines are used to calculate the value of the BCC’s inventory and the amount owed to the PBPO after each transaction. After each transaction, BCCs should use the dark (shaded) lines to calculate

- the *value of BCC’s inventory* of appliances and spare parts, by subtracting the value of appliances or spare parts from the previous value of inventory, and
- the *amount owed to PBPO*, by adding the amount owed to the PBPO for the appliance or spare parts transaction to the amount previously owed to the PBPO.

New totals of the value of inventory and amount owed to the PBPO should be entered after each transaction in the next dark (shaded) line.

17. User Training: Explaining Plant Operations

After the completion of all construction work, the BCC mason must provide proper training to users in plant operation and minor maintenance. The importance of daily feeding in the right amount, operation of different appliances, and major points to be remembered while operating the plant should all be explained to the user before leaving the construction site. Information on the following aspects of operational activities must be provided.

- Initial filling of plant
- Daily feeding of plant
- Use of main valve
- Checking leakages
- Use of water drain
- Cleaning of outlet
- Composting/maintaining compost pits

- Oiling of gas tap
- Cleaning of gas stove
- Cleaning of gas lamp
- Breaking of scum layer

Approximately 3–7 days after plant completion, you should visit your customer to make sure that the plant is functioning properly.

18. Collecting Work and Appliance Payments from Customers

After the plant is finished and you have given basic user training and maintenance instruction to the customer, you may collect the appliance and work payments. At this time, you should do the following:

1. Present the customer with an official NBP invoice.

This should clearly show the amounts that the customer owes for appliances and construction services. The approved NBP invoice is shown below.

2. Ask the customer for payment in full.

Some customers may ask you to wait for payment until they have received their subsidy payment after the plant completion report. This practice is not approved by NBP, although it may occur occasionally. If this is the case, you should require the customer to make a partial payment.

Official Biodigester Construction Company Invoice					
				Invoice No. _____	
				Date of Sale _____	
Company Information			Customer Information		
Name _____			Name _____		
Address _____			Address _____		
Telephone _____			Telephone _____		
No	Name of Item	Description	Quantity	Unit Cost	Total Amount
1					
2					
3					
4					
5					
6					
				Total Amount	
				Discount	
				Payment Received	
				Balance	
_____ Signature of Seller			_____ Signature of Customer		

4. Enter the customer's payment on page 4 of the Project Control Folder in the appropriate place.

5. Calculate amount owed to PBPO for appliances.

Calculate how much of the payment must be saved (put away) to pay the PBPO for appliances. NBP strongly recommends depositing this amount into your bank account immediately.

6. Pay your workers.

When you give your workers payment for their labor, write their names, the amount, and the date of the payment on page 4 of the Project Control Folder and require that they sign to verify that you have paid them.

7. Pay the promoter who referred your customer.

NBP strongly recommends that you (the company owner) go to thank the promoter for his referral and deliver the US\$5 promoter fee yourself.

PLANT COMPLETION REPORT

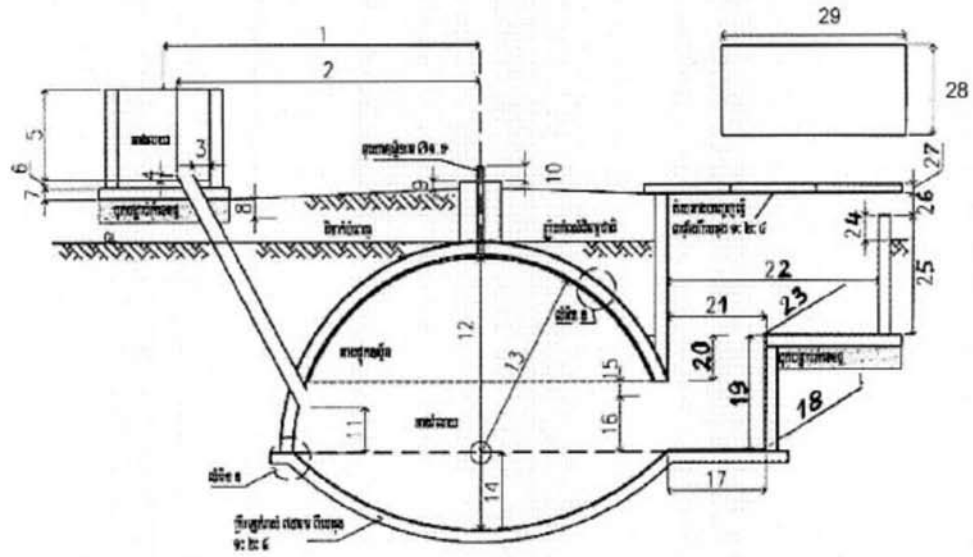


កម្មវិធីជំនួយស្តុកស្តុកជាតិ
របាយការណ៍បញ្ចប់ការងារសាងសង់ឡ

ព័ត៌មានទូទៅ:		តារាងលេខ ៩
លេខកូតឡ:	បរិមាណស៊ីម៉ង់ត៍ប្រើសរុប:	_____ តោន
ឈ្មោះម្ចាស់ឡ:	ជីហោរបស់ចម្រុះ:	ចំនួនដែលប្រើ: _____
អត្តសញ្ញាណប័ណ្ណលេខ:	ជីហោចម្រុះ:	ចំនួនដែលប្រើ: _____
ឈ្មោះមេគ្រួសារ:	ជីហោវាងមេ:	_____
អាសយដ្ឋាន:	ភូមិ:	ជីហោវាងដោះទឹក: _____
ឃុំ:	ស្រុក:	ជីហោវាងចម្រុះ: _____
ខេត្ត:		ប្រភេទបំពង់ឧស្ម័នមេ: _____
ចំនួនសមាជិកគ្រួសារដែលប្រើប្រាស់ចម្រុះ: _____ នាក់		ប្រភេទឧបករណ៍បង្កឧស្ម័ន: <input type="checkbox"/> ឧបករណ៍PVC ផ្ទៃក្រចក, <input type="checkbox"/> ឧបករណ៍PVC ធ្វើក្នុងស្រុក
ទំហំឡ: <input type="checkbox"/> ៤ម ^៣ <input type="checkbox"/> ៦ម ^៣ <input type="checkbox"/> ៨ម ^៣ <input type="checkbox"/> ១០ម ^៣ <input type="checkbox"/> ១៥ម ^៣		ប្រវែងឧបករណ៍ឧស្ម័ន: _____ ម
ឈ្មោះជាងចម្បងឧស្ម័ន:		ជម្រកឈ្នួលបំពង់ឧស្ម័ន: _____ ម
ឈ្មោះរបស់ក្រុមហ៊ុន:		សារធាតុកាបូនជីវៈ: <input type="checkbox"/> កាបូនPVC <input type="checkbox"/> ស្ថិតិទឹក <input type="checkbox"/> ថ្នាំចោលដឹក
កាលបរិច្ឆេទចាប់ផ្តើមសាងសង់: ថ្ងៃ _____ ខែ _____ ឆ្នាំ ២០០០		គុណភាពការប្រកបរបស់អាងរំលាយ: <input type="checkbox"/> ល្អ <input type="checkbox"/> មធ្យម <input type="checkbox"/> អស់
កាលបរិច្ឆេទបញ្ចប់សាងសង់: ថ្ងៃ _____ ខែ _____ ឆ្នាំ ២០០០		គុណភាពការប្រកបថ្ងៃខាងក្រុងរបស់អាងរំលាយឧស្ម័ន: <input type="checkbox"/> ល្អ <input type="checkbox"/> មធ្យម <input type="checkbox"/> អស់
សាមគ្គីភាពបំពេញកុំឡ:		គុណភាពរបស់បំពង់បំពង់បញ្ចេញ: <input type="checkbox"/> ល្អ <input type="checkbox"/> មធ្យម <input type="checkbox"/> អស់
ចំនួនត្រូវបានដំឡើង: _____ ត្រូវ _____		គុណភាពរបស់បំពង់ដោះទឹក: <input type="checkbox"/> ល្អ <input type="checkbox"/> មធ្យម <input type="checkbox"/> អស់
ចំនួនត្រូវបានដំឡើងដែលមាន: _____ ត្រូវ _____		គុណភាពស្នាដៃសាងសង់របស់ជាង: <input type="checkbox"/> ល្អ <input type="checkbox"/> មធ្យម <input type="checkbox"/> អស់
បរិមាណធារមកសរុបដែលបានប្រើប្រាស់ (គម្រ/ថ្ងៃ): _____		ចំនួនរណ្តៅដឹកបំពង់: <input type="checkbox"/> ០ <input type="checkbox"/> ១ <input type="checkbox"/> ២
បរិមាណធារមកសរុបដែលបានប្រើប្រាស់ (គម្រ/ថ្ងៃ): _____		មាតិកាបំពង់បំពង់បញ្ចេញ: _____
មានបង្គំសង់ហើយឬទេ: <input type="checkbox"/> មាន <input type="checkbox"/> អស់មាន		លក្ខណៈរបស់បំពង់បញ្ចេញ: <input type="checkbox"/> ស្អាត <input type="checkbox"/> ត្រឹមត្រូវ <input type="checkbox"/> ត្រូវបានណាស់
បង្គំសង់ភ្ជាប់ទៅនឹងឡជីវៈឧស្ម័នហើយឬទេ: <input type="checkbox"/> ត <input type="checkbox"/> មិនទាន់		ទីតាំងរបស់ឧបករណ៍បង្កឧស្ម័ន, អាងរំលាយនិងអាងរំលាយឧស្ម័ន:
តើទីតាំងភ្ជាប់ទៅថ្ងៃអាតត្រូវបានដំឡើង: <input type="checkbox"/> ភ្ជាប់ <input type="checkbox"/> មិនភ្ជាប់		ច្រកចេញឧស្ម័នរបស់ឡ និង អាងបញ្ចេញឧស្ម័ននៅលើកំពូកឡ:
គិតវិថីរបស់ឡ:		<input type="checkbox"/> ត្រឹមត្រូវ <input type="checkbox"/> មិនត្រឹមត្រូវ
ប្រវែងគ្រឿងបញ្ចេញ: _____ ម		ការវិនិច្ឆ័យរបស់អ្នកប្រើប្រាស់:
ប្រវែងគ្រឿងបញ្ចេញប្រើ/ប្រែប្រួល: _____ ម		លំដាប់ទៅដល់អ្នកប្រើប្រាស់បានត្រឹមត្រូវ: <input type="checkbox"/> ត្រូវ <input type="checkbox"/> មិនត្រូវ <input type="checkbox"/> អត់ទាន់បានធ្វើ
ប្រវែងគ្រឿងបញ្ចេញដឹក/ខ្ទង់: _____ ម		បើសិនជាបានធ្វើ, តើដោយឧបករណ៍: <input type="checkbox"/> ជាង <input type="checkbox"/> អ្នកប្រើប្រាស់
មានបញ្ហាទឹកក្រាមឱ្យអត់: <input type="checkbox"/> មាន <input type="checkbox"/> អស់មាន		ឧបករណ៍ត្រូវបានធ្វើការណែនាំ: សមាជិកគ្រួសារ <input type="checkbox"/> ប្រុស <input type="checkbox"/> ស្រី <input type="checkbox"/> ប្រុសនិងស្រី
ងាយស្រួលក្នុងការចាក់ធារមក: <input type="checkbox"/> ងាយ <input type="checkbox"/> មធ្យម <input type="checkbox"/> លំបាក		ស្បូវកៅណែនាំ និង វិញ្ញាបនប័ត្រធានាបានផ្តល់អោយអ្នកប្រើប្រាស់ឡ:
សុវត្ថិភាពពីការប្រេះប្រាស់/ការបំផ្លាញប្រព័ន្ធស្រូស្យូស្រាវាចារណៈ:		<input type="checkbox"/> ប្រគល់អោយរួចហើយ <input type="checkbox"/> មិនទាន់បានប្រគល់អោយ
<input type="checkbox"/> ត្រឹមត្រូវ <input type="checkbox"/> មិនត្រឹមត្រូវ		ចំណាប់អារម្មណ៍របស់អ្នកប្រើប្រាស់:

ហត្ថលេខាម្ចាស់ឡ
ហត្ថលេខារបស់មេគ្រួសារកំណត់
ហត្ថលេខារបស់នាយកកម្មវិធីជំនួយស្តុកស្តុក

PLANT COMPLETION REPORT (CONTINUED)



១.	ប្រព័ន្ធពីកំពូលរបស់ខ្លួនដល់ចំនុចកណ្តាលរបស់អាងលាយ	.....មម	១៦	កំពស់ជញ្ជាំងច្រកចេញចូល	.....មម
២	ប្រព័ន្ធពីកំពូលរបស់ខ្លួនដល់ចុងបំពង់បញ្ជូនល្បាយខាងក្រៅ	.....មម	១៧	ប្រព័ន្ធបញ្ជាញរបស់ធាតុអាងទី ១	.....មម
៣	ប្រព័ន្ធពីជញ្ជាំងអាងលាយដល់ចុងបំពង់បញ្ជូនល្បាយខាងក្នុង	.....មម	១៨	ប្រព័ន្ធទទឹងរបស់ធាតុអាងទី ១	.....មម
៤	ប្រព័ន្ធពីចុងបំពង់ដល់ធាតុអាងលាយ	.....មម	១៩	កំពស់របស់អាងបញ្ចេញជាន់ទី ១	.....មម
៥	កំពស់ខាងក្នុងរបស់អាងលាយ	.....មម	២០	កំពស់សំពាធ	.....មម
៦	សាបធាតុរបស់អាងលាយ	.....មម	២១	ប្រព័ន្ធមាត់ច្រកចេញចូលអាងទី១	.....មម
៧	កំរាលធាតុបេតុងរបស់អាងលាយ	.....មម	២២	ប្រព័ន្ធបញ្ជាញរបស់អាងបញ្ចេញទី ២	.....មម
៨	ប្រព័ន្ធកំពស់ពីធាតុរបស់រន្ធបញ្ចេញល្បាយដល់ធាតុគ្រឹះរបស់អាងលាយ	.....មម	២៣	ប្រព័ន្ធទទឹងរបស់អាងបញ្ចេញទី ២	.....មម
៩	ប្រព័ន្ធពីកំពូលរបស់សរសរឥដ្ឋចប់ខុបយានស្នៀមមេដល់គ្រឹះកំពស់ដីចាក់បំពេញឲ្យ	.....មម	២៤	កំពស់ពីដី (ឬពីកំណែងកំពូលឲ្យ) ដល់ធាតុរន្ធបញ្ចេញល្បាយ	.....មម
១០	ប្រព័ន្ធពីកំពូលរបស់សរសរឥដ្ឋចប់ខុបយានស្នៀមមេដល់ចុងខុបយានស្នៀមមេ	.....មម	២៥	កំពស់អាងបញ្ចេញជាន់ទី ២ដល់រន្ធបញ្ចេញល្បាយ	.....មម
១១	កំពស់ពីគ្រឹះកំពូលដល់ចុងបំពង់បញ្ជូនល្បាយ	.....មម	២៦	កំពស់រន្ធបញ្ចេញល្បាយ	.....មម
១២	កំពស់ខាងក្នុងរបស់ឲ្យ	.....មម	២៧	កំរាលកំរាលអាងបញ្ចេញ	.....មម
១៣	កំរាលកំណែងខាងលើរបស់ឲ្យ	.....មម	២៨	ប្រព័ន្ធទទឹងកំរាលអាងបញ្ចេញ	.....មម
១៤	កំពស់ពីកំណែងធាតុក្រោមដល់គ្រឹះកំពស់គ្រឹះកំពូល	.....មម	២៩	ប្រព័ន្ធបញ្ជាញកំរាលអាងបញ្ចេញ	.....មម
១៥	កំពស់កំណែងច្រកចេញចូល (ចំណុច)	.....មម			

Section 3. After Plant Completion: Warranty, Maintenance, and After-Sales Service

19. BCC Obligations Under the NBP Guarantee: Maintenance and After-Sales Service

A guarantee is a written promise by a company that if a product they build and/or sell develops faults or problems within a particular time, it will be repaired or replaced free of charge. Each NBP customer pays a guarantee fee based on the size of the plant constructed. This fee is paid to the PBPO and deposited into a special bank account.

Under the NBP guarantee, BCCs are obligated to provide a guarantee of their services to biodigester customers, and to address any problems with the biodigester during this period. The following are BCC obligations.

1. Guarantee of BCC Work for a Period of 24 Months

BCCs must guarantee their work for the period of two years (24 months) from the date of the Plant Completion Report. In particular, BCCs must respond quickly to customer complaints about problems with their plants, and maintain at the place of business a record of all such complaints and the solutions provided. Detailed procedures on guarantees are provided in sections 21–22.

2. Replacement of Appliances Provided by NBP for 12 Months (excluding lamps)

The NBP guarantee requires that BCCs replace any NBP-provided appliance found within 12 months of construction to be defective or broken beyond repair. If the customer claims that the appliance is broken or defective but cannot produce the appliance for inspection by the company and return to the PBPO, the customer must pay for the replacement appliance(s).

3. Scheduled Maintenance Visits

Every six months for a period of two years after construction, a Certified NBP Mason representing the BCC must pay a routine visit to inspect the structure of the plant, the pipeline, and the appliances. Detailed procedures for scheduled maintenance are outlined in section 21.

Exceptions to the Guarantee

NBP and the BCC are not responsible for the Farmer's Friend guarantee in five situations that are outlined on the guarantee certificate:

- 1) Problems that result from mistakes of users who do not follow PBPO Supervisor's instructions on the proper use of the plant;
- 2) Problems that result from maintenance and use that does not follow the mason's, the BCC's, or other NBP instructions on proper use of the plant;
- 3) Where repair or change of damaged parts is not done by the mason or BCC who built the plant;
- 4) Damage to a plant that occurs during natural disaster (for example, flood).
- 5) Damage to lamp parts, which must be replaced by the customer.

20. Scheduled Maintenance Visits to Customers

As a Private Biodigester Construction Company, or as a Certified NBP Mason, you or another Certified NBP Mason who works for your company are required to visit each customer once every six months for scheduled maintenance of the biodigester.

You should make a schedule for follow-up at the beginning, write the approximate follow-up dates in your Project Control Folder in the section illustrated below, and make a note on your schedule.

Scheduled Maintenance Visit	Date
Scheduled Maintenance Visit 1	
Scheduled Maintenance Visit 2	
Scheduled Maintenance Visit 3	
Scheduled Maintenance Visit 4: End of Guarantee Period	

When you or your employee visits for scheduled maintenance, make sure to:

1. **Call the customer in advance.** Let them know when you plan to come, and ask them to identify any issues they may have. In particular, ask whether there are any appliance parts that they know need to be replaced. This may save you an extra trip.
2. **Bring tools and spare parts.** You should always bring your tools and spare parts, including those listed on the next page, on scheduled maintenance visits. Forgetting tools or spare parts makes you lose face because you are not prepared, and lose time because you have to make several trips back to the customer's property.

NBP BIODIGESTER WARRANTY CERTIFICATE

Biodigester size: _____ m³; Plant code code: ____ - ____ - ____ / ____
 Household Head: _____
 Address: _____
 Date of Acceptance: ____ / ____ / 200 ____
 Warranty Performance Organisation: Company Code: ____ - ____ - ____
 Address: _____ Telephone: _____
 Team Leader: _____

1. Warranty period is 24 months from the date of the Plant Completion Report
2. NBP appliances are covered for the period of 12 months
3. Plant owner must keep broken appliance(s) or part(s) in order for NBP to provide a replacement
4. BCC will provide two scheduled visits during the warranty period
5. Lamps are not warranted by NBP:
6. All faults caused by the following reasons will **not** be covered under the warranty:
 - a. Faults caused by carelessness of customer
 - b. Operation and maintenance activities are not performed correctly according to program instructions
 - c. Repair activities have been conducted other than by Certified NBP Masons.
 - d. Natural disaster or Act of God
 - e. Material quality does not meet program requirement

For user only:

Date	Trouble	Repair activities	Name of technician (Full name + signature)

Biodigester Construction Company Owner
 (Full name + signature)

3. **Inspect the plant, the pipeline, and appliances.** Examine, and where necessary, adjust and clean the various parts of the biodigester plant so that it will keep working efficiently and safely.
4. **Perform maintenance.** If the mason performing this work detects a fault in the structure that is hampering the proper performance of the plant or has the potential to threaten the functioning of the plant in the future, the mason must carry out the necessary repair work. If not possible at that moment, the mason should make an appointment to perform that repair work within a period of one week.
5. **Replace broken appliance parts and provide spare parts.** Appliances should be inspected for proper

functioning and general condition. If necessary, the BCC should immediately repair or replace an appliance. If immediate replacement is not possible, replacement should be made within a one week. Masons may also sell spare parts to customers for appliances that are not under guarantee according to the NBP spare parts pricing guidelines.

6. **Suggest improvements to user.** During the visit, the mason should interview the user to obtain information on plant operation such as daily feeding with manure and water, mixing and straw removal, use of appliances—main valve, water drain, taps, stoves, lamps, and the like. The mason should instruct users on how operation of the plant can be improved.

National Biodigester Program—Form 10-P

BIODIGESTER COMPANY WORK REPORT

Plant Code	
Name of biodigester owner	Mr/Mrs.
Address	Commune: District: Province:
Name of user(s) consulted during visit	
Size of biodigester (m ³)	4/6/8/10/15
Visited by	
Date of visit	
Purpose of visit	
Main activities carried out at the site during the visit	
Existing problems reported by the user(s), if any	
Instruction(s) given to the users	
User's level of satisfaction	Fully satisfied/Partly satisfied/Not satisfied
Reason for not satisfying fully	
Comments on overall condition and functioning of the biodigester	
Recommendation for follow-up	

Signature: _____

Date: _____

7. **Ask for help from the PBPO if needed.** You must first try to solve the customer's problem yourself, but if you cannot, PBPO supervisors should be called to help you with any difficult problems that you cannot solve on your own.
8. **If you need help and can't get it, call NBP.** If a PBPO supervisor does not make him/herself available to address difficult problems with your customers within three days, call the NBP office immediately. Telephone number _____.

Procedure for Appliance Guarantee:

If the broken or defective appliance can be presented by the customer, neither the BCC nor the client will be charged for appliances provided by NBP/PBPO that are replaced during their guarantee period. The BCC should return any defective appliances that are under the guarantee period to the PBPO and receive replacement appliances. For example, if a customer's stove is not functioning properly and cannot be fixed, the BCC should replace the broken stove from its stock (inventory) and take the broken stove to the PBPO along with BCC Work Report (Form 10-P) to secure a replacement.

If the customer claims that the appliance is broken or defective, but cannot produce the appliance for inspection by the company and return to the PBPO, the customer must pay for replacement appliance(s).

Tools and equipment that should be carried on scheduled maintenance visits

To be able to perform his/her duties adequately, the Certified NBP Mason should carry the following tools and spare parts on visits.

- 1 pipe wrench
- 1 pair of pliers
- 2 rolls of Teflon(R) tape
- 1 bottle of shampoo solution for leak testing
- 20 nylon washers
- 20 o-rings for gas taps
- 5 meters of rubber hose pipe
- 20 lamp mantles
- 1 small container of grease

21. Providing After-Sales Service for Customer Problems

As a company owner, you are also responsible for providing service to your customers after biodigester construction is completed. In addition to the annual routine visits, BCCs must visit a plant free of charge in case the owner or user lodges a complaint.

When the BCC receives a complaint from a customer about the operation or functioning of a biodigester, the company must send a Certified NBP Mason to the plant owner within one week.

Here are some guidelines for responding effectively to customers' requests for after-sales service:

1. **Ask questions before you go:** When the customer contacts you asking for service, ask him or her to describe the problem. Ask the customer whether all of the appliance parts are functioning, and whether they need spares.
2. **Schedule promptly:** You should schedule an after-sales service visit within 48 hours of the customer contacting you.
3. **Always bring spare parts and tools:** Always bring basic spare parts with you to visit a customer and the correct tools that you require to fix the problem they have described to you.
4. **Analyze the problem, and conduct the necessary repair(s):** If it is not possible to repair the plant at that moment, make an appointment to come back within one week.
5. **Sign the customer's guarantee card:** This shows that the company has responded effectively to a customer complaint and will protect you and your company in case the customer is not satisfied.
6. **Fill out a BCC Work Report (Form 10-P):** Fill out a report on the work performed on the service visit and ask the client to sign the report.
7. **Ask for help from the PBPO if you need it:** PBPO supervisors should be called to help you with any difficult problems that you cannot solve on your own.
8. **If you need help and can't get it, call NBP:** If a PBPO supervisor does not make him/herself available to address difficult problems with your customers within seven days, call tel _____ at NBP immediately to secure the assistance of an NBP Technical Supervisor.
9. **Keep records:** The BCC must keep BCC Work Reports (Form 10-P), and any written complaints by the plant owner, in the Project Control Folder at the company's place of business. The company must also maintain at its place of business a register for complaints lodged in writing or verbally by or on behalf of plant owners. In this register, the company must note the owners name, address, and plant code number, the date the complaint was received, the nature of the complaint, the date and nature of the company's response to the complaint, and the result of that action.

22. NBP Problem Reports

Problem reports are created when NBP or the PBPO identifies a serious problem with an operational plant during the course of a random inspection. Problem reports are made for plants that require major repair in order for the plant to meet NBP standards and to continue operation. Either NBP or the PBPO may initiate a problem report, but the BCC and PBPO are responsible for the process as a whole.

The procedure for problem reports is as follows.

- PBPO will create a problem report using the NBP Problem Report form (see below).
- Within three days of creating a problem report, the PBPO will deliver one copy of the report to the place of business of the BCC that constructed the plant, and one copy to NBP. When delivering a problem report, the PBPO must obtain the signature of the person at the BCC's place of business who receives it.
- After receiving a problem report, the BCC has five business days to respond with either (a) a plan for repair of the problem, including a repair schedule and list of masons and helpers who will conduct the repair, or (b) a request for re-inspection of the problem by NBP. The BCC owner must request the re-inspection directly to the NBP Technical Supervisor responsible for the district in which the plant is located.
- On request of the BCC, NBP will re-inspect the plant with a reported problem within five business days.
- If, after re-inspecting the plant, NBP verifies that the plant has a serious problem in need of repair, the BCC will be charged a fee of US\$10 to cover the costs of re-inspection. If NBP determines that the plant does not have a serious problem that requires repair, the BCC will not be charged any fee. The decision of the NBP Technical Supervisor is final in this situation.
- Costs for repairs of problem plants will be allocated as follows.
 - If the Quality Control Checklist in the Project Control Folder was completed properly during construction, 60 percent of the cost of the plant repair will be charged to the PBPO, and 40 percent of the cost of the plant repair will be charged to the BCC.

NBP BIODIGESTER PROBLEM REPORT FORM

Date _____ Province _____

I. General Information about the Plant

Plant Code Number _____ Plant Size _____ m³

Date of Plant Completion Report DD ____ MM ____ YY ____

Does the plant owner have Guarantee Certificate ____ Y ____ N

Address of Plant _____ Village _____ Commune _____ District

Party Making Report ____ Plant Owner ____ Mason ____ VLA ____ BCC ____ OTHER

Date of Report DD ____ MM ____ YY ____

When was the last supervision by PBPO or NBP? DD ____ MM ____ YY ____

Name of Supervisor to last inspect plant _____

II. Problem

What is the problem with the plant? Provide explanation and *please attach photo*.

When was the plant broken? DD ____ MM ____ YY ____

III. Plan or Strategy to Solve Problem

1. What measures have been taken to solve the problem? When were these measures taken? What were the costs involved?
2. If you did not solve problem, what approach (measures) will be used to fix it and when will they be taken? What is the estimated cost of repair?
3. Do you need the assistance of a National Technical Supervisor? Y/N

Report Made by/Signature _____

To collect the guarantee fee, the following steps should be taken.

- A Certified NBP Mason should visit the customer for the final scheduled maintenance visit. This final scheduled maintenance visit should be performed within two weeks of the date two years after the Plant Completion Report.
- At this time, the mason fills out the End Of Guarantee form, receives the customer's signature, and submits the form to his/her supervisor.
- PBPO Technical Supervisors will randomly select biodigester plants to re-inspect within 14 days of submission of the End-Of-Guarantee form. If the PBPO detects a problem with a plant where the guarantee has expired, the PBPO will follow the procedures outlined for problem reports to ensure that the plant is repaired by the BCC. The BCC is responsible for completing any repairs to the plant before receiving the guarantee fee in accordance with the procedures for problem reports outlined in section 23.
- An authorized agent of the Company can collect the guarantee fee from the PBPO within 21 days of submitting the End of Guarantee form if no problem report is filed by the PBPO.
- If a problem report is filed by the PBPO, the Company can collect the guarantee fee from the PBPO within 21 days of resolving the problem with the plant in accordance with the official procedures for problem reports.



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