Formulation of Programme Implementation Document for Domestic Biogas Programme in Tanzania

Mission Report on Selection of Biogas Plant Design and Formulation of Quality Control Framework and Certification Procedures for Biogas Constructors

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ABBREVIATION

ABC	:	Arusha Biocontractors Company Ltd.
ABP	:	Asia Biogas Programme
CBO	:	Community Based Organisation
CAMARTEC	:	Centre for Agricultural Mechanisation and Rural Technology
ELCT	:	Evangelical Lutheran Church in Tanzania
FIDE	:	Friends in Development
GGC	:	Gobar Gas (Biogas) Company (Nepal)
GHG	:	Green House Gases
GTZ	:	German Agency for Technical Cooperation
HRT	:	Hydraulic Retention Time
M&E	:	Monitoring and Evaluation
MIGESADO	:	An NGO Based in Dadoma working in Biogas Sector
NGO	:	Non Governmental Organisation
O&M	:	Operation and Maintenence
PID	:	Programme Implementation Document
PDR	:	Peoples' Democratic Republic
QC	:	Quality Control
R&D	:	Research and Development
SNV	:	Netherlands Development Organisation
TSh	:	Tanzanian Shilling
ToR	:	Terms of Reference
USD	:	United States Dollar

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Prakash C. Ghimire

1. Introduction and background

In June 2007, Tanzanian Biogas Stakeholders with defined interest in domestic biogas promotion, initiated common platform, the Biogas Task Force, with a view to develop a link with the Biogas African Initiative and prepare a proposal for a national domestic biogas programme to present to the Tanzanian government as well as other potential financial donors for funding. In the framework of the “Biogas for Better Life” an African Initiative, the task force aimed to facilitate in setting-up of the implementation modality for a large-scale domestic biogas programme in Tanzania. Referring to the history of former biogas initiatives in Tanzania, the present increasing need for renewable and environmental friendly energy sources and the mainly positive outcome of the feasibility study conducted by GTZ in 2007, Biogas Task Force aimed to formulate a Programme Implementation Document (PID) for a national programme on domestic biogas in Tanzania. The Task Force has already identified Centre for Rural Mechanisation and Rural Technology (CAMARTEC), a pioneer organization which has been supporting research and development as well as installation biogas plants in Tanzania and some other African countries for the last two decades, to coordinate and manage this future programme, a responsibility CAMARTEC management is willing to fulfil. Based on the recent feasibility study done by GTZ, there is ample potential for domestic biogas promotion and the initial targets suggested are an increase of quality domestic biogas plants by 100,000 in ten year’s time across the country.

The anticipated overall objective of proposed national programme on domestic biogas is to further develop and disseminate domestic biogas technology in Tanzania with the ultimate goal to establish a sustainable and commercial biogas sector in the country.

The tentative specific objectives contributing to its overall objectives are:

- To develop a commercially viable, market oriented biogas industry in Tanzania,
- To further strengthen involved institutions for sustainable development of the biogas sector,
- To provide low cost, clean and environmental friendly energy for cooking and lighting and reduce smoke-borne and smoke-induced diseases inherent to traditional cooking,
- To enhance household as well as environmental sanitation conditions,
- To reduce workload of the people, especially that of women and encourage the use of time saved to productive agriculture and family care as well as welfare activities,
- To facilitate employment generation by creating jobs at the local level in the form of construction masons, supervisors and biogas entrepreneurs,
- To improve the productivity of agricultural fields with the effective use of nutrient bioslurry and minimise the adverse effects of chemical fertilizers, and,
- To ensure environmental benefits through forest conservation as the results of reduced use of firewood and charcoal and reduced Green House Gas emissions (GHG),

A Terms of Reference (ToR) was developed by the Biogas Task Force with the objective to prepare a detailed PID for the proposed national programme on domestic biogas in Tanzania to be presented to the African Initiative, Rural Energy Fund as established in 2005 by the Tanzanian Government and other potential donors for funding. The execution of this ToR was proposed to be done in two stages, the first team of technical experts to initiate with the finalisation of various technological aspects such as selection of best suited standard model of biogas plant for Tanzanian context and its characteristics, quality control mechanisms and private constructors certification process which are integral part of the PID and the second team of experts with the responsibility to finalise the institutional set-ups and other key issues related to programme management and to carry out the writing exercise of the PID to be presented to the National Workshop of all biogas stakeholders for final approval.

SNV Tanzania is coordinating the formulation of the PID by making available the services of the in-house personnel who have been working in biogas programmes in different Asian countries under the framework of

Aisa Biogas Programme (ABP). This brief report summarises the activities and outcomes of the mission of first team in Tanzania during the period June 13-30, 2008.

2. Rationale

It is well understood that the success of biogas programme depends heavily upon the workable and effective implementation plan that is based upon the grassroots reality of the sector. These include, among others, information on physical status and functioning of existing biogas plants, users' perception on the technology, impact of biogas plants on the users, and capacity of the grassroots communities to adopt and internalise the technology. Information on these issues would help in deciding best suitable implementation modality for the program. This technical mission has been considered to be instrumental in colleting first hand primary data and information on these issues from the users' level so that the findings are reflected in the implementation plan.

Non-functioning and poorly functioning biogas plants cause not only capital waste but also do a lot of harms and damages to the reputation of biogas technology and eventually to the desired future expansion biogas program. The satisfied biogas users are the main and effective extension media for the promotion of the technology and vice-versa. And hence, to safeguard the interest of the users, it is important that the biogas plants functions to the desired level; which is only possible when the plants are constructed and operated as per the set quality standards. To ensure the quality of biogas plants, it is important that effective quality control mechanisms are formulated and enforced effectively. Quality management, therefore, should be a vital component of the PID.

Private sector, especially the constructors of biogas plants and manufacturers of biogas appliances, are means to develop a more productive biogas sector and to increase the economic participation of the population in the sector. Participation of the private sector helps in checks and balances between countervailing powers, and dismisses the government sector from the need to intervene. Keeping this in mind, biogas programme is anticipated to aim at letting the biogas sector develop by using the internal forces of demand and supply and by reducing external driving forces such as centrally planned production targets and subsidization in the long run, though the immediate or short term driving force should be external, like subsidy. Effective mobilization of private sector is very important for the sustainability of the proposed biogas programme. The proposed PID should, therefore, address the issue of private sector mobilisation in an effective and efficient manner.

3. Objective of the Mission

The main objective of the mission was to assist in the formulation of PID for the National Domestic Biogas Programme in Tanzania by:

a. Selecting best suitable design/model of biogas plants for wide-scale dissemination of the technology in Tanzania
b. Formulating basic framework for quality management mechanism in general and quality control in particular, within the Biogas Programme
c. Preparing general accreditation/certification modality for the participation of private sector constructors/manufacturers in Biogas Programme

4. Activities

The following activities were carried out during the mission:

- Study the feasibility report prepared by GTZ in 2007 and other relevant documents to collect secondary data and information,

- o Linking with and incorporating initial lessons from ongoing national domestic biogas initiatives in line of the "Biogas for Better Life" an African Initiative,
- o Conduct a survey to identify prices of needed materials, agree on performance factors and match the CAMARTEC, MIGESADO and the Rwanda GGC designs (all 8 m3) with the performance factors as preparation for the constructors' workshop.
- o Prepare an overview of the findings and present to a workshop which groups all identified biogas constructors both of the public, private or development institutions.
- o Facilitate the workshop to select;
    - a standard appropriate design, size(s) and investment costs for household based on agreed criteria and performance factors.
    - quality control mechanisms
    - certification process for private sector constructors/manufacturers
- o Prepare report on outcome of the workshop

5. Outcome of Field Investigation

The field investigation works consisted of the following activities (Detail itinerary has been provided in Annex-1):

- Review of existing data and information available in Tanzania and elsewhere
- Consultation with experts and professionals involved in the sector
- Observations of biogas plants of different models/designs installed in different parts of Tanzania to assess physical status and functioning as well as quality of workmanship
- Consultations with the users to know the effects/impacts of biogas plants on them
- Visits to appliances manufacturing workshop and consult with the entrepreneur

The outcome of the field investigation revealed the following facts:

- Qualities of construction and workmanship, in general, have been good. Even with little training to masons and minimum supervision, the quality has been satisfactory.
- Majority of the users were satisfied with the performance of their biogas plants.
- The plants in general were too costly, there is need to assess cost reduction methodologies without compromising the quality.
- Biogas plants were over-sized and under-fed resulting in under utilisation.
- Efficiency of biogas plants based upon actual feeding was satisfactory; however, the overall efficiency based upon their capacity was very low – far below the anticipated level.
- There was high need to optimize the efficiency of biogas appliances – biogas stoves and lamps.
- There were lots of rooms for improvements in fitting pipes and appliances.
- O&M training to users needs to be emphasized.
- Users were aware of the nourishing value of the bioslurry; however, handling of slurry was not done properly – slurry pits need to be constructed.

- Quality of feeding has to be improved to avoid/minimize the scum formation.
- Urine collection system has not been integrated in most of the cases.
- Inlet tanks are oversized - could be reduced in MIGESADO plants.
- Location of main gas valve should be changed in FIDE plants.
- There is high need to diversify the end use applications as the users reported that biogas still remains in the plant at the end of the day when all the cooking activities are complete. The installer reported that availability as well as accessibility of appliances, especially the lamps, have been one of the major problems.

The following section provides some information on the biogas plant inspected during the process of field investigation.

- Supported by: AEC Tanzania Ltd.
- Model: CAMARTECH
- Size: 60 cum (2 plants of 30 cum)
- Cost of biogas plant – 8 mill TSH
- Feeding – 70 kg of dung (15% of the required feeding)
- Gas output 7 hours of stove burning (2.1 cum of biogas)
- Efficiency: Based on actual feeding – 75%, Based on the size – 12%
- Saving – About TSh 25,000/month
- Payback period – 26.5 years
- Main Problem: None till date
- Comment: Plant is VERY MUCH over-sized and Under-fed

- Supported by: CAMARTECH
- Model: CAMARTECH
- Size: 16 cum
- Cost of installation – 2.1 mill TSH
- Feeding – 80 kg of dung (about 70% of the required feeding)
- Gas output 3 hours of stove burning (about 1 cum of biogas)
- Efficiency: Based upon actual feeding – 30%, Based upon the size – 20%
- Saving – About TSh 20,000/month
- Payback period – 8.75 years
- Main Problem: Low gas production and hard slurry despite feeding with enough water
- Comment: Plant is over-sized and less efficient

- Supported by: HoRa Energy
- Model: CAMARTECH
- Size: 16 cum
- Cost of biogas plant – 2.4 mill TSH
- Feeding – 60 kg of dung (50% of the required feeding)
- Gas output 7 hours of stove burning (2.1 cum of biogas)
- Efficiency: Based upon actual feeding – 85%, Based upon the size – 43%
- Saving – About TSh 30,000/month
- Payback period – 6.6 years
- Main Problem: Leakage from pipe and neck
- Comment: Plant is over-sized

- Supported by: Friends in Development (FIDE)
- Model: Basic Design from CAMARTECH, however the digester walls are not constructed)
- Size: 12 and 16 cum
- Cost of biogas plant – 900000 TSH for 12 cum and 1.1 mill for 16 cum
- Feeding – 30 to 60 kg of dung (30 to 50% of the required feeding)
- Gas output 4-6 hours of stove burning (1.2 to 1.8 cum of biogas)
- Efficiency: Based on actual feeding – 60-75%, Based on the size – 25-50%
- Saving – TSh 20,000 to 30,000/month
- Payback period – 4 to 6 years
- Main Problem: Orientation of inlet and outlet tanks, leakage from pipes
- Comment: Plants are over-sized as well as under-fed; O&M training to users lacking

- Supported by: MIGESADO
- Model: Basic Design Indian Deen-bandhu with some modifications
- Size: 5 to 12 cum
- Cost of biogas plant – 800,000 TSH for 5 cum and 1.1 mill for 12 cum
- Feeding – 40 to 70 kg of dung (50 to 90% of the required feeding)
- Gas output 5-9 hours of stove burning (1.5 to 2.7 cum of biogas)
- Efficiency: Based upon actual feeding – 80 to 95%, Based upon the size – 50 to 80%
- Saving – TSh 25,000 to 35,000/month
- Payback period – 3 to 4 years
- Main Problem: Clogging of jet in lamp, low efficiency of stoves, clogging of stove burner holes
- Comment: Rooms for further improvements in Pipe fitting and appliances, as well as inlet tank (smaller)

6. Constructors' Workshop

Field investigation exercise was followed by a 3-day workshop of the constructors' of biogas plants in Tanzania to select a standard appropriate design, size(s) and investment costs for household based on agreed criteria and performance factors; quality control mechanisms and certification process for private sector constructors. The workshop was attended by 11 participants from private and public constructors as well as experts in the sector. The workshop schedule and the details of participants have been given in Annex-2 and 3. The following sections highlight the events and outcome of this workshop.

6.1 Events and Outcomes

6.1.1 Welcome and Opening

The workshop formally started with the welcome of participants, opening remarks and agenda introduction from Mr. Harold Z. Ngowi, Chairperson of the Biogas Task Force. He highlighted the objectives of the workshop and requested the participants to contribute their time and efforts to make this workshop a success. The participants then introduced themselves and expressed their interests to participate constructively in the workshop.

Addressing the participants, in his inaugural remarks from the chair of the guest of honour, Dr Patrick J Makungu, Director General of CAMARTECH highlighted the importance and significance of biogas technology in the global as well as Tanzanian contexts. He emphasised the need for the large scale dissemination of biogas technology in Tanzania and urged the participants to come up with the consensus on the best model of biogas plant to be promoted in the country. Expressing best wishes for the success of the workshop, and urging the participants for their valuable contributions, he expressed his belief that active participation of the participants in the whole process of the workshop would be instrumental in achieving the workshop objectives which ultimately would ensure effective dissemination of biogas technology in the country and minimise negative consequences of the conventional fuel sources.

6.1.2 Presentation and Discussion on Best Model of Biogas Plant for Tanzania

The informal opening ceremony was followed by the presentations from the facilitator, Prakash C. Ghimire, Senior Advisor, Asia Biogas Programme of SNV; plenary discussions, group works and group presentations on different models of biogas plants being used under the frameworks of biogas programmes in Asia and Africa including their general characteristics, associated strengths, weaknesses and suitability in Tanzanian context. The facilitator then described the following major criteria for the selection of biogas plants for a particular context.

Criteria for Selection of Biogas Plant Model

To successfully achieve anticipated objectives of biogas programme, it is imperative that the best suited model/design of biogas plant is selected for the wide-scale dissemination. Varieties of models/designs of biogas plants are being used in different countries in the world with successful track records. As reported earlier, there are different models being installed in Tanzania-the fixed dome models, plastic tunnel model etc. Based upon the performance of the existing biogas plants and experiences from other biogas countries, attempts have been made to select the best model for the wide-scale dissemination of the biogas technology in the country.

A biogas plant should be:

- Strong
- Reliable/robust
- Water tight
- Gas-tight
- Built of local materials
- Cheap to build
- Easy to build
- Cost effective to supervise the construction
- User-friendly (Easy to operate and maintain)
- Easy to insulate (in cold areas).

To ensure that a biogas plant fulfils the above mentioned parameters, the following factors need to be considered to evaluate the suitability of biogas plant assuming that the adaptability of any biogas plant in a given context depends mainly upon these factors.

a. Climatic and geo-physical parameters
    - Ambient temperature
    - Geo-physical conditions of the soil
    - Condition of ground water-table
    - Sunshine and humidity

b. Technological Parameters
    - Structural strength against different load conditions (structural durability)
    - Methods of construction/supervision
    - Time and effort in quality control
    - Methods of operation and maintenance
    - Applicability/adoptability of the design in different geographical context for mass dissemination
    - Prospects for sharing of technical information and know-how

c. Affordability of potential farmers to install biogas plant
    - Availability of construction materials
    - Availability of human resources (skilled and unskilled) at the local level
    - Cost of installation, operation and maintenance
    - Transportation facilities

d. Purpose of the use of the products from biogas plant
    - Use of gas for cooking, lighting and/or operating a duel-fuel engine
    - Use of slurry as organic fertiliser
    - Gas use pattern/cooking habits of people (type of food, time for cooking, cooking style etc.)

e. Performance of existing models, if any, in the local and/or regional conditions
    - Existing physical status and functioning
    - User's level of satisfaction

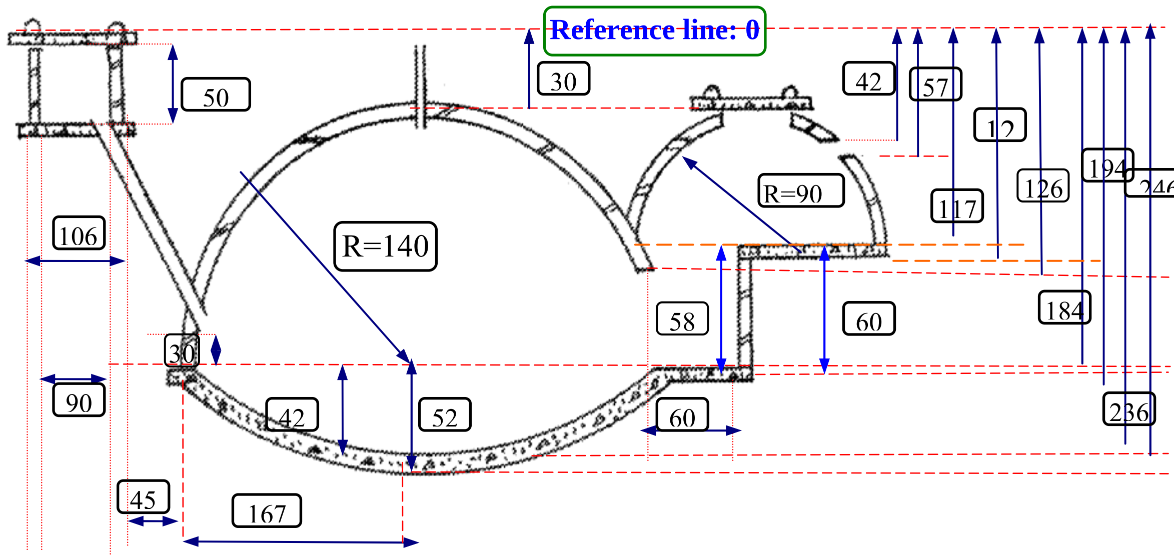
f. Quality and quantity of available feeding materials
    - Type of feeding materials (cattle dung, pig manure, human excreta etc.)
    - Availability of water for mixing
    - No. of cattle/pig per household

The following factors were considered to select the types of biogas design for detailed analysis:

- Models presently in use at the local level
- Models not in use at the local level but are being widely used in other countries with similar socio-economic and climatic conditions
- Models with proven track records of successful operation

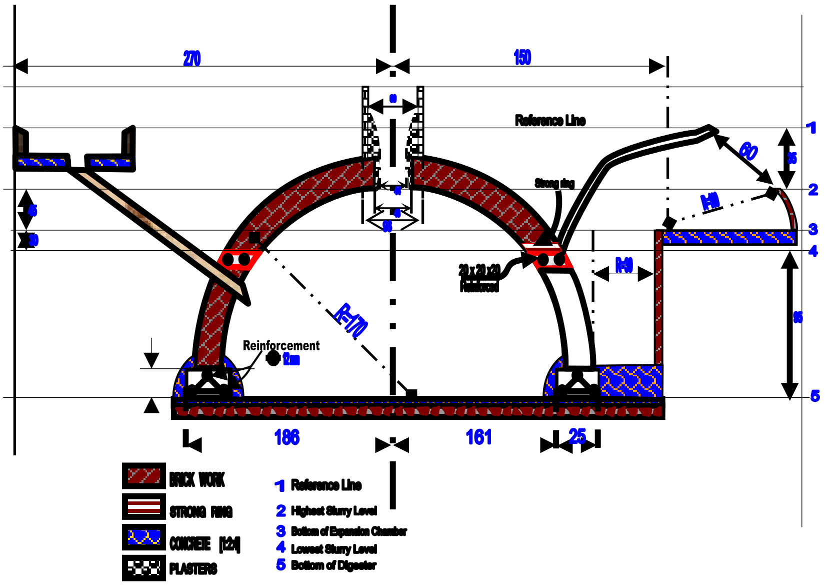
The following models were considered for detailed discussions:

a. **MIGESADO Design:** This is a fixed dome design plant originally based on Indian Deen Bandhu technology, modified to the Tanzanian context by MIGESADO, a local NGO based in Dodoma. More than 900 biogas plants of this design have been installed in central Tanzania with the technical and financial support form MIGESADO. Experiences show that these plants have long lifetimes and relatively lower installation costs than other designs being installed in Tanzania, especially the CAMARTEC Model. The drawing of this model is given below:



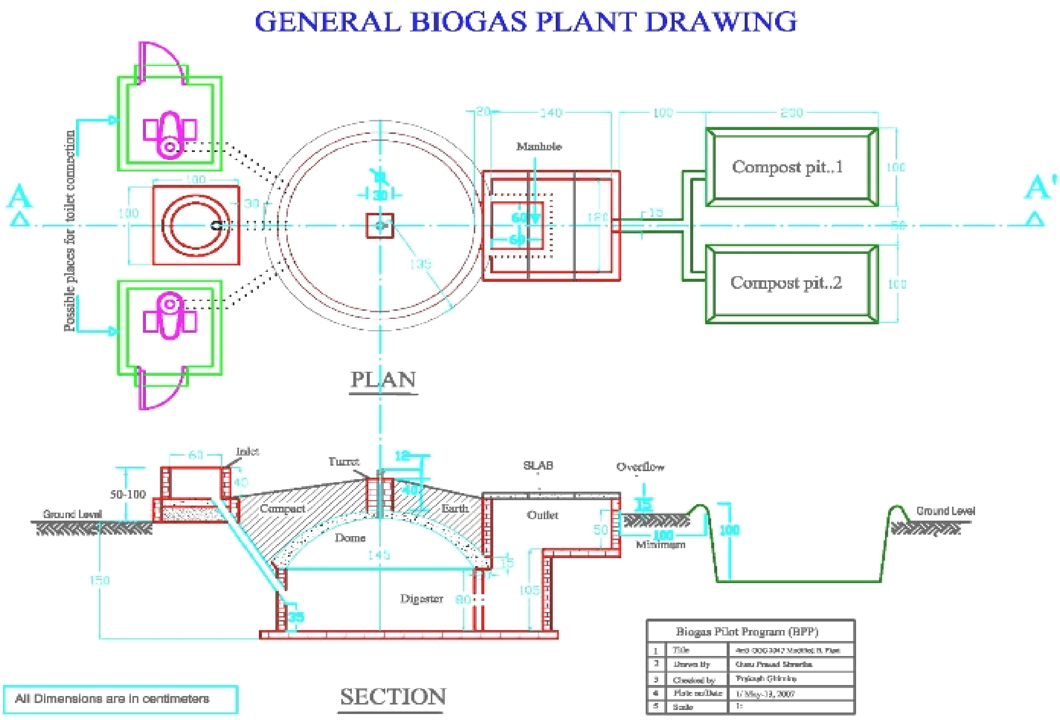
MIGESADO Model Biogas Plant – 8 cum

b. **CAMARTEC Model**: This type is also a fixed dome design originally based on Chinese technology, and modified to the Tanzanian context by CAMARTEC. More than 1000 biogas plants of this design have been reported to be installed in different parts of Tanzania and experiences show long lifetimes and relatively high costs. This type has not only been adopted by Tanzanian private sector, also other African countries have installed this design successfully. Therefore, this design demonstrated technical suitability for African context, but costs remains a barrier to wide-spread dissemination. The drawing of CAMARTEC model being used by HoRa Energy is given below:



CAMARTEC Model Biogas Plant

c. **Modified GGC Model**: This design is also fixed dome model contextualised for the Nepalese environment by a Biogas Company in Nepal (Gobar Gas Company) in late eighties. About 200,000 biogas plants of this design have been successfully installed in Nepal. In 2007, SNV modified this design to suit the contexts of Rwanda and Lao PDR. About 200 pants each in Rwanda and Lao PDR have already been installed till the end of June 2008. This design is also selected for mass dissemination of biogas technology in Ethiopia. Some pilot biogas plants are being installed in different parts of Ethiopia. This design has an advantage over other designs as it could be constructed both with stone and brick masonry works. The following diagramme shows the general drawing of modified GGC biogas plant being disseminated in Rwanda, Ethiopia and Lao PDR.



Rwandan Model (Modified GGC from Nepal) Biogas Plant

The following table shows the relative merits and demerits of the three potential biogas plant models based upon the above described criteria.

Table-1: Evaluation Matrix

Evaluation Criteria	**MIGESADO (Modified Indian Deenbandhu) Model**	**Rwandan/Ethiopian (Modified Nepalese GGC Model)**	**CAMARTEC Model**
Climatic and Geological Conditions			
Condition of Soil	++Suitable for all types of soil. --Less suitable for earthquake-prone areas	+Suitable for all types of soil. - If soil is sticky, like red laterite, difficult to make earthen mould for casting gas holder.	++Suitable for all types of soil. --Less suitable for earthquake-prone areas
Ambient Temperature	+Less risks of temperature fluctuations in digester – top of the plant is not exposed.	+Less risks of temperature fluctuations in digester - top of the plant is not exposed.	-Risks of temperature fluctuations in digester - top of the plant is exposed.
Condition of Ground Water Table	+Suitable for all areas. ++Best suitable for areas with high water table.	-Less suitable for areas with high water table. +Best suitable with areas with low water table especially in the hilly regions.	-Less suitable for areas with high water table. +More suitable with areas with low water table.
Sunshine and humidity	+ Suitable for dry and sunny areas where evaporation is high and water is problem	-Less suitable than MIGESADO for dry areas where evaporation is high	-Less suitable than MIGESADO for dry areas where evaporation is high
Technological Parameters			
Structural Durability			
Inlet Chamber and Inlet Pipe	+Comfortable in mixing, makes the condition of mix suitable for anaerobic digester (better quality mix)	+Comfortable in mixing, makes the condition of mix suitable for anaerobic digester (better quality mix)	+ Allows gravity flushing and urine collection -Small tank, difficult to operate.
Digester and Gas Holder	++ Spherical shapes at the bottom and the top is best for load bearing purpose -Brick gas holder is prone to leakage +Closed top of gas holder is less prone to gas leakage. +Manhole in the side eliminates the risk of gas leakage from the top. --Cracks in stone/brick wall can extend to gas holder if ring is not provided in between +Arch frame over the manhole is structurally sound. -The small size of manhole opening makes it difficult to enter into the digester.	+Concrete gas holder with closed top is less prone to gas leakage. +Manhole in the side eliminates the risk of gas leakage from the top. +Manhole in the side with adequate height provides best situation to enter into the digester to monitor the construction and break the scum. ++Cracks in stone/brick wall can not extend to concrete gas holder -Joints in the base and bottom of dome makes the structure less stronger	+The bottom ring provides structural safety. -Brick gas holder is prone to leakage -Manhole at the top increases the risk of gas leakage. -Difficult to break scum, plant has to be emptied +Cracks in digester wall can not extend to the gas holder due to the provision of concrete ring in between
Outlet Tank	+ Spherical shape, structurally strong, no chance of formation of dead volume.	-Rectangular structure, chances of formation of dead volume and cracks in the corner if backfilling is not provided +The overflow opening is designed to be above the ground level which facilitates the flow of slurry by gravity and also decreases the chance of flood water entering into the tank.	+Circular structure more durable and less chance of formation of dead volumes in the corners +Separate pipe for overflow -The overflow opening is designed to at the ground level which increases the risk of flood water entering into the tank.
Methods of Construction			
Required area for construction	+Requires less area, can be constructed below the cattle	+Requires less area, can be constructed below the cattle	- Requires relatively more area

	shed	shed	
Digging of Pit	--Very complicated excavation	+No complications in excavation	Less complications in excavation
Construction of Base	--Very complicated base concreting as it demands spherical shape and properly adjusted collar -Consumption of more construction materials	+Easy in preparing the base + Consumes less materials, broken bricks bats are used	-Slightly complicated base concreting as the ring has to be casted accurately -Consumption of more construction materials
Construction of Digester	-Skilled person needed to construct -Fixing of curvature constructing of arch needs careful attentions --Not suitable in areas where brick is not available and stone are widely used -Only limited number of brick layers could be constructed in one day to allow the brick to set properly, time consuming	+Construction is easy; mason with a skill to construct masonry walls can do it with a little orientation. ++ Suitable for both brick and stone masonry walls +Construction of digester wall can be finished in one day, no need to wait for the brick to set. Less time consuming. -Care has to be given to maintain the wall perfectly vertical	-Skilled person needed to construct --Not suitable in areas where brick is not available and stone are widely used -Only limited number of brick layers could be constructed in one day to allow the brick to set properly, time consuming
Construction of Gas Holder	-Only limited number of brick layers could be constructed in one day to allow the brick to set properly, time consuming -Hooks and counterweights are needed for each and every freshly laid brick, which is a cumbersome task to do -Scaffoldings are needed from inside and outside to close the dome which adds more complications -Joints between bricks should be filled well to make it gas tight – more care is needed -Cracks developed during construction have to be monitored properly and work has to be stopped immediately if cracks appear. Masons tend to violet this in quest to complete work quickly.	--The whole part of the digester has to be filled with soil to erect a framework for casting concrete for the gas-holder which is very cumbersome job demanding more unskilled labours -Templates have to be used to shape the soil mould; carrying of such moulds though not very difficult is an added job. -Made up of concrete, consumes more construction materials -Labour intensive to mix and pour concrete	-Only limited number of brick layers could be constructed in one day to allow the brick to set properly, time consuming -Hooks and counterweights are needed for each and every freshly laid brick, which is a cumbersome task to do -Construction of manhole in the top needs more skills and care -Joints between bricks should be filled well to make it gas tight – more care is needed -Cracks developed during construction have to be monitored properly and work has to be stopped immediately if cracks appear. Masons tend to violet this in quest to complete work quickly.
Inlet and Outlet Tanks	+No major difficulties in constructing inlet tank. +Rectangular/circular tank, easy to construct +Overflow opening is above the ground level, slurry flows by gravity -Care needed to fix the mixing device properly	+No major difficulties in constructing inlet tank. +Rectangular/circular tank, easy to construct +Overflow opening is above the ground level, slurry flows by gravity -Care needed to fix the mixing device properly	- Location of inlet should facilitate easy flow of dung from cattle stable. -Spherical outlet tank, difficult to construct -Overflow opening is on the ground level, construction of drain in needed to facilitate the slurry flow.
Operation and Maintenance			
Operational Activities	+Easy to inspect and clean over-flow opening +Relatively easy to break scum layer from manhole -Adds time to collect and transport dung from the cattle shed to the inlet tank +Less chance of scum formation +Less chance of settlement	+Easy to inspect and clean over-flow opening +Easy to break scum layer from manhole -Adds time to collect and transport dung from the cattle shed to the inlet tank +Less chance of scum formation +Less chance of settlement	-Difficult to inspect and clean overflow opening (blocked overflow may invite slurry into the pipeline) -Difficult to break the scum layer, entire plant has to be emptied + Easy to flush dung into the inlet --Cumbersome to separate

	of particles in the digester base +Mixing can be made easy with installation of mixing device	of particles in the digester base +Mixing can be made easy with installation of mixing device	inert materials that flow into the inlet tank - High chance of scum formation - High chance of settlement of particles in the digester base -Mixing device can not be installed
Maintenance Activities	+Emptying of digester is easy and it does not effect on structural stability	+Emptying of digester is easy and it does not effect on structural stability	-Breaking of the seal at the manhole and repositioning it is difficult when the digester and gas holder need maintenance. -Repeated breaking of this seal may lead to gas leakage
Top-filling and protection of plant	+The whole structure above the dome could be back-filled and protected well under ground	+The whole structure above the dome could be back-filled and protected well under ground	-The whole structure above the dome could not be back-filled to allow constant monitoring of the manhole seal -Chances of mosquito breeding is high in the stagnant water
Applicability/Adoptability in different Geographical context	-Not suitable in areas where bricks are not available or could not be transported easily	+Suitable for all the areas. Bricks could be supplemented by stone in areas where bricks are not available	-Not suitable in areas where bricks are not available or could not be transported easily
Prospects for sharing of Technical Information and Know-how	+Information are widely available which could be shared	+Information are widely available which could be shared	+Information are widely available which could be shared
Affordability of Farmers to install biogas plant			
Availability of construction materials at the local level	All three designs will be constructed with similar construction materials.		
Availability of human resources	-Trained technical manpower available to some extent -Needs intensive training	-Trained technical manpower is not available -Needs training	+Trained technical manpower available
Cost of Installation (excluding transportation, guarantee and after-sales-services)	TSh 900,000 to 1,000,000 for 6 cum biodigester TSh 1,000,000 to 1,100,000 for 8 cum biodigester	USD 860 for 6 cum biodigester USD 1,000 for 8 cum biodigester	TSh 1,500,000 to 1,800,000 for 8 cum biodigester
Operation and maintenance cost	Negligible cost of O&M if operated effectively.	Negligible cost of O&M if operated effectively.	More than other two models as clay seal on the top has to be changed occasionally
Transportation facilities	-Less suitable with areas where bricks has to be transported	++Suitable in all the parts of the country as bricks can be replaced with stones	-Less suitable with areas where bricks has to be transported
Purpose of the use of Biodigester Products	All the biodigester under the framework of the study are designed for the same purposes.		
Performance of Existing biodigesters in local/regional context			
Existing physical status and functioning	All the biogas plants installed in the country are working very well	100% of the biodigesters installed in Rwanda are operational and have good physical status.	-The physical status and functioning of majority of the biodigesters installed in is satisfactory, however, the efficiency is reported to be low.
Level of Satisfaction of Users	Users are highly satisfied in Tanzania. However, the functional condition in India is not satisfactory. The official document indicates	+all the users in Rwanda are fully satisfied +93% of the users in Nepal are fully satisfied and 7% of them are partly satisfied	Users had mixed feelings on the functioning. Most of them are satisfied. There are plants being operational for more than 20 years.

	that about 50% of the plants are functioning in the country	+User's in Nepal prefer GGC more than Deenbandhu	
Quality and Quantity of available feeding materials	+Best suited for cattle dung feeding -Modifications in inlet needed for urine collection +Design of smaller size (4, 6 cum) is also available. +Chances for scum formation is low	+Best suited for cattle dung feeding -Modifications in inlet needed for urine collection +Design of smaller size (4, 6 cum) is also available. +Chances for scum formation is low	+ Suitable for urine collection and direct feeding -Design of smaller size (less than 8 cum) is not available. Not suitable for families with small cattle holding. Smaller size plants should be designed. -Chances for scum formation is very high

Following the presentation from the facilitator; Mr. Herbert Kitange and Mr. Sanford J Kombe described the salient features of MIGESADO and CAMARTEC Models respectively. The participants were than requested to evaluate the three models based upon the criteria as discussed. Majority of the participants were of the view that only two models, viz. MIGESADO and CAMARTEC, be considered given their popularity in the country. As bricks and casted in situ concrete blocks are available through out the country, according to the participants, there is no need to consider the model that suits both with stone or brick masonry. For final evaluation, therefore, MOGESADO and CAMARTEC models were considered. The participants were requested to evaluate these models objectively as per the score sheet given below as well as subjectively as per their experiences with these models. The suitability of different models of biogas plant potential to be disseminated in Tanzania as discussed above were ranked based upon the criteria shown in the evaluation matrix.

Table-2: Biogas Plant Model Score Sheet

SN	Evaluation Criteria	MIGESADO	RWANDAN	CAMARTECH
1	**Climatic and Geological Conditions**			
1.1	Ambient Temperature			
1.2	Type of Soil			
1.3	Condition of Ground Water Table			
1.4	Sunshine and humidity			
2	**Technological Parameters**			
2.1	***Structural Durability and functioning***			
2.1.1	Inlet Chamber and Inlet Pipe			
2.1.2	Digester			
2.1.3	Gas Holder			
2.1.4	Outlet Tank/hydraulic chamber			
2.2	***Methods of Construction/ supervision***			
2.2.1	Requirement of area for construction			
2.2.2	Digging of Pit			
2.2.3	Construction of Base (foundation)			
2.2.4	Construction of Digester			
2.2.5	Construction of Gas Holder			
2.2.6	Inlet and Outlet Tanks			
2.2.7	Time and Efforts in Quality Control			
2.3	***Operation and Maintenance***			
2.3.1	Operational Activities			
2.3.2	Maintenance Activities			
2.3.3	Top-filling and protection of plant			
2.4	***Applicability/Adoptability in different Geographical context (including suitability with locally available construction materials)***			
2.5	***Prospects for sharing of Technical Information and Know-how***			

3	**Affordability of Farmers to install biogas plants**			
3.1	Availability and accessibility of construction materials at the local level			
3.2	Availability of human resources			
3.3	Cost of Installation			
3.4	Operation and maintenance cost			
3.5	Transportation facilities			
4	**Purpose of the use of the Products from biogas**			
4.1	Use of Gas			
4.2	Use of Bio-slurry			
4.3	Gas use pattern/Cooking habits			
5	**Performance of Existing biogas plants in local/regional context**			
5.1	Existing physical status and functioning			
5.2	Level of Satisfaction of Users			
6 6.1 6.2 6.3 **7.** 7.1 7.2 7.3	**Quality and Quantity of available feeding materials** Number of cattle/grazing pattern Type of feeding materials (cattle dung, pig manure, human excreta etc.) Availability of water for mixing **Other Criteria**			
	Total Marks obtained			
	Ranking **Final Decision**			

The following additional selection criteria were suggested by the participants:

- Compatibility with integrated system
- Room for community plants
- Inoculation capability
- Familiarity (commonly heard or talked of)
- Gas storage ability

The outcome of the ranking exercise revealed that there is not a wide difference on ratings among the two models under consideration. The following table reveals the evaluation results.

Table-3: Evaluation Results

Participant	Marks Allocated for MEGESADO	Marks Allocated for CAMARTEC	Preferred Model	Suggestions for Improvement
1	49	57	CAMARTEC	Improvements in the neck Improvements in digester size
2	60	73	----	----
3	56	66	CAMARTEC	Size should be scaled down to reduce cost Modification leading to a better model be done Cost estimates to be prepared If possible and resources are made available, a test model be developed
4	65	54	MIGESADO	-----
5	41	43	MIGESADO	Neck should be removed in CAMARTECH design

6	45	53	CAMARTEC	Transfer qualities of the CAMARTEC model to the MIGESADO model. There should be 2 or 3 different sizes of both the designs to be tested over a period of less than one year.
7	45	52	CAMARTEC	Any improvements can be added if it is agreed upon.
8	37	38	Rwandan	Has ranked Rwandan Model to be the best!
9	49	40	MIGESADO	----
10	44	44	------	-----
11	61	52	MIGESADO	Would go for CAMARTEC design if there is improvement in the lower side (base), and improvement on construction and cost.
Total	552	572		

Outcome of Discussion on Design Selection

As shown in Table-3, the out of 11 participants, 4 preferred MOGESADO Model, another 4 favoured CAMARTEC model, 1 recommended Modified GGC (Rwandan) model, though it was not included in the final selection process and the remaining 2 were undecided though one of them allocated more scores to CAMARTEC model. CAMARTEC and MIGESADO follow the same technical principle of the fixed dome design. As a consequence of the outcome of the evaluation and characteristics of the designs, it was agreed to follow a technology resulting of a development of a combination of these two designs and also to incorporate recent technological achievements of other countries, for mass dissemination of biogas digesters in Tanzania. Main differences are in the gas outlet system, which are considered as problematic with the CAMARTEC design and, therefore, are subject for redesign following the similar approach of MIGESADO. Keeping in view the outcome of the evaluation, the facilitator then proposed the following modifications in the CAMARTEC design to overcome the existing technical problems as well as incorporate the strengths of MIGESADO model to evolve a new design named as the Modified CAMARTEC design.

Characteristics of the New Model

Combination of CAMARTEC and MIGESADO Model of Biogas Plants is selected with the following proposed modifications:

- The neck portion on the top of the gas holder will be removed and the man hole will be constructed in top of outlet tank, similar to that of MIGESADO model. (The manhole in the top of dome will be taken out).
- The shape of outlet tank (hydraulic chamber or compensation tank) will be spherical with overflow outlet in it (similar to MIGESADO model).
- The outlet passage will be design in such a way that it facilitates easy entrance of people inside the digester (at least 60 cm square or circular).
- The overflow level in the outlet will be arranged in such a way that gravity flow of slurry from inlet to slurry pit is possible.
- The gas holder will be designed to store at least 50% of the daily gas production.
- 4 different sizes (6, 8, 10 and 12 cum) of biogas plant will be considered for mass dissemination.
- The minimum pressure to be considered while designing the biogas plant will be 70 cm of water column for all the plants.
- HTR of 50 days will be considered while preparing the modified design.
- The design will incorporate options for direct feeding of dung from the cattle shed as well as separate mixing tank depending upon the site condition and user's demand/need.
- The other design parameters such as weak/strong rings, foundation etc. will be based upon the modified CAMARTECH model

The participants unanimously approved the modification provisions. It was decided that a new design will be prepared with on 15 days and submitted to Biogas Task Force for final approval. The final design as well as costs and quantity estimation of the new design have been given in Annex-4 and 5.

6.1.3 Presentation and Discussion on Quality Control Framework

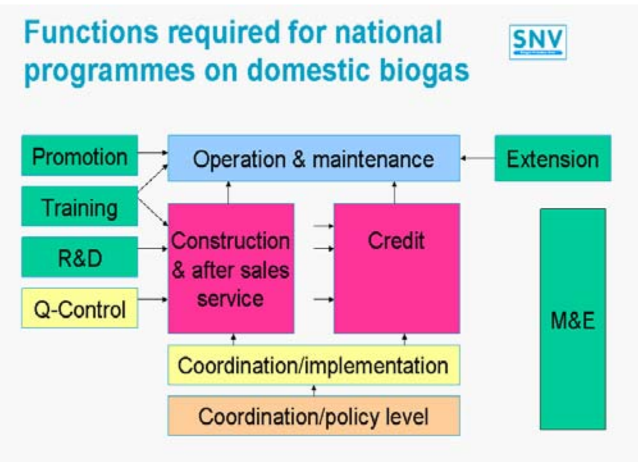
As per the agenda for the second day, the facilitator started the sessions with the presentation on importance of quality management in biogas programme. He emphasised the fact that non-functioning and poorly functioning biogas plants cause not only capital wastes but also harm the reputation of biogas technology and eventually to the desired establishment of permanent biogas sector. Therefore, 'quality' should be the prime concern of the future biogas programme. The quality should basically relate to the following aspects of biogas programme implementation:

- **Quality of the design of biogas plant**: The biogas plant should be cost-effective; users' friendly; easy to construct, operate and maintain.
- **Quality of training and capacity building activities**: Correct training need assessment; proper selection of training participants, proper selection of facilitators, suitable training contents, session plans and scheduling; appropriate training methods; effective practical sessions; effective evaluation of training; timely follow-up of the evaluation findings.
- **Quality of promotion and extension works**: Potential customers should fully be aware and understand all the benefits and costs. They should be provided with factual data and information and should be aware of their roles and responsibilities for quality control.
- **Quality of the construction** (including selection of construction materials and appliances): Strict adherence of set quality standards on site selection, selection of construction materials and appliances and construction.
- **Quality of the operation and maintenance** by the users and technical backstopping from the installer: Effective training to users', timely follow-up visits by the installer.
- **Quality of after-sale-services** on behalf of the installers: Strict adherence of terms and condition of after-sale-service provisions including timely actions to the complaints from users, routine visits and problem-solving.
- **Quality of financial and administrative procedures and practices**: Proper utilisation of fund, timely disbursement of subsidy amount, proper book-keeping, less-lengthy procedures, fast, friendly and useful customer services.

The facilitator told if the biogas plant does what is anticipated by the programme personnel and what the user wants it to do, then it is a quality plant. That's meeting the anticipated requirements. Hence, quality is the performance excellence of biogas plant as viewed by all stakeholders. Thus, if the installed biogas plant:

- has the right dimensions, configuration and features,
- does what it's supposed to do,
- is reliable and durable,
- is delivered on-time, and
- is well-supported; then

It is quality biogas plant.



Describing various functions under a biogas programme as shown in the following figure, the facilitator stressed the need to integrate quality aspects in all these functions. The basic objective of quality control in any biogas programme is to ensure that the installed biogas plants meet the set quality standards and they function optimally without any major problems for the anticipated duration of time. Quality should be the prime concern of the programme. Effective quality control not only helps in ensuring the compliance of quality standards but also provides learning opportunity for the programme personnel.

The facilitator than explained the importance of structured QC system as follows:

- o To maximize performance, reliability and lifetime of every biogas plant
- o To maximize the value for money for biogas customers, biogas programme, donors and Government of Tanzania
- o To maximize the potential livelihood benefits to customers and communities
- o To minimize the risk of accidents or damage to users or property
- o To maintain the reputation, credibility and value of the Biogas Program in Tanzania

Emphasising that the quality control refers to the operational techniques and the activities used to fulfil and verify requirements of quality and it is the planned process of identifying established technical specifications for the project and exercising influence through the collection of specific (usually highly technical and standardized) data, he pointed out the need to formulate quality standards related to various aspects of biogas programme implementation.

In biogas programme, quality control is involved in developing systems to ensure biogas plants are designed and constructed to meet or exceed users' requirements. As with cost control, the most important decisions regarding the quality of a biogas plant are made during the design and planning stages rather than during construction. It is during these preliminary stages that component configurations, material specifications and functional performance are decided. Quality control during construction consists largely of insuring conformance to this original design and planning decisions.

After the presentation, the participants were divided in three different groups to work out on the best model of quality control system during construction and installation of biogas plant as shown in the table-4.

Table-4: Group Division

SN	Name	Organisation
Group-1		
1	Evarist Ngwandu	CAMARTEC
2	Lehada C. Shila	TNCDD
3	Herbert Kitange	MIGESADO
4	Robert Makapo	AEC Tanzania Ltd.
Group-2		
5	Innocent Mjema	Freelancer
6	Jaochim P. Mallya	HoRa Energy
7	Senkondo Mgalla	FIDE
8	Harold Z. Ngowi	CAMARTEC
Group-3		
9	Ndel R. Mollel	ELCT-Arusha
10	Sanford J. Kombe	ABC Ltd.
11	Msafiri Athumani	CAMARTEC

The participants were requested to focus their discussions on the following two key questions:

- o What should be the general process of Quality Control under the framework of national biogas programme in Tanzania?
- o What are the potential roles and responsibilities of different stakeholders in quality control?

Outcome of Discussion on Quality Control

Summarising the presentation from the three working groups, the facilitator presented the following major points as the outcome of the discussion:

Quality in terms of biogas programme in Tanzania will relate to:

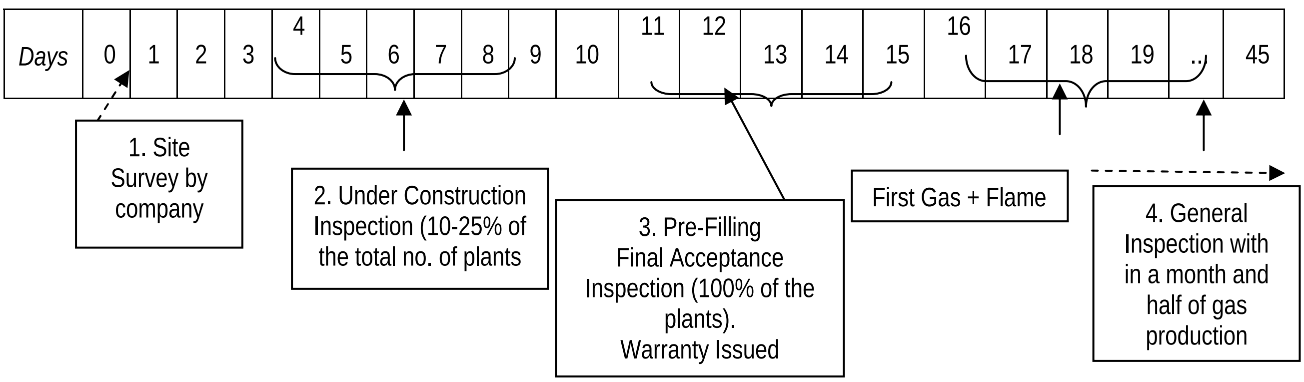
- Quality of information flow, promotion and extension
- Quality of training and capacity building activities
- Quality of the design of biogas plant
- Quality of the construction and supervision
- Quality of the operation and maintenance by the users
- Quality of after-sale-services on behalf of the installers
- Quality of financial and administrative procedures and practices

The proposed biogas programme will formulate quality standards on the following aspects based upon the agreed deign of biogas plant to be disseminated:

- Household, plant size and site selection
- construction materials & appliances
- workmanship of construction (plant) and installation (pipeline & appliances)
- user instruction (verbally & provision of user manual)
- after-sales service

The following will be the general process for Quality Control:

- o An apex regulating body (Steering committee) will be established with clear mandate of coordinating the activities related to quality control. Possibilities to make this body a legal entity will be sought for.
- o CAMARTEC as the lead implementing partner will be responsible to implement the quality control activities.
- o Given the present capacity within the CAMARTEC, the task of quality control will be outsourced to specialized consulting firm which will be selected on competitive bidding process.
- o CAMARTEC will be responsible for the bidding process. The final decision on the selection of consultant to act as the external arm of CAMARTEC will be taken by the apex regulating body.
- o The biogas companies will be responsible for carrying out the internal quality control of the activities.
- o Biogas users will be provided with pre-construction training in which their roles on quality control will be discussed. They will also be involved in quality control.
- o The biogas programme in consultation with the biogas companies will finalise the sampling methods and process of external quality control mechanisms including number of visits
- o The timeline in general will be as follows:



6.1.4 Presentation and Discussion on Certification Process for Private Sector

The third and final day of the workshop commenced with the recapitulation of the previous day. The facilitator initiated the session on certification process for private sector constructors and manufacturers to participate in biogas programme. He underlined the importance of private sector involvement in an effective and efficient manner for effective promotion and extension of biogas technology and to ensure sustainability of the sector. Central in the concept of any biogas programme should be the inclusion of the private sector constructors and manufacturers in the primary process leading to sector growth.

The presentation from the facilitator included the following important roles that the private sectors can play effectively based upon past experience in previous biogas programmes:

- Promotion and marketing of the technology
- Demand collection
- Construction and quality control
- After-sales-services
- Users training
- Manufacturing of appliances
- Marketing of appliances
- Ensuring availability of spare parts
- Research and development (user's satisfaction surveys)

The presentation also highlighted the following basic pre-requisites for the private sector to participate in biogas programme:

- Commitment to comply with the approved standard design and sizes of biogas plants;
- Commitment to employ trained, certified and registered masons for the construction of biogas plants;
- Commitment to construct biogas plants on the basis of detailed quality standards;
- Commitment to participate in production and marketing of quality biogas appliances (pipes, valve, stove, water trap, lamp) approved by the programme
- Commitment to provide proper user training and provision of a user instruction manual;
- Commitment to provide at least one year guarantee on appliances and two years guarantee on the civil structure of the biogas plant, including an annual maintenance visit during guarantee period;
- Commitment to ensure timely visit of a technician to the biogas household in case of a complaint from the user;
- Proper financial and administrative management system in place

Following the presentation on importance and roles of private sector, the participants were divided into three groups for discussion on the following two key questions:

- What are the potential roles of private sector companies in the biogas programme?
- What should be the certification/accreditation criteria for the involvement of private sector companies in biogas programme?



Outcome of Discussion on Private Sector Involvement

Based upon the presentations from the three working groups, the following outcome was summarised and agreed upon by the participants.

Roles of Private Sector

- Test the market trend (positive or negative) for promotion; marketing of the product through: brochures, well done works and performances, exhibitions, fairs, media, words of mouth, CBOs (groups), effective after-sales services
- Act as a link between users and R&D institutions; users and financers (banks, credit associations); manufacturers and consumers; users and policy makers
- Identify the training needs for artisans and users
- Provide users manuals and guidelines and conduct users' training and follow ups
- Conduct R&D activities in situ
- Carry out construction activities as per the set quality standards/Enforce quality control mechanisms/Compliance with set standards
- Ensure the sustainability of the technology (self propelling)
- Create awareness at the community on the product and services
- Capacity building and resource generation –human and other resources
- Ensure effective after sales services
- Provide guarantee on the services and comply with the guarantee provisions
- Establish linkages with other stakeholders, e.g. for R&D
- Comply with the financial and administration rules and regulations of the country, e.g. pay taxes
- Pay attention to employment creation at the local level
- Participate in training courses organised form time to time on biogas business management
- Select proper households for the installation of biogas plant
- Produce quality biogas appliances

Accreditation/Certification Criteria

- The company or NGO/CBO with a provision of formal registration in appropriate government authority
- Possessing a minimum of 3 qualified technicians/engineers
- Having a physical office/premises to work (well established office)
- Owning a minimum sets of required tools and equipment
- Well established financing procedures/Standard financing/accounting system or management in place
- Duly clearance of government taxes (free from any liabilities)
- Holding a concise business plan (at least 3 years) with clear vision, mission and objectives
- Having field experience in the sector
- Sound background (proven track records)
- Having clear organizational structure
- Well established data handling and communication facility in place
- Having sound knowledge on biogas technology
- Knowledgeable not only in construction but also in socio-cultural values/norms, economic situation etc.
- Reliability and trustworthiness in the community where they work
- Accessible to people

Question was raised by the participants on whether or not to accredit NGOs/CBOs as private constructors and/or appliance manufacturers. Given the limited information available on the willingness of the private companies to be involved in the sector as well as their technical capability to provide quality services, it was agreed that NGOs/CBOs will also be considered to take part in the programme in the initial phase as constructors and/or manufacturers if they agree to be abided by the set terms and conditions.

6.1.5 Informal Closing of Workshop

The 3-day workshop came to an end with the closing remarks from Mr. Peter Bos, Senior Advisor, SNV who is also acting as secretary of the Biogas Task Force and Mr. Harold Z. Ngowi, Principal Technologist, CAMARTEC and Chairperson of the Biogas Task Force. They expressed their deep satisfactions on the outcome of the workshop and thanked all the participants and the facilitator for their active participation, constructive suggestions and effective facilitation. An informal evaluation of the workshop from the participants indicated that the process has been effective and outcomes have been beneficial for the future of biogas programme in the country.

7. Conclusion

The mission has successfully been completed in the stipulated time frame. It has been effective and successful in selecting best appropriate model of biogas plant to be disseminated under the framework of the proposed national biogas programme; formulating workable quality control framework; and preparing accreditation/certification mechanisms for effective participation of private sector companies, NGOs and CBOs in the programme. The workshop provided a common platform to share ideas, information, problems and potential solution on biogas plant construction in Tanzania. The outcome of the general evaluation of the training program supports the effectiveness and success of the workshop in particular and the mission as a whole. To formulate practical PID for effective promotion and extension of biogas technology in the country, outcomes of this mission is expected to be instrumental and highly beneficial.

Annex-1: Itinerary

Dates	Agenda
June 14, 2008	Arrival in Dar es Salaam, Meeting with Mr. Safiri of CAMARTEC
June 15, 2008	Meeting with Personnel from two private companies in Dar es Salaam and visiting CAMARTEC plants in and around Dar es Salaam. Mr. Jaochim Mallya, HoRa Energy Ltd., Da res salaam jmallya@horaenergy.com 0712-370037 / 2666254 Mr. Hamisi Kalumege and Mr. Bakiri Ali A E C Tanzania Ltd., Dar es salaam aectanzania@gmark.com 071767852
June 16, 2008	Visiting CAMARTEC plants in and around Dar es Salaam. Travel to Arusha from Dar es salaam
June 17, 2008	Meeting with Personnel from CAMARTEC, observation of biogas plants and production units Dr. Patrick J. Makungu, Mr. Harold Z. Ngowi, Mr. Evarist Ngwandu CAMARTEC 27 2553214 Meeting with Personnel from two private companies in Arusha Mr. Sanford J. Kombe ABConstructors 0754285737 Mr. Ainea Kimaro Arusha Biogas and Solar Energy Company 0754898227
June 18, 2008	Travel to Babati, Meeting with Personnel in FIDE, and observation of Biogas Plants Mr. Senkondo Mgalla 0784392979 mgallabbt@yahoo.com
June 19, 2008	Travel to Dodoma, Meeting with Personnel in MIGESADO, and observation of Biogas appliances Manufacturing Workshop Mr. Herbert Kitange 0714410007 herbertkitange@yahoo.co.uk
June 20, 2008	Observation of Biogas Plants
June 21, 2008	Travel back to Arusha from Dodoma
June 22, 2008	Preparations for Biogas Constructor's Workshop
June 23, 2008	Visit CAMARTEC Plants Preparations for the Workshop
June 24, 2008	Workshop on Selection of Best Biogas Plant Model
June 25, 2008	Workshop on Quality Control Framework
June 26, 2008	Workshop on Certification Procedures for Biogas Constructors
June 27, 2008	Final Reporting
June 28, 2008	Travel Back to Dar es Salaam
June 29-30, 2008	Travel back to Phnom Penh via Addis Ababa and Bangkok

Annex-2

Constructor' Workshop on Selection of Best Model of Biogas Plant; Quality Control Mechanisms and Accreditation of Private Companies

Workshop Schedule

Session No.	Time Schedule	Session Topic
	Day-1: June 26, 2008	
	08:30-09:30	Registration and Opening ceremony
1	09:30-10:00	Introduction, Objectives, Expected Outputs and Detailed-Schedule
	10:00-10:30	Tea break
2	10:30-11:30	Presentation and discussions on three models of biogas plants under scrutiny
3	11:30-12:15	Presentation on outcome of field investigation
	12:15-13:30	Lunch
4	13:30-14:15	Criteria for the selection of best suitable model of biogas plant
5	14:15-15:15	Individual ranking and group discussions to evaluate the biogas models under consideration based upon the selected criteria
	15:15-15:45	Tea break
6	15:45-16:30	Presentation of the outcome of the group discussion
	16:30-17:00	Recapitulation and closing of the first day
	Day-2: June 27, 2008	
7	08:30-09:30	Presentation and discussions on potential changes in the selected design to suit Tanzanian context
8	09:30:10:30	Presentation on importance of quality management in biogas programme
	10:30-11:00	Tea break
9	11:00-12:15	Group discussion on quality management process, quality control and role of different stakeholders on quality control
	12:15-13:30	Lunch
9a	13:30-14:15	Presentation on the outcome of group discussions
10	14:15-15:15	Group discussion on Quality standards
	15:15-15:45	Tea Break
11	15:45-16:30	Group presentation on Quality standards
	16:30-17:00	Recapitulation and closing of the first day
	Day-3: June 28, 2008	
12	08:30-09:30	Presentation on the role of different stakeholders on biogas programme
13	09:30-10:30	Discussion and presentation on potential role of private sector on biogas programme
	10:30-11:00	Tea break
14	11:45-12:15	Discussions and presentation on basic minimum criteria to be fulfilled by the private companies for the accreditation
	12:15-12:30	Recapitulation and closing of the workshop
	12:30-13:30	Lunch

Annex-3
Constructors' Workshop on Selection of Best Model of Biogas Plant; Quality Control Mechanisms and Accreditation of Private Companies

List of Participants

SN	Name	Organisation	E-mail Address
1	Evarist Ngwandu	CAMARTEC	Evarist_ng@yahoo.com
2	Msafiri Athumani	CAMARTEC	mlimasunzuma@yahoo.com
3	Lehada C. Shila	TNCDD	clshila@yahoo.com
4	Ndel R. Mohel	ELCT-DAR	elctdar@habari.co.tz
5	Herbert Kitange	MIGESADO	herbertkitange@yahoo.com
6	Innocent Mjema	Freelancer	innomjema@yahoo.com
7	Senkondo Mgalla	FIDE	mgallabbt@yahoo.com
8	Robert Makapo	AEC Tanzania Ltd.	aectanzania@gmail.com
9	Jaochim P. Mallya	HoRa Energy	Jaochim-pm@canopiesinternational.co.tz
10	Sanford J. Kombe	ABC Ltd.	abckombe@gmail.com
11	Harold Z. Ngowi	CAMARTEC	haroldngowi@yahoo.com

Annex-4
Design of Modified CAMARTEC Biogas Plant (6, 8, 10 & 12 m^3 Sizes)

Annex-5
Quantity and Cost Estimation of Modified CAMARTEC Biogas Plant

SN	Item	Unit	Unit Cost Tsh	6m³ Quantity	6m³ Total Cost Tsh	8m³ Quantity	8m³ Total Cost Tsh	10m³ Quantity	10m³ Total Cost Tsh	12m³ Quantity	12m³ Total Cost Tsh
I	**Construction Materials**										
1	Bricks/Concrete blocks	No.									
2	Cement – 50 kg bag	bag									
3	Gravel 1x2	m^3									
4	Coarse sand	m^3									
5	Fine sand	m^3									
6	Inlet pipe 10cm dia, length 2m	piece									
7	Iron bars ø 8 mm	Kg									
8	Binding wire	kg									
9	Water proofing compound	kg									
10	Acrylic emulsion paint	Lit									
	Subtotal 1										
II	**Accessories**										
11	G.I Gas outlet pipe Ø 0.5", 0.6m length	pcs									
12	GI nipple, Ø 0.5" for connecting main gas pipe and main gas valve	pcs									
13	Main gas valve (Ballvalve Ø 0.5")	pcs									
14	Male-female socket Ø 0.5", G.I. with aluminum thread, for connecting main gas valve and gas pipeline (G.I.)	pcs									
15	G.I. 90◦ elbow	pcs									
16	T-socket Ø0.5" for water trap (aluminum thread inside)	pcs									
17	Water drain	pcs									
18	Gas tap	pcs									
19	Teflon tape	pcs									
21	Gas pipe, G.I. or PVC pipe Ø 0.5”	m									
22	Gas rubber hose pipe Ø 0.5” and 2 clamps	m									
23	Stoves – single burner	pcs									
24	Lamp	pcs									
25	Pressure meter/Manometer	pcs									
26	Miscellaneous										
	Subtotal-II										
III	**Labours**										
26	Skilled Labour	No.									
27	Unskilled Labour	No.									
	Subtotal III										
	Total										
	Overhead, Guarantee and After-sales Services(20%)										
	Total Cost of Installation										