Report on Technical Support to Biogas Project Division of Ministry of Agriculture and Rural Development, Vietnam

Prakash C. Ghimire
Senior Advisor
Renewable Energy/Biogas Programmes
SNV-Netherlands Development Organization

September 2006

Table of Contents

Chapter-I: Introduction

1.1 Biogas Project in Vietnam

In January 2003, the Vietnamese and Netherlands Governments signed a Memorandum of Understanding for the implementation of a domestic biogas dissemination project in 10 provinces of Vietnam. The project –*"Support Project to the Biogas Programme for the Animal Husbandry Sector in some Provinces in Vietnam"* or "BP I"- uniquely joined Vietnam's technical knowledge on plant design and construction with Netherlands' experience with large-scale dissemination of domestic biogas.

The combination was successful; at an early stage the project expanded to two additional provinces and increased its quota from 10,000 to 18,000 biogas plants. Even so, many more provinces had to be disappointed when they requested participation in the project because of the high demand and limited quota.

Keeping in view the success of the first phase, a proposal to extend the program to another phase has been agreed. The second phase of the programme (BP II) will be implemented from 2007-2010 with the overall objective of establishing a commercial viable biogas sector in Vietnam. The project, during this phase, will:

- Cover about 58 out of Vietnam's 64 provinces. The participating provinces will be supported to be able to continue all aspects of the programme independently at the end of the programme.
- Support the construction of 140,000 biogas installations with technical, operational and financial assistance.
- Provide technical, financial and operational training to staff of the participating DARDs, Agricultural Extension Centres, and Rural Sanitation and Water Centres (initially approximately 58 provincial biogas technicians, 58 PBPO accountants and managers, 580 district biogas technicians, and approximately 1,800 commune extension workers)
- Support establishment of more than 1,000 Biogas Construction Teams, and support these teams with technical training and business development services.
- Assess financial mechanisms to reach poorer farmers and to guarantee the continuation of quality control and training after the project life time.

In 2006, preparations of BP II will be finalized to continue with the programme as a project. In the mean time, 'Bridging Phase 2006' has been developed and approved. In 2006, some 10,000 biogas plants will be built and systems & trainings will be improved to be used in BPII.

1.2 The Assignment

In this context, Biogas Project Division (BPD) felt a need to strengthen the technical capacity of technical staff members in delivering services related to training and quality control of biodigester installation and proposed for the input of the Flexible Senior Biogas Advisor from SNV to provide the required assistance to the BPD.

The objective of the assignment was to assist the Biogas Project Division (BPD) of the Ministry of Agriculture and Rural Development (MARD) in the training of newly recruited technical staff and in the development of training, technical standards and quality control.

The following activities and methodologies were proposed:

A. Training of technical staff of BPD, being Mrs. Thoa (Training Officer), Mrs Thu (Extension Officer), Mr. Duc (Quality Control Officer) and Mr. Thang (CDM and R&D officer) in best practices biogas technology;
B. Further improvement of training materials for technician, mason and biogas user trainings;
C. Further development of technical standards for biogas plants KT1 and KT2;
D. Assessment and possible improvement of procedures for quality assurance in the biogas project;
E. Submission of a concise report about the activities conducted within this ToR.

1.3 Works Carried out

The following works were carried out during the first official visit in Vietnam (June 25 to July 01, 2006) :

- Review of Technician's Training Manual
- Observing the ongoing training sessions (theoretical) organised for Provincial Technicians in Vinh City
- Formal and informal discussions with the participants of the training and provincial technicians in Nghe An Province
- Observation of practical training sessions (construction of biogas plants)
- Formal and informal discussions with the staff members of Biogas Project
- Review of Quality standards on Biogas Plant Installation, Operation & Maintenance

Likewise the following works were carried out in Phnom Penh during the period July 03 to July 25, 2006.

- Fine-tuning of the technical manual
- Formulation of Quality Standards and quality control mechanisms
- Preparation of Trainer's Guide to conduct Technician's Training
- Preparation of Trainee's manual

During the second field visit in Vietnam (August 13 to 26, 2006) the following works were conducted:

- Orientation to technical staff members on newly drafted quality standards and quality control forms
- Orientation to Technical Staff on key practical issues related to biogas technology
- Quality control visits with technical staff members to some households with biogas plant in different districts in Hanoi province
- Visit to Thanh Hoa province to observe the ongoing mason's training
- Visit to Ha Nam province to monitor the biogas plants under-construction

Chapter-II: General Observations and Recommendations

2.1 Training of Technicians (Supervisors)

2.1.1 Observations

- Technician's Training which is basically designed as a 'Training of Trainers' aims at enhancing the knowledge of the provincial biogas technicians (BTs) on biogas technology and prepares them as a trainer to conduct Mason's Training programmes in the provinces. The contents of the training are designed to accommodate topics on Introduction of Biogas Technology, Use of biogas and bio-slurry, Construction procedures of biogas plant, Quality standards, Basics of CDM as well as brief session on conducting mason's training. Out of the total 6 days, two days are allocated for field demonstration of biogas plant construction.

- The training manual, prepared for the technicians' training, incorporates sufficient information related to biogas technology; methods of biogas plant construction, operation & maintenance; use of biogas; and application of bio-slurry. It has been an excellent source-book. As this manual was prepared during the initial phase of the biogas project, it has more 'supply-driven' orientation. The manual contains more theoretical and academic information than basic problem-solving guidelines needed by a technical at the workplace.

- The outcome of the observation and discussion with some of the participants revealed that the content covered the whole ranges of issues; however, time allocated for each session was not sufficient.

- On site observation indicated that session plans were not prepared by the facilitators. The objective of each session was not clear to the participants.

2.1.2 Recommendations

- There is a need to make the trainee's manual more practical, user-friendly and grass-roots-oriented with the addition of demands/viewpoints of the prospective users. The following topics need to be added in the training manual besides simplifying the existing topics:
    a. Quality control of biogas plant installations - need, importance and techniques of quality control; and quality standards
    b. Roles and responsibilities of different stakeholders, in general and that of masons and supervisors, in particular.
    c. Basic introduction on Biogas Project in Vietnam
    d. Training and Facilitation skills

  The existing training manual could be used as reference material; if the participants want to go more in deeper on the technological aspect.

- A trainer's guide which includes session objectives and expected outputs, training methods and training aids, time management and steps for deliberations has to be prepared to facilitate the trainers in conducting the session. (The trainer's guide is given in the annex)

- While conducting session on quality standards, the 'why' part should be described clearly. For example, the need of good quality sand, which is validated by a bottle test, is vital for proper bonding (binding) of cement and sand. If sand contains more mud (silt or clay), the binding capacity of cement is adversely affected which is manifested by the cracks in plaster or bulging of plastered surface.

- A follow-up/refresher training of 2 days is recommended to be organised for the technicians after 6-8 months of the initial training to share lessons learnt (including problems, difficulties and constraints) and get feedback from each other.

- To institutionalize the technical training related to the construction of KT1 and KT2 models of biodigester in Vietnam, BPD is recommended to partner with few well established technical educational institutes in different parts of Vietnam, probably one in the north, one in central and once in south, as far as possible. As the initial step to institutionalize the training event, a TOT could be organised for the instructors in the selected training institutions to capacitate them with in-depth technical knowledge and skills on methods of construction and supervision of KT1 and KT2 models of biodigester as well as facilitation skills.

  The overall objective of the TOT should be to build capacity within the selected technical institutes to conduct quality training courses on Construction and Supervision of Biodigesters through Training of Trainers; and develop these institutions as the National Training Institutes for Biodigester related Technical Training Courses in Vietnam.

2.2 Training of Masons

2.2.1 Observations

- The participants for mason's training were reported to be selected by the provincial and district Agriculture Extension offices, the implementer of the project at the provincial and district levels. In all the cases, the participants were head-hunted.

- The training consisted of two parts. The theory part, dealt in the first day, comprised of brief sessions on biogas technology, benefits of biogas, components of biogas plants, and methods of plant construction. The practical sessions on construction of biogas plant were conducted in the second, third, fourth, fifth and sixth days of the training. Events on the seventh and final day included sharing and discussion sessions on plant construction and basic operational issues (utilisation of bio-slurry, operation

and maintenance of biogas plant). The practical session is done in a household in nearby community.

- The duration of training, in general, is enough to meet the objective of the training. The participants are awarded with a completion certificate and are eligible to take responsibilities of construction of biogas plant independently immediately after the completion of the seven days training. The is no provision of further practical sessions for those who are not yet competent to take the responsibilities independently.

- The team of facilitators for mason's training usually consisted of one trained technician each from provincial and district agriculture offices (newly trained persons in the case of new provinces) and an experienced mason. The outcome of the discussions with some of the participants indicated that the newly trained technicians seemed to have a lot of rooms for further improvements.

2.2.2 Recommendations

- The participants' selection process needs to be made more transparent and process-driven to get rid of the existing ambiguity. Public announcement at the district level would ensure appropriate candidates to apply for the training. The head-hunting method of selection of participants will add the risk of exclusion of good/skilled persons with previous experience of construction of biogas plants.

- While forming the team of facilitators, it is recommended that at least one experienced technician and one skilled mason are included; besides the newly trained district or provincial technicians. Inclusion of experienced technician in the team will be beneficial even for the new supervisors to acquire more practical knowledge and skills and gain confidence on conducting future training events.

- To make the practical sessions on construction of biogas plant more effective and ensure active participation of each and every individual in the exercise, it has to be conducted in different households in the same location ensuring 4-5 trainees in each group. A feeling of competitiveness develops between the groups which leads to active participation of team members ultimately leading to effective intentional learning. Monitoring of the skill of individual trainee and coaching them as needed become easier in smaller groups.

- At the end of the training, the facilitators should categorise the trainees in three categories – 'very competent', 'competent' and 'not yet competent'. Those who fall under 'not yet competent' category should be instructed to work with an experienced mason or those participants categorised under 'very competent' category to construct one or two biogas plants depending upon their skills. Certificates should only be awarded when the district technician, in consultation with the accompanying mason, certifies them as 'competent'.

- One session on 'quality standards' has to be added in which the participants should be instructed how to comply with the set standards including selection of construction materials. As in the case of technicians' training, the 'why' part of quality standards should be dealt in depth.

- The mason's manual needs minor updates to accommodate the new quality standards as given in Chapter-III.

2.3 Quality Standards and Quality Control System

2.3.1 Observation

The existing mechanisms of quality control of biogas plants have been in practice:

- The district level technicians are responsible to monitor the work of the masons in the respective district. They visit each and every biogas plants being constructed and give feedback to the masons.

- The provincial technicians visit some of the under construction plants in the districts selected on random sampling basis to monitor the construction works and ensure the quality and compliance of quality standards.

- The provincial technicians visit the completed plants after 2-3 months of operation to monitor the performance before awarding acceptance certificates and release the subsidy amount.

- The technical officers from BPD visit some plants selected on random sampling basis to monitor the performance prior to awarding acceptance certificates to specific plants.

In conclusion, the district technicians are mainly responsible to carry out quality control visits to under construction plants.

In general, the following major observations were made:

- The quality control visits being done by BPD officials at present seem more a 'performance monitoring visit' or 'technical audit' than QC visits. As all the biogas plants are considerably old (3 months to more than a year?), there was no question of controlling quality rather than to monitor the performance of plant – whether gas is being produced as anticipated. All of the biogas plants visited during various trips (more than 15 plants) were constructed beneath the pigsty making it difficult to monitor the quality of construction. Apparently, all the plants visited were producing biogas and majority of the users were satisfied with the functioning of their plants. However, the water dung ratio was observed to be very high in all of the plants endangering the functioning of the plants at a longer run because of the dead volumes at the bottom.

- There is standardised quality control procedure in place, however, detailed guidelines on how to monitor the compliance of the procedure is lacking.

- The role of BPD for quality control of under-construction plant has been minimal. There are no effective monitoring mechanisms to ensure the quality of works of provincial or district technicians who have overall responsibilities of quality control at the field level. Monitoring coverage from provincial and national technical personnel is rather low. Sampling methods to select the biogas plant for monitoring is not standardised.

- Acceptance reports are accepted 'quite easily' without proper validation or cross-checking. The authenticities of such reports are questionable. Moreover, this form does not include any measurement of biodigester components.

- The quality standards presently being used are very much descriptive and elaborative. The existing quality standards contain too-many clauses and issues that need compliances. Quality control of biogas plant installation based upon these standards will be rather difficult and time consuming. To make the quality control system more effective, there seems a high need to simplify the quality standards and make it more concise. Quality Standards as well as suitable forms and formats for monitoring the compliance of these standards have been prepared to accommodate the changes (refer to the Annex).

2.3.4 Recommendations

a. Given the limited resources (human and financial) and time, BPD is not in a position to visit targeted number of under-construction or completed biogas plants to ensure the compliance of quality standards by the masons. The role of BPD should be to build the capacity of provincial and district biogas technicians to internalise the quality control process. To ensure this to happen, BPD personnel should:
    i. train the provincial technicians
    ii. accompany them to the field to monitor their works at the field level and provide necessary back-stopping services at site
    iii. ensure that the provincial technicians are building capacity of district technicians to effectively carry out the quality control activities through transferring of their skills and knowledge

b. Clear and concise quality standards should be formulated to use as bench marks for quality control visits. Relevant formats to monitor the compliance should be prepared. (quality standards and quality monitoring forms have been given in Annex)

c. The presently practiced 'acceptance report', which could be renamed as 'Plant Completion Report', should include proper measurement of different vital components of biodigester such as diameter of digester, pressure height, diameter and height of outlet tank etc (as

given in Annex). This form should be filled before the initial feeding of the plant. District technicians should be oriented to fill this form for all the new plants. Provincial technicians should randomly sample some of the filled forms at the site and validate it instantly. This may eliminate the necessity of 'acceptance visits' being carried out at present. Subsidy could be released immediately after the approval of 'Plant Completion Report'. The presently practiced 'Acceptance Visits' could be continued as 'Performance Monitoring Visits' or 'Technical Audit Visits'.

d. The BPD, PBPD and district technical personnel should realise the general concepts and importance of quality control as well as the correct procedures to do so as described in Chapter-III in this report.

e. The BPD or provincial technicians should be equipped with a minimum set of field tools and equipment while visiting biogas households for quality control or performance monitoring. These include:

   - Measuring tape (3 or 5 m)
   - Digital pH meter
   - Gas pressure meter
   - GPS devise
   - Gas stove burner
   - Simple spirit level

Chapter-III: General Concept of Quality Control (QC)

3.1 General

Non-functioning and poorly functioning biodigesters cause not only capital waste but also do a lot of harms and damages to the reputation of biodigester technology and eventually to the desired future expansion biogas program. The satisfied users are the main and effective extension media for the promotion of the technology and vice-versa. To safeguard the quality of biodigesters, it is important that effective quality control mechanisms be formulated and enforced properly. The quality on construction, operation and maintenance of biodigesters has to be a major concern. Biogas Technicians (BTs) have to play vital roles in this regard. The quality is basically related to the following aspects:

- Quality of the design
- Quality of the construction (including selection of construction materials and appliances)
- Quality of the operation and maintenance by the users and technical backstopping from the installer
- Quality of after-sale-services on behalf of the installers

The rate of installation of biodigester will be increasing year by year. This increases calls for more effective quality management system in place.

The objective of the quality control should be to encourage installers (mason's team or companies) to comply with the quality standards on the above four aspects. The quality enforcing system generally consists of the following:

- Companies and/or mason's teams, who wish to corporate with the BPD and benefit from the subsidy scheme, will be required to seek recognition from the BPD office. Such recognition is subject to a series of strict conditions such as:

    - approval of standard design and sizes of biodigesters;
    - trained, certified and registered masons for the construction of biodigesters;
    - construction of biodigesters on the basis of detailed quality standards;
    - provision of BPD approved quality biodigester appliances (pipes, valve, stove, water trap, lamp);
    - provision of proper user training and provision of a user instruction manual;
    - provision of one year guarantee on appliances and two years guarantee on the civil structure of the biodigester, including an annual maintenance visit during the guarantee period;
    - timely visit of a technician to the biodigester in case of a complaint from the user;
    - proper administrative system in place.

The task of quality control should be carried out by Provincial and District Biogas Project Divisions with technical back-stopping from BPD. The quality control system should also grade/categorise the installers in different levels based upon their compliance to quality standards.

3.2 Responsibilities of BPD Technical Personnel

BPD with its limited resources, human and financial, may not be able to monitor the required number of biogas plants under-construction. Also, from sustainability point of view, quality control from BPD is not appropriate. The overall aim should, therefore, be to build the capacity of provincial and district technicians to carry out these tasks. The provincial and district technicians should internalize the process of quality control and feel ownership of the process. For this to happen, they should be provided with appropriate capacity building initiatives related to quality control. Once they are provided with such capacity building package, they should be given responsibilities to carry out quality control activities in the provinces.

Quality control visits are important to check the compliance of the quality standards. Visits to all the biodigester will not be possible because of the resource constraints. Therefore, random sampling or stratified random sampling methods (stratifications made based upon responsible supervisors or masons, provinces, districts, types and/or sizes of biodigesters etc.) have to be used to select the biodigesters for control visits. The number of biodigester should be at least 10% of the total number installed in the initial year, which can gradually be reduced to 5% in the years to come. Before the visit, the following points should be clear to the technicians:

- Purpose of quality control visits
- Frequency of visits
- Reporting and documentation methods
- Corrective actions

The following four basic principles of quality control should be given due care:

- Reliability
- Uniformity (consistency)
- Impartiality (neutrality)
- Transparency

Standard formats are needed to collect data and information from the respective site of biodigester. These include:

- Quality control of under-construction biodigester
- Quality control of biodigester before filling dung/pig manure (Biodigester construction completion report)
- Quality control of After-sale-services

3.3 Responsibility of Quality Control (QC) activities for Biodigesters

- Trained and certified Biodigester Technicians (BTs) from provinces and districts will be responsible for supervising, testing construction works, and other activities such as acceptance, operation and maintenance and after sale services.

- Trained and certified Companies or Biodigester Masons Teams (BMTs) will sign assignment contracts with the Provincial Biogas Project Division (PBPD) before starting their construction works and will be responsible for construction quality and after sale service within the guarantee period.
- Users will be responsible for direct supervising and testing construction works as well as ensuring the proper functioning of biodigesters.
- Technical personnel from BPD will be responsible for capacity building of provincial and district technicians in quality control; provide necessary feedback to them and randomly check the accuracy of the reporting from them

3.4 QC activities to construction works of biodigesters

- ***Training***
  - PBPD will select suitable and responsible Biodigester Technicians (BTs) and Biodigester Masons (BMs) from that province for training based upon a set selection criteria. A public announcement at the district and provincial levels will be made to collect applications from interested persons.
  - PBPD, with support from BPD, will organize training programmes for BTs and BMs, provide them necessary background knowledge and skills on biodigester so that they can perform programme activities as anticipated. These activities can largely be contracted out to a recognized Training Institute, if feasible.
  - PBPD with support from BPD will organize training programmes (pre and post construction) for the (potential) users in which they will be oriented on their roles during construction and post construction operation and maintenance.

- ***BTs tasks in the construction***
  - Select suitable households to register with the Programme for technical and financial assistances.
  - Help users select suitable designs, sizes, locations for biodigesters and required construction materials as per the quality standards.
  - If required, assist users in obtaining a biodigester construction loan with a recognized financial institution.
  - Help users prepare accessories and tools as per required technical standards for the biodigesters.
  - Introduce trained and certified BMs to the users for their selections and construction agreements.
  - Help and provide document to users instructing construction supervising procedure in order to assure construction and installation quality.
  - Supervise BMTs during construction and installation works in order to control construction quality. Any BMTs who violate seriously construction requirements will be reported to the BPD/PBPD for final solution or stop BM jobs, revoke certificates, cancel construction contracts and inform users**.**

- Instruct biodigester users to prepare feedstock as per quality requirements before operating plants.
- Instruct biodigester users on methods to apply feedstock and start up the biodigesters according to technical requirements.
- Carry out Test and Acceptance jobs in cooperation with users and BMs and sign Certificate of Acceptance. The plant code will be mentioned in the Certificate of Acceptance for programme management.
- Register the plant into programme management file.
- Supervise, follow up, support Companies and BMTs, solve complains from biodigester users if required.

3.5 Quality Control types

3.5.1 QC of Training Events

Capacity building of local masons, district technicians, provincial technicians and other stakeholders involved in biogas sector is crucial for the sustainability of the programme. Keeping this fact in view, BPD has been organizing and conducting various training programmes. Knowledge and skills of biogas technicians and masons are vital in ensuring the quality of construction, operation and maintenance. QC activities should begin from the very beginning of these training programmes. To ensure effective learning from training the following issues should be considered:

- Proper selection of training participants
- Proper selection of facilitators
- Suitable training contents, session plans and scheduling
- Appropriate training methods
- Effective practical sessions
- Effective evaluation of training
- Timely follow-up of the evaluation findings

The BPD should facilitate PBPD to formulate selection criteria for the participants and ensure that these criteria are adhered to. For example the selection criteria for masons could be:

- Formal education of at least up to 5th standard. Should be able to read technical drawings and other instructions provided to them from time to time
- At least 2 years of experience in construction works as a mason or plumber. Previous experience in biogas plant construction would be an added advantage.
- Be a permanent resident of the province
- Have good reputation in community – should be a trusted person
- Good interpersonal and communication skill
- Receptive to community's need and willingness to support them
- Age between 20 to 40 years
- Good health

Likewise, BPD should monitor the training programme to evaluate the overall effectiveness of such programmes.

3.5.2 QC for Construction Works

Quality control visits to under-construction biogas plants are very important to check the compliance of the quality standards by the mason. Visits to all the biodigester will not be possible because of the resource constraints. Therefore, random sampling or stratified random sampling methods (stratifications made based upon responsible supervisors or masons, provinces, districts, types and/or sizes of biodigesters etc.) have be used to select the biodigesters for control visits. The number of biodigester should be at least 10% of the total number installed in the initial year, which can gradually be reduced to 5% in the years to come. It should be done by provincial technicians. The scope of work includes assisting and checking the construction and providing feedback to mason. The purpose is also to make sure that the masons are qualified enough to carry out their activities.

3.5.3 Quality Control - Acceptance (Construction Completion)

Once the construction work of biogas plant is complete, the district technician should visit all the plants for filling construction completion report (also known as acceptance report). This visit has to be made before the initial feeding of the biogas plant. Measurements of various key components have to be taken and crossed checked with the standard. Provincial technicians should select some plants on random sampling basis to validate the data and information filled in the form by the district technicians. Plant owners should only be instructed to feed the biogas plant only if the quality standards are met. Any rectification needed has to be carried out by the mason as early as possible.

3.5.4 Quality Control of Operational Biodigester

Quality control of operational biogas plant is to be done by provincial and district technicians. The scope of work includes the checking of current physical status and functioning of the plant and the warranty responsibilities. Plant monitoring form (given in Annex) has to be used during this visit. BPD should facilitate provincial technicians to carryout this task and should also validate some of the forms filled by provincial technicians.

3.5.5 Complaints

District technicians should also visit all the plants in which complaints from users have been received mentioning that the mason has not been able to fix the problem. The scope of work during this visit includes the checking of current operation status of the plants and fixing all troubles to have the plants working normal. The same form as used to monitor the functional biogas plant could be used for this purpose.

3.6 Quality Standards and Tolerances

To facilitate effective monitoring for ensuring quality, some standards have been developed. The quality standards are basically related to the following aspects:

- Quality standards related to the design of biodigesters

- Quality standards for the construction of biodigesters
- Quality standards for the operation and maintenance of biodigesters (after-sale-services on behalf of the installers and routine O&M on behalf of users)

Most of the quality standards developed for the construction of biodigester allows certain tolerances and all the supervisors should know these tolerance limits.

The quality standards, monitoring formats for under-construction and completed biodigesters and observation checklist for operational biodigester have been given in the Annex.

Annexes

Annex-1: Quality Standards for the Installation of KT1 and KT2 Models of Biodigester

SN	Standards	Description/Tolerances	Type of Default
	Standards in Household, Size and Construction Site Selection		
1	One biodigester per household	Separate kitchen per biodigester.	Critical
2	Construction site not far from kitchen	Distance from kitchen not more than 20 meters.	Minor
3	Construction site not far from cattle shed or pig sty	Distance from cattle shed or pig sty not more than 20 meters.	Minor
4	Construction site at adequate distance from water well or underground water tank	At least 10 m away from the ground water wells or tanks to prevent the possibilities of contamination from leakage of bio-slurry	Minor
5	Components of the biodigester adequately far from existing structures or trees	Plant components should be at least 2 m away from existing foundation of house or trees.	Major
6	Enough space for biodigester construction as per drawing	Enough space to orient the plant location and slurry pits. Baffle wall is provided/reorientation of inlet pipe to avoid short-circuiting of slurry in case the space is not suitable	Major
7	Correct size of KT1 or KT2 plant based upon the availability of feeding materials	Minimum 5 kg and maximum 12 kg of dung available per cubic meter capacity of biodigester.	Critical
8	No plant fed with latrine only	Inlet tank should be constructed and used	Critical
9	Pre-construction training provided to the user	At least one member of the household has taken part in pre-construction training	Major
	Standards on Construction Materials and Appliances		
10	Good quality bricks	Best quality locally available. Well baked, regular in size, free from cracks and broken parts. Able to withstand a pressure of 75kg/cm^2 (Drop test)	Major
11	Good quality sand	Not contain more than 3% impurities as determined by bottle test.	Major

12	Good quality cement	Portland cement with grade PC30 or higher, fresh, free from lumps, best locally available.	Major
13	Good quality aggregate	Angular, of regular size not more than 2 cm and free from dust or impurities.	Major
14	Good quality MS Rod (iron bar)	Free from heavy rust and at least 6 mm diameter. The size of the mess should be maximum 15 X 20 cm.	Major
15	Good quality acrylic emulsion paint	Approved by the quality control authority.	Major
16	Good quality inlet and outlet pipes	PVC, concrete or Polyethylene pipe, no cracks. At least 10 cm diameter.	Major
17	Good quality water	Clean and free from suspended particles.	Major
18	Good quality main gas pipe	The size bigger than 21 mm outer (15 mm inner) diameter	Major
19	Good quality main gas valve	Approved by the quality control authority.	Major
20	Good quality pipes and fittings	Minimum ½" GI or 20 mm PVC pipe of best quality locally available for up to 45 meter. For lengths more than 45 m-60 m, the size is 25 mm.	Major
21	Good quality water drain (trap or outlet)	As approved by the quality control authority. No need if the pipe profile allows water to drain into the digester.	Major
22	Good quality gas tap (cock)	As approved by the quality control authority.	Major
23	Good quality connecting pipe	Either neoprene rubber hose or good quality plastic pipe as approved by the quality control authority. No cracks appear when folding.	Major
24	Good quality gas stove	As approved by the quality control authority.	Major
25	Good quality gas Lamp	As approved by the quality control authority.	Major

26	Good quality mixing devise (optional)	As approved by the quality control authority.	Minor
	Standards on Construction		
27	Only trained masons carry out the construction work	The mason registered in Provincial Biogas office after successfully completing the required training courses on biodigester construction	Critical
28	Correct cement, sand, aggregate ratio	For all masonry works the ratio is 1:3 (cement: sand). For plastering works, it is 1:3 for inner surface and 1:4 for outer surface of the biodigester. The ratio of concreting in foundation is 1:2:4 (cement: sand: aggregate).	Major
29	Biodigester appropriately placed under the ground	The depth of digging as per drawing. Maximum allowable deviation by ±5 cm from the standard. If because of high water table/rocky strata the depth is not adequate proper justification is provided. In this case, proper stabilisation measures are provided around the structure.	Major
30	Correct diameter of the digester	The diameter of the completed biodigester not to differ by ±1.5% from the standard.	Major
31	Correct height of the conical bottom portion of KT2 plant	The height not to differ by ±2 cm from the standard.	Major
32	Correct height of the position of the bottom of the inlet and outlet pipes	The height of bottom of the inlet and outlet pipes from the bottom not to differ by ±2 cm from the standard.	Major
33	Correct height of the gas storage area (distance between the bottom of outlet pipe inside digester and the bottom of outlet tank)	The height of gas storage area not to differ by ±2 cm from the standard.	Major
34	Correct height of neck	The height of neck not to differ by ±2 cm from the standard.	Minor
35	Correct positioning of the main gas pipe	The location of the main gas pipe to be at the centre of the cover. Maximum allowable deviation is 2% of the diameter of the digester.	Minor
36	Proper plastering of inside of the digester	The finished surface is properly finished and smooth.	Major

37	Proper plastering inside the gas-holder	Gas holder is treated with 5 layers of plastering as indicated in the construction manual. The finished surface is smooth and free from cracks.	Critical
38	Proper back-filling in the outside of the wall of digester and gas holder	The space between natural soil and the digester wall is filled with soils and compacted well. The height of back-filling is at least equal to 19 cm from the top of the dome.	Major
39	Proper diameter of outlet tank	The diameter of outlet tank not to differ by ±2% from the standard.	Major
40	Proper height of outlet tank	The height of the outlet tank not to differ by ±1 cm from the standard	Major
41	Proper volume of outlet tank	The volume of outlet tank not to differ by ±5% from the standard.	Major
42	Correct positioning of the outlet pipe	The out pipe is placed at the near end to the digester so that inserting of pipe or pole is possible. It discharges exactly at the hart line (imaginary line that joins centre of digester, manhole and outlet tank).	Major
43	Outlet floor and walls properly finished	The floor and walls are smooth and properly plastered.	Minor
44	Properly casted outlet slabs	The thickness of the outlet slab not to differ by ±0.5 cm.	Minor
45	Proper size of overflow opening	The length and height of overflow opening not to differ by ±2 cm from the standard.	Minor
46	Correct positioning of outlet tank	The centre line of outlet, manhole, digester and inlet pipe is located in one straight line. The deviation not to differ by ±5 cm.	Major
47	Proper backfilling against the outlet walls	The outside of the outlet walls is properly compacted with rammed soil to prevent soil erosion.	Major
48	Correct height of inlet tank	The height of inlet tank not to differ by ±5 cm from the standard.	Minor

49	Correct positioning of the inlet pipe	The inlet pipe is placed at the near end to the digester so that inserting of pipe or pole is possible. It discharges exactly at the hart line (imaginary line that joins centre of digester, manhole and outlet tank). If because of space limitations it is not possible baffle wall is provided or inlet pipe is repositioned	Major
50	Proper finishing works of inlet tank	The plaster surface is smooth and free from cracks.	Minor
51	Positioning of the inlet chamber	The floor of the inlet chamber is at least 15 cm higher than the bottom of overflow opening in the outlet tank.	Major
52	Correct positioning of collection chamber for maturating swine manure/feeding channel	Swine manure and urine flow by gravity to the collection chamber. Separate channel to drain the water used for pig-bath or manure of pig treated with antibiotics	Major
53	Positioning of the collection chamber	The floor of the collection chamber/feeding channel is at least 15 cm higher than the bottom of overflow opening in the outlet tank.	Major
54	Correct positioning of inlet pipe from the latrine attached to biodigester	The inlet pipe discharges within the location of 30^{o} from the hart-line	Major
55	Correct positioning of the pan level	The pan level of the latrine is at least 20 cm higher than the bottom of overflow opening in the outlet tank.	Major
56	Correct positioning and sealing of the neck cap	The diameter of the neck-cap not to differ by ±1% from the standard. The clay seal is gas-tight.	Major
57	Correct thickness of the neck-cap	The thickness of the neck cap not to be less than the standard	Major
58	Correct fitting of main gas valve	No fittings in between elbow in the dome gas pipe and the main valve. The joint is properly sealed with Teflon tape and good quality adhesive.	Critical

59	No unnecessary fittings in pipeline	Pipeline contains minimum joints. No unions are used.	Major
60	Proper burial of pipeline	The pipeline is buried to at least 30 cm where possible. It is protected well with clamps and covers where burial is not possible.	Major
61	Water drain able to drain the whole quantity of condensed water	The profile of pipeline is maintained properly so that the whole quantity of accumulated water is easily drained.	Major
62	Water drain protected in a well maintained chamber	The size of the chamber is such that it is easy to operate water drain and rain water does not enter into it. The pit is provided with a good cover.	Minor
63	Correct fitting of gas tap (cock)	The gas tap is placed in convenient place and the joint is sealed with Teflon tape and good adhesive.	Major
64	Correct fitting of gas stove	The connecting pipe from gas tap to the stove is correctly fitted to avoid the gas leakage. It should be installed at least 50 cm from inflammable items.	Major
65	Correct fitting of gas lamp	The gas lamp is located in safe and convenient place. The joint is sealed with Teflon tape and good adhesive. It should be installed at least 50 cm from inflammable items.	Major
66	Proper construction of slurry composting pit	2 compost pits at least equal to the volume of biodigester are constructed as per the standard dimensions	Major
67	Proper installation of 'U' shape pressure gauge	The maximum height of the pipe must not be more than the maximum design pressure. The tube is transparent enough to read the pressure rating.	Major
Standards on Operation and Maintenance			
68	User's instructed on operation and minor repair works	At least one member from the user's household is provided with proper orientation on operation and minor maintenance of biodigester	Major

69	Provision of instruction book let	Instruction booklet is provided to the users	Major
70	Guarantee and After-sale-service provisions	Guarantee of 1 year in structural part is provided by the installer to the users	Critical
71	Post construction O&M training is conducted	At least one member of the biogas household has attended an O&M training at least once	Major
72	Proper composting of slurry	The user has to add other organic wastes daily to cover-up the bio-slurry coming out of biogas plant.	Major
73	Properly maintained clay seal	The clay seal always submerged in water to detect leakage.	Major

Annex-2

Quality Control of a Non-filled Biodigester

Questionnaire to be filled during the Visit to Under-construction Biodigester

ID No	Parameters	Responses
1	Plant Code	
2	Name of the Installer	
3	Address of the Installer	
4	Name of Mason	
5	Registration no. of Mason	
6	Name of the Biodigester Owner	
7	Name of the Respondent	
8	Relation with Plant Owner	
9	Address: Commune	
10	District	
11	Province	
12	Location of Biogas Plant (if different from above)	……
13	Biodigester Type and Size	KT1/KT2 of……. cum
14	Date of Commencement of the Construction	
15	Date of Completion	……../Not completed
16	If construction time longer than 30 days, reason	
17	One Biodigester per household	Yes/No
18	Any member participated the pre-construction training	Yes/No
19	No. of People using the gas	……. persons
20	No. of Cattle	…. Adult, ….. calf, …….. total
21	No of Swine/pig	…. Adult, ….. calf, …….. total
22	Quantity of available dung	…… kg
23	Quantity of feeding expected	…… kg
24	Cattle/pig dung being collected for initial feeding	Yes/No
25	Toilet constructed in the house	Yes/No
26	Toilet attached to the Biodigester	Yes/No
27	Provision for toilet-attachment in the future	Yes/No
	Financing	
28	Total estimated cost of Installation	USD…….
29	Subsidy amount	USD…….
30	Subsidy through	Bank/Company/Mason/other
31	Loan taken	Yes/No
32	If yes, taken from	Bank/MFI/Local money lenders
33	Bank service	Good/satisfactory/poor
34	Duration of loan process	…… days
	Observation	
	Location of the Biodigester	
35	Distance from Kitchen	……m
36	Distance from cattle shed/pig sty	……m
37	Distance from the nearest foundation of a building	……m
38	Distance from the nearest tree	……m

39	Distance from main highway/heavy machines	……m
40	Distance from well/water source	……m
41	Ground water problem	Yes/No
42	Flood/stagnant water problem	Yes/No
43	Enough space for plant and slurry pit	Yes/No
44	Symmetry of the plant maintained	Yes/No
	Bricks	
45	Best locally available	Yes/No
46	Shape	Good/fair/bad
47	Sound	Good/fair/bad
48	Drop test	Good/fair/bad
49	**Sand** – Bottle test	…….% impurity
	Gravel/aggregates	
50	Cleanliness	Good/fair/bad
51	Maximum size	……. mm
52	Shape	Good/fair/bad
	Cement	
53	Total quantity used/purchased	…… bags of …kg
54	Brand name	
55	Lumps	Yes/No
	Paint	
56	Total quantity used/purchased	……. litres
57	Type	Acrylic emulsion/……
58	Brand name	
	MS Reinforcement rod	
59	Diameter	……. mm
60	Quantity purchased	……. kg
61	Quality of water used for construction	Good/Fair/Poor
	Digester and gas holder	
62	Diameter of digester	……. cm
63	Overall height from bottom centre to top of dome	……..cm/not yet complete
64	Height from floor to bottom of inlet pipe	……..cm/ not yet complete
65	Height of bottom of outlet pipe from the digester floor	……..cm/ not yet complete
66	Vertical height - bottom of outlet pipe and outlet floor	……..cm/ not yet complete
67	Main gas pipe in the centre	……..cm/ not yet complete
68	Finishing of floor	Good/fair/bad/not yet complete
69	Plastering inside the gas holder (according to the construction manual)	Good/fair/bad/ not yet complete
70	Height of the neck	……..cm/not yet complete
71	Thickness of neck cover	……..cm/not yet complete
72	Correct positioning of gas pipe in neck cover	Yes/No/not yet complete
73	Top filling over dome	Good/fair/bad/ not yet complete
74	Cement, sand and aggregate ratio as per recommended	Yes/No
	Outlet	
75	Diameter of outlet tank	……..cm/ not yet complete

76	Height of tank up to the bottom of overflow opening	……..cm/ not yet complete
77	Height and length of overflow opening	……..cm/ not yet complete
78	Floor and wall finishing	Good/fair/bad/ not yet complete
79	Backfilling against the wall	Good/fair/bad/ not yet complete
80	Thickness of slab	…….. cm/ not yet complete
81	Cover (Slab) as per dimension	Yes/No/ not yet complete
82	Type and size of outlet pipe	PVC/Concrete/HDP of …… diameter
83	Position of Outlet pipe	Correct/not correct
	Inlet	
84	Type	Mixing tank for cattle dung/channel for pig manure
85	Pig manure and urine flow by gravity to the chamber	Yes/No/Not yet complete
86	Separate channel to drain the water used for pig-bath or manure of pig treated with antibiotics	Yes/No/Not yet complete
87	Finishing	Good/fair/bad/ not yet complete
88	Height of inlet pit	…… cm/ not yet complete
89	Inlet floor vs. bottom of overflow opening	sufficiently above/just above/below/ not yet complete
90	Type of inlet pipe	PVC/Concrete/Other
91	Inlet pipe position	Correct/not correct
92	Diameter of inlet pipe	…… cm
	If toilet Attached,	
93	Position of Pan level vs. bottom of overflow opening	sufficiently above/just above/below/ not yet complete
94	Type and diameter of toilet inlet pipe	PVC/Concrete/Other ……. of ……cm
95	Positioning of inlet pipe	……. degree in hart-line
96	Pipe Provisions for future attachment	Yes/No
97	If not, the reason	
	Appliances	
98	Brand name of main gas pipe	…….
99	Quality of fitting of main gas pipe	Good/fair/bad
100	Brand name of main gas valve	….
101	Quality of fitting of main gas valve	Good/fair/bad
102	Type of gas pipe	PVC/Flexible plastic/GI ……Φ
103	Quality of fitting of gas pipe	Good/fair/bad
104	Brand name of water drain	……
105	Quality of fitting of water drain	Good/fair/bad
106	Brand name of gas tap	…..
107	Quality of fitting of gas tap	Good/fair/bad
108	Brand name of stove	……
109	No. of stoves	1/2/3/not installed
110	Quality of fitting of stove	Good/fair/bad
111	Expected duration of stove-use	……. hour/day
112	Quality of connecting pipe	Good/fair/bad/not installed
113	Brand name of gas lamps	None/Chinese/…….
114	No. of lamps	0/1/2/3/4
115	Quality of fitting of gas lamp	Good/fair/bad
116	Expected duration of lamp use	……. hour/day

	Condition of Pipeline	
117	Shortest pipe alignment	Yes/No
118	Sealing agent	Good/fair/bad
119	Unnecessary fittings	Yes/No/ not yet complete
120	Pipe buried where possible	Yes/No/ not yet complete
121	Depth of trench	…… cm/ not yet complete
122	Pipe protected against damage	Yes/No/ not yet complete
123	Water drain able to drain condensed water	Yes/No/ not yet complete
124	Drain pit properly maintained	Yes/No/ not yet complete
125	U shaped pressure gauge installed properly	Yes/No/ not yet complete
126	Clay-Water seal maintained properly	Yes/No/Not yet completed
	Instructions to User	
127	Slurry pit constructed	Yes (1/2 nos with volume…..)/No/Not yet
128	User properly instructed	Yes/No/ not yet
129	If yes, by whom	Mason/supervisor/……
130	Who was instructed	Male member/Female member
131	Instruction booklet provided	Yes/No/ not yet
132	One member participated in O&M training	Yes/No
133	Guarantee certificate provided	Yes/No/ not yet
134	Remarks, if any	
	Form Filled by (Officer PBPD)	
	Seconded by (The user)	
	Agreed by (The company/installer/mason)	

Annex-3: Construction Completion Reporting Form

Biogas Project Division (MARD)
BIODIGESTER CONSTRUCTION COMPLETION REPORT

General

Plant Code No:……..

Name of Plant Owner:…….

Name of Household Head: …….

Address: Village…….....

District……

Province…….…….

No. of family Members sharing the kitchen: ……..

Size of Plant: …….. cum

Name of Mason Responsible:…….

Name of Company/Mason Team:……..

Date of Start of Construction: ……

Date of Completion of Construction:……

Feeding Materials

No. of Adult Cattle:…….

No. of Adult Pig:……..

Total Quantity of Dung Produced:…… kg/day

Total Quantity of Dung Fed: :…… kg/day

Toilet constructed: Yes/No

Latrine Attached to biodigester: Yes/No

Provision of future attachment: Yes/No

Location of Plant

Distance from Kitchen:……

Distance from Cattle shed/Pig Sty:……

Distance from dug well/tube well:……..

Distance from main road or heavy machine:……

Ground water problem: Yes/No

Ease in Dung Feeding: Easy/Moderate/Difficult

Safe from erosion, vandalisms etc.: Yeas/No

Quality of Construction

Total Quantity of Cement used:……Bags

Gas Stoves Brand:…….. Installed No:…….

Gas Lamp Brand:……... Installed No:…….

Main Gas Valve Brand:……

Water Outlet Brand: …….

Gas tap Brand:…….

Type of Dome Gas Pipe:……

Type of Gas Pipe:

- GI 13 mm, Flexible Plastic
- 13 mm, PVC 17 mm,
- Other (specify)……

Length of Pipeline: …….. metre

Depth of Pipe trench:…….

Sealing Agent(s): Teflon Tape, …….

……

Quality of plaster inside the digester: good/fair/poor

Quality of plaster coats inside gas holder: good/fair/poor

Thickness of Outlet slab: ……

Quality of Outlet slab: good/fair/poor

Quality of water drain pit: good/fair/poor

Quality of workmanship in general: good/fair/poor

No of composing pit: 0/1/2

Total volume of Compost pit: …….

Condition of the surrounding: clean/dirty/very dirty

Symmetry of inlet pipe, digester, manhole and outlet maintained: Yes/No

Overall Comments:

……

……

……

Measurement of Different Components

Drawing of Biogas Plant

1.	Inner Diameter of digester	.....	cm
2.	Total inner height of digester	.....	cm
3.	Height from floor to bottom of inlet pipe	.....	cm
4.	Height from floor to bottom of outlet pipe	.....	cm
5.	Height between bottom of outlet pipe and floor of outlet	.....	cm
6.	Diameter of outlet tank	.....	cm
7.	Height of outlet tank up to the bottom of over flow opening	.....	cm
8.	Height of overflow opening	.....	cm
9.	Thickness of slab	.....	cm
12.	Height of inlet tank from the ground level:	.....	cm
13.	Inner height of the inlet chamber	.....	cm
15.	Height of neck	.....	cm
16.	Height of top filling over dome	.....	cm

Annex-4

Biodigester Monitoring Form

Name of Biodigester Owner	Mr/Mrs.……..……..…….
Address	Commune: ……..……..…… District: ……..…… Province: ……..…….
Name of user(s) consulted during visit	1. ……..……..…….. 2. ……..……..
Size of Biodigester	4 / 6 / 8 / 10 cum
Visited by	1. ……..……..…….. 2. ……..……..
Date of Visit	……..
Purpose of Visit	1. ……..…….. 2. ……..…….. 3. ……..……..
Main activities carried out at the site during the visit	1. ……..……..……. 2. …….. 3. ……..……..
Existing problems reported by the user(s), if any	1. ……..……..…… 2. ……..…….. 3. ……..……..
Instruction given to the users	1. ……..……..…… 2. ……..…….. 3. ……
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: ……..

Annex-5: Trainer's Manual
(Submitted separately)

Annex-6: Trainee's Manual (draft for discussion)
(Submitted separately)

Annex-7: Presentation Slides (draft for discussion)
(Submitted separately)