BIOGAS PLANT TECHNICIAN FIXED DOME

CBT Curriculum

National Vocational Certificate Level 3

Version 1 - December 2014

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Preface

This curriculum is developed for the competency based training of Biogas Technical Supervisors. The term competency is at the heart of the training reform agenda, the new system of vocational education and training. Competency refers to the ability to perform 'whole' work roles to the standard expected in employment. Job performance involves more than the performance of a well-defined set of tasks in a routine, predictable way. Human performance is more than that of a programmed robot. 'Whole' work roles means that competency encompasses not only the obvious aspects of the technical skills involved in a job but also the less obvious skills such as the ability to:

- juggle/handle a number of tasks, deal with variability, coordinate and organize work (task management skills)
- deal with contingencies, problems such as delays, break downs, tight schedules (contingency management skills)
- work within an organisation; interact with groups and individuals, follow health and safety requirements, communicate effectively (job role/environment skills)

Todays 'World of Work' has undergone radical changes. The emergence of new technologies, global markets for products and services, and international competition require economies to upgrade and enhance the skill level of their human resources. Technical and Vocational Education and Training (TVET) systems all over the world are constantly challenged by this question of how to respond to the demand of a knowledge-based economy. As TVET systems and their training programmes directly relate to the world of work in terms of quantity and quality output, the approach of TVET programmes need to focus on the acquisition of technical and non-technical skills, also referred to employability skills.

With the release of the National Skills Strategy 2009-2013 the Pakistan government has made skills development a political priority. The framework for skills development aims to:

- Change TVET education from time-bound, curriculum-based training to flexible, competency-based training;
- Bring about a shift from supply-led training to demand-driven (outcome-based) skills development by promoting the role of industry in designing and delivering TVET.

The curriculum for ***Biogas Technical Supervisor – Level 3*** aims to respond to this demand. It has been developed as an outcome-based course designed to teach the employability skills needed to succeed in a high-performance work environment, as defined by labour market requirements. Given the high potential of biodigester technology in the country with approximately 5 million household qualifying for installing domestic biodigesters, there is significantly large market in the country (*Prakash C. Ghimire, Final report on the technical study of biogas plants installed in Pakistan. SNV, December 2007*) for the qualified personnel to find a job.

1. Introduction

1.1 **Name of course**: The title of the course is **'Biodigester Technical Supervisors to Supervise the Construction of Fixed Dome Biodigester for Running Tube-wells'**. This curriculum represents plan for the term, and communicates expectations to the training participants - the junior engineers and technical supervisors. The following are the competency standards for this course:

a. **Standard-1**: Describe basic concepts of biogas production and benefits of biodigester technology
b. **Standard 2**: Describe basic concept of designing a fixed dome biodigesters and perform cost and quantity estimation
c. **Standard 3**: Read and interpret drawings of fixed dome biodigesters
d. **Standard 4**: Select suitable type and appropriate size of fixed dome biodigester
e. **Standard 5**: Select construction materials and construction site
f. **Standard 6**: Supervise the construction of civil structural components of a fixed dome biodigester
g. **Standard 7**: Supervise the installation of pipeline, appliances and electro-mechanical components
h. **Standard 8**: Ensure effective operation and timely maintenance of the installed Biodigesters
i. **Standard 9**: Perform technology promotion and quality assurance tasks

1.2 **Overall objective of course**: The main objective of the course is to enhance the knowledge and develop the skills of would-be technical supervisors (i) to construct and supervise the construction of quality biodigesters and (ii) to ensure continued operation of the installed facility, so that the users are benefitted for long run. This curriculum is expected to be useful for the participants to gain employment as biodigester technical supervisors as specified by TEVTA and National Vocational and Technical Training Commission. The focus of the curriculum is on construction, supervision, quality control and after-sale-services of biodigesters to be installed in farms to run tube-well for irrigation. The following are specific objectives of the course:

- To familiarize the participants on Biogas Technology, in general, and Fixed Dome Biodigesters, in particular.
- To acquaint the participants on technological aspects of fixed dome biodigester, its components and working principle.
- To build skills and enhance knowledge of the participants on construction of structural components of fixed dome biodigester.
- To build skills and enhance knowledge of the participants on installing biogas-filtration devices, and end-appliances (pumps, generators, stoves, lamps etc.).
- To build skills and improve the knowledge of the participants on supervision of construction of structural components and, fabrication and installation of electro-mechanical components of fixed dome biodigester.

- To capacitate the participants in delivering quality services related to operation and maintenance, quality assurance, diversification of end-use applications, and users' training.
- To capacitate the participants to carry out effective quality control tasks and manage data and information collected from the field.

1.3 **Competencies gained after completion of course:** The learning outcomes describe what participants should know, be able to do, and value by the end of this training program. Within this curriculum, four general dimensions of learning outcomes are commonly identified:
(a) Knowledge outcomes, pertaining to grasp of fundamental cognitive content, core concepts or questions, basic principles of inquiry, a broad history, and/or varied disciplinary techniques. (b) Skills outcomes, focussing on capacity for applying basic knowledge, analysing and synthesizing information, assessing the value of information, communicating effectively, and collaborating. (c) Attitudes and values outcomes, encompassing affective states, personal/professional/social values, and ethical principles. (d) Behavioural outcomes, reflecting a manifestation of knowledge, skills, and attitudes as evidenced by performance, contributions, etc.
This curriculum envisages to equip the participants with required knowledge and underpinning skills in all duties and tasks of different modules formulated for biodigester technical supervisors to supervise the construction and ensure effective operation and maintenance of fixed dome biodigesters. After the completion of the training course, the participants will be able to:

a. explain the basics of biogas generation
b. know the micro-biological activities inside the digester, ideal conditions for gas production and potential inhibiting factors
c. know the basics of designing of fixed dome biodigesters
d. calculate cost and quantity estimation of fixed dome biodigesters
e. read and interpret drawings of biodigesters,
f. supervise the construction works of fixed dome biodigester as per set quality standards,
g. plan and conduct quality control visits and ensure fata and information management
h. instruct users for effective operation and timely repair and maintenance,
i. advice users for optimal utilization of the products of biodigesters - biogas and bioslurry.
j. promote and extend biodigester technology in the country

The following are the specific outputs expected from the training:

- The participants will acquire detailed knowledge on biogas technology, micro-biological activities inside the digester, ideal conditions for biogas generation and inhibition factors
- The participants will be familiar with the importance and use of biodigester-products (biogas and bioslurry)
- The participants will know the basic concept of designing a fixed dome biodigesters and carry out cost and quality estimations
- The participants will have hands-on skills and knowledge on:

- Reading drawings of biodigesters
- Selection of biodigester-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 filtration system
- Fitting of end-use-applications (stove, lamps, pumps and generators)
- Construction of slurry pits and importance of composting
- Routine operation and maintenance activities
- Quality standards on biodigester construction, operation and maintenance

- The participants will be able to supervise the construction process and provide effective coaching and mentoring to biogas technicians in the field
- The participants will know the principle of quality assurance, quality control mechanism and plan quality control visits
- The participants will know and realise the roles and responsibilities of local technicians to install biodigester.
- The participants will be able to orient/train users for ensure effective operation and routine maintenance activities.
- The participants will know the methods of promoting biodigester technology in the country.

1.4 **Job opportunities available immediately and in the future**: The graduates of this course are expected to find employment in government agencies, bilateral and multi-lateral organisations, non-governmental organisations, private and public limited companies, and consultancies implementing biodigester technology related initiatives in the country as the technical supervisors. Given the high potential of biodigester technology in the country with approximately 5 million household qualifying for installing domestic biodigesters, there is significantly large market in the country. (*Prakash C. Ghimire, Final report on the technical study of biogas plants installed in Pakistan. SNV, December 2007*).

1.5 **Trainee entry level**: The basic qualification for the participants to take part in this training should have: (a) Diploma in Associate Engineering (b) At least 10 class pass (Matric) havingbasic know how about the biogas plants.. Individuals having prior experiences in supervision of construction works should be given priority.

The selection of trainees must be done through structured interview sessions. Preference should be given to individuals showing greatest aptitude for the occupation demonstrated in the interview sessions. The perspective trainee should be of matured age to fit physically to the work and be able to travel even in difficult circumstances. Economically deprived and marginalized people meeting the set criteria should be given preferences. Candidates having a driving skill should be given priority.

1.6 Minimum qualification of trainer: The trainer/facilitator should have the following minimum qualification to organize and facilitate the training as trainer.

***Basic Academic Qualification*:** The basic qualification for the participants to take part in this training should have a minimum of: (a) Diploma in Associate Engineering (b) At least 10 class pass (Matric) having work experience of minimum of 2 years with Biogas Construction Companies as technical supervisor or trainer. Individuals having prior experiences in supervision of construction works should be given priority..

***Training*:** Specialized training on Training of Trainers

***Skill and Competencies*:** The trainer should be able to wear different hats as required to ensure effective learning while facilitating the training sessions, such as:

- Facilitator/Lecturer/Instructor
- Designer/Organiser
- Listener/Learner
- Interpreter/ Para-phraser
- Leader/Role Model
- Negotiator/Moderator
- Observer/Monitor
- Entertainer
- Evaluator
- Problem-solver/Manipulator
- Motivator

The trainer should be able to:

- Present an effective introduction.
- State the objectives and asks expectations.
- Ask multiple questions at a variety of levels.
- Provide positive feedback.
- Respond to participant questions positively.
- Follow trainer's notes/a personalized reference manual.
- Maintain eye contact.
- Project voice so that all participants can hear.
- Move about the room with balance postures and gestures.
- Use audiovisuals and other methods of teaching effectively.
- Display a positive use of humor.

- Present an effective summary.
- Provide for application or practice of presentation content.
- Strong communication skills

1.7 **Medium of Instruction i.e. language of instruction**: English/Urdu/Local Languages (Punjabi, Sindhi, Pashto, Balochi)

1.8 **Sequence of the modules**:

The participants must take part training on all the four modules as given below

Module 1: Describe basics of biogas generation including micro-biological activities inside the biodigester and installation of biodigesters

Module 2: Supervise the construction of civil structures of a fixed dome biodigester

Module 3: Supervise the fabrication/manufacturing of filter systems and installing of pipeline, appliances and electro-mechanical components

Module 4: Ensure effective operation and timely maintenance of a fixed dome biodigesters

1.9 **Timeframe of assessment**: The assessment of the trainees will be carried out during the entire process of the training sessions and, at the end of the training sessions using appropriate assessment methods such as oral questions, observation of on-the-job involvement, simulations, and case studies to collect factual evidences. Methodology for assessments should be designed and used to make sure that the participants are assessed properly and relevantly. A standard checklist should be developed to facilitate the assessment process. Collection of evidence is important to assess the learning outcomes. Evidences should: (a) cover core knowledge and skills that are developed throughout the program's curriculum, (b) involve multiple judgments of student performance, (c) provide information on multiple dimensions of student performance. Good evidence is also relevant, verifiable, representative or typical, cumulative, actionable, and reflectively analyzed.

1.10 Duration: The total duration of the training would be 264 hours divided in to:

- Theoretical Sessions: 100 hours
- Practical Sessions: 164 hours
- Total Duration: 264 hours (33 days)

2. Overview about the training program

Module Title and Aim	Learning Units	Theory[1] hours	Workplace [2] hours	Timeframe of modules
Module 1: Describe basics of biogas generation including micro-biological activities inside the biodigester and installation of biodigesters **Aim**: The aim of this module is to make trainees familiar with the process of biogas generation, micro-biological activities inside the biodigester, ideal conditions for biogas generation, inhibition factors, basics of designing a fixed me biodigester, cost and quality estimation, importance of biogas, and pre-requisites for installation of a fixed dome biodigester.	C1.1: Explain prerequisites for biogas generation C1.2: Explain basic concept of micro-biological activities inside the biodigester C1.3: Describe types and functioning/ working of biodigesters C1.4: Describe benefits of biodigesters and importance of the technology in Pakistan C2.1: Describe basic criteria for designing a fixed dome biodigesters C2.2: Interpret the relation between HRT, quantity of feeding materials and required size of biodigester C2.3: Carry out quantity estimation of different sizes of fixed dome biodigester C2.4: Carry out cost estimation of different sizes of fixed dome biodigester C3.1: Describe the basic concepts of a drawing of an object C3.2: Demonstrate ability to read basic drawings C3.3: Demonstrate ability of interpret drawing of fixed dome biodigesters C3.4: Read and interpret drawings of templates, appliances, pipes and fittings and filter systems C4.1: Select suitable type of biodigester C4.2: Select suitable size of biodigester C5.1: Name different types of construction materials needed for constructing a fixed dome biodigester C5.2: Appraise quality standards of construction	40	8	48

[1] Learning hours in training provider premises
[2] Training workshop, laboratory and on-the-job workplace

	materials C5.3: Explain criteria for selection of construction site C5.4: Explain steps (sequences) of construction of a fixed dome biodigester C9.1: Promote biodigester technology in Pakistan			
Module 2: Supervise the construction of the civil structures of a fixed dome biodigester **Aim**: The aim of this module is to ensure that the participants: (a) acquire hands-on-experiences on construction of different structural components of fixed dome biodigesters, (b) realise the importance of quality assurance, and practice quality norms while construction, and (c) supervises construction of biodigester as per set standards	C6.1: Supervise the construction of digester C6.2: Supervise the construction of gas holder and turret C6.3: Supervise the construction of manhole, outlet/ hydraulic chamber C6.4: Supervise the construction of inlet and mixing tank C6.5: Supervise the construction of slurry collection and composting pit C9.2: Describe the importance of quality assurance C9.3: Ensure that the masons/technicians practice quality norms during construction C9.4: Describe the roles and responsibilities of a technical supervisor C9.5: Ensure that occupational health and safety measures are practiced properly C9.6: Conduct routine quality control visits and manage data properly	20	108	128
Module 3: Supervise the fabrication of biogas filter system and installing of pipeline, appliances and electro-mechanical components **Aim**: The aim of this module is to ensure that the participants are acquainted with the correct methods of fabricating filter systems; installing of pipes and biogas appliances, and are familiar with different types of gas-	C7.1: Supervise the installation of pipeline C7.2: Supervise the installation of appliances C7.3: Supervise the fabrication/ manufacturing and preparation of filtration systems C7.4: Supervise the installation of gas filtration/purification system C7.5: Supervise the installation of pump and/or generator C9.2: Describe the importance of quality assurance C9.3: Ensure that the masons/technicians practice quality norms during construction C9.4: Describe the roles and responsibilities of a	16	32	48

filtration systems as well as machine (generators, pumps, induction motors etc.) to operate with biogas	technical supervisor C9.5: Ensure that occupational health and safety measures are practiced properly C9.6: Conduct routine quality control visits and manage data properly			
Module 4: Ensure effective operation and timely maintenance of a fixed dome biodigester **Aim**: The aim of this module is to build capacity of trainees for effective operation and timely maintenance of biodigesters to ensure sustained benefits and optimal use of biodigester products – biogas and bioslurry to enhance benefits from biodigesters.	C8.1: Describe routine operation activities for trouble-free functioning of biodigester C8.2: Conduct minor repair and maintenance works C8.3: Identify potential problems and likely solutions C8.4: Explain methods for optimum utilization of biogas and bioslurry C8.5: Instruct users for effective operation and maintenance of biodigester C8.6: Conduct Users Training C8.7: Ensure sustainable benefits from biodigester C9.4: Describe the roles and responsibilities of a technical supervisor C9.5: Ensure that occupational health and safety measures are practiced properly	24	16	40
	Total	**100**	**164**	**264**

3. Curriculum Contents (Teaching and Learning Guide)

Module 1: Describe basics of biogas generation including micro-biological activities inside the biodigester and installation of biodigesters

Aim: The aim of this module is to make trainees familiar with the process of biogas generation, micro-biological activities inside the biodigester, ideal conditions for biogas generation, inhibition factors, basics of designing a fixed dome biodigester, cost and quality estimation, importance of biogas, and pre-requisites for installation of a fixed dome biodigester.

Duration: 48 hours; Theory - 40 hours; Practice - 8 hours

Learning Unit	Learning Outcomes	Learning Elements	Duration	Materials Required	Learning Place
C1.1: Explain prerequisites for biogas generation	The participants will be able to: - Explain methods of biogas production - Explain different types of inputs (feeding materials) for biodigesters - Explain merits and demerits of different feeding materials - Describe why cattle dung is the best feeding material for Pakistan context	• Basic bacterial activities to produce biogas, prerequisites for biogas production • Different types of inputs to operate a biodigester • Merits and demerits of different feeding materials • Understanding on why cattle dung is best feeding material for Pakistan	1 hour	Presentation slides, slide projector, computer, stationaries, literatures/reports, bulletins	Classroom
C1.2: Explain basic concept of micro-biological activities inside the biodigester	The participants will be able to: - Explain ideal conditions for biogas generation - Describe inhibiting factors for gas production - Describe the basic concept of waste-to-energy	- Effects of (i) temperature, (ii) pH, (iii) total solid (dilution factor) content, (iv) mixing quality, (v) carbon-nitrogen ratio, (vi) HRT and (vii) over and under-feeding on the production of biogas - Microbiological activities and effect of toxicity and aerobic condition on biogas generation	4 hours	Presentation slides, slide projector, computer, stationaries, literatures/ reports, bulletins. video	Classroom, laboratory, if available

		- - Organic and inorganic wastes, management of waste			
C1.3: Describe types and functioning/ working of biodigesters	The participants will be able to: - Describe different types of biodigesters and their strengths and weaknesses - Explain components of a fixed dome biodigester and function(s) of each component - Explain inter-relations of different components of a fixed dome biodigester - Describe the criteria to select a particular model of fixed dome biodigesters - Explain suitability of fixed dome designs for electricity generation	- Different types of biodigesters and their comparative advantages - Components and functions of a fixed dome biodigesters - Working principle of a fixed dome biodigester - Merits and demerits of different designs of fixed dome biodigesters in particular context - - Strengths and weaknesses of fixed dome design for electricity generation	8 hours	Presentation slides, slide projector, computer, stationaries, literatures/reports, bulletins; working biodigester	Classroom and biodigester venue
C1.4: Describe benefits of biodigesters and importance of the technology in Pakistan	The participants will be able to: - Explain the products of a biodigester - Recall various end use applications of biogas - Recall advantages of bioslurry over FYM - Explain benefits of biogas at household and community level - Explain why biodigester technology is important for Pakistan - Explain energy situation in Bhutan	- Products of biodigesters; Biogas and bioslurry - Diversified use of biogas; cooking, lighting, running an engine - Comparative advantage and disadvantages of FYM and bioslurry - Benefits of biogas over conventional fuel sources - - General energy scenario in Pakistan	2 hours	Presentation slides, slide projector, computer, stationaries, literatures/reports, bulletins	Class room and biodigester venue
C2.1: Describe	The participants will be able to:	- Knowledge of feeding	4 hours	Presentation	Classroom

basic criteria for designing a fixed dome biodigesters	- Describe the relationship between feeding material (quantity and quality) and type and size of biodigester - Describe the steps of designing a fixed dome biodigester - Describe effects of the characteristics of construction site (site condition) on design	requirements for a specific size of biodigester, understanding of HRT - Knowledge of sequential steps to design a fixed dome biodigester - Knowledge of site information that need to be collected before staring the design		slides, Slide projector, computer, calculator	
C2.2: Interpret the relation between HRT, quantity of feeding materials and required size of biodigester	The participants will be able to: - Describe the effect of HRT on size selection - Explain relation between quantity of feeding and HRT - Select size of biodigester based upon feeding materials and estimated HRT	- Concept of HRT and its effect on size selection - Types of feeding materials and estimated HRT - Different sizes of biodigesters and quantity of feeding materials needed.	2 hours	Presentation slides, Slide projector, computer	Classroom
C2.3: Carry out quantity estimation of different sizes of fixed dome biodigester	The participants will be able to: - Practice basic mathematical calculations - Describe the quantity of various construction materials needed for different sizes of biodigesters - Prepare detailed quantity estimation of fixed dome biodigesters	- Basic addition, subtraction and multiplication and division , Use of calculators - Types and quantity of construction materials needed for construction - Quantity estimation format, norms and methods, use of calculators	4 hours	Presentation slides, Slide projector, computer, calculator	Classroom
C2.4: Carry out cost estimation of different sizes of	The participants will be able to: - Collect information on market process of construction	- Market prices of various construction materials - Cost estimation formats,	4 hours	Presentation slides, Slide projector,	Classroom

fixed dome biodigester	materials - Prepare detailed cost estimation of fixed dome biodigesters	norms and methods, use of calculators		computer, calculator	
C3.1: Describe the basic concepts of a drawing of an object	The participants will be able to: - Tell why drawing is needed - Describe the concept of plan, elevation and sections while preparing drawings	- Pictures vs. drawings - Concept of Plan, elevation, section, isometric views of drawing	1 hour	Presentation slides, Slide projector, computer, objects of different shapes, models, cut-pieces of wood, drawing	Classroom
C3.2: Demonstrate ability to read basic drawings	The participants will be able to: - Explain the concept of foot-inch and meter-centimeter system of measurement - Demonstrate ability to distinguish different types of drawings	- FPS and MKS systems of measurements - Concept of Plan, elevation, section, isometric views of drawing	2 hours	Presentation slides, Slide projector, computer, objects of different shapes, measuring tape, models, cut-pieces of wood, drawing	Classroom
C3.3: Demonstrate ability of interpret drawing of fixed dome biodigesters	The participants will be able to: - Describe the dimensions of various components of a fixed dome biodigesters - Define plan, section, isometric view, and half sectional elevation of biodigesters - Describe inter-relationship of various components of a biodigester	- Reading dimensions in drawing - Components of fixed dome biodigester - Inter-relation between different components	2 hours	Presentation slides, Slide projector, computer, objects of different shapes, models, cut-pieces of wood, drawing	Classroom
C3.4: Read and	The participants will be able to:	- Types of templates and	1 hour	Presentation	Classroom

interpret drawings of templates, appliances, pipes and fittings and filter systems	- Read drawings of various sizes of templates - Read drawing of mixing devices - Read drawing of biogas stoves and lamps - Read drawings of pipes and fittings - Read drawings of filter systems	uses - Types of mixing device and uses - Types of pipes, required fittings such as tee, elbow, nipple - CO_2 scrubber, H_2S remover, moisture remover		slides, Slide projector, computer, templates, appliances, pipes and fittings and filter systems with drawings.	
C4.1: Select suitable type of biodigester	The participants will be able to: - Explain pre-requisite for the selection of biodigester type such as consideration on durability, reliability, affordability, user-friendliness for construction and operation - Describe suitability of different designs in specific site conditions	- Criteria for site selection, proximity to cattle shed and point of application - Characteristics of safer construction place - Soil conditions	1 hour	Presentation slides, Slide projector, computer, models of biodigesters	Classroom
C4.2: Select suitable size of biodigester	The participants will be able to: - Explain pre-requisite for the selection of biodigester size - Estimate the quantity of feeding materials (cattle dung) available and gas production - Estimate the quantity of gas required based upon end-use applications - Select suitable size of biodigester based upon main selection criteria	- Criteria for biodigester size selection – availability and accessibility of feeding materials (cattle dung), gas/demand requirements, gas use patterns, types of end-use applications	1 hour	Presentation slides, Slide projector, computer, models of biodigesters	Classroom
C5.1: Name different types of	The participants will be able to: - State the type of	- Construction materials such as cement, sand,	1 hour	OHP, presentation	Classroom

construction materials needed for constructing a fixed dome biodigester	construction materials needed for construction	stone, brick, aggregates, MS rod, acrylic emulsion paint,		slides, Computer	
C5.2: Appraise quality standards of construction materials	The participants will be able to: - Describe quality standards of bricks and stones - Describe quality standards of cement - Describe quality standards of sand - Describe quality standards of aggregate/gravel - Describe quality standards of MS rod - Describe quality standards of acrylic emulsion paint	- Quality standards of bricks, stones, cement, sand, aggregate, MS rod, acrylic emulsion paint	1 hour	OHP, presentation slides, Computer, visual aids, Sample of construction materials, and bottle for sand test.	Classroom
C5.3: Explain criteria for selection of construction site	The participants will be able to: - Explain why biodigester should be constructed near cattle shed - Explain why biodigester should be located in sunny place - Explain why the distance between biodigester and point of use should be as minimum as possible - Explain why biodigester should not be constructed too close to foundation of structures, growing trees, main trail and machines producing vibrations - Explain why biodigesters	- Added workload if biodigester is constructed far from cattle shed - Effect of temperature on biogas production - Effect of longer pipes on cost and on risk gas-leakage - Damage to biodigester due tree-roots, vibrations - General characteristics of best suitable site for biodigester construction	1 hour	OHP, presentation slides, Computer, visual aids	Classroom

	should not be constructed in water logging areas and slide-prone areas - Explain the characteristics of best site for constructing biodigesters				
C5.4: Explain steps of construction of a fixed dome biodigester	The participants will be able to: - Describe methods of construction of different components of a fixed dome biodigester - Describe relative positioning of different components of a fixed dome biodigesters - Explain the importance of reference line	- Sequential order of biodigester construction (layout, excavation, digester, gas holder, manhole, outlet, inlet, slurry pits) - Methods to fix reference line	4 hours	OHP, presentation slides, Computer, visual aids	Classroom
C9.1: Promote biodigester technology in Pakistan	The participants will be able to: - Identify and explain unique-selling points for marketing biogas technology in Pakistan - Adopt different tools and techniques for the promotion of biogas technology	- Promotion and marketing of new technology - Promotion and marketing tools and their application	4 hours	OHP, presentation slides, Computer, posters, pamphlets, brochure, visual aids	Classroom

Module 2: Supervise the construction of civil structures of a fixed dome biodigester

Aim: The aim of this module is to ensure that the participants: (a) acquire hands-on-experiences on construction of different structural components of fixed dome biodigesters, (b) realise the importance of quality assurance, and practice quality norms while construction, and (c) supervises construction of biodigester as per set standards

Duration: Total – 128 hours; Theory – 20 hours; Practice – 108 hours

Learning Unit	Learning Outcomes	Learning Elements	Duration	Materials Required	Learning Place

C6.1: Supervise the construction of digester	The participants will be able to: - Demonstrate methods for lay out (demarcation) of biodigester - Supervise the excavation of pit - Prepare mortar - Prepare base of the digester and construct foundation - Construct digester walls - Fix inlet pipes - Plaster digester walls - Maintain plumb of digester wall - Coach and mentor masons to construct digester	- Quality standards for the construction of digester components (correct radius, correct height, foundation, floor, walls, inlet pipes, plastering, verticality of wall, smoothness of walls) - Correct placing of inlet pipes - Coaching and mentoring in site	32 hours	OHP, Presentation slides, Measuring tape, lime, construction tools and equipment, construction materials, visual aids	On-the-job training venue
C6.2: Supervise the construction of gas holder and turret	The participants will be able to: - Prepare scaffolding and formworks for dome casting - Select and use proper size of templates - Prepare mortar and cast gas holder - Remove scaffolding and frameworks - Carry out inside plastering of gas holder - Coach and mentor masons to gas holder and turret	- Quality standards for the construction of gas holder (correct frameworks, correct plastering layers for gas tightness, correct height, smoothness of the surface, correct placing of gas outlet pipe) - Coaching and mentoring in site	32 hours	OHP, Presentation slides, Measuring tape, lime, construction tools and equipment, construction materials, visual aids	On-the-job training venue
C6.3: Supervise the construction of manhole, outlet/	The participants will be able to: - Maintain correct size of manhole	- Quality standards of construction of manhole and outlet	24 hours	OHP, Presentation slides,	On-the-job training venue

hydraulic chamber	- Construct outlet walls - Plaster outlet walls - Maintain plumb of outlet wall - Cast concrete cover slab for outlet and fit in place - Coach and mentor masons to construct outlet tank	tank of biodigester (correct size, proper finishing and plumb, correct placing of over-flow opening, correct earth-filling against the walls)		Measuring tape, lime, construction tools and equipment, construction materials, visual aids	
C6.4: Supervise the construction of inlet and mixing tank	The participants will be able to: - Construct platform for inlet tank - Construct walls of inlet tank - Plaster inlet tank - Fix mixing device - Coach and mentor masons to construct inlet tank	- Quality standards of construction of mixing tank or inlet of biodigester (correct diameter and height, proper finishing and plumb, correct placing of mixing device) - Coaching and mentoring in site	16 hours	OHP, Presentation slides, Measuring tape, lime, construction tools and equipment, construction materials, visual aids	On-the-job training venue
C6.5: Supervise the construction of slurry collection and composting pit	The participants will be able to: - Select location of slurry collection and composing pit - Decide the size of collection and composing pits - Supervise excavation of pits - Construct walls and roof of the pits - Coach and mentor masons to construct slurry collection pits	- Quality standards of construction of slurry pits (proper positioning, suitable volume, proper drainage systems, proper covering to protect against direct sun light) - Coaching and mentoring in site	8 hours	OHP, Presentation slides, Measuring tape, lime, construction tools and equipment, construction materials, visual aids	On-the-job training venue
C9.2: Describe the	The participants will be able to:	- Quality assurance	8 hours	OHP,	Classroom

importance of quality assurance during construction	- Describe the definition of quality assurance while constructing biodigester - Explain why quality in needed while construction - Explain how quality is maintained during construction	is the integral part of biodigester construction - Quality control framework - Quality control visits		Presentation slides, computer, visual aids	
C9.3: Ensure that the masons/ technicians practice quality norms during construction/ installation	The participants will be able to: - Explain quality standards to be complied while construction - Comply with set quality standards while constructing biodigester	- Effect of sub-standard quality of construction on the durability and serviceability of the biodigester - Coaching and mentoring in site		OHP, Presentation slides, computer, visual aids	On-the-job training venue
C9.4: Describe the roles and responsibilities of a technical supervisor	The participants will be able to: - Tell roles and responsibilities of a technical supervisor while construction and supervision - Describe what happens if a technical supervisor does not fulfil his/her responsibilities	- Roles and responsibilities of a technical supervisor to install quality biodigester - Effect of quality works on the long term functioning of a biodigester		OHP, Presentation slides, computer, visual aids	Classroom, On-the-job training venue
C9.5: Ensure that occupational health and safety measures are practiced properly	The participants will be able to: - Demonstrate proper use of personal safety gears such as helmet, dungaree, safety shoes, safety belt - Exhibit safe use of construction tools and equipment - Practice safety measures at works	- Safety precautions during construction - Proper use of safety tools and equipment - Safe handling of construction tools and equipment - Coaching and mentoring in site		OHP, Presentation slides, computer, visual aids	On-the-job training venue

C9.6: Conduct routine quality control visits and manage data properly	The participants will be able to: - Fill quality control forms and formats - Ensure proper management of data and information - Coach and mentor the masons/technicians as and when needed	- Different forms and formats for quality control - Data collection, data handling and data management techniques - Coaching and mentoring skills	8 hours	OHP, Presentation slides, computer, visual aids, quality control forms and formats	Classroom, on-the-job training venue (for filling forms)

Module 3: Supervise the fabrication of biogas filter systems and installing of pipeline, appliances and electro-mechanical components

Aim: The aim of this module is to ensure that the participants are acquainted with the correct methods of fabricating filter systems; installing of pipes, fittings, biogas appliances, gas-filtration systems as well as machine (generators, pumps, induction motors etc.) to operate with biogas.

Duration: Total - 48 hours; Theory - 16; Practice - 32 hours

Learning Unit	Learning Outcomes	Learning Elements	Duration	Materials Required	Learning Place
C7.1: Supervise the installation of pipeline	The participants will be able to: - Describe quality standard of pipes and fittings - Select correct size of pipes and fitting - Select best alignment for pipe laying - Join pipes using correct fitting and sealing agent - Protect pipeline against possible damage - Coach and mentor technicians to install pipeline	- Quality standards of pipes and fittings - Effect of longer pipeline on cost and leakages from pipelines - Safety measures to protect pipe and fitting against damages - Types and use of sealing agents - Coaching and mentoring skill	4 hours	OHP, presentation slides, computer, visual aids, pipes and fittings, plumbing tools and equipment.	On-the-job training venue
C7.2: Supervise the installation of	The participants will be able to: - Name different types of	- Types of biogas appliances such as	4 hours	OHP, presentation	On-the-job training

appliances/Equipments	biogas appliances and end use applications - Describe quality standards of appliances - Fix biogas stoves, lamps and other appliances as per users' need - Coach and mentor technicians to install appliances - Install gas flow meter, pressure and temperature gauges -	biogas stoves, lamps, cookers, water-heaters - Methods to fix appliances properly - Use of sealing agents - Coaching and mentoring skill - Method to install gas flow meter, pressure and temperature gauges -		slides, computer, visual aids, pipes and fittings, plumbing tools and equipment.	venue
C7.3: Supervise the fabrication/ manufacturing and preparation of filtration systems	The participants will be able to: - Describe quality standards of fabrication/manufacturing of filter systems - - Supervise the fabrication of H_2S remover - Supervise the fabrication of moisture removal	- Quality standards of biogas purification system - Plumbing skill - understanding of functioning of , H_2S remover, and moisture removal - Types of filter media/materials	8 hours	OHP, presentation slides, computer, visual aids, pipes and fittings, filter system, plumbing tools and equipment.	Classroom, mechanical workshop
C7.4: Supervise the installation of gas filters	The participants will be able to: - Describe quality standards of filter system - - Install H_2S remover - Install moisture removal - Coach and mentor technicians to install filtration systems	- Quality standards and methods to install filter systems (, H_2S remover, moisture removal) - Coaching and mentoring skill	8 hours	OHP, presentation slides, computer, visual aids, pipes and fittings, filter system, plumbing tools and	On-the-job training venue

				equipment.	
C7.5: Supervise the installation of Tube-wells/Generator	The participants will be able to: - Describe quality standards of pump/generator - Calculate gas demand and select suitable pump/generator size - Explain modifications of conventional machines to operate with biogas - Install pumping arrangements, generators, control systems and blowers/compressors - Coach and mentor technicians to install pump/generator	- Proper methods to install pimp/generators - Calculation of gas demand for a particular engine - Modifications of conventional engine to operate with biogas - Coaching and mentoring skill	8 hours	OHP, presentation slides, computer, visual aids, pipes and fittings, plumbing tools and equipment.	On-the-job training venue
C9.2: Describe the importance of quality assurance during installing electro-mechanical components	The participants will be able to: - Describe the definition of quality assurance while installing pipes, appliances and filters - Explain why quality in needed while installing pipes, appliances and filters - Explain how quality is maintained while installing pipes, appliances and filters	- Quality assurance is the integral part of installation of pipes, fittings and appliances - Quality control framework - Quality control visits	8 hours	OHP, Presentation slides, computer, visual aids	Classroom
C9.3: Ensure that the masons/ technicians practice quality norms during construction/ installation	The participants will be able to: - Explain quality standards to be complied while installing pipes, appliances and filters - Comply with set quality	- Effect of sub-standard quality of installation on the durability and serviceability of the biodigester		OHP, Presentation slides, computer, visual aids	On-the-job training venue

	standards while installing pipes, appliances and filters - Coach and mentor technicians to ensure quality				
C9.4: Describe the roles and responsibilities of a technical supervisor	The participants will be able to: - Tell roles and responsibilities of a technical supervisor while installing pipes, appliances and filters - Describe what happens if a technical supervisor does not fulfil his/her responsibilities	- Roles and responsibilities of a biogas technician (mason) to install quality biodigester - Effect of quality works on the long term functioning of a biodigester		OHP, Presentation slides, computer, visual aids	Classroom, On-the-job training venue
C9.5: Ensure that occupational health and safety measures are practiced properly	The participants will be able to: - Demonstrate proper use of personal safety gears such as helmet, dungaree, safety shoes, safety belt - Exhibit safe use of construction tools and equipment - Practice safety measures at works - Coach and mentor technicians to practice safety measure	- Safety precautions during the installation of pipes and appliances - Proper use of safety tools and equipment - Safe handling of construction tools and equipment		OHP, Presentation slides, computer, visual aids, safety gears	On-the-job training venue
C9.6: Conduct routine quality control visits and manage data properly	The participants will be able to: - Fill quality control forms and formats - Ensure proper management of data and information - Coach and mentor the	- Different forms and formats for quality control - Data collection, data handling and data management techniques	8 hours	OHP, Presentation slides, computer, visual aids, quality control	Classroom and on-the-job training venue (for filling forms)

	masons/technicians as and when needed	- Coaching and mentoring skills		forms and formats	

Module 4: Ensure Effective Operation and Timely Maintenance of a Fixed Dome Biodigester

Aim: The objective of this module is to build capacity of trainees to carry out effective operation and timely maintenance of biodigesters to ensure optimal use of biodigester products – biogas and bioslurry, and sustained benefits.

Duration: Total – 40 hours; Theory – 24 hours; Practice – 16 hours

Learning Unit	Learning Outcomes	Learning Elements	Duration	Materials Required	Learning Place
C8.1: Describe routine operation activities for trouble-free functioning of biodigester	The participants will be able to: - Prescribe correct quantity of feeding - Describe the effect of under-feeding and over-feeding - Demonstrate efficient use of different appliances such as water drain, main valve, gas taps - Perform leakage testing - Explain dos and don'ts dos for effective functioning of biodigesters	- Operational activities such as feeding of biodigester, checking of gas leakages, regeneration of filter media - Potential problems and likely solutions - Users' training on operation and maintenance	8 hours	OHP, Presentation slides, computer, visual aids.	Classroom, simulation
C8.2: Conduct minor repair and maintenance works	The participants will be able to: - Demonstrate changing of washers - Perform greasing/oiling of gas taps - Perform minor repair of appliances - Perform repair of leaked pipeline	- Minor maintenance works such as changing of washers of valves and taps, maintaining leaking joints	8 hours	OHP, Presentation slides, computer, visual aids, plumbing tools and sealing agents	Classroom, simulation
C8.3: Identify	The participants will be able to:	- Methods to use pH	4 hours	OHP,	Classroom,

potential problems and likely solutions	- Demonstrate the use of pH meter, pressure meter, foot pump, gas flow meter to identify potential problems - Carry out pressure testing to detect biogas leakages - Inspect the colour of bioslurry, water dung ratio, flow pattern and odour of bioslurry to asses potential problems	meter, pressure meter, foot pump, gas flow meter to identify potential problems - Method to carry out leakage tests - Characteristics of digested and undigested bioslurry		Presentation slides, computer, visual aids, pressure testing tools	simulation
C8.4: Explain methods for optimum utilization of biogas and bioslurry	The participants will be able to: - Describe different uses of biogas and biogas appliances - Identify potentials for diversification of biogas end use applications - Tell the effect of under-utilisation of biogas - Describe characteristics and benefits of bioslurry - Apply suitable methods for optimal utilisation of bioslurry - Describe the benefits of composting of bioslurry	- Diversification of end use application to optimize the use of biogas - Effect of surplus biogas escaping into atmosphere - Characteristics of FYM and bioslurry - Advantages of bioslurry over FYM - Proper handling of bioslurry	4 hours	OHP, Presentation slides, computer, visual aids	Classroom, simulation
C8.5: Instruct users for effective operation and maintenance of biodigester	The participants will be able to: - Inform potential problems and likely solutions to users - Teach users to carry out effective operation works - Teach users to carry out minor repair and maintenance works	- Potential problem and likely solution - Orientation to users - Need of capacity building of users for effective operation and maintenance	4 hours	OHP, Presentation slides, computer, visual aids	Classroom, simulation
C8.6: Plan, conduct	The participants will be able to	- Content of user's	8 hours	OHP,	Classroom,

and facilitate users' training	organize, conduct and facilitate user's training on operation and maintenance and use of bioslurry	training - Training and facilitation skill - Application of biogas and bioslurry		Presentation slides, computer, visual aids, simulation exercise	simulation, user's house
C8.7: Ensure sustainable benefits from biodigester	The participants will be able to: - Provide warranty to ensure long term functioning of biodigester - Perform timely after-sale services - Provide user's manual	- Warranty provisions - Importance of users' manual - Need of after-sale-services	4 hours	OHP, Presentation slides, computer, visual aids, warranty card	Classroom, simulation
C8.3: Describe the roles and responsibilities of a technical supervisor	The participants will be able to: - Tell roles and responsibilities of a biogas technician while operation and maintenance - Describe what happens if a biogas technician does not fulfil his/her responsibilities	- Roles and responsibilities of technicians to ensure effective operation and maintenance of a biodigester		OHP, Presentation slides, computer, visual aids	On-the-job training venue
C8.4: Ensure that occupational health and safety measures are practiced during O&M	- The participants will be able to: - Demonstrate proper use of personal safety gears such as helmet, dongri, safety shoes, safety belt - Exhibit safe use of maintenance tools and equipment - Practice safety measures at works	- Safety precautions during the operation and maintenance - Proper use of safety tools and equipment - Safe handling of maintenance tools and equipment		OHP, Presentation slides, computer, visual aids, safety gears	On-the-job training venue

4. Assessment Method

- **Assessment context**: Assessment in the context of this training program is the "systematic collection of information about learning, using the time, knowledge, expertise, and resources available, in order to inform decisions about how effective was the learning'. This is the process of collecting evidence and making judgements on whether competence has been achieved. This confirms that an individual can perform to the standard expected in the workplace as expressed in the nationally endorsed competency standards, or competency standards approved by National Vocational & Technical Training Commission of Pakistan. The requirements for this training, therefore, expect the standard of National Vocational & Technical Training Commission of Pakistan to be fulfilled.

  When planning contexts for performance assessment factors such as ability, gender, size and physique must be taken into account to ensure that all candidates have opportunities to show their performance at its best. Ideal contexts are those which challenge all the candidates involved and encourage them to perform to the best of their ability.

  In this case, both classroom assessment and on-the-job assessments that involve assessment of student work by the course instructor is recommended. The instructors/facilitators are free to apply whatever approach they found are suitable for assessment. Every module should be assessed with objective type questions after the completion of each module. To ensure effective assessment, the methodology necessarily also involve collecting direct evidence of participant learning. Direct measures are those derived through the systematic analysis of student projects, exams, or sets of specified course assignments. As such, they can make a compelling case for the extent to which the trainees have achieved expected learning outcomes. The assessment has to be done in classroom where theoretical presentation are made and in the construction site where on-the-job training is conducted. Evidences for assessment should be collected in two ways: (i) performance evidence as individuals carry out work activities/tasks; and (ii) evidence of knowledge and understanding which together form the base and context of an individual's action.

- **Critical aspects:** The most important aspect is that the learner must be able to do/demonstrate skill to do each of the tasks of biogas technicians during on-the-job sessions. Skill evaluation methodology should be designed based on each module and test should be administered accordingly. A comprehensive module test should be conducted at the end of the training and trainees' performance should be rated according to standard grading system. Assessment results should be used to monitor program activities, identify weaknesses in student learning, and guide decision-making and improvement for the future.

  The general principle of assessment necessitates that assessments must be valid, reliable, flexible and fair. Assessors must ensure that assessment decisions involve the evaluation of sufficient evidence to enable a judgement to be made on the student's competence.

- **Assessment condition:** The assessment should be done both in the class and on-the-job training venue. Structured objective type questions, checklists for verbal questions and standard cases for discussion should be designed for conducting assessment. A checklist

needs to be prepared to assess the performance during on-the-job training. Instructors should assess performance through direct observation of the candidate's work. Assessment decisions should be based upon the instructors' judgement of the candidate's performance with continuous reference to the single performance outcome at the appropriate level.

It is important that teachers/lecturers ensure that candidates are assessed when performing in the best environment available. This will include consideration of space, equipment, demands of the performance context, the relative abilities of supporting and opposing candidates and the social context.

The instructors should select from the following approaches, combine them or add to them as considered necessary:

- *continuous*: on-going professional judgements informed by unit performance criteria
- *continuous and cumulative*: for example, all candidates assessed in the same aspects at the same time; serial assessments following the pattern of content learning
- *fixed 'assessment days'*: can increase motivation in some candidates (or cause anxiety in others); can ease administration for instructors
- *assess 'when each candidate is ready'*: involves candidates closely in their own assessment and assists with consolidation and individual target setting
- *group assessments*: assess candidates who are working at similar levels, allowing others to continue to work separately.

For this curricula, the first method is suggested.

Assessment methods are the particular techniques used to gather evidence and a means of collecting evidence and these may include:

- direct observation, for example:
  - real work/real time activities at the workplace
  - work activities in a simulated workplace environment
- structured activities, for example:
  - simulation exercises/role-plays
  - projects
  - presentations
  - activity sheets
- questioning, for example:
  - written questions, e.g. on a computer
  - interviews
  - self-assessment
  - verbal questioning

    - questionnaires
    - oral or written examinations (applicable at higher NQF levels)
- portfolios, for example:
    - collections of work samples compiled by the candidate
    - product with supporting documentation
    - historical evidence
    - journal/log book
    - information about life experience
- review of products, for example:
    - products as a result of a project
    - work samples/products
- third party feedback, for example:
    - testimonials/reports from employers/supervisors
    - evidence of training
    - authenticated prior achievements
    - interview with employer, supervisor, peer

Assessment Instruments are the documented questions/assessment activities developed to support the selected assessment method/s used to collect the evidence of candidate competence and may include:

- oral and written questions
- observation/demonstration checklists
- projects, case studies, scenarios
- candidate self-assessment guides
- recognition portfolios
- workplace portfolios
- simulation activities
- definition of relevant workplace documents
- a profile of acceptable performance measures
- templates/proformas
- evidence/observation checklists
- checklists for the evaluation of work samples

- **Resources required for assessment**: Drawings, Construction tools (trowel, hammers, spirit level, measuring taps, maintenance tools (pliers, hexa-fame with blades, pipe wrenches, screw-drivers, Teflon tape) monitoring tools (pH meter, thermometer, gas analyzer, gas flow meter, pressure meter), structured questionnaires and checklists. A simulation exercise will be the effective method to assess the learning quality.

5. Assessment Framework

Module 1: Describe basics of biogas generation including micro-biological activities inside the biodigester and installation of biodigesters

Learning Units	Theory Days/hours	Workplace Days/hours	Recommended formative assessment	Recommended Methodology	Scheduled Dates
C1.1: Explain prerequisites for biogas generation	1	-	Trainees should be asked for: - Ideal conditions for biogas generation - Effects of temperature, HRT, pH, carbon/nitrogen ration, water-dung ratio on biogas production - Biogas generation per kg of cattle dung	Knowledge test (Oral Questions, pre-training and post-training tests, written test-objective type of questions)	At the end of training
C1.2: Explain basic concept of micro-biological activities inside the biodigester	4	-	Trainees should be asked for: - Effects of (i) temperature, (ii) pH, (iii) total solid (dilution factor) content, (iv) mixing quality, (v) carbon-nitrogen ratio, (vi) HRT and (vii) over and under-feeding, on the production of biogas - Microbiological activities and effect of toxicity and aerobic condition on biogas generation - Organic and inorganic	Knowledge test (Oral Questions, pre-training and post-training tests, written test-objective type of questions)	At the end of training

			wastes, management of waste		
C1.3: Describe types and functioning/ working of biodigesters	4	4	Trainees should be asked for: - Difference between fixed dome and floating drum biodigesters - Working principle of a biodigester (maximum and minimum pressure, hydraulic flow pattern, short circuiting)	Knowledge test (Oral Questions, pre-training and post-training tests)	At the end of training
C1.4: Describe benefits of biodigesters and importance of the technology in Pakistan	2	-	Trainees should be asked for: - Benefits of biodigesters at household and community levels - Impacts of biodigesters on health, sanitation, energy security, environment, agricultural production - Potential of biodigesters in Pakistan	Knowledge test (Oral Questions, pre-training and post-training tests)	At the end of training
C2.1: Describe basic criteria for designing a fixed dome biodigesters	4	-	Trainees should be asked for: - feeding requirements for a specific size of biodigester, understanding of HRT - sequential steps to design a fixed dome biodigester - site information that need to be collected before staring the design	Knowledge test (Oral Questions, pre-training and post-training tests)	At the end of training
C2.2: Interpret the relation between HRT, quantity of feeding materials and required size of biodigester	2	-	Trainee should be asked for: - concept of HRT and its effect on size selection - types of feeding materials and estimated HRT - Different sizes of biodigesters and quantity of	Knowledge test (Oral Questions, pre-training and post-training tests)	At the end of training

			feeding materials needed.		
C2.3: Carry out quantity estimation of different sizes of fixed dome biodigester	2	2	The trainee should demonstrate skill and knowledge on: - basic addition, subtraction and multiplication and division , and proper use of calculators - types and quantity of construction materials needed for construction - Quantity estimation format, norms and methods, use of calculators	Knowledge test (Oral Questions, pre-training and post-training tests), performance test (practical exercise of estimation)	At the end of training and/or during sessions
C2.4: Carry out cost estimation of different sizes of fixed dome biodigester	2	2	Trainees should be asked for: - Method of estimating (calculation of quantity, market prices of various construction materials) - Cost estimation formats, norms and methods, use of calculators	Knowledge test (Oral Questions, pre-training and post-training tests), performance test (practical exercise of estimation)	At the end of training and/or during sessions
C3.1: Describe the basic concepts of a drawing of an object	1	-	Trainees should be asked: - Why drawings are needed - What happens without drawing	Knowledge test (Oral Questions, Simulations)	At the end of training
C3.2: Demonstrate ability to read basic drawings	2	-	Trainees should be asked: - to identify plan, section, elevation and isometric views.	Knowledge test (Oral Questions, Simulations), Performance test (asking to read a drawing)	During the session and at the end of training
C3.3: Demonstrate ability of interpret drawing of fixed dome biodigesters	2	-	Trainees should be asked: - to read measurements of different components of a biodigester	Knowledge test (Oral Questions, Simulations), Performance test (asking to read a	During the session and at the end of training

				drawing)	
C3.4: Read and interpret drawings of templates, appliances, pipes and fittings and filter systems	1	-	Trainees should be asked to: - Tell measurements of different components of templates - Name appliances, pipes and fittings showing them the drawings - Describe different types of filters	Knowledge test (Oral Questions, Simulations), Performance test (asking to read a drawing)	During the session and at the end of training
C4.1: Select suitable type of biodigester	1	-	Trainees should be asked to: - Name different types of biodigesters - Select suitable type for a specific case	Knowledge test (Oral Questions, During the session and at the end of training Simulations, Case presentation)	At the end of training
C4.2: Select suitable size of biodigester	1	-	Trainees should be asked: - to calculate amount of dung required for different sizes of biodigesters - to calculate gas demand. - How will they advise others to select suitable size of biodigesters	Knowledge test (Oral Questions, Simulations, Case presentation)	At the end of training
C5.1: Name different types of construction materials needed for constructing a fixed dome biodigester	1	-	Trainees should be asked: - to name types of construction materials needed to construct fixed dome biodigesters	Knowledge test (Oral questions Observation, Simulations)	During the session and at the end of training
C5.2: Appraise quality standards of construction materials	1	-	Trainees should be asked: - To describe basic quality standards of construction materials To conduct bottle test to test quality of sand	Knowledge test (Oral questions, simulations)	During the session and at the end of training

			- To conduct drop test to test quality of brick - To conduct abrasion test to test quality of stones		
C5.3: Explain criteria for selection of construction site	1	-	Trainees should be asked: - to select proper site for plant construction in a given case scenario (e.g. minimum distance from cattle shed, water source and kitchen, sunny place; sufficient distance from trees, foundation of building, vibrating machines, main roads etc.)	Knowledge and Performance tests (Oral Questions, Simulations, Case presentation)	During the session and at the end of training
C5.4: Explain steps of construction of a fixed dome biodigester	4	-	Trainees should be asked: - to describe the extent of works while constructing structural components of a biodigester (e.g. layout, excavation, digester foundation, digester walls, gas holder, manhole, outlet, inlet, compost pits)	Knowledge test (Oral Questions, Simulations, Case presentation)	During the session and at the end of training
C9.1: Promote biodigester technology in Pakistan	4	-	Trainees should be asked: - Tools and techniques for promoting biogas technology - Potential unique selling points - Problems and constraints in promotion and marketing of biodigester technology in Pakistan	Knowledge and skill test (Oral Questions, Simulations, Case presentation)	During the session and at the end of training

Learning Units	Theory Days/hours	Workplace ays/hours	Recommended formative assessment	Recommended Methodology	Scheduled Dates
C6.1: Supervise the construction of digester	1	31	Trainees should know: - how to do layout - how to set a reference line - how to construct foundation - how to construct digester walls - how to fit inlet pipes - how to prepare mortar (mortar ratio) for various works - How to plaster walls and maintain plum of walls Participants should know how to construct digester following the procedures as described in the construction manual. They should be capable of coaching and mentoring masons while construction.	Knowledge and Performance tests (Oral questions, observation on-the-job)	During on-the-job sessions and at the end of training
C6.2: Supervise the construction of gas holder and turret	1	31	Trainees should know: - How to backfill the walls before making formwork/mould for constructing gas holder - How to prepare mortar mix for casting concrete - How to place reinforcements - How to cast concreate dome - How to remove formwork/mould - How to plaster inside of gas holder to ensure gas-	Knowledge and Performance tests (Oral questions, observation on-the-job)	During on-the-job sessions and at the end of training

			tightness Participants should be able to demonstrate the correct procedures of dome construction as specified in the construction manual. They should be capable of coaching and mentoring masons while construction.		
C6.3: Supervise the construction of manhole, outlet/ hydraulic chamber	1	23	Trainees should demonstrate skill: - to construct manhole of correct size - to construct the foundation of outlet tank - to construct walls of outlet tank - to prepare mortar of required ratio - to do plastering works and maintain the plumb of the walls - to backfill the outside of walls - to cast slab of correct size Participants should be able to demonstrate the correct procedures of outlet construction as specified in the construction manual. They should be capable of coaching and mentoring masons while construction.	Knowledge and Performance tests (Oral questions, observation on-the-job)	During on-the-job sessions and at the end of training
C6.4: Supervise the construction of inlet and	1	15	Trainees should know: - how to select the location of	Knowledge and Performance tests	During on-the-job

mixing tank			inlet - how to construct foundation of inlet - what should be the relative positioning of inlet floor and overflow opening (at least 10 cm above) - how to construct walls - how to fit mixer machine Participants will be able to demonstrate the correct procedures of inlet construction as specified in the construction manual. They should be capable of coaching and mentoring masons while construction.	(Oral questions, observation on-the-job)	sessions and at the end of training
C6.5: Supervise the construction of slurry collection and composting pit	1	7	Trainee should be asked for: - the correct size and dimensions of a slurry pit for the given size of biodigester - different methods of constructing bioslurry pits (earthen lined, plastic-sheet lined, masonry walls etc.) Participants should be able to advise farmers on digging and constructing correct size compost pits. They should be capable of coaching and mentoring masons while construction.	Knowledge and Performance tests (Oral questions, observation on-the-job)	During on-the-job sessions and at the end of training
C9.2: Describe the importance of quality	1	-	Trainees should be asked about:	Knowledge test (Oral questions,	At the end of training

assurance			- the importance of quality assurances while constructing a biodigester - effects of sub-standard works on the long-term functioning of a biodigester	case presentation)	
C9.2: Describe the importance of quality assurance during construction	1	2	Trainees should be asked for: - Do's and don't while construction - how to comply with the set quality standards	Knowledge and Performance tests (Oral questions, observation on-the-job)	At the end of training
C9.3: Ensure that the masons/ technicians practice quality norms during construction/ installation	-	1	Trainees should be asked for: - Importance of compliances of quality norms - Methods to check the compliance - Methods to coach and mentor masons	Knowledge and Performance tests (Oral questions, observation on-the-job)	At the end of training
C9.4: Describe the roles and responsibilities of a technical supervisor	1	-	- Trainees should be able to realize their roles and responsibilities on promotion, extension, and construction	Knowledge test (Oral questions, case presentation)	At the end of training
C9.5: Ensure that occupational health and safety measures are practiced properly	1	1	- Trainee should be asked about their understanding on occupational health and safety measures during construction - Trainee should be observed whether he/she has practiced occupational health and safety measures	Knowledge and Performance tests (Oral questions, observation on-the-job)	During on-the-job sessions and at the end of training
C9.6: Conduct routine quality control visits and manage data properly	4	4	Trainees should be asked for: - Frequency of Quality control visits - Types of quality control forms	Knowledge and Performance tests (Oral questions, observation on-the-	During on-the-job session and at the end

			and formats - Data collection tools and data management techniques	job filling of forms)	of training

Module 3: Supervise the Installation of pipeline, appliances and electro-mechanical components

Learning Units	Theory Days/hours	Workplace Days/hours	Recommended formative assessment	Recommended Methodology	Scheduled Dates
C7.1: Supervise the installation of pipeline	1	3	- Trainees should be able to tell and demonstrate the correct procedures of pipeline fitting, e,g. with minimum joints, using proper sealing agents, shortest alignment, correct sizes.	Knowledge and Performance tests (Oral questions, observation on-the-job)	During on-the-job sessions and at the end of training
C7.2: Supervise the installation of appliances/equipments	1	3	- Trainees should be able to tell and demonstrate the correct procedures of fitting of appliances as per the user's need.	Knowledge and Performance tests (Oral questions, observation on-the-job)	During on-the-job sessions and at the end of training
C7.3: Supervise the fabrication/ manufacturing and preparation of filtration systems	2	6	Trainees should be asked for: - Fabrication method of, H_2S remover, and water remover - Necessary filter media and quantity	Knowledge and Performance tests (Oral questions, observation on-the-job)	During on-the-job sessions and at the end of training
C7.4: Supervise the installation of gas filters	2	6	Trainee should be asked: - Why filters are needed - What types of filters are needed (, H_2S filter, moisture remover) - How to install these filters, eg. with proper filter media, proper sequence, ease in regenerating filter media etc.	Knowledge and Performance tests (Oral questions, observation on-the-job)	During on-the-job sessions and at the end of training
C7.5: Supervise the	2	6	The participants should demonstrate	Knowledge and	During on-

installation of Tube-wells			skill to: - Select correct location of pump/ generator - Install pump/ generator correctly	Performance tests (Oral questions, observation on-the-job)	the-job sessions and at the end of training
C9.2: Describe the importance of quality assurance during installing electro-mechanical components	1	1	Trainees should be asked about: - the importance of quality assurances while installing pipelines, appliances and filters - effects of sub-standard works on the long-term functioning of a biodigester	Knowledge test (Oral questions, case presentation)	At the end of training
C9.3: Ensure that the masons/ technicians practice quality norms during construction/ installation	2	2	Trainees should be asked for: - Dos not don't dos while installing pipelines, appliances and filters - how to comply with the set quality standards while installing pipelines, appliances and filters	Knowledge and Performance tests (Oral questions, observation on-the-job)	During on-the-job sessions and at the end of training
C9.4: Describe the roles and responsibilities of a technical supervisor	1	-	- Trainees should be able to realize their roles and responsibilities on installing pipelines, appliances and filters	Knowledge test (Oral questions, case presentation)	At the end of training
C9.5: Ensure that occupational health and safety measures are practiced properly	-	1	- Trainee should be asked about their understanding on occupational health and safety measures during installing pipeline, appliances and filters - Trainee should be observed whether he/she has practiced occupational health and safety measures	Knowledge and Performance tests (Oral questions, observation on-the-job)	During on-the-job sessions and at the end of training
C9.6: Conduct routine quality control visits and	4	4	Trainees should be asked for: - Frequency of Quality control	Knowledge and Performance	During on-the-job

manage data properly			visits - Types of quality control forms and formats - Data collection tools and data management techniques	tests (Oral questions, observation on-the-job filling of forms)	session and at the end of training

Module 4: Ensure Effective Operation and Timely Maintenance of a Fixed Dome Biodigester

Learning Units	Theory Days/hours	Workplace Days/hours	Recommended formative assessment	Recommended Methodology	Scheduled Dates
C8.1: Describe routine operation activities for trouble-free functioning of biodigester	4	4	Trainees should be asked for: - Required quality of feeding for a given size of biodigester - Water-dung ratio - Characteristics of proper feeding and effect of improper feeding on functioning of biodigester - Routine operational activities and frequencies (feeding, testing of gas leakages regenerating filter media, use of gas control valves, proper use of appliances, oiling and greasing of movable parts, breaking of scum layers etc.) Participants should be able to realize the importance of proper O&M	Knowledge and Performance tests (Oral questions, case presentation observation on-the-job)	During on-the-job sessions and at the end of training
C8.2: Conduct minor repair and maintenance works	4	4	Trainee should be asked for: - Demonstrating skill to carry out minor maintenance works such changing of washers, repairing of	Knowledge and Performance tests (Oral questions, case presentation	During on-the-job sessions and at the end of training

			valves, repair/ changing of mixture machine, repair of appliances	observation on-the-job)	
C8.3: Identify potential problems and likely solutions	4	-	Trainee should be asked for: - Using of different tools and equipment to monitor functioning of a biodigester (pH meter, thermometer, gas analyser) - Identifying problems by observing slurry colour, odour, consistency, flow pattern etc. - Describing most common problems and suitable solutions	Knowledge and Performance tests (Oral questions, case presentation observation on-the-job)	During on-the-job sessions and at the end of training
C8.4: Explain methods for optimum utilization of biogas and bioslurry	2	2	Trainee should be asked for: - Points to be considered for optimal utilization of biogas (diversification of end-use applications, adjustment of air flow to appliances for full combustion, use of valves and pressure meters etc.) - Different methods for application of bioslurry (composting, draining with irrigation water, wet-application, trenching etc.)	Knowledge and Performance tests (Oral questions, case presentation observation on-the-job)	During on-the-job sessions and at the end of training
C8.5: Instruct users for effective operation and maintenance of biodigester	2	2	- Trainee should be asked to demonstrate his/her facilitation skill by giving a case scenario or simulate a users' training	Knowledge and Performance tests (Oral questions, case presentation observation on-the-job)	During simulation and at the end of training

C8.6: Plan, conduct and facilitate users' training	6	2	- Trainee should be asked to conduct a user's training in a simulated scenario	Knowledge and Performance tests (Oral questions, case presentation observation on-the-job)	During simulation and at the end of training
C8.7: Ensure sustainable benefits from biodigester	2	2	- Trainees should be asked for ways to ensure sustainable benefits from a biodigester (effective operation, timely maintenance, proper use of biogas and bioslurry etc.)	Knowledge test (Oral questions, case presentation observation on-the-job)	During simulation and at the end of training
C9.4: Describe the roles and responsibilities of a biogas technical supervisor			- Trainees should be able to realize their roles and responsibilities to ensure effective operation and timely maintenance of a biodigester	Knowledge test (Oral questions, case presentation)	At the end of training
C9.5: Ensure that occupational health and safety measures are practiced properly			- Trainee should be asked about their understanding on occupational health and safety measures during conducting operation and maintenance activities - Trainee should be observed whether he/she has practiced occupational health and safety measures	Knowledge and Performance tests (Oral questions, case presentation observation on-the-job)	During simulation and at the end of training

6. List of Tools, Machinery & Equipment

Name of Trade	Training of Biodigester Technical Supervisors to Construct Fixed Dome Biodigesters for Running Tube-wells	
Duration	Four weeks	
Sr. No.	**Name of Item/ Equipment / Tools**	**Quantity**

	Training Equipment	1
1.	Computer	1
2.	Over-head Projector with screen	1
3.	White/black board	1
4.	Model/prototype of biodigester	1
5.	Flip chard board and paper	1
6.	Camera/Mobile camera	1
7.	Construction video/DVD	1
8.	Calculators	1
	Masonry Tools – for a group of 25 participants	
9.	Measuring tape – 5m and 30m length	5 each
10.	Plumb-bob	5
11.	Water level	5
12.	Mason's Trowel	25
13.	Plastering trowel- 2 types	5
14.	Pointing trowel	5
15.	Pick axe with handle	5
16.	Wheel barrow	2
17.	Chisel sets – 9" and 12"	5 each
18.	Mason's hammer	5
19.	Hammer – 1.5 kg and 3 kg	5 ecah
20.	Templates (different sizes according to size of biodigester)	1
21.	Straight Edge (4 ft long), metal or wooden	5
22.	Level pipe (transparent plastic)	2
23.	String/thread roll	5
24.	Lime for layout	5 kg
25.	Iron trough/mortar pan – GI 18" dia (for handling concrete, mortar)	10
26.	Line and pins	LS
27.	Spirit level	3
28.	Brushes (wire brush, painting brush)	5 each
29.	Shovel with handle	5
30.	Builders square	5
31.	Striker for horizontal and vertical joints	5
32.	Steel float – small, medium and large	5
33.	Wooden float – small, medium and large	5
34.	Mason's Tool bag	25
	Plumbing tools	
35.	Hexa-frame and blade sets	5

36.	Pipe wrench – 9" and 12"	2
37.	Plier/slide wrench	2
38.	Spanners	2
39.	Needle file	2
40.	Dice and vice set	1
	Personal Protective equipment	
41.	Helmet	25
42.	Dungaree (Working Dress)	25
43.	Safety belt	25
44.	Boots	25
45.	Gloves	25
46.	Rain coats	25
	Biogas Related Appliances/Equipment	
47.	Pressure meter	1
48.	*Biogas analyser	1
49.	pH meter	1
50.	Thermometer with probes	1
51.	Foot or hand pump	1

- One with each organization. It will be used during biogas plant commissioning.

7. List of Consumable Supplies

Name of Trade	Training of Biodigester Technical Supervisors to Construct Fixed Dome Biodigesters for Running Tube-wells
Duration	Four weeks

Sr. No.	**Name of Consumable Supplies (for a group of 25 participants)**	**Quantity**
	Stationaries	
1.	Flip chart paper	
2.	Meta cards – different colours	
3.	Marker pens (Permanent and board marker)	
4.	Masking tape (rolls)	
5.	Cello tape	
6.	Lime or marking powder	
7.	Biodigester drawing	
8.	Construction manuals	
9.	Operation manual	
10.	Ball pen	

11.	Pencils	
12.	Erasers	
13.	Writing pad/note book	
14.	Glue stick	
15.	Brochures of biodigester technology	
16.	Plastic bag	
17.	White paper (A4)	
	Construction Materials and appliances for 20 m^3 fixed-dome biodigester	
18.	Cement	
19.	Bricks	
20.	Sand	
21.	Aggregates 20mm	
22.	Inlet pipes PVC 110 mm diameter 3 m long	
23.	MS Rod 10 mm diameter	
24.	Binding wire	
25.	Acrylic emulsion paint	
26.	Scaffolding (if earthen mould is not used)	
27.	PVC/GI pipe and fittings as per site condition	
28.	Biogas filters (CO_2 scrubber, H_2S remover, moisture remover)	
29.	Biogas appliances (as per sit condition and users' need)	
30.	Control valves – as per site condition	
31.	Main gas pipe – GI 1.5" diameter, 1 m long with reducing elbow	
32.	Teflon tape	
33.	Pressure meter	
34.	Gas flow meter	

8. Worker Traits and Related Knowledge

Traits:

- Physically fit/healthy
- Sincere
- Interactive
- Good listener
- Able to work under pressure and difficult circumstances
- Polite
- Cooperative
- Dedicated
- Working with humility

- Intuitive and creative
- Motivating
- Team-spirit
- Trustworthy
- Good communicator
- Influencing
- Hard working
- Out-spoken
- Helpful
- Friendly
- Proactive/ active

Related Knowledge:

- Basic principle of biogas generation
- Types and functioning of a biodigester
- Measurement, Units of measurements
- Basic mathematics/calculations
- Drawing reading an interpretation
- Masonry works/ construction methods
- Plumbing works
- Operation and functions of different biogas appliances
- Quality standards of construction materials and appliances
- Use of biogas
- Application of bioslurry
- Routine Operational activities
- Minor repair and maintenance of biodigester
- Potential problems and likely solution
- Gas filtering mechanisms
- Effective communication\
- Loyal
- Effective

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