Modified GGC Model for Lao PDR-2006

Trainer's Guide for Training of Trainers for Construction and Supervision of Biogas Plant

Biogas Pilot Program

SNV Lao PDR

April 2006

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Purpose of this Manual

A training program is like a big house with foundation and two floors. To get from the bottom to the top, one has to take one step after the other carefully. In a training program, the trainer/facilitator acts like a guiding architect/engineer in the construction and maintenance of this house, assisting the group to build its own house, floor by floor. However, the trainer/facilitator is not responsible for the final building. Although the architect/engineer has to have an eye on the floors and the steps so that nothing is forgotten, the ultimate success rests on the team who builds the house. Similarly in training, the trainer/facilitator has to have deep eyes on the process and performance of the participants. Each floor (session) requires certain skills of the trainer/facilitator to enable the group and its members to move around the house (training objectives) in order to learn most effectively.

Building of a quality biodigester not only requires good knowledge and skills on the part of the constructor, the mason, but also effective supervision of installation and post-installation activities on behalf of a supervisor. 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. In other words 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 major concern. Supervisors have to play vital role in this regard. This manual envisages helping the trainer / facilitators in imparting effective supervisors' training and preparing the participants as multi-skilled persons to supervise the installation and post-instillation operation and maintenance services related to biodigester, provide back-stopping services to masons as well as promote the technology at the grass-roots level.

Trainer's Roles

A trainer during the same training, or even the same session has to wear many different hats, depending upon the training environment such as, setting, the purpose of the session, the type of participants, the group dynamics, the situation etc. Every trainer needs to find his or her own style as a trainer, balancing all these different hats. Each of us has his or her own strengths and weaknesses in carrying out these different roles. Some roles will be easier to perform, while on the others, the trainers have to work harder. The following are some of the major roles that the trainer has to play:

a. Facilitator/Lecturer/Delegator/Instructor
b. Designer
c. Organiser
d. Listener/Learner
e. Interpreter/ Paraphraser
f. Role Model
g. Negotiator/Moderator
h. Leader
i. Observer/Monitor
j. Entertainer
k. Evaluator

l. Problem-solver/Manipulator
m. Motivator

It is therefore important that the trainers assess their own training qualities taking into account the multifaceted roles they have to play. They need to prepare well in advance for successful deliberations and transfer of knowledge and skill to the participants. The following sections provide details on training objectives, training contents/sessions, training schedules and training plans to successfully organise and conduct the Trainer's Training to Construct and Supervise Modified GGC Model of Biodigester being introduced in Lao PDR.

1. Background

A detailed feasibility study carried out by SNV in July 2003 recommended to initiate a moderate Biodigester Program in Lao PDR and accordingly an agreement was signed between the STEA (on-behalf of Government of Lao PDR) and SNV to implement a Renewable Energy Programme. SNV in March 2006 conducted a study on selection of appropriate model of biodigester for wide-scale dissemination of biodigester technology in Lao PDR. The study, after thoroughly reviewing the technical details of five different potential models, recommended the Nepalese GGC or alike to be the most suitable model of biodigester for the Laotian context.

In the process to build the capacity of local artisans especially the masons, by imparting them detail technical knowledge and skills on methods of construction and supervisions of the household Biodigester, a Training of Trainers has been felt needed. The participants of this TOT are expected to organise and conduct technical training programs to masons and supervisors in the future.

2. Training Objectives

The overall objective of the TOT is to build capacity especially within STEA/TRI to conduct quality training courses on Construction and Supervision of GGC model Biodigesters; and develop STEA/TRI as the National Training Institute for Biodigester related Technical Training Courses in Lao PDR.

The following are the specific objectives:

a. To familiarise the participants on Biogas Technology, Biodigester Program in Lao PDR and related issues
b. To acquaint the participants on technological aspects of GGC model Biodigester being introduced in Lao PDR
c. To build skills and enhance knowledge of participants on biodigester construction through on-the-job training on biodigester construction
d. To build capacity of participants on imparting training on construction, monitoring, supervision and O&M of biodigesters

3. Expected Output

The overall output expected from the training programme is the internalisation of the training process by the individuals as well by STEA/TRI to be able to impart training to masons and supervisors to construct, monitor, supervise, operate and maintain biodigesters in Lao PDR.

The following are the specific outputs expected from the TOT:

- The participants will be familiar about the Pilot Bio-digester Program in Lao PDR
- The participants will acquire detail knowledge on biogas technology, its importance and use of biodigester-products (biogas and bio-slurry)
- The participants will have hands-on knowledge and skills on:

- Reading plant drawings
- Selection of plant-size, construction sites and construction materials
- Plant lay-out, digging of pits and construction of foundation
- Construction of digester and gas storage tank
- Construction of Inlet and Outlet chambers
- Laying of pipelines and installation of appliances
- Construction of slurry pits and importance of composting
- Routine operation and maintenance activities
- Monitoring and supervision of construction of bio-digesters
- Quality standards on biodigester construction, operation and maintenance

- The participants will know and realise the roles and responsibilities of Masons and Supervisors on promotion and extension of biodigester technology
- The participants will demonstrate ability to transfer skills and knowledge on above mentioned issues to the larger audiences (masons and supervisors) in the future (Hands on skill to conduct technical training programmes to masons and supervisors)

4. Participants

Participants in TOT will include:

- Instructors from STEA/TRI
- Local technical persons from Communities who have hands on skills on masonry works

5. Training Venue and Duration

The overall training programme will be conducted in two different phases:

- Theoretical deliberation with practical demonstration; and
- On-the-job practical exercises.

The theoretical part of the training will be conducted in STEA/TRI training centre(?). The participants will be provided with theoretical and practical knowledge through classroom sessions and construction of a demonstration biodigester in the premises of STEA/TRI training centre. The theoretical training and installation of demonstration biodigester will be conducted for 7 days.

The on-the-job practical exercises on biodigester construction will be carried out in different locations in Vientiane provinces at the farmers' household premises for 15 days.

6. Training Contents

The contents of training programme has been finalised keeping in view the objectives and expected outcomes. The following table briefly describes the contents of the training programme.

Table-1: Training Topics, Contents and Methods of Deliberation

Main Topic	Contents	Methods of Deliberation
Training objectives and expected outputs	a. Need for the training b. Objectives of the training c. Expected Outputs	Theoretical
Introduction of Pilot Program on Biogas	a. Evolution of Biogas Pilot Program in Laos b. Program objectives and targets c. Progress/activities undertaken till date	Theoretical
Introduction to Biogas Technology	a. Biogas in general b. Ideal Conditions for gas production c. Benefits of Biogas d. Use of Biogas	Theoretical
Overview on Biodigester Construction and Design/ Drawings	a. Types of biogas plant b. Different Components of a biogas Plant c. Functioning of a biogas Plant d. Plant being introduced in Laos (GGC Model) e. Familiarization on design and drawing of GGC Model of Biodigester	Theoretical and Group exercise
Selection of Biodigester Size, Construction Site and Construction Materials	a. Points to be considered while selecting the size of biodigester (feeding availability vs. family size) b. Quantification of dung based upon cattle numbers c. Hydraulic retention time d. Selection of appropriate size of biodigester based upon dung availability e. Points to be considered while selecting site for biodigester construction (location of plant vs. cattle shed, kitchen, water fetching points etc.) f. Types and quality standards of construction materials g. Quantity requirements of construction materials	Theoretical and practical
Laying out and Digging of Pit	a. Methods of laying out of biodigester (fixing the relative positions of inlet, digester, manhole and slurry pits) b. Methods of digging the pit c. Fixation of the centre point d. Preparation of the base	Theoretical and practical

Main Topic	Contents	Methods of Deliberation
Construction of base	a. Firming-up of foundation base b. Methods of preparing mortar c. Methods of fixing the base for round wall d. Laying of bricks and mortar to construct round wall	Theoretical and practical
Construction of Digester	a. Checking of central pillar for its verticality b. Fixation of chord/string to facilitate the construction of round-walls c. Methods of preparing mortar and bricks for construction of wall d. Construction of round wall e. Fixing of inlet pipe f. Construction of manhole g. Construction of floor (brick soling and plastering) h. Plastering of walls i. Backfilling in cavity outside the wall j. Curing of wall	Theoretical and practical
Construction of Dome (gas holder)	a. Filling of earth in digester b. Shaping of the dome with the use of template c. Preparation of surface for concreting (watering and sprinkling of sand) d. Fixing of the position of main gas pipe e. Concreting of dome and maintaining the thickness of dome f. Fixation of main gas pipe g. Curing of concrete	Theoretical and practical
Plastering of Dome	a. Taking out of soil-mould b. Preparation works (scrubbing and washing) c. Application of plastering layers d. Application of acrylic emulsion paint e. Importance of dome plastering	Theoretical and practical
Construction of Outlet	a. Preparation for the base b. Brick soling and plastering of the base c. Construction of walls d. Plastering of walls e. Casting and fixing of RCC cover slab f. Soil stabilization to safeguard walls against slurry pressure g. Curing of plastered surface	Theoretical and practical

Main Topic	Contents	Methods of Deliberation
Construction of Inlet	a. Preparation for the base b. Construction of base c. Construction of round wall d. Fixation of mixing device e. Plastering and finishing woks f. Curing of plastered surface	Theoretical and practical
Installation of Pipeline and Appliances	a. Construction of Turret b. Fixation of pipeline alignment and digging of trench c. Installation of main gas valve d. Pipe-laying works e. Installation of water-trap and chamber f. Fixation of gas taps, rubber hose pipe, stove and lamps g. Checking for leakages	Theoretical and practical
Construction of Slurry Pits	a. Site preparation and laying out b. Digging of pits c. Stabilizing of the slopes d. Importance of composting and shading of pits	Theoretical and practical
Overview on Operation and Maintenance	a. Filling up of the digester with feedstock b. Importance of routine operation activities (plant feeding, use of gas valves, draining condensed water from pipeline etc.) c. Minor maintenance activities d. Potential problems and likely solutions (ex. Slurry in the pipeline)	Theoretical and Group exercises
Quality Management (Quality standards, Supervision and Monitoring)	a. Importance of Quality Management b. Quality Standards and Quality Management Systems c. Supervision and monitoring visits and feedback to Masons/Users d. Familiarisation with forms and formats and practice to fill these forms e. Filling of Quality Control Form for Under-construction Biodigester (Visit to under-construction plant) f. Filling of Quality Control Form after the Completion of Construction (Visit to Completed plant to fill Construction Completing Report)	Theoretical lectures, discussions, demonstration and practical exercise
Role of Mason and Supervisor	a. Roles of mason and supervisor for quality plant construction b. Role of mason and supervisor for promotion and extension of the technology	Theoretical, Group exercises and simulation

7. Training Events and Process

Training management activities to be carried out during the process of the TOT can broadly be classified into three phases as described below:

7.1 Pre-training Preparatory Phase

Pre-training activities mainly include the agreement with STEA/TRI, finalisation of design and drawing of GGC model of Biodigester, selection of participants, formulation of aim, objectives and expected results, planning of sessions and events, preparation of hand-outs, arrangement of training aids and other logistic arrangements.

7.2 In-training Operational Phase

The in-training operational phase will be divided into two main sub-phases: theoretical classes with practical demonstration, and on-the-job training. The schedules of each of the sub-phase have been given in the Annex. Operational activities included all the events that will take place during the conduction of training sessions. In general training sessions will consist of the following:

- Opening ceremony
- Class room deliberations and discussion
- Field demonstration and construction of one demonstration biodigester
- Installation of pilot biodigesters by the trainee in the process of on-the-job training
- Sharing of lessons learnt and collection of comments and suggestions
- Closing ceremony

The in-training program, especially the on-the-job training will be instrumental in internalising the steps of installation. It is expected that the participants, after the training, will realise that the construction technique is not as difficult as anticipated, if the steps and norms of construction are followed strictly.

7.3 Post-training Concluding Phase

Post training activities will include documentation of events, process, review of learning and questions that may emerge. Preparation of concise training report consisting of participants, session plans, schedules and evaluation by the participants on the training program will be a major part of the post-training activities. The main outcome of the post-training phase will be the finalisation of the Curricula for New Mason's Training and Curricula for New Supervisor's Training. Other main achievement during this phase will be the finalisation of cost and quality estimates based upon the field experience.

8. Programme Overview

8.1 Inaugural (Opening) Session

The formal inauguration program will be organised and conducted with active participation of STEA/TRI.

8.2 Training Sessions

8.2.1 Introduction and Expectation of the Participants

Following the short inauguration session, the main training session will start with the introduction of participants and the facilitators. The reasons for their participation in the training program (the expectations), will be asked with the participants and documented.

8.2.2 Pre-test

To assess the general knowledge of participants on biodigester technology, they will be provided with a standard set of questionnaire to answer. The pre-test will aim at assessing the level of understanding of the participants on biodigester technology, which in turn, will guide the facilitators to plan the session contents and deliberations.

8.2.3 Deliberation and Demonstration Session

The detailed schedule of the session has been given in the Annex. The training program will be conducted as per the schedule. Slight alterations can be made depending upon the need of the participants.

8.2.4 Practical (on-the-job) Training Session

The participants of the TOT will be divided into groups, each comprising of 2-3 members, to install biodigesters in the process of the application of their theoretical learning to the real field situation. The following criteria will be used for the selection of households for installation of biodigester.

- Households in clusters to facilitate the monitoring of activities during construction, sharing of lessons learnt and optimisation the resources
- Availability of feeding materials (at lest 20 kg of cattle dung or 15 kg of swine manure)
- Commitment of the owner to operate the plant efficiently for a longer run
- Willingness to use of gas for both cooking and lighting purposes
- Commitment of the owner to provide non-skilled labours (??) required for the construction works
- Assurance from the owner that the family will entertain the visitors who come to monitor and observe the plant for research or learning purposes

9. Installation Modality

Prior to the selection of households for installation of pilot biodigesters, an implementation modality has to be agreed with the households selected to install biodigesters. For discussions purpose, the following proposal is made:

SNV will be responsible to:

- Prepare tentative bills of quantity and cost and hand over it to the respective team leaders for the purchase of construction materials
- Reimburse the cost of construction materials, tools and equipment upon the receipt of bills and vouchers from the respective team leaders
- Provide all the pipes and appliances to the users free of cost

- Facilitate the installation process through technical back-stopping services

The respective households selected for the installation of biodigester will be responsible for:

- Providing unskilled labour needed for the installation of the biodigester
- Procurement and transportation of construction materials in consultation with the trainees and submit bills and vouchers for payment through the trainees

The trainees will be responsible for:

- Overall construction management as the lead mason.
- Constructing of biodigester as per the design/drawing.
- Supporting households in procuring construction materials that meets quality standards.
- Facilitate the biodigester owners in getting final payment of the expenses incurred to purchase construction materials.
- Sharing of lessons learnt with other participants and facilitators.

10. Training Evaluation

Evaluation of training program will consist of the two tasks – the first will be the task of assessing participants' level of understanding and the second aims at getting feedback from the participants on various aspects of the training programme including the issues related to training management, performance of trainers and effectiveness of the training methods.

A post test will be conducted at the end of the first phase of the training to assess the level of understanding of the participants. The marks obtained by the participants before and after the training will be compared to assess the effectiveness of the training.

Similarly, participants will be asked, through a questionnaire, to provide their constructive comments and feedback on overall aspects of the training programme, including, training and facilitation techniques, learning climate and effectiveness of the training to fulfil the anticipated objectives.

11. Closing Ceremony

At the end of the Phase-1 and 2 of the training program, a closing ceremony will be organised in which overall review and recapitulation of the training program will be made. The participants who complete the course successfully will be distributed with the certificates.

12. Training Schedule (Session Plan) – Phase 1: Theoretical Training

Session No.	Time Schedule	Session Topic
	Day-1	
	08:00-10:00	Registration and Opening ceremony
	10:00-10:15	Tea break
1	10:15-12:15	Introduction, Objectives, Expected Outputs, Detailed-Schedule and Pre-test
	12:15-13:30	Lunch
2	13:30-14:00	Introduction of Biogas Pilot Program (BPP) in Lao PDR
3	14:00-15:30	Introduction to Biogas Technology: General and Ideal Condition for Gas Production, Design Principle of Biodigester, Cost and Benefits of Biodigester including Use of biogas and bio-slurry
	15:30-15:45	Tea break
4	15:45-16:45	Significance in biodigester technology in Lao PDR
	16:45-17:00	Recapitulation and discussion
	Day-2	
5	8:00-08:30	Introduction to Biogas Technology: Functioning and types of biodigesters
6	08:30-10:00	Video show or Visits to biogas plant to familiarise the plant components and discussions
	10:00-10:15	Tea break
7	10:15-12:15	Design/Drawings of GGC model Biodigester
	12:15-13:30	Lunch
8	13:30-14:30	Biodigester Construction methods and steps
9	14:30-15:00	Selection of Construction Site
10	15:00-15:30	Selection of biodigester size
	15:30-15:45	Tea Break
10	15:45-16:45	Selection of Biodigester Size continues
	16:45-17:00	Recapitulation and discussion
	Day-3	
11	8:00-09:00	Quality Standard of Construction Materials and appliances
12	9:00-10:00	Construction of Biodigester: Lay out of biodigester (theory and practice)
	10:00-10:15	Tea break
12	10:15-11:15	Lay out of biodigester (practice)
13	11:15-12:15	Construction of Biodigester: Trench digging and foundation works (Theory and practical demonstration)
	12:15-13:30	Lunch
14	13:30-15:30	Construction of Biodigester: Construction of digester (Theory and demonstration)
	15:30-15:45	Tea Break

14	15:45-16:45	Construction of Biodigester: Construction of digester (practical demonstration)
	16:45-17:00	Recapitulation and discussion
	Day-4	
15	08:00-10:00	Construction of gas holder: Making mould for casting gas holder
	10:00-10:15	Tea break
15	10:15-12:15	Construction of gas holder: Concreting of gas holder
	12:15-13:30	Lunch
15	13:30-15:30	Construction of gas holder: Concreting of gas holder continues
	15:30-15:45	Tea Break
15	15:45-16:45	Construction of gas holder: Plastering and treatment of gas holder (Theory and demonstration of making plastering coats)
	16:45-17:00	Recapitulation and discussion
	Day-5	
16	08:00-10:00	Construction of Turret, Manhole, Inlet and Outlet tanks
	10:00-10:15	Tea break
17	10:15-12:15	Installation of Pipeline and appliance and construction of slurry pit
	12:15-13:30	Lunch
18	13:30-15:30	Quality standards
	15:30-15:45	Tea Break
18	15:45-16:45	Quality standards continue.
	16:45-17:00	Recapitulation and discussion
	Day-6	
19	08:00-09:00	Technology Promotion and Quality Management: Importance and Process
20	09:00-10:00	Introduction to Promotion and Quality control forms and formats
	10:00-10:15	Tea break
21	10:15-12:15	Overview on O&M of biodigester: Routine Operational and Minor Maintenance Activities
	12:15-13:30	Lunch
22	13:30-14:30	Potential problems and likely solutions
23	14:30-15:30	Guarantee, After-sales services and User's Training
	15:30-15:45	Tea Break
24	15:45-16:45	Role of Mason and Supervisors and other Stakeholders
	16:45-17:00	Recapitulation and discussion
	Day-7	
25	08:00-09:00	Participatory Discussion/Recapitulation of the overall learning
26	09:00-10:00	Formulation of future plan of action
	10:00-10:15	Tea break
27	10:15-11:15	Post Test and Training Evaluation
	11:15-12:15	Closing
	12:15-14:00	Lunch and Departure

13. Activity Schedule – Phase 2 (Practical on-the-job Exercise)

Date	Activities	Monitoring Indicators
1st Day	• Finalisation of households based upon the set criteria, household visits, selection of construction sites	• Households should comply with the selection criteria
2nd Day	• Supply of construction materials • Plant Layout	• Construction materials should meet the quality standards • The dimensions should be as given in the drawing
3rd Day	• Starting of digging of pit	• Digging depth and circumference has to be as per the layout plan
4th Day	• Digging completes	• The depth of digging should be as per the drawing
5th and 6th Days	• Construction of round wall	• The centre of digester should carefully be fixed and central pole should tightly be secured. The pole should be vertical. • Radius of digester – as per drawing • The distance between the centre of the pole to end of chord or string should be equal to radius of digester plus 15 mm. • Mortar ratio – 1:3 • Length and height of collar – 15 and 6 cm respectively • Bricks/stones should be soaked in water before using • Each brick/stone has to be laid by matching its side (rise) with the chord/string fixed on the centre pole. • Joints between brick/stones should be well compacted. Joints in adjacent layer should not fall in a vertical line. • The lowest point of inlet pipe should be 35 cm above the collar • The walls should be plaster with smooth surface – mortar ration 1:3 (cement: sand) • The cavity in the back of the wall should be filled properly
7th Day	• Preparation of earthen mould for dome concreting	• Care should be provided to fill in the earth to avoid damage to the round wall • Proper compaction of soil is important • Use of correct size of template is necessary • Proper use of template is essential • The finished surface of the mould should be sprinkled with water and covered with a thin layer of sand before concreting.
8th Day	• Concreting of gas holder	• The mix of mortar should be 1:2:3

	• Casting of outlet cover (slab)	(cement:sand:aggregate) • The work of concreting should start from on edge and continue to the opposite edge via the top • The depth of concrete should be as per drawing • Freshly laid concrete should be properly compacted • The mortar should be used within 30 minutes from its preparation • Concreting works should be done uninterruptedly • Dome gas pipe should be correctly placed in the centre of the dome • The finished surface should be properly cured for at least five days. • Outlet cover should be casted as per instruction in construction manual
9th Day	Construction of turret and Outlet	• Turret has to be constructed as shown in the drawing • The base of outlet tank should be prepared with broken bricks and a thick layer of plastering • The length, breadth and height of outlet should be as per the drawing • The overflow opening should be in the longer wall parallel to the hart-line • The walls should be vertical and plastered with 1:3 mortar • The overflow opening should be built slightly higher than the ground level (as per the drawing) to avoid water entering into the outlet during rainy season.
10th Day	Construction of inlet (maturation chamber)	• The foundation of the inlet pit should be places in well rammed, hard and levelled surface. • In this rammed surface first of all the rectangular base of inlet tank is constructed. • The height of the base should be decided in such a manner that the floor of inlet tank is at least 15 cm above the outlet overflow level. • Height of inlet should not be more than 1m from the ground level • The drain from pigsty should facilitate easy flow of feeding to the digester
11th Day	Plastering of gas holder (1st , 2nd and 3rd layers)	• The inner surface of dome should be chiselled and clean well with water before starting plaster work

		• First, the surface should be flushed with cement-water solution • Then, a layer of plaster (1:3), 12 cm thick has to be applied. • Then, a thin layer (5 mm) of cement-sand punning (1:2) has to applied once the second layer is set • The surface of plastering and punning should be smooth and fine.
12th Day	Plastering of dome (4th and 5th layers) Digging for pipe trench	• 1 part of Acrylic emulsion paint has to be well mixed with 10-12 parts of cement by volume adding required quantity of water to make fine paste • This paste should be applied evenly through out the surface of dome (5 mm thick) • The alignment for pipe trench should be the shortest and safe. • The depth of pit should be at least 30 cm.
13th Day	Plastering of dome (5th layer) Pipe laying and installation of Appliances and Finishing Works	• 1 part of Acrylic emulsion paint has to be well mixed with 2 parts of cement by volume adding required quantity of water to make fine paste • This paste should be applied evenly through out the surface of dome (2 mm tick) with the brush • Avoid to many joints • Water drain pit must be constructed at the lowest point of the pipe line where it is easy accessible. When finished, the inside dimension must be 40 X 40 cm and the height 50 cm. To avoid rain water entering into the drain pit the walls must be at least 5 cm above ground level. For easy operation of the water drain must be installed 30 cm below the ground level. The drain pit slab has to be of 66 X 66 cm and easy to handle by 1 person. • To avoid gas leakage Teflon tape must be used on every joins. • One must minimise using unnecessary fittings and unions in the pipe line. • No unnecessary fittings should be used in between the reducer of dome gas pipe and the main valve. • To prevent it from damage the pipe line must be buried 1 foot where possible.
14th Day	Construction of Slurry pits Construction Works Completes	• The compost pit must be minimum 1 m away from the outlet where the slurry can flow into the pit easily. 2 compost pits

		equivalent to the plant volume must be made. • The depth of the compost pits must not exceed more than 1m and the distance between the two compost pits must not be more than 50 cm. • The length and width at the top must be more than of the bottom and add 10 cm mud on all sides to raise the height from the ground level to avoid rain water enter the compost pits. • Cover the entire dome with at least 30 cm thick layer of soil • Clean the site properly
15th Day	Sharing of difficulties and lessons learnt and closing of the training program	• Participants discuss on the problems and lessons learnt during the course of training

14. Training Plans

Session-1: Training objectives and expected outputs

Objectives

At the end of this session participants will be able to:

- Get familiarised with each other
- Tell the purpose and expected output of the training
- Know the schedule of the training
- Assess their level of understanding on biodigester technology

Training Method

Presentation, Game Play, Group exercise

Training Aids	**Time**
Flip Charts, Meta Cards, OHP/LCD, Handouts on Objectives, expected outputs and schedules	120 minutes (Introduction-30 minutes, objective and expected output-30 minutes, schedules-10 minutes, pretest-50 minutes)

Steps

- Explain the purpose and procedure of the session
- Ask the participants to introduce themselves (Introduction can be done in various ways depending upon the knowledge and skill of the trainer)
- Ask the participants to write three main expectations in meta-cards. Group the expectations and list out the main three to five expectations
- Link these expectation with the training objectives and expected outcome (Write the objectives and outcomes in meta-cards; explain them one by one and stick them in soft board)
- Present the detailed training schedule
- At the end of the presentation ask the participants if they have any queries related to training objectives and schedules
- Distribute the pre-test questionnaires to the participants and ask them to answer the questions
- Exchange the answer copies and check the answers
- Note the highest, average and minimum marks obtained by the participants
- Plan your methods of deliberations as per the level of understanding of the participants

Session-2: Introduction of Biogas Pilot Programme (BPP)

Objectives

At the end of this session participants will have knowledge on:

- Evolution of Biogas Pilot Programme (BPP) in Lao PDR
- Programme objectives and targets
- Progress/activities undertaken till date

Training Method

Presentation and discussion

Training Aids	**Time**
Flip Charts/white board, Meta Cards, Masking tape, OHP/LCD, Marker pens (permanent/board marker), Handouts on National Biodigester Programme	30 minutes

Steps

- Explain the purpose and procedure of the session
- Start with a question on whether the participants know about Biogas Pilot Programme (BPP). If the answer is 'yes' ask them what they know and list down the responses in flip chart/white board
- Present information on evolution of BPP, objectives and targets, and progress/activities undertaken till date
- At the end of the presentation ask the participants if they have any queries related to the BPP.

Sessions-3 and 4: Introduction to Biogas Technology, Significance of Biogas Technology in Lao PDR

Objectives

At the end of these sessions participants will have knowledge on:

- Biogas Technology in general
- Ideal Conditions for biogas production
- Design principles of a Biodigester
- Costs and Benefits of Biodigesters
- Use of Biogas and Bio-slurry
- Importance of biodigester technology in Lao PDR

Training Method

Presentation, participatory discussions and observation of the non-filled plant

Training Aids

Flip Charts/white board, Meta Cards, Masking tape, OHP/LCD, Marker pens (permanent/board marker), Empty biodigester, and Handouts on Biodigester Technology

Time

150 minutes

- Biodigester technology in general and Ideal condition for biogas generation-60 min
- Design principles of a biodigester – 30 min
- Cost and Benefits of biodigester-30 min
- Use of biogas and bio-slurry-30 min,

Steps

- Explain the purpose and procedure of the session
- Start with a question on whether the participants know about Biodigester technology. If the answer is 'yes' ask them what they know and list down the responses in flip chart/white board
- If the answer is 'no', ask what they would like to know about the technology
- Present lectures with the help of OHP or LCD projector related to various topics as per the timing mentioned above. Start with the general introduction and end with potential application of gas and effective use of bio-slurry
- Ask the participants about their views on use of gas and the (dis)advantages of bio-slurry over the farm-yard manure.
- Present slides on advantages/benefits of bio-slurry over the farm-yard manure, methods of composting and proper use of bio-slurry
- Describe the use of biogas for cooking and lighting. Clearly explain why electricity generation is discouraged in domestic biogas plants

- Highlight the important points to be taken care while composting and using bio-slurry such as:
  - Not to expose bio-slurry in sun for longer duration
  - Adding household and cattle-shed wastes to bio-slurry in layers to prepare good composting
  - Mix bio-slurry with soil as soon as it is transported to the farm without exposing it to the sun light for longer duration
- Ask the participants if they have any queries related to composting of slurry, use of slurry and construction of slurry pits.
- Pay effort to make the presentation as participatory as possible
- At the end of the presentation ask the participants if they have any queries related to Biodigester Technology, use of gas and application of bio-slurry.

Sessions-5, 6, 7 and 8: Overview on Functioning and Types of Biodigester, Design and Drawing of GGC model, and Construction Steps

Objectives

At the end of these sessions participants will have knowledge on:

- Various types of biodigesters
- Functioning of biodigester
- Different Components of a biodigester
- Functioning of a biodigester
- Biodigester being introduced in Lao PDR (Modified GGC Model)
- Familiarization on design and drawing of Modified GGC Model of biodigester
- Construction steps and standards in general

Training Method

Presentation, Participatory discussions, Plant Visit or Video-show

Training Aids

Flip Charts/white board, OHP/LCD, Marker pens (permanent/board marker), Empty biodigester, design/drawing of biodigester, video-film or biogas plant and Handouts on biodigester types and construction steps.

Time

180 minutes

- Types, Components and functioning of Biodigester - 30 min
- Plant observation or video show – 90 min
- Concept of reading drawing-45 min
- Familiarisation with drawing of Modified GGC model – 75 min
- Construction methods and steps in general – 60 min

Steps

- Explain the purpose and procedure of the session
- Ask the participants if they have seen any model of biodigester, write the answers, if any, in white board/flip chart
- Deliver session on type of biodigester - show different types and ask them what similarity and differences they see in those designs
- Talk about the basic operating/functional principle of biodigester and make them clear that the principle is same for all models/designs
- Take the participants to biogas plant or show video on biogas plant to familiarise them with the components
- Present the sketch of Modified GGC Model and ask participants to draw the sketch and name various components
- Show the drawings and describe in detail each and every dimensions
- Present slides on construction steps and general standards to be followed while constructing. Explain the steps in the empty biodigester, if possible
- At the end of the presentation ask the participants if they have any queries related to the Modified GGC model, it's functioning and dimensions of different components.

Sessions-9, 10, 11: Selection of Biodigester Size, Construction Site and Quality Standards of Construction Materials & Appliances

Objectives

At the end of these sessions participants will have knowledge on:

- Points to be considered while selecting site for biodigester construction (location of plant vs. cattle shed, kitchen, water fetching points etc.)
- Points to be considered while selecting the size of biodigester (feeding availability vs. family size)
- Quantification of dung based upon cattle numbers
- Hydraulic retention time
- Selection of appropriate size of biodigester based upon dung availability
- Types and quality standards of construction materials
- Quantity requirements of construction materials

Training Method

Presentation, Demonstration, Participatory discussion, Simulation

Training Aids

Flip Charts/white board, Meta Cards, Masking tape, OHP/LCD, Marker pens (permanent/board marker), Samples of construction materials and appliances, bottle for sand test, Handouts on National Biodigester Programme

Time

240 minutes

- Selection of Site-30 min,
- Selection of size-60 min,
- Simulation on size and site selection-60 min, Quality standards of construction materials-90 min

Steps

- Explain the purpose and procedure of the session
- Ask the participants what are some of the criteria they may consider to select any construction site (ask them to share experience) and note down the answers in white board/flip chart
- Relate their answer with the criteria to select site for biogas plant construction and describe all the points in detail
- Carefully describe the criteria to select size of biodigester. Give emphasis that **the basis for selecting size is the availability of dung not the family size or gas demand. If the farmer has higher number cattle or pigs then only the size is determined by the gas demand which is usually taken to be 0.33-0.40 cum gas per person per day.**
- Once presentation on selection of site and size is complete, conduct a simulation. Divide the participants in different groups each consisting of 4-5 members. Select one person to be a mason and one to be a farmer in each group. Take them to a simulated site. Ask the farmer to present a scenario on number of cattle/pig he/she owes and the shape of land he/she has. Based upon the scenario, asks the mason to recommend appropriate size and site. Repeat the exercise with changing the roles to different participants each being mason and farmer turn by turn. Ensure that all the participants play the role of a mason.

- Ask the participants about the name of construction materials they usually use in their workplace. Once they answer, ask them whether they check for the suitability of construction materials. If they say yes, ask them how they know if the material is suitable or not. Link this with quality standards and explain in detail the types of construction materials and appliances used in biodigester and their quality standards. Properly demonstrate them the materials and appliances. Demonstrate the method of bottle test to assess the quality of sand.
- At the end of the presentation ask the participants if they have any queries related to the selection biodigester size, site for construction and quality standards of construction materials.

Sessions-12, 13, 14, 15, 16 and 17: Construction of Biodigester

Objectives

At the end of these sessions participants will have knowledge on methods and process of:

- Laying out of biodigester (fixing the relative positions of inlet, digester, manhole and slurry pits)
- Digging the pit, fixation of the centre point and preparation of the base
- Construction of Digester
- Method to made earthen-mould and concreting for gas holder (dome)
- Methods to make dome gas-tight (plastering of inside of the gas-holder)
- Construction of Turret, Manhole, Outlet and Inlet tanks
- Installation of Pipeline and Appliances
- Construction of Slurry Pits

Training Method

Presentation, discussions, demonstration and practical exercise

Training Aids

Flip Charts/white board, OHP/LCD, Marker pens (permanent/board marker), white powder, wooden peg, string, excavation tools, masonry tools, biodigester appliances and construction manuals

Time

1020 minutes

- Plant Lay-out (theory and demonstration) – 120 min,
- Digging of Pit and Construction of Foundation – 60 min
- Construction of Digester (theory and demonstration)– 180 min
- Preparation of mould, casting of concrete and plastering of Gas-holder- 420 min
- Construction of Turret, Manhole, Outlet and Inlet tanks – 120 min
- Installation of Pipeline and Appliances and Construction of Slurry Pits – 120 min

Steps

- Explain the purpose and procedure of the session.
- Start with a question to the participants – What do you understand by the term 'lay out'? Explain them what it means.
- Now, start with a discussion on the drawing of biodigester and ask the participant what are the dimensions mainly needed for lay out of biodigester?
- Describe the process of plant lay-out and demonstrate it in the field.
- Explain the important points to do plant layout which includes:
    - The centres of inlet tank, digester, manhole and outlet have to be in a straight line.
    - The biodigester should be constructed as per the dimensions given in the drawing.
    - The base of the round wall and floor of digester should be constructed in untouched/unmoved strata; therefore the depth of pit should be as per drawing.

- Positioning of pegs in the four corners to fix the centre of digester once the pit is excavated.

- Discuss the importance of firm foundation relating with the structural needs
- In an already dug pit, demonstrate how to fix the centre of digester with the help of four pegs and string.
- Explain methods to fix a centre pole and importance of its verticality
- Present slides on fixing of radius of digester and laying of first layer of bricks
- Discuss the importance of quality construction and correct sizing of digester
- Present slides on construction of digester and gas holder
- Explain in detail how the roundness of the digester wall is maintained with the help of central pole and string.
- Describe the methods of construction of wall and floor
- Highlight the important points to be taken care while constructing the digester such as:
  - Bricks must be soaked in water for 10-15 minutes before use.
  - The length of the guiding string should be more than the radius of the digester. The distance between the centre of the central pole and end of string should be equal to inner diameter of the digester plus plaster thickness. Each brick has to be laid by matching its side with the end of the guiding string. The bricks thus laid will be perpendicular to the radius of curvature.
  - Void at the outer part of the wall constructed in the previous day should be well filled with soil before laying the fresh layer of brick.
  - The ratio of cement mortar for all the brickwork has to be 1:3. The thickness of inside plaster should not be more than 10 mm and the mortar ratio should be 1:3.
  - The joints between two bricks should be well compacted with the mortar. No voids should be left during the construction of brick wall.
  - The verticality of the round wall should be checked regularly with the help of plump bob
  - Once the wall is constructed to the required height, the floor has to be constructed with broken bricks. A brick layer has to be rammed in the floor and then compacted with cement-sand mortar 2-3 cm thick
- Demonstrate the techniques of construction of digester in the field
- Discuss the importance of gas-holder and its gas-tightness
- Describe the methods of preparing earthen mould for casting the dome
- Highlight the major points to be considered while constructing gas holder such as:
  - The earthen mould should be well compacted
  - The shape of the mould should be framed by the use of appropriate sized template
  - The finished surface of the earthen mould should be sprinkled with water and covered by a thin layer of sand before casting concrete over it
  - The thickness of concrete should be more (10 cm) in the edges and less (7 cm) in the centre
  - Concreting should be completed in a single day
  - The concrete should be used within 30 minutes from the time of mixing
  - The dome gas pipe should be properly fixed at the centre of the dome, the reducing

elbow should point towards the direction of the kitchen

- Present slides on application of different plaster layers to make gas holder perfectly gas-tight
- Explain in detail how the plastering mix is prepared
- Describe the methods of application of different layers
- Highlight the important points to be taken care while plastering the gas holder such as:
  - The inner surface of dome should be chiselled and clean well with water before starting plaster work
  - First, the surface should be flushed with cement-water solution
  - The ratio of mix (cement-sand, cement-acrylic paint) and the thickness of the layer should be appropriate.
  - The surface of plastering and punning should be smooth and fine.
- Demonstrate the techniques of preparing plastering mix and application in the surface in the field
- Recapitulate the functioning of turret, manhole and outlet tank by asking the participants why these components are constructed.
- Present slides on the methods of construction of turret, manhole and outlet tank
- Explain in detail how the first layer of brick for outlet walls is laid, how to ensure that the corners are at 90 degree.
- Describe the methods of casting of outlet cover (concrete slabs)
- Highlight the important points to be taken care while constructing the manhole and outlet tank such as:
  - The base of outlet tank should be concreted with 1:2:4 mix
  - The length, breadth and height of outlet should be as per the drawing, bigger and smaller outlet will result adversely to functioning of plant
  - The overflow opening should be in the outside wall perpendicular to the hart-line
  - The walls should be vertical and plastered with 1:3 mortar
  - Cover should be casted as per instruction in construction manual
  - The overflow opening should be built slightly higher than the ground level to avoid water entering into the outlet during rainy season.
- Demonstrate the techniques of construction of turret, manhole and outlet in the field
- Discuss the functioning/importance of inlet tank
- Present slides on construction of inlet tank
- Highlight the important points to be taken care while constructing inlet tank such as:
  - The foundation of the inlet pit should be places in well rammed, hard and levelled surface.
  - In this rammed surface first of all the rectangular base of inlet tank is constructed.
  - The height of the base should be decided in such a manner that the floor of inlet tank is at least 15 cm above the outlet overflow level.
  - Height of inlet should not be more than 1m from the ground level
- Demonstrate the techniques of construction of inlet tank in the field
- Discuss the functioning/importance of pipeline and use of appliances
- Present slides on aligning trench, jointing of pipe and fittings and installation of appliances
- Highlight the important points to be taken care while aligning trench, jointing of pipe and fittings and installation of appliances such as:
  - The alignment for pipe trench should be the shortest and safe.
  - Joints in the pipeline should be as minimum as possible to minimise the potential gas-

leakage. One must minimise using unnecessary fittings and unions in the pipe line.

- Water drain pit must be constructed at the lowest point of the pipe line where it is easy accessible. When finished, the inside dimension must be 40 X 40 cm and the height 50 cm. To avoid rain water entering into the drain pit the walls must be at least 5 cm above ground level. For easy operation of the water drain must be installed 30 cm below the ground level. The drain pit slab has to be of 66 X 66 cm and easy to handle by 1 person.
- To avoid gas leakage Teflon tape and sealing agent must be used on every joins.
- No unnecessary fittings should be used in between the reducer of dome gas pipe and the main valve.
- To prevent the pipe line from damage it must be buried 30 cm below the ground as far as possible.

- Demonstrate the techniques of aligning trench, jointing of pipe and fittings and installation of appliances in the field
- Highlight the important points to be taken care while constructing the compost pit such as:
  - The compost pit must be minimum 1 m away from the outlet where the slurry can flow into the pit easily.
  - 2 compost pits with volume equivalent to the total plant volume must be constructed.
  - The depth of the compost pits must not exceed more than 1m and the distance between the two compost pits must not be more than 50 cm.
  - The length and width at the top must be more than of the bottom and add 10 cm mud on all sides to raise the height from the ground level to avoid rain water enter the compost pits.
- Demonstrate the techniques of calculating the dimensions and methods of constructing slurry pits in the field
- At the end recapitulate the steps of construction and major points to be remembered by asking questions to the participants.

Sessions-18, 19 and 20: Quality Standards, Promotion and Quality Control (Supervision and Monitoring)

Objectives

At the end of these sessions participants will have knowledge on:

- Promotional Activities
- Importance of Quality Management
- Quality Standards and Quality Management Systems
- Supervision and monitoring visits and feedback to Masons/Users
- Familiarisation of Quality Control Forms for Under-construction and completed Biodigester

Training Method

Presentation, discussions, demonstration, site visits and practical exercise

Training Aids	**Time**
Flip Charts/white board, OHP/LCD, Marker pens (permanent/board marker), and Handouts on Quality Management	300 minutes • Quality standards– 180 min • Promotional Activities – 60 min • Familiarisation of quality control forms and formats – 60 min

Steps

- Explain the purpose and procedure of the sessions
- Ask the participants about their knowledge on promotion and extension
- Present slides on promotion and extension
- Ask the participants about their views on the importance of quality management during construction and operation phases of biodigesters.
- Present slides on importance of quality management, quality standards and quality management systems and Supervision and Monitoring visits
- Familiarise the participants with different quality management forms and explain how to fill these forms during quality control visits
- At the end of ask the participants if they have any queries related to quality management during construction and post construction phases of biodigester

Sessions-21, 22 and 23: Overview on Operation and Maintenance, Problems and Likely solutions, and Guarantee, After-sales-services and User's Training

Objectives

At the end of these sessions participants will have knowledge on:

- Initial and daily feeding of the digester with feedstock
- Importance of routine operation activities (plant feeding, use of main gas valves, draining condensed water from pipeline etc.)
- Minor maintenance activities
- Potential problems and likely solutions (ex. Slurry in the pipeline)
- User's problems related to operation and maintenance of biodigesters
- Importance of Guarantee and After-sales-services
- Importance and contents of User's Training

Training Method

Presentation, discussions, demonstration, observation of functional biodigester, discussion with users and practical exercises to repair different appliances

Training Aids

Flip Charts/white board, OHP/LCD, Marker pens (permanent/board marker), repair and maintenance tools, and Handouts on Operation and Maintenance of Biodigester

Time

240 minutes

- Overview on O&M and Routine Operational and Maintenance Activities – 120 min
- Potential Problems, Causes and likely solutions – 60 min
- Highlights on Guarantee, user's training and ASS – 60 min

Steps

- Explain the purpose and procedure of the session
- Ask the participants about their views on general operation and maintenance activities in biodigesters
- Present slides on operation and maintenance of biodigesters
- Highlight the important points to be taken care while carrying out O&M of biodigester related to:
  - Feeding of biodigester (Initial and Daily Feeding)
  - Use of Main valve
  - Checking of gas leakages
  - Use of Water drain
  - Cleaning of overflow opening in outlet
  - Use gas tap
  - Use of gas stove
  - Use of gas lamp
  - Composting/ maintaining compost pits
  - Breaking of scum layer
- Present slides on likely problems and potential solution (be as participatory as possible)

- Demonstrate the techniques of carrying out routine repair and maintenance activities.
- Discuss on the importance of guarantee and effective after-sale-services
- Discuss on the importance of User's Training and topics that are needed to be included in User's training
- At the end of theoretical class, ask the participants if they have any queries related to operation and maintenance of biodigester.

Session-24: Role of a Stakeholders, Supervisor and a Mason

Objectives

At the end of this session participants will have knowledge on:

- Roles of different stakeholders in promotion and extension of the technology
- Roles of supervisor's and mason's for quality plant construction
- Role of supervisor's and mason's for operation and maintenance
- Role of supervisor's and mason's for promotion and extension of the technology
- Role of supervisors on quality management

Training Method

Presentation, discussions, and simulation

Training Aids

Flip Charts/white board, OHP/LCD, Marker pens (permanent/board marker), and Handouts on Role of Mason

Time

60 minutes

- Lecture on role of different stakeholders- 30 min
- Lecture on role of mason – 15 minutes
- Lecture on role of supervisor – 15 minutes

Steps

- Explain the purpose and procedure of the session
- Ask the participants – Who are the potential stakeholders for the implementation of biogas program? Write their answers in flip chart or white board.
- Discuss about the potential roles of these stakeholders
- Ask the participants about the role of mason and supervisors in promotion and extension of biogas technology
- Present slides on role of stakeholders, masons and supervisors
- At the end ask the participants if they have any queries regarding the role of stakeholders including masons and supervisors.

Session-25, 26 and 27: Overall Recapitulation, Formulation of Future Plan of Action, Post-test and Training Evaluation

Objectives

At the end of these sessions participants will:

- Carry out overall recapitulation of the entire training program and list out major lessons learnt and areas of further improvements
- Prepare future plan of action
- Assess the level of their knowledge on biodigester technology, knowledge on construction of biodigester, and hands-on knowledge and skills on quality management
- Provide constructive comments and feedbacks for improving the efficiency and effectiveness of similar training in the future

Training Method

Discussions, brain-storming, test and answering the questionnaires

Training Aids	**Time**
Flip Charts/white board, OHP/LCD, Marker pens (permanent/board marker), and questionnaire sets for post test and training evaluation	180 minutes (Recapitulation of the entire training program – 60 min, Formulation of future plan of action-60 min, post-test-30 min, training evaluation-30 min)

Steps

- Explain the purpose and procedure of the session
- Divide the participants in groups each containing 4-5 members and ask then to list the major learning of the entire training period. Ask them to present the group findings. Observe the group dynamisms. Summarise the major lessons learnt and assess areas for the future improvements/ attentions
- Distribute a form to formulate future plan of action, especially the schedule of activities they will carry out after the training, to each individual participant. Ask them to fill the form clearly. Once the form is filled, make copy and give one copy to the participants. Instruct them to follow the plan of action strictly.
- Distribute post-test questionnaires (Annex) and ask the participants to answer them.
- Distribute questionnaires to evaluate the overall training program (Annex) and ask the participants to answer them.
- At the end of ask the participants if they have any queries or concerns related to the overall training program
- Thank all the participants for their active participation in the training and express best wishes for the successful completion of future plan of action.
- Ask them to participate in the formal closing program.

15. Conclusion

It is expected that the training will be effective and highly beneficial in imparting basic knowledge on biodigester technology and enhancing skills on construction and supervision of household biodigesters. The training will provide a common platform to share ideas, information, problems and potential solution on biodigester construction in Lao PDR. The outcomes of this training program are expected to be instrumental and highly advantageous for effective promotion and extension of biodigester technology in the country.