Practising Dissemination of Biogas:

Promoting a Low-cost Model and Developing a Manual

Submitted in partial fulfilment of the requirements
of the degree of

M. Tech. in Technology and Development

By

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चला पेटवू गॅस तिथे
जिथे अजूनही धुमसे चूल ।।
अन्न शिजवण्या वृक्ष तोडतो,
तुम्ही आम्ही हतबल आज ।
बहुगुणी त्या शेणखताची,
क्षणात जाळुनी करतो राख ।।
या साऱ्याला उत्तर शोधू
विज्ञानाची कास धरू......... ।।1।।
वृक्ष तोडता जमीन धुपते,
नदी पात्रातून गाळ भरे ।
वर्षामागुनी वर्षे जाता
बंद होती सर्व झरे ।।
जलस्त्रोतांचे पुनरुज्जीवन
आपण करूया सर्व मिळून......... ।।2।।
स्वयंपाकामध्ये येई सुलभता,
निळ्या ज्योतीने नवल घडे ।
गृहस्वामिनी सुखी जाहता,
आनंदाचे पडती सडे ।
सुखी कुटुम्ब संपन्न देश हे
चित्र भूवरी येई फिरून......... ।।3।।

- डॉ. हर्षदा प्रसाद देवधर

To understand a system, disturb it.

Dissertation Approval

This is to certify that the M. Tech. Dissertation report titled "**Practising Dissemination of Biogas: Promoting a Low-cost Model and Developing a Manual**" by **Yatin RS Diwakar** (10335001) is approved for the degree of **M. Tech. in Technology and Development** in the Centre for Technology Alternatives for Rural Areas at Indian Institute of Technology, Bombay.

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Abstract

This report records the work done for dissemination of biogas over a period of six months. Promotion of low cost Ferrocement-based Deenbandhu biogas plant was done at two places with different agencies. One was with villagers in Manyali, Yavatmal. The other was with district Agriculture Development Office in Thane. For cost reduction, use of Bamboo reinforcement for dome and Sandwich Bentonite liner for base in Ferrocement-based Deenbandhu biogas plant was explored. Within cost reduction, two different approaches were used. One was to promote alternate materials in the Ferrocement-based Deenbandhu biogas plant by using Bamboo and Bentonite and the other was of design modifications in the KVIC floating drum plant to make an assemble-on-site drum. As two deliverables, a users' manual in Marathi for Ferrocement based biogas plant and a design for assemble-on-site drum of KVIC floating drum model have been made. Help of Bhagirath Gramvikas Pratishthan, an agency working in biogas dissemination in Sindhudurg, was taken in the promotion and the cost reduction attempts. The results of all these attempts and the lessons from this hands-on experience at practising dissemination of biogas are detailed in this report.

Keywords

Bamboo, Bentonite, Biogas, dissemination, Ferrocement-based Deenbandhu biogas plant, KVIC floating drum, users' manual,

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Nomenclature

ADO	Agriculture Development Office
FDBP	Ferrocement-based Deenbandhu biogas plant
FRP	Fibre Reinforced Plant
INSEDA	The Integrated Sustainable Energy and Ecological Development Association
MNRE	Ministry of New and Renewable Energy
NABARD	National Bank for Agriculture and Rural Development
NBMMP	National Biogas and Manure Management Program
NPBD	National Program for Biogas Development

Chapter 1 Introduction

"If you want to learn to swim, jump into the water. On dry land, no frame of mind is ever going to help you." – Bruce Lee (27 November, 1940 - 20 July, 1973).

1.1 Background

The stage one of M.Tech. project, between August and December 2011, was an attempt at understanding 'how can the dissemination efforts of an appropriate technology by a change agency be improved?' An overview of dissemination theory, stages in change adoption, adopter classes and barriers to dissemination was taken in the literature review to understand the process of technology dissemination. Biogas technology was chosen as the specific instance of technology and its dissemination by four agencies in Western Maharashtra was studied. 'Click factors' were identified from these discussions and literature review, that affect dissemination efforts of biogas (Diwakar, 2011).

Some crucial factors for successful biogas dissemination are:

- *Advertising* and educating people
- *Training* local masons for technical perfection in construction
- *Women empowerment* and participation
- *Institutional arrangements* for loans, installations and maintenance & repair service
- *Management* skills of the agency

It was decided that the knowledge accumulated during this study should be applied to improve biogas dissemination. Work on one specific aspect, i.e. the training of biogas technicians was proposed for second stage of M. Tech. research. The plan was to train new masons who could also take care of the institutional arrangements, advertisement and to inculcate some management skills in them. In this context, the exploration in stage two started, but quickly diverged to a new set of possibilities, which were set as the objectives for this study.

1.2 Objectives of the Present Study

With this background, an experiential approach was chosen. Study of dissemination theory in stage one project implies that successful dissemination depends upon:

- Engagement with the community,
- Improving acceptability by providing allied services,
- Modifying existing technology to overcome on-field challenges,
- Cost reduction for cost sensitive individuals and
- Simplifying repair and maintenance for ease of users.

It was decided to attempt few of these and thus, the objectives of stage two were set as:

1. ***Promote low-cost Ferrocement-based Deenbandhu Biogas Plant***
    a. In Manyali, Yavatmal, to establish basic set-up as requested by an agency
    b. In Thane District Agriculture Development Office, as a cost reduction measure
2. ***Explore cost reduction*** in existing Ferrocement-based Deenbandhu Biogas Plant using
    a. Bentonite material for bottom
    b. Bamboo frame for dome
3. ***Propose a modified drum*** for KVIC floating drum type biogas plant.
4. ***Develop a biogas manual:*** users' manual, mason's field-guide and guidelines for change agency, in Marathi, for Ferrocement-based Deenbandhu biogas plant.

Success was achieved to some extent in each objective, as documented in this report.

1.3 Outline of the Report

The experiences while achieving these objectives are described in the subsequent chapters. The second chapter is about the two attempts made for promotion of Ferrocement-based Deenbandhu biogas plant (FDBP) and insights gained from these. In the third chapter, the process that went into writing the FDBP users' manual is given. In the next chapter, the three design modifications, involving collaboration with different agencies are described. In the final chapter, lessons learnt from this project and some comments are made.

Chapter 2 Promoting Low-cost Biogas Model

“The process of disseminating the technology has to be a multi-institutional effort involving development agencies, technologists, financial institutions and rural users”

- Amulya K N Reddy (Reddy, 1989)

This chapter describes the attempts at dissemination of the low-cost Ferrocement-based Deenbandhu Biogas Plant (FDBP). In the two attempts, one in Manyali, Yavatmal and second with Thane District Agriculture Development Office (ADO), after initial positive response, low priority to adopt changes left biogas on a backburner (pun intended). The justification of FDBP as the low-cost model, experience with people in Manyali and interactions with Thane officials are detailed in this chapter.

2.1 Choice of Low-cost Model

This section describes why FDBP was chosen as the low-cost model for promotion. The following household level biogas plant models are approved for promotion by the Ministry of New and Renewable Energy, under the National Biogas and Manure Management Program (NBMMP) (MNRE, 2011)**:**

Table 2.1: Models of household level biogas plants approved for promotion

	Model Type	**Capacity**
(a)	KVIC Floating Drum Type Biogas Plants	1 to 10 cu.m.
(c)	KVIC Type Biogas Plant with Fibre Glass Reinforced Plastic Gas holder	1 to 10 cu.m.
(d)	Deenbandhu Model (Brick masonry, in-situ Ferrocement, Prefabricated HDPE material based or Solid-State Deenbandhu design plant	1 to 6 cu.m.
(e)	Pre-fabricated (i) RCC fixed dome model (ii) Shakti-Surbhi FRP based floating drum (iii) Sintex make plastic based floating drum	2 & 3 cu.m.
(f)	'Flexi' model Bag digester type plant made of rubberised nylon fabric	1 to 6 cu.m.

Although Janata biogas model is not listed here, it was promoted in the 80's with wide-spread masons' training under the NPBD (Myles, 2001). So, there are many masons today who can build Janata type plants and thus that model is still built under government program.

The history of biogas in India shows a gradual shift over the decades from KVIC floating drum model to Janata model with centring to Janata model without centring to Deenbandhu model (Myles, 2001). Today, agencies like Vivekananda Kendra, Kanyakumari; Bhagirath Gramvikas Pratishthan, Sindhudurg; INSEDA, Kerala; etc. are promoting the Ferrocement-based Deenbandhu Biogas Plant which achieves a 40% cost reduction over the Brick masonry Deenbandhu plant (INSEDA, 2008). Each successive model further reduced the cost of material, time of construction and expertise needed for flawless construction and provided greater opportunities to the village artisans. This culminated with the development of the *Shramik Bandhu* Bamboo reinforced Cement Mortar plant in 1996 (Myles, 2007).

Although developed 16 years ago, apprehension for using bamboo in construction, non-availability of uniform bamboo of correct age, lost bamboo-working skills in many parts of the country, etc. have prevented this model from spreading. As seen in Table 2.1, it is not approved for promotion under NBMMP. So the first step is to convert from brick masonry, still practised widely, to FDBP and attain immediate cost reduction with an accepted technology. The next step is to introduce Bamboo-reinforced model, while developing necessary bamboo-work skills and policy advocacy to promote this model under NBMMP.

The flexi-bag type model manufactured by Swastik Plastics, Pune is approved by MNRE. But the life of these rubberized nylon fabric digester plants is short (4-5 years) and it is a prefabricated model which is to be installed on site (Myles, 2007). As this has little employment opportunities for the local artisans and procurement needs to be done centrally, agencies working for social development through biogas dissemination are not keen on adopting this. On site construction which offers job to masons and local plumbers is favoured over pre-fabricated models which are brought and installed by company representatives.

Considering these factors, it was realised that Ferrocement-based Deenbandhu biogas plant is the low cost model which can be rapidly and acceptably disseminated today.

2.2 Experience at Manyali, Yavatmal

In Yavatmal District, about 25 km from Umarkhed, a taluka place, there is a small village, Manyali. Till March 2012, it was connected to the nearest tar-road by a dirt track. Till previous summer, there was an acute water shortage in the summer months as all the 4 wells within village would dry up. The villagers had developed an attitude of apathy and helplessness, as in most other villages. This was changed by Mr Santosh Gawale, a Nirman fellow[1], working for all round development of the village. Over the past two years, he brought the people together, organised meetings, interacted with government officials and local leaders and implemented some schemes leading to development of the village. An agency, christened *Nirmitee Bahu-uddeshiya Sanstha, Manyali* was established and various activities are undertaken through it. With the village slowly uniting and mind-set of people changing, there was an opportunity for rapid development. To reduce villagers' dependency on firewood for cooking fuel, Mr Gawale wanted to build biogas plants and approached the author for inputs. Initial discussions led to a plan to train few masons to build biogas plants and establish a set-up for overcome administrative hassles involved in obtaining subsidy, loans, and permissions; provide institutional facilities of construction, repair, maintenance, etc.

2.2.1 About Manyali village

Manyali is a small village made up of two habitations- Manyali and Manyali tanda. It has about 240 house-holds altogether, split roughly equally between the two habitations. Village is surrounded by forest land on east and north side, which is the source of fuelwood and fodder for the domestic animals in the village. This covers over 900 hectares of total 1555 hectare land of the village. Within the main habitation area, Manyali, there are 4-5 wells that are dry between March and June every year. Last year, a new well was dug next to a seasonal stream which can provide water year round for domestic purposes. The arrangement of houses in the village is compact, with virtually no space between neighbouring houses. The village has shops, PDS centre, Anganwadi, one primary and one secondary school.

[1] http://nirman.mkcl.org/nirmanfellowships.htm

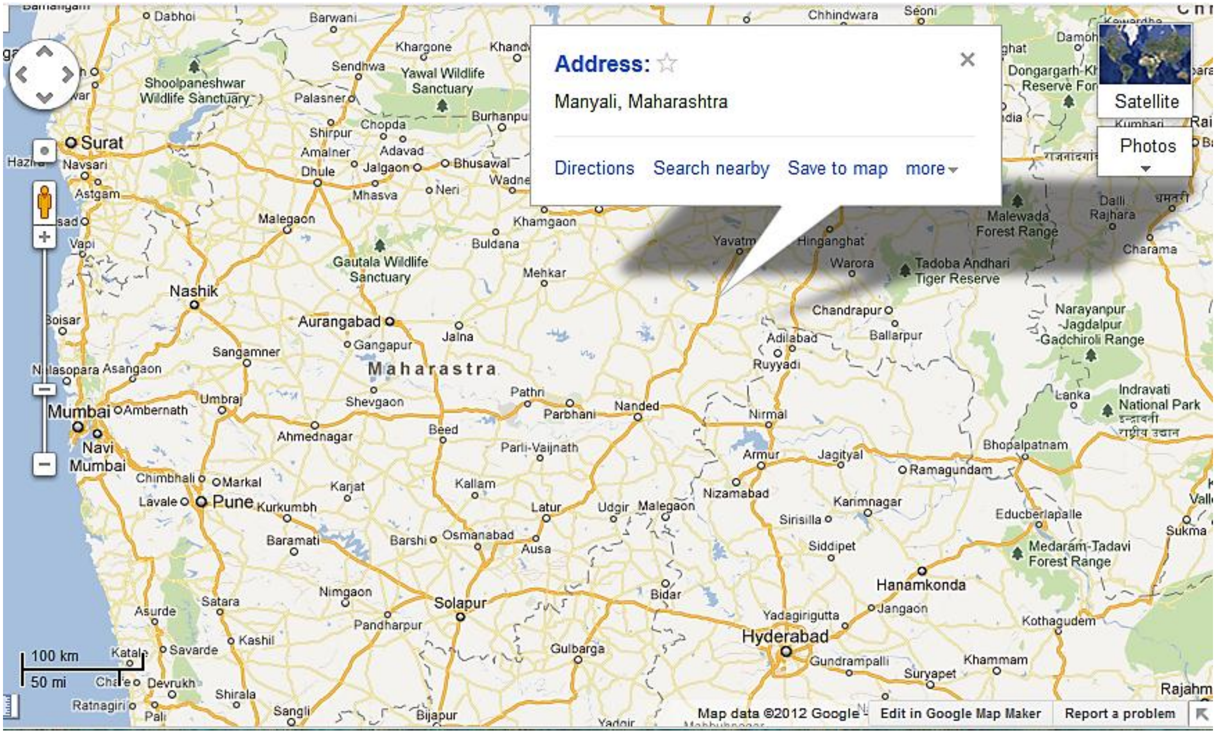

Figure 2.1: Location of Manyali, Yavatmal

Cotton is the main crop and Soybean is the second crop. With recent increase in number of farm wells, some farmers are taking a summer crop as well. Digging farm-wells under the *Million Wells Scheme* was one of the activities taken up by Mr Gawale, to gain people's confidence. With irrigation available, farmers can now grow fodder crops and are able to rear animals for dairy. Through Mr Gawale's efforts, a dairy collection centre is being established in the village and hybrid cows and buffaloes have been bought by some families.

With access to dung and water, the village now has many families which can build biogas plants. For this purpose, Mr Gawali contacted the author, for inputs. After the initial meeting, a visit was planned to Manyali in January 2012. During visit, while interacting with villagers, it was felt that the village has a good potential for building biogas plants.

2.2.2 Favourable conditions for biogas dissemination

In December 2011, three Janata biogas plants were built in the village through Panchayat Samiti. The cost of these 2 cu.m. plants was around Rs 20,000 each (including subsidy of Rs 8000). Seeing the successful operation of these, villagers were ready to build biogas plants, but at a lower cost. Unfortunately there are only two masons in the entire Umarkhed taluka who are trained to build biogas plants, so farmers have to wait their turn.

Thus, this village was a readymade site for biogas dissemination. The *backward linkages* were taken care of – village houses had water supply for the entire year and most households have 3-4 animals. One of the *forward linkages* – connection to dairy to make rearing animals profitable was also being established. Three plants built recently served as *demo plants* and their success would increase interest of others in biogas. Also, there was a change agent with a team of voluntary workers in the village. The village had met few of the necessary pre-requisites for biogas dissemination, as mentioned in the stage one report section 3.3 (Diwakar, 2011), and was ready for building more biogas plants.

With positive response from villagers during discussions, it was planned to send some local masons to Bhagirath Gramvikas Pratishthan, Zarap for training to build FDBPs. Access to easy loans for biogas constructions was explored through the district lead bank. In the bank though, it was observed that no one had idea about the paperwork needed for providing loans for biogas. According to one employee, it was same as needed for building a house. The NABRD DDO too didn't have any idea. One reason for this lack of knowledge can be the very low target to this region (on an average, during 2007-2010, 100 plants have been built every year (Yavatmal ZP, 2010)) owing to low potential (based on cattle availability).

When the local MLA was approached, he listened but was more concerned about the upcoming elections. The visit was in January, just before the local Zilla Parishad and Panchayat Samiti elections. Due to this, no officials in Tehsildar office were available and the details of biogas program in the taluka could not be taken. Tentatively, early April was fixed for training. Five masons were identified and funds were being explored for the training.

2.2.3 Roadblock

In 2011, the monsoon was poor and the cotton crop failed to earn any profit. Even the soybean crop grown in *Rabbi* was not very successful. On the other hand, due to increased leverage with the taluka officials through a change agent and volunteers had brought *Indira Awaas Yojana* to 42(of ~120) households and thus significant part of the village was being re-constructed. A payment pre-requisite under the scheme is construction of personal toilets. These, along with the investments on farm wells (under the *Million Wells Scheme*) left villagers cash-strapped and though they were ready to build biogas plants, no one could afford to build this summer. The masons were busy with house constructions and gave importance to current wage earning over possible income, by building biogas plants, in future. Moreover, now that water was available in the village during summer, people wanted better access to it and were interested in a piped water supply scheme. People who bought hybrid milch animals had to repay that loan before they could take another loan for biogas.

Figure 2.2: House construction going on under the IAY

All these factors worked against biogas construction this year and thus the training too was shelved. It is expected that in a couple of years though, if the existing biogas plants remain functional, more villagers will demand for biogas plants. In hopes of this happening, a direct communication between Mr Gawale and Dr Deodhar of Bhagirath Pratishthan was started, as the author will not be able to mediate in future.

This is a case where the interested user group existed, resources were available, local volunteers were enthusiastic but dissemination had to be delayed due to other factors which are out of our control. There is also the revolutionary transition associated with decades of development being compressed over a short duration. The village is changing at a frantic pace and life-style and daily routine of villagers is changing. Once these changes settle in, people will be ready to take more and sustain them. It was an issue of priority, which has to be ultimately sorted by the villagers themselves.

2.3 Thane

While Manyali was a case where there was a demand from change makers and village community, in Thane, the District Agriculture Development Office (ADO) had approached CTARA for assistance in cost reduction of biogas plants constructed by them. Though the initial plan was to conduct Research and Development to lower the cost while maintaining properties, it was soon realised that a substantive saving could be done if a shift from Brick based model to Ferrocement-based Deenbandhu biogas plant (FDBP) was made.

2.3.1 Problem statement

Following a meeting with the Thane district officials for potential tie-ups in November 2011, CTARA received a communication from the ADO for assistance in reducing the cost of the 4 cu.m. biogas plants constructed in Thane district under the allotted target of building roughly 300 biogas plants every year (see Appendix I). The cost of this plant is estimated at Rs 38,808. With this information, the initial problem statement was to modify the method of construction to use less material and less support structure for the big dome size. This would involve civil engineering knowledge and as the author lacks this, taking assistance from civil engineering students within IITB was being attempted.

Meanwhile, during a meeting with Thane agriculture officials, it was realised that the price is not for a 4 cu.m. capacity, as mentioned in the letter, but for a 2 cu.m. capacity biogas plant. The MNRE estimate for a 2 cu.m. plant is Rs 16,200 (MNRE, 2011) which is less than half the cost in Thane. So, instead of working on a cost reduction in the existing technology, it was realised that immediate benefits could be had by simply replacing the brick masonry biogas plants with Ferrocement-based Deenbandhu biogas plants. The justification for the same is provided in the next section

2.3.2 Cost of Biogas plants in Thane

Table 2.2 gives the costing for 2 cu.m. biogas plants built in Thane district, as given in document shared by Thane Agriculture office.

Table 2.2: Estimate for 2 cu.m. Janata Biogas Plant by Thane ADO

Material	**Amount**	**Rate in Rs**	**Cost in Rs**
Sand	2 brass (brass = 100 cu.ft.)	6000/brass	12000
Bricks	2000	4.5/brick	9000
Cement 50 kg bag	17 bags (each of 50 kg)	324/bag	5508
Grit	1 brass	900/brass	900
Colour	2 litre	250/litre	500
GI Pipe			
Gate valve			
P.V.C. Pipe	As per distance		3500
Gas burner			
Digging labour			2000
Skilled mason	1, 4 days	3000/plant	3000
Unskilled mason	4 masons, 3 days	200/labourer/day	2400
TOTAL			**38,808**

It can be seen that the major cost is of sand, bricks and labour charges for digging and unskilled work (Rs 25,400 of Rs 38,808). Thus cost is high due to both the resources used and the process which necessitates five (4+1) masons working for at least 3 days. This high cost is cited as a reason for farmers not building biogas plants in Thane, by the ADO.

In contrast, the cost for FDBP in Sindhudurg is much lower, as bricks are replaced by mild steel and chicken mesh, amount of sand and cement needed decreases and a simpler process eliminates the need of unskilled masons. Table 2.3 is the cost estimate from Bhagirath Pratishthan for the financial year 2010-11.

Table 2.3: Estimate for 2 cu.m .FDBP by Bhagirath Pratishthan

Material	**Quantity**	**Rate in Rs**	**Cost in Rs**
Cement	14 bags	270/bag	3780
Sand	1 brass	1750/brass	1750
6 mm steel	40 kg	45/kg	1800
Chicken Mesh	100 ft. * 3 rolls	550/roll	1650
Winding Wire	1 kg	70/kg	70
Stones	3 bullock carts	350/cart	1000
Grit	1 brass	950/brass	950
Dome pipe		150	0150
Inlet pipe		300	0300
Waterproof powder	1 kg	75/kg	0075
Gate valve		160	0160
GI Reducer		20	0020
Metal hose nipple		25	0025
Gas transport pipe	10 meter	18/meter	0180
Teflon tape	1	25	0025
Gasket		20	0020
White cement	2 kg	25/kg	0050
Fevicol	200 gm.	50/200 gm	0050
Rough paper	1 kg	5/kg	0005
Hose clip		16	0016
Belmast		125	0125
Fastener packet		25	0025
Wire for pipe		150	0150
Gas burner		1000/unit	1000
Mason		3300/ plant	3300
TOTAL			**18,656**

The material costs are not the same in Thane and Sindhudurg. So using the rates prevalent in Thane, costing for the FDBP has been calculated below. This shows that there is some obvious reduction in cost. The saving are shown in terms of difference in total estimates, using higher end and lower end costs, to give idea over a range.

Table 2.4: Estimate of 2 cu.m. FDBP in Thane

Material	Quantity	Rate (Rate in estimates) Rs	Higher end Cost in Rs	Lower end cost in Rs
Cement	14 bags	350 (324)/bag	4900	4536
Sand	1 brass	7000 (6000)/brass	7000	6000
6 mm steel	40 kg	75 (45)/kg	3000	2400
Chicken Mesh	100 ft * 3 rolls	700 (550)/roll	2100	2100
Winding Wire	1 kg	100 (70)/kg	0100	0100
Stones	3 carts	700 (350)/cart	2100	1500
Grit	1 brass	1400 (900)/brass	1400	0900
Dome pipe		(150)	0200	0150
Inlet pipe		(300)	0400	0300
Waterproof powder	1 kg	150 (75)/kg	0150	0100
Gate valve		(160)	0200	0160
GI Reducer		(20)	0040	0020
Metal hose nipple		(25)	0050	0025
Gas transport pipe	10 m	(18)/m	0250	0250
Teflon tape	1	(25)	0025	0025
Gasket		40 (20)	0040	0020
White cement	2 kg	50 (25)/kg	0100	0050
Fevicol	200 gm	50 (50)/200 gm	0050	0050
Rough paper	1 kg	10 (5)/kg	0010	0007
Hose clip		20 (16)	020	0020
Belmest		200 (125)	0200	0150
Fastner packet		40 (25)	0040	0030
Wire for pipe		200 (150)	0200	0200
Gas burner		1200 (1000)/unit	1200	1000
Mason		3500 (3000)/plant	3500	3000
excavation		2500 (2000)/plant	2500	0000
Untrained labour	1, 3 days	300 (200)/day	900	600
TOTAL			**30675=31000**	**23693=24000**
Savings	**(From 38,808)**		**8133 (20%)**	**15,115 (38%)**

Here, both the higher end and the lower end costs are given to show the range of savings. Since the construction is simple, there is no need of hiring unskilled mason; one/two helpers from the household to mix concrete and assist the mason as and when needed are enough. The pit required is not deep and the family can dig it by itself, saving money. Thus, a maximum saving of Rs 15,000 or a minimum of Rs 8,000 can be made. So, 20-40% savings over the current costs can be made making biogas affordable to more farmers.

Assuming a saving of Rs 8900 per 2 cu.m. plant (based on material reduction only) and an annual target of 300 plants for Thane district, the total saving is Rs 26,70,000. FDBP saves 2000 units of brick per plant, which equals six lakh units p.a., which will save tonnes of top soil, necessary for productive agriculture and energy used (over 2,400 GJ)[2]. This plant can be constructed in less time than a brick plant, there is lesser chance of cracks in concrete than in brick work, and construction quality doesn't depend on quality of bricks or on whether they are soaked previously. Considering all this, the author convinced the Thane Agriculture Development officials that a shift from current Janata plant to FDBP must be done in Thane.

2.3.3 Current status

After the first meeting, the costing for FDBP was e-mailed to Thane officials. In spite of a warm response during the meeting, there was no reply to this communication. When the author contacted them back, some excuse was given for not responding. In the next meeting, when the topic of training of masons came up, the officials expressed their wish of holding the training in Thane. Since the training was to be provided by Bhagirath Pratishthan and its masons, their availability was a must. Due to over 500 plants to be built in this summer, no masons were free to come to Thane for training. Talks couldn't proceed further.

Then, due to the financial year ending, nothing moved ahead in the month of March. After that, a different approach was planned. It was already clear that no training could be held in the period of this project. So, only an attempt to convince Thane officials about the benefit of Ferrocement-based Deenbandhu biogas plant was done. This was successful when the above costing was kept in front of them with calculations showing the total savings per

[2] Average brick kiln uses 3.2-5 GJ per 1000 bricks (http://www.vsbkindia.org/vsbkhow.htm)

year in the entire district. But even after this, there was no response and later on, efforts were stopped to further interact when phone calls and emails were not answered.

2.4 Insights

"If designer cannot meet all the user's objectives simultaneously but only in stages, then it is imperative that the designer's sequence must be in the same as the user's priorities -- otherwise, the implementation may run into problems" (Reddy, 1989). This is equally applicable to choice of problem. If people prioritise different problems than what the change agent wishes to solve, she must rethink her strategy rather than convincing people otherwise.

In Manyali, condition was right for biogas dissemination and it was the logical next step in the development of the village, but the villagers were not ready yet. Their priorities were a better home, water in house and roads. Though they understood the importance and benefits of biogas, realised the time savings in fetching firewood, and accepted that the dung currently heaped for a year will be used productively, their priorities were different. Returning loans came first over increasing saving through more investment/loans. A change agent can't predict the ground reality and thus should not go with a single point agenda, but try to satisfy the priorities and perceived problems of the people. People, in turn, will one day be ready for the change envisioned by the change agent.

In Thane, the interaction was with government employees. It was necessary to present them with right facts to convince them to make a decision. But as an outsider, the author was at a disadvantage. Changing promoted model is a policy change. As it involves investment, forces to move away from set practices and discomforts the related officer, there is an inherent resistance to change. As the proponent is an outsider, who has not yet won confidence, doesn't interact on a daily basis and will move away after a few months, it is hard to take decisions relying on him. Also, there is a tendency to push such policy decisions to higher authorities. Even though this was realised, if a direct attempt had been made to interact with the higher authorities, it would have made the officers in-charge hostile and any benefits would come to naught. So, while in Manyali, the priorities were different, in Thane, there was a problem of trusting an outsider and making policy decisions.

Chapter 3 Developing Users' Manual for FDBP

If everything else fails, read the instructions!

In stage one MTP, while studying factors leading to successful use of biogas plants, it was realised that a users' manual is must. The need is of a manual which the user can refer to at every stage: construction of plant, its daily operation, maintenance and eventual repairs. As manuals exist for various biogas plants, it was felt that these could be adapted and a small manual in Marathi for users of Ferrocement-based Deenbandhu biogas plant (FDBP) be made.

3.1 Need of the manual

Agencies involved in biogas dissemination stress on the need of print material which will be left with the household (Diwakar, 2011). This would be a guide on how to use the biogas plant effectively and serve as first help in case of any problem. A short field manual for masons would serve as a checklist for best practices and ready reference when in doubt. A third part, for any change agency which wants to take up the work of biogas dissemination in its area was also thought to be useful. Moreover, these three parts serve different purpose and are independent; three short manuals, each targeted for different audience, were envisioned.

Extension Manual

Any agency interested in biogas dissemination should first visit other successful agencies involved in this field and learn from them instead of reinventing the proverbial wheel. Even then, a lot of paper work, advertisement efforts, rule of thumbs, etc. should be made easily accessible to reduce efforts spent in creating the formats. This can be achieved through an extension manual, assisting in replication of the process of dissemination.

Masons' field manual

Once a new agency starts working, it will train masons for biogas construction. They will need to memorise the measurements, important steps, best practices, etc. Till then, they will need some leaflet with them having all these printed

Users' manual

A major step towards success in dissemination is institutionalisation. A product spread through market mechanism has auxiliary material bundled with it; all accessories are made available at one place and there is some documentation. This aides in improving adoption by people as it is now easier for them to understand. Taking a similar approach for biogas, a good users' manual is necessary as documentation. This manual should be easy to comprehend and be precise. This would provide basic information about operation, maintenance and repairing to the users along with the do's and don'ts.

3.1.2 Reducing scope

While training of masons from Thane and Manyali was to take place at Bhagirath Gramvikas Pratishthan, it would have been easy to write the masons' manual. When it was realised that the training won't take place during the course of this project, writing a manual useful for masons became difficult as the author has no experience in constructing biogas plants. Interacting with masons associated with Bhagirath Gramvikas Pratishthan while they worked gave some insights, but these were the best masons with the agency and they were confident that masons can and should work without any manual. If at all, a mason needs anything, it is the dimensions card, which is already provided.

Cancellation of the training of masons reduced on-field interaction at Bhagirath and complete information for the extension manual could not be gathered. It was realised that using inputs from a single agency will not do justice to the manual. As the hands-on attempt at extension in Manyali had been stopped, a clear idea of needs of a new agency could not be gained. Thus, these two manuals were not written but the third manual meant for users was completed with the help of literature review and interaction with experts. The process involved in creation of the users' manual is described in this chapter.

3.2 Review of Existing manuals

A literature review was the first step towards writing the manual. For this, some of the widely circulated and used manuals were referred to. The motive of this survey was to

- Decide contents of the manual
- Arrangement of content
- Presentation
- Judge readability and ease of access to necessary information

The following manuals were referred:

Deenbandhu biogas plant manual, Bhagirath Pratishthan, Zarap

This is a recent Marathi manual for brick based Deenbandhu Biogas plant by Bhagirath Pratishthan (Satelkar, 2004), dealing with history, need, benefit to poor farmers, information about steps before construction, basic repair and maintenance, drawings and working of Deenbandhu biogas plant. The dimensions of the manual are small; it has 56 pages and many drawings. Though it has numerous typographical errors, it is a good advertisement for biogas with lot of information for average users. In spite of this, it is not used as expected. It was given to biogas plant users after construction, but none reported having benefited from it.

The manual is hard to use, probably because there is far more information than needed for operating a biogas plant and the content is not well ordered. On the other hand, the division of maintenance into daily, weekly, monthly, yearly and 5 yearly activities is a useful feature.

User Manual of biogas Plants, Belize Biogas extension program

This is a short manual (Klatte, 1992), with a table of contents. It has a significant section on uses of slurry and biogas. While these sections are useful in the long run, average farmers will dump the slurry in their field and use gas for cooking at home. It includes a useful section on potential malfunctions and repair situations. Only seven figures are incorporated, but except for two none aide the understanding of the text. This manual has multiple sections; each with a title, making it is easy to search necessary information.

Instructions for users of Syntex Deenbandhu Type Bio Gas Plant

This is a short manual written for the Syntex prefabricated biogas plant (Syntex, 2010). After a short introduction, this directly deals with the installation and usage instructions, followed by common maintenance issues, Do’s and Don’ts, making it short and precise.

End User Biogas Manual by IT Power Eastern Africa

In line with above two manuals, this too is short with only 12 pages (W N Musungu, 2008). Except for two sections out of six, it mostly deals with benefits of biogas and its uses, different sources of raw material. The necessary information passed in this short manual is concentrated at the centre and the end of the booklet and leaves many aspects untouched.

Kenbim Biogas User Manual

This manual focuses on general operation, feeding, maintenance and basic trouble-shooting (KENDBIP, 2010). The trouble shooting is divided into problem, cause and solution.

All these manuals gave material and content. But arranging the material was still a question as this is to be a users' manual, for users who have built a biogas plant, rather than a prescription for people to build biogas plants.

3.2.2 Mobile manuals

The current Minister of Rural Development and Minister (Additional Charge) of the Ministry of Drinking Water and Sanitation, Mr Jairam Ramesh commented in a recent event that Indian rural women demand mobile phones and not toilets (Indian Express, 2012). He compared basic facilities like sanitation to a market driven technology. The author feels that this was a comparison between an institutionalised technology promoted by market forces and a rural technology being promoted by developmental agencies. The same is the case with biogas and mobile phones. With this in mind, a few mobile manuals[3] were referred to.

The common feature in all of these was – small table of contents, labelled diagram of the phone, installation/setup, operation of various features, basic trouble-shooting and some contact information. None of them described how good the phone was, its benefits, how to procure one or such other pre-sales advertisement details.

[3] The manuals referred to were of Micromax A75, LG GT-540 and Motorolla Fire.

3.2.3 Format for new manual

The analysis of these manuals gave few thumb-rules which were later put into the writing of this manual. The size of the manual was decided to be A5, single column text, with a type 10-12 font for main body. On the first page, a labelled diagram of the Deenbandhu plant would be put, to identify easily the various parts, by the names they will be referred to in the text. For the reasons of cost, a black and white manual was found to be adequate. The text should follow the sequence: site identification-construction-installation/fitting-operation-maintenance-repairs, while highlighting major points. It was realised that most figures can be omitted, as people can easily read and comprehend. Also, figures take up space and distract from the important instructions if these are not summed up properly in the figures. A final checklist for daily, monthly and yearly maintenance, as in the earlier manual by Bhagirath Pratishthan, was felt useful and was to be put at the end of the manual.

3.3 Development of the manual

During visit to Bhagirath Pratishthan, the author interacted with the masons, biogas users, biogas technician and experts working with the organisation. Through interaction, an outline was made. The author of earlier manual, Mr Manohar Satelkar was very helpful and shared the various manuals he had with him and his own ideas about the users' specific manual. Using these, the main part of manual was written and sent to Dr Deodhar. Combining inputs from Mr Satelkar and the author, a first version of users' manual is being prepared for circulation with new users. Appendix II contains the draft of the main body of the manual. This draft was given to Bhagirath Pratishthan who gave it for Desktop Publishing. The printed manual is expected to be ready by June end.

Chapter 4 Cost Reduction in Biogas Plants

"Maybe Adidas can start with a mission statement, something like this: Nobody in the world should go without shoes. And as a shoemaker we make sure that we produce shoes affordable to the poorest people."

"That's a big ambition!"

"But Adidas is a big company! What's your problem? Why do you want a small ambition?"

"How do we go about it?"

"Well, make up your mind, that's all. If you make up your mind, it will happen!"

(Mohommad Yunus' dialogue with Adidas CEO, narrated by him in IIT Bombay in an interaction on Social Business on 13th February, 2012[4]

An aspect of dissemination is reducing cost of the technology to make it affordable to the first cost sensitive individuals. For this, Research and Development is needed to reduce cost by either changing design, replacing material or simplifying manufacturing process. In household biogas technology, this constant R&D has led to development of new, efficient and cheaper models (see Section 2.1). Still, the low-cost model promoted in Maharashtra, the Ferrocement-based Deenbandhu biogas plant (FDBP) costs above Rs. 16,200 for 2 cu.m (see section 2.3.2). While subsidy and loan facilities will reduce the first-cost for the end user, there can be further reduction in the basic cost of the plant.

Continuing the analogy with mobiles from section 3.2.2, Dr Deodhar of Bhagirath Gramvikas Pratishthan asks, in the same spirit as Prof Md. Yunus, "If mobiles can be made available for Rs One thousand, then why cannot we bring down the cost of biogas plants?" In case of biogas plant there is another philosophy, alluded to in section 2.1, of giving maximum employment to local artisans. Combining this with Gandhiji's mandate for a self-sustainable village using local resources, the question is, how well can we replace different components of the existing biogas plant model with low cost local alternatives?

[4] (Samhita, 2012) and (ElonUniversityNews, 2012)

Dr Amulya Reddy says, “Rural technologies are neither trivial nor second-class because they invariably pose the extremely tough challenge of having to be ‘zero-cost’.” (Reddy, 1989). The same challenge is posed in cost reduction of biogas plant. For this, two approaches were attempted,

- Replacing costly material with locally available resource in FDBP and
- Changing design and construction process to reduce manufacturing and transport cost in KVIC floating drum plant.

4.1 Cost reduction opportunities in FDBP

“Traditional technologies must not be ignored as sources of innovation. Traditional technologies may have been optimal solutions in the past, but almost all of them are sub-optimal and inadequate today because of changed expectations, resource availability, materials and circumstances” (Reddy, 1989). Thus, sometimes traditional technologies can be apt, at others we have to use modern technologies to optimise cost and desired properties.

For 2 cu.m. FDBP, 40 kg of 6 mm mild steel is used. Most of this is for supporting the chicken mesh and maintaining the dome shape. As in Shramikbandhu Biogas plant, bamboo can be used to replace the steel bars. Chicken mesh can be replaced by bamboo mat. Keeping the design same as the current FDBP, material used can be replaced partially. While this is an example of using traditional technology of bamboo in construction, the next change is a modern technology, Sandwich Benotnite liner, coming up in construction industry for low-cost water proofing of large surfaces. Bentonite is a type of clay that is impermeable to water when wet. This can be used in the base of the biogas plants, reducing the need of sand, grit and cement. As Bentonite rate is much lower than that of cement, this will reduce costs.

4.1.1 Idea

While interacting with Dr Prasad Deodhar of Bhagirath Gramvikas Pratishthan, use of bamboo discussion was discussed. One trial plant using bamboo was built three years ago but further trials and adoption had not been done. This year though, another plant was built, using information from Vivekanand Kendra, Kanyakumari and knowledge of local artisans.

Partially replacing steel with bamboo in the dome can reduce expenditure by up to rupees two thousand. If cost of procuring, treating and cutting bamboo into required strips is lower than use of steel, it will be a cheaper, local alternative.

While discussing cost reduction options with Dr Satish Agnihotri, who disseminated biogas in Orissa in the 90's, information about Bentonite material was obtained. Use of Bentonite in the base of biogas plants was tried in those days with the help of Mr Vilas Gore of Geoscience Services and was demonstrated to be possible. After a gap of 20 years, it was decided to promote this innovation and try it out with the help of Bhagirath Pratishthan in the FDBP. Bentonite clay swells when it comes in contact with water. If it is filled between two layers of polypropylene or polyester fibre and used as the base of biogas plant, it will swell up and provide a waterproof layer. Since this reduces the efforts involved in construction, replaces a costly material, i.e., cement and provides a water-proof solution, it is expected to be a very useful innovation towards reducing the cost of the base of FDBP by up to two thirds.

4.1.2 Existing model

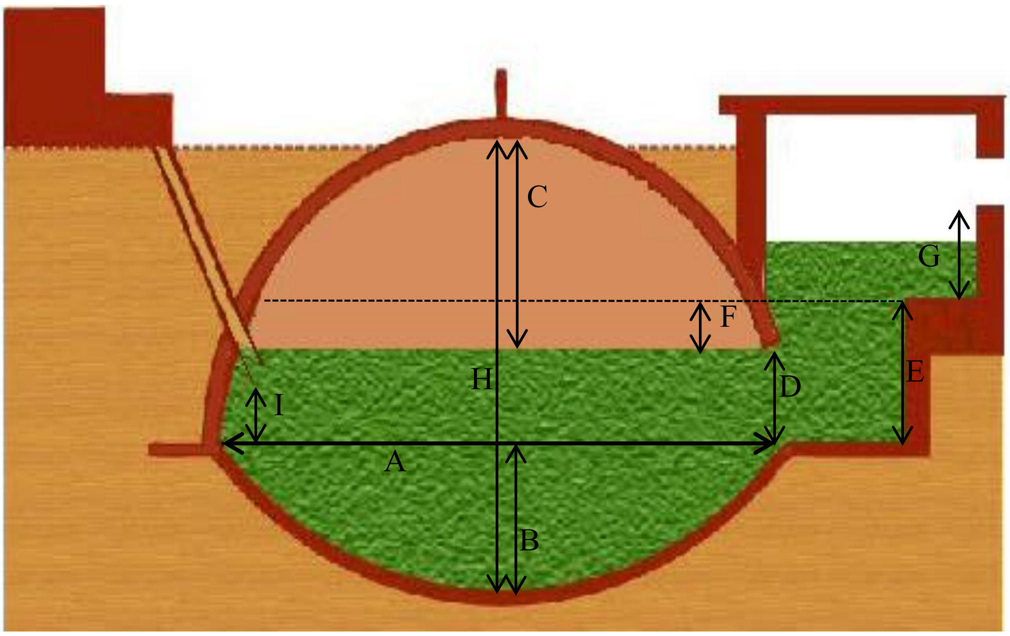

Figure 4.1: Schematic diagram of FDBP

This is a schematic diagram of the existing 2 cu.m. Ferrocement-based Deenbandhu biogas plant. The labels are related to the dimensions in Table 4.1.

Table 4.1: Dimensions of FDBP

Dimension	**Cm**	**Label**
Diameter/radius of base	255/128	A
Finished depth of base	58.5	B
Distance between dome upper inner surface and upper edge of window	73	C
Ht of window	47	D
Ht of outlet, first level	65	E
Gas store (first level ht – window ht)	18	F
First level outlet size	60*60	
Second level outlet size	160*160	
Slurry outflow opening ht	40	G
Distance between inner surface of dome and slurry outflow opening	15	
Inner ht of plant	178.5	H
Ht of inlet pipe from lower edge	25	I

The dome in this is made using 3 semi-circular arcs and 18 quarter arcs of steel. This is made rigid with 11 rings of steel. The Figure 4.2 shows the dome structure with chicken mesh tied to it.

Figure 4.2: Steel cage of the FDBP dome

While plastering this dome in-situ, a cardboard is held from the inside and concrete mix (sand + cement + water) is applied from the outside, as shown in Figure 4.3 (a). The concrete holds on to the chicken mesh as visible in Figure 4.3 (b)**Error! Reference source ot found.**. For next layer, no support is needed. One coat is given from inside and then plastering is done.

Figure 4.3: (a) First layer of concrete of FDBP (b) Concrete latched to chicken mesh

For the base, which is constructed first, digging is done before the mason comes to build plant. This is a cylindrical pit as shown in Figure 4.4 (a) and it is given the final shape under the supervision of the mason. Any mistake in the shape has to be repaired using extra stones or concrete mix, increasing the cost of the plant.

Figure 4.4: (a) Digging of pit for FDBP (b) Arranging stones for base

The finished pit is filled with stones for a strong foundation as in . Without this, the base of the plant can crack and move when the soil swells and contracts with changing moisture. After stones are arranged and packed, concrete is poured, with or without steel bars, depending on soil type (hard soil – no steel, soft soil with high water table – steel). If steel is used, it is laid in the pattern as in Figure 4.5 (a). This steel reinforces the concrete and is not connected to the upper dome, which is constructed independently.

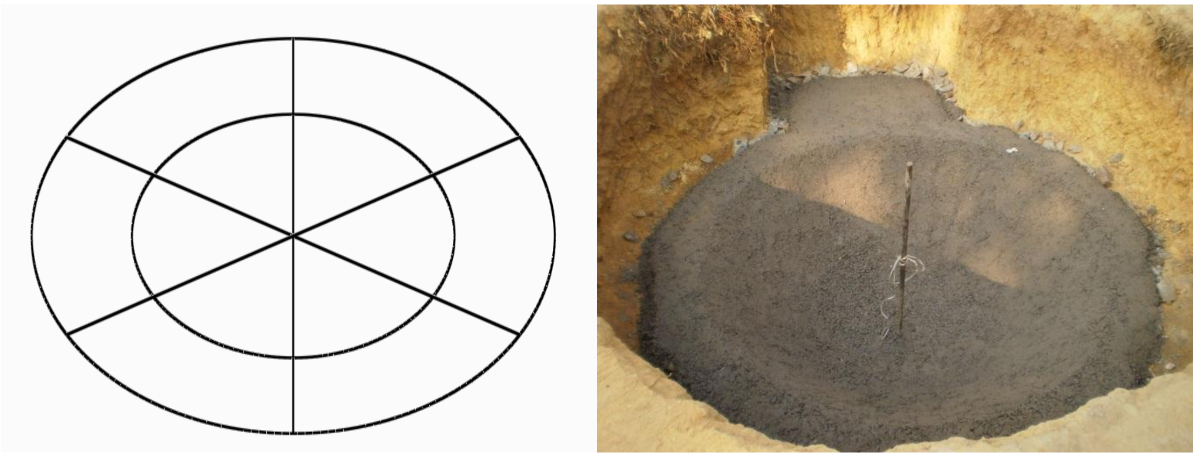

Figure 4.5: (a) Pattern of steel bars in base of FDBP (b) Completed base of FDBP

The final base looks as in Figure 4.5 (b). The dome cage is kept on this and then concrete is applied on it as described earlier. Finally, after entire construction is over, plastering is done together for the upper and lower half, as is water-proofing.

Costing for Base of FDBP

Using formula surface area = π (a^2+h^2), For 2 cu.m. FDBP a = 1.28 m, h = 0.59 m, the surface area of Base is = **6.24 m^2**

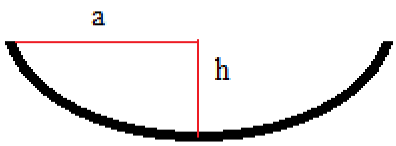

Figure 4.6: Calculating surface area

Material Requirement for this, as told by biogas technician of Bhagirath Pratishthan, is

Rabali/dabar/Stones - 3 bullock carts == **Rs 1200** (a)

+ 8kg steel == **Rs 600** (b)

+ concrete of 1.5 bags of cement = Rs 450 (cement) + Rs25/ghamela*20 ghamela (sand) + Rs20/ghamela*15ghamela (grit).

or Rs 450 + Rs 500 + Rs 300 == **Rs 1250** (c)

Thus total cost is (a+b+c) Rs 1200 + Rs 600 + Rs 1250 = **Rs 3050**

This is the higher estimate, as many farmers are able to procure sand and stones at very low cost/free from the surrounding streams and lands. Still, working with Rs 3050, the rate is **Rs 490/ sq.m.** for the base of Ferrocement based Deenbandhu biogas plant of 2 cu.m. capacity.

4.1.3 Modifications

Two modifications can be made in the FDBP as mentioned in section 4.1.1. Here, both the modifications are described in short.

Use of Bamboo in dome cage

3 semi-circular arcs and 18 quarter arcs make the (longitudinal). On this, 11 circular rings are tied (latitudinal). One attempt is replacing 18 arcs and 8 rings by bamboo. The others were made of steel to retain the shape and provide extra strength. This is a reduction in MS bars usage by about 60% or around 25 kg in a 2 cu.m. plant; about 1000-1500 Rs. A detailed analysis is needed to compare this saving with the amount spent on bamboo cutting, treatment and payment to the bamboo artisans.

Figure 4.7: Constructing dome with Bamboo frame

The bamboo arcs were removed later, as they do not attach properly to the concrete. The steel or bamboo arcs are just to support the mesh. Being dome shaped and made of ferrocement, it is supposedly strong enough to bear the pressures. Also, if bamboo weaved mats are used, they are thicker and stronger than chicken mesh and this would further reduce need of support. Such usage is seen in grain storage structures and walls.

Use of Bentonite in Base

In biogas plant, the function of base material/reinforcement is to avoid slurry seepage. For this, Bentonite clay + polypropylene fabric can be used. The weight of this fabric is below 200 g/sq.m., so transportation is cheap. This Innovation has been implemented by Vivekananda centre, Kanyakumari and in Orissa - in 1990s - successfully. Mr Vilas Gore has worked on this technology.

Initially, polypropylene or polyester can be tried, but eventually natural fabrics can be used. This can be a link to village economy and local resource utilisation. Fibre grass can be grown on wasteland and industry for fibre material production can be set in villages.

Bentonite clay is filled in between two fabric layers. Mines of this are in Kutch, Gujarat. Bentonite costs about Rs. 1-2/kg. It can be ordered in bulk and delivered directly in villages. This clay is waterproof – when filled in between layers of fabric, water can't seep across it. It expands on coming in contact with water and makes an impervious layer. As it is between two layers of fabric, this is called the *Sandwich Bentonite liner model*.

Costing for Sandwich Bentonite liner base

Fabric costs Rs 50/sq.m., Bentonite layer costs Rs.3/kg*2 kg/sq.m. == Rs 6/sq.m.
Adding Rs 5/sq.m. as transport cost of fabric and using 2 kg/sq. m. cement for impregnation costing another Rs 5/sq.m., cost for Fabric = 50+5+5 /sq.m. == **Rs 60/sq.m.**
For Bentonite assuming extra usage, or 5 kg/sq. m., the cost == **Rs 15/sq.m.**
So the total is Rs 120/sq.m. for fabric (2 layers) + Rs 15/sq.m. for bentonite == **Rs 135/sq.m.**
Adding labour cost of 50 % of material or Rs 70/ sq. m., the total is **Rs 205/sq. m.**
The surface area of Base of FDBP is = **6.24 m^2 .** Thus, cost is **Rs 1280** for a 2 cu.m. FDBP or 40 % of traditional cost, calculated to be Rs.3050 (see section 4.1.2).

So, there is a saving of about 60%. If stone foundation is made, costing Rs 1200, the total cost will be about Rs 2500. Thus, there is a saving of 20% over current costing. Although here we are assuming that the mason is being paid 50% of material cost for the base, it is not the case. Removing that, saving is almost 40%.

4.1.4 Progress

The second plant with bamboo reinforcement was built this year. It is a 2 cu.m. plant, daily fed with starch and used for cooking mid-day meal for anganwadi children. As supporting bamboo arcs are removed, this is different than the Shramikbandhu plant and is in process for registration under Rural Innovation Foundation with help from NABARD. Recently Bhagirath Pratishthan approached Mr Vilas Gore who is also a bamboo expert. When the author visited in May to discuss the future prospects Dr Deodhar expressed interest in experimenting further at local level and then validating it for strength. As neither masons nor users are ready to accept bamboo based model, an alternate piecemeal approach is being tried. Initially, the masons will be encouraged to build water storage structures, similar to the outlet and inlet tanks. For interested farmers, dome shaped grain storage structures will be built of bamboo reinforced concrete. Over a period of two years, once masons get comfortable, these two techniques will be put together in the biogas plant construction.

The author discussed the aspect of procuring bamboo of the right age (3-4 year old), its treatment (water curing or copper sulphate) and stripping into pieces (2-4 cm thick). All these have to be tackled. These techniques should be taught to the bamboo artisans in the villages, to provide them extra income source. But this will be an intermittent source; the flow will be too small to provide work for all artisans. Not all artisans will be keen to do it, limiting the sites where bamboo mat weaving and stripping can be done.

When Bentonite and fabric was shown and its procurement, costing and benefits explained, there was a mixed response. While Dr Deodhar had shown interest earlier, he was reluctant to immediately test it in a biogas plant. One reason is *absence of existing demo plant* using this technology. Encouragingly, he is ready to test it for water-proofing ability by using in water tanks. This will also allow checking whether absence of foundation will affect the base’s water permeability. As water tanks are low investment, risk is small and can be taken.

Mr Manohar Satelkar (biogas expert and author of the earlier manual) had questions over strength of the foundation without use of stone. If stone is used, it will need cementing and thus eliminate any cost saving by using Bentonite. He enquired why any market available water proofing chemical could not be used? Another question was about the need to centrally procure Bentonite from Gujarat. Though this can be answered by countering that even cement comes from outside, it can be procured by the normal market mechanism. The use of Bentonite is not voluminous enough for a trader to sell it in open market.

Mr Santosh Teli (Biogas technician and supervisor) put up exactly same problem. This will have to be procured by the agency, won't be available in market as is cement. As it involves a new technology completely unknown to the masons, learning will take time.

4.1.5 Comments

"It is a Hobson's choice for the poor, traditional technologies are inadequate and modern technologies are inaccessible. The rural technologists should generate technological options, each more effective than the traditional, and more accessible than the modern. These options must enable the poor to escape from this dilemma" (Reddy, 1989).

There is similar dilemma in cost reduction of Ferrocement Based Deenbandhu Biogas Plant. Using bamboo is deemed inadequate replacement by the masons, who are unaware of the strength characteristics of bamboo reinforced concrete. Even if it is used, it may not be a cheaper alternative unless better means of processing bamboo are used and higher volumes are processed. Bentonite is not easily available in the local markets and there is no awareness about its benefits. It is not used regularly in construction industry even in Mumbai, so its accessibility in a remote area is a problem.

Testing of the material strengths on a demo plant, exact calculation of costs, exploring linkages for cheap and quality supply before either technology can be pushed for implementation has to be done and is a possible future research.

If the technologies are validated, still there will be need of infrastructure – for bamboo: training of artisans, transport to and from artisans to farmers; in case of Bentonite: storing centrally procured clay, procuring synthetic fabric or setting up natural fabric production unit. Also, there will have to be assurance of availability on time and quality. Also, if cost of FDBP is to be brought down, some centralisation in transport and storage will be needed to take benefit of economies of scale. Other aspects like procuring local resources and maintaining their quality will need attention too. Without these, neither technology will reduce costs for end users.

4.2 KVIC Floating Drum Modification

4.2.1 Idea

The KVIC floating drum gas holder made of MS sheet with a supporting structure of MS bars served three functions: gave required strength, weight and gas holding capacities. The MS is an effective gas barrier until it corrodes or cracks causing leakages. This drum serves the functions but has a large empty volume, high production and transport cost and is hard to repair as either the drum has to be taken to workshop or welding machine to site.

If the three functions are divided into three different components, how will it work out? The initial idea was to replace the dome with a flexi-bag. But it doesn't maintain constant pressure. Also, it has to be attached at the top of the digester, changing slurry dynamics. So, instead of fixing the bag onto the digester, it can be fixed on the supporting structure of angle iron used in the traditional floating drum. So gas trapping and structure/volume and constant pressure are obtained. But the weight of the mild steel pushed the traditional drum downwards. Without it, maintaining pressure is difficult. So if possible, a water column on top of the bag should provide the weight. Evolution of idea started from here.

4.2.2 Existing model

It was decided that the dimensions of existing plant should not be changed. For design, a 2 cu.m. water jacket plant was chosen. Figure 4.8 is of the traditional water jacket drum.

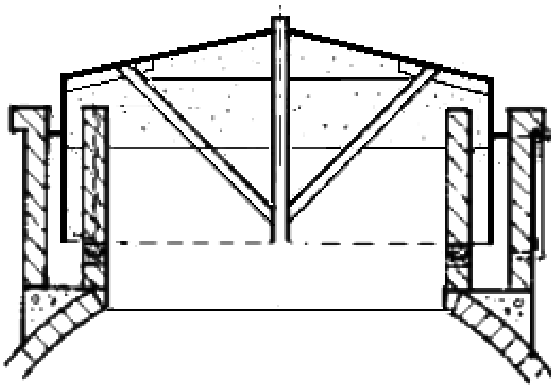

Figure 4.8: Traditional water jacket floating drum (Sasse, 1988)

The dimensions of this typical drum of 2 cu.m. capacity (HRT = 40 days) are: Diameter = 125 cm and Height = 100 cm (Khandelwal & Mahdi, 1986).

The material requirements for the drum are given in the below table (ibid.).

Table 4.2: Material requirements for 2 cu.m. Floating drum

Part	**Quantity**
Top and bottom rings 12 mm diameter MS bar	4.1 m
Verticle support; 4 nos. 12 mm diameter MS bar	4 * 0.9 m
Top support spokes; 4 nos. 12 mm diameter MS bar	4 * 0.65 m
MS pipe, outlet (40 mm)	1.2 m
MS sheets 2.5 m * 0.9 m	2.0 mm thick, 2.25 nos.

Construction of the drum

The fabrication of drum is done in a workshop; first the skeleton of the MS bars is constructed and welded together. Then the MS sheets are wrapped around it and welded. For the top, a circular sheet is used of a slightly bigger diameter and a segment is cut off to allow folding it into a cap-shape. This is welded to the skeletal structure. The two MS sheets are welded ensuring no gas leaks from the joint.

4.2.3 Concept of assemble-on-site drum

The concept was to replace the MS sheets with a rubberised nylon bag (used in flexi biogas plant) and keep the inner skeletal structure intact. Only, this was to be made in a way that could be assembled on site. This would necessitate the need of custom joints in which the MS bars could be fitted. Another idea was to use angle iron rods, which can replace the bars. It will need only nuts and bolts to be fitted on site. A design was being conceptualised where the rings are broken into four pieces and the vertical supports are separate. All these could be fitted together with nuts and bolts. But it was realised that there will be uneven stress on the cloth of the bag at the flat angle iron surface and its edges.

When this was discussed with Mr Jairaj and Mr More in CTARA mechanical workshop, a new solution came up. With their inputs, it was realised that GS pipes could be used. Initially, the idea was to cut notches in the ring pieces and fit the vertical pipes in them. If joints are introduced in the rings, those edges will cause higher friction with the bag and bag will tear at those points. Since for a 2 cu.m. plant, the diameter of the ring is only 125 cm, it was decided that there is no need of a joint. When dealing with larger plant size, joint will have to be given and that will have to be experimented with later.

Later, it was recognized that cutting exact notches, drilling the pipes to fit nuts, etc. will need to be done to join the frame together. A chance observation in Sindhudurg, during work for the FDBP modifications gave a new idea. A small foldable table was seen which had fit-in joints, where the ring had small node-like protrusions onto which the vertical legs capped. This same concept can be used in the biogas plant dome skeleton joints. Figure 4.9 is a concept diagram of the ‘Assemble-on-site Floating Drum’ for 2 cu.m. KVIC type biogas plant with water jacket.

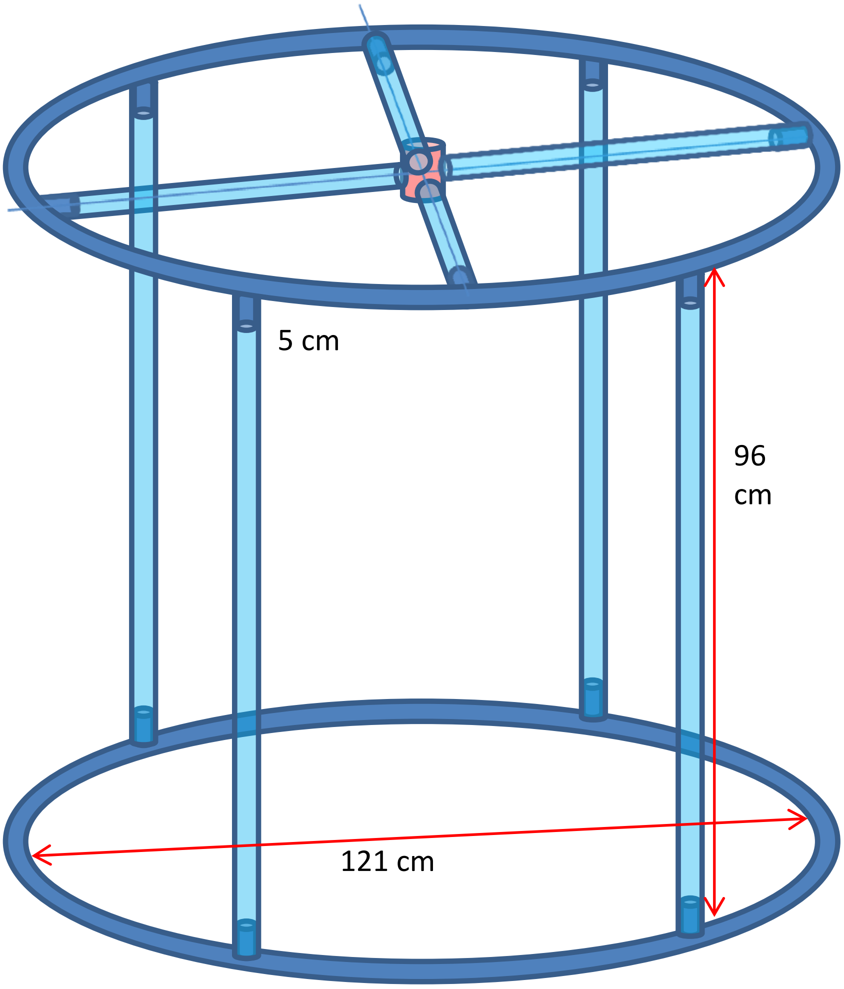

Figure 4.9: Concept of Assemble-on-site drum

The pieces, their dimensions and numbers are given in the following table:

Table 4.3: Details of parts of Assemble-on-site drum (2 cu.m.)

Part	**Material**	**Dimensions**	**Pieces**
Supporting bars	Galvanised Steel pipe, 20mm, C grade	96 cm	4
Circular rings	Same	121 cm	2
Joint Length	Galvanised Steel pipe, 15mm, C grade	5 cm	12
Central socket		25 cm	1
Bag	Rubberised Nylon fibre bag, as used in flexi bag digester	105 cm (ht) * 130 cm (dia)	1

Features of the assemble-on-site drum

- Design for 2 cu.m. floating drum KVIC model with *water seal* arrangement with external guiding frame with central gas outlet.
- Requires welding at 16 pipe-pipe joints, involves cutting and bending of the Galvanised Steel pipes. These pipes are used in construction industry for structural purpose.
- Assembly-on-site by push-fitting of joints and use of m-seal and Teflon tape.
- Rubberised Nylon bag covers the frame to hold the gas. It is secured at bottom with rope weaved around bottom ring. Extra securing possible by tying rope at different heights around the drum.
- In current setup, flat wooden slabs can be put on the drum and weights put on the same.
- Transport volume – 130 *130 * 15 cu.cm. box + packed balloon. Will require far less space than the current KVIC drums with a huge empty volume.
- For repairing, if any individual pipe is damaged, only that needs to be replaced. Transport of damaged part to fabrication workshop is easy after disassembly.

4.2.4 Benefits

This assemble-on-site drum will

- have low cost
- corrode less due to reduced contact with slurry as compared to traditional floating drums
- allow on-site assembly and easy repairing
- have a central external guide frame that allows easy movement and is cheaper.

Though the flexi-bag has short life-span of 4-5 years, replacing it will be easy. As it will be covered on top with a wooden plank, it can get damaged faster due to dampness and friction or slower due to decrease on direct solar radiation falling on it. These aspects and exact costing needs to be worked out during prototype building and testing.

4.2.5 Response from KVIC

Initially, in a meeting with an HR official, he was happy that IIT is interested in the now rarely used KVIC drum plant. Although the author was interested in redesigning the drum, their expectations were for collaboration in biological processes. A positive feedback to the design was obtained from Biogas Development Officer, KVIC, Vile Parle. He was enthusiastic to discuss the design further but did not reply to latter mails or phone calls.

Today, KVIC too has moved away from the floating drum model. It is worth questioning its relevance for home use. Also, prefabricated floating drum models have come into the market. So, why not shift to them? On the other hand, will a bamboo reinforced Ferrocement Deenbandhu/ Shramikbandhu model built in-situ be costlier than any KVIC floating drum plant? What are the benefits of KVIC model which no other model offers? Most industrial, institutional and community plants are KVIC drums. Should more effort be put into R&D for household KVIC floating drums or rather into community plants? These questions need to be first satisfactorily answered, if this idea has to be taken from research to dissemination.

Chapter 5 Conclusions

Do not put all your eggs in one basket.

As the report shows, there were multiple dimensions to this short duration project. On one hand, an agency was engaged in Manyali, on the other, there was a government office in Thane and an attempt to coordinate progress at both these for a common training at Bhagirath Gramvikas Pratishthan, Sindhudurg. While this was for promotion, another part involved technology modification. Here, two parties were connected for researching use of Bamboo; one party was being convinced on the behalf of another to use Bentonite. Another part was to create a new design. Since dissemination is not only these but transferring documentation as well, writing a manual was also attempted.

While all this was attempted, having put eggs into different baskets, it was expected that some success would be had. But the author missed that he was holding all the baskets and one slipping meant others slept as well. All activities were interconnected and it was necessary to tackle all of them in order to achieve some of them. But as time passed, improper allocation of resources, time and energy led to less than expected results.

Today, there is awareness in the Thane ADO that a significant cost reduction can be achieved in the biogas plants constructed in the district by changing the technology. Villagers in Manyali have accepted benefits of biogas and are ready to build plants in the coming years. Feasibility of modifications in Ferrocement-based Deenbandhu biogas plant is being further explored at Bhagirath Pratishthan. The design for assemble-on-site floating drum is ready, a prototype has to be built and tested at some biogas research centre. Talks are going on with the agriculture and biotechnology division in BARC, Mumbai. The users' manual is sent for printing and will be circulated to the new users of FDBP built by Bhagirath Gramvikas Pratishthan in Sindhudurg.

Some *lessons learnt* from this project are:

1. While working for development, the community should set the priority and not the change agent. We cannot force the pace of change, but have to wait for a favourable environment.
2. While development enables further changes, a quick pace of development, as in Manyali, can lead to counterproductive conditions for further development.

3. While working with official systems, engaging them long term is necessary if you are an outsider. Policy decisions diverging from status quo will normally be deferred.
4. It is not possible to document without practising. Only theoretical knowledge is not enough in writing a manual.
5. Though a technical innovation might have succeeded in some part, adopting it needs far more than just technology transfer. Infrastructure, resource availability, man-power and attitude are also needed as can be seen in the case of use of bamboo in FDBP.
6. Without demo, a new technology can't be expected to be accepted by rational users. Bentonite technology is viewed sceptically as no examples exist today, independently verifiable, that can vouch for the innovation.
7. While taking an idea to a concept and designing it, changes occur. More should be expected if a prototype is built and tested. Only first step has been taken in the making of an effective low-cost Assemble-on-site floating drum of KVIC biogas plant.

Some other things realised during this journey, which the author feels should be mentioned are given in this paragraph. While dissemination is to engage people, convince them and make them to decide to adopt a technology, this is not possible unless the basic mind-set changes. Also, it is not feasible to concentrate on a single technology for social development, but rather the general attitude must be changed. The government infrastructure is one of the best in terms of outreach to people and work-force. If any dissemination occurs through government mechanism, it can reach out to more people, but for its effectiveness there should be proper monitoring and evaluation, leading to a feedback and reaction. On field, there is a need for coherency between different agencies. If one district in Maharashtra so successfully employs a technology under a government program, the same should be picked up by the other districts. Necessary interactions and information transfers for the same should happen. Successful interventions end with the funds and do not spread out. The bamboo based biogas plants have been first built successfully almost two decades ago and still, today another agency has to reinvent the same.

Institutes like CTARA play a crucial role in understanding developmental problems, solving them and disseminating solutions. But such academic institutes suffer from transient-student-population syndrome. When a student finishes designing a technology, it is already time for her to leave before she can test it on field. If someone is able to test on field and get feedback, it is too late to improve the technology based on feedback. If a technology is developed and deployed successfully, by the time it is ready for wider dissemination, the student behind all this work leaves. The Principle Investigators stay behind and have to train a new student before continuing the work, but many times no one comes to take it forward. This problem with continuity, perseverance and involvement over long duration is a bane of many technologies that are developed in the lab, but rarely transferred to land and should be tackled at a priority. It is important to have a team working on a project, rather than individuals to take the work forward when one member leaves/ is replaced.

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Appendix

Appendix I: Letter from Thane ADO for assistance in cost reduction of biogas plants

जा.क्र./ठाजिप/कृषि-६बायो / १२२२ /११
कृषि विभाग, जिल्हा परिषद ठाणे
दिनांक : २३ /११/२०११

प्रति,

Shri. Milind Sohoni.
Head, Centre For Technology
Alternatives For Rural Areas
(CTARA) IIT Bombay, Powai, Mumbai

विषय:- **IIT मुंबई (पवई) यांचे समवेत आयोजित केलेल्या बैठकीस उशिरा उपस्थित होणेबाबत.**

संदर्भ:- मा.मुख्य कार्यकारी अधिकारी यांचे पत्र क्रं.जा.क्रं. ठाजिप/मुकाअ/स्टेनो/१०६/२०११ दिनांक ४/४४/२०११.

उपरोक्त विषयांकीत संदर्भान्वये दिनांक ३/११/२०११ रोजी ठाणे जिल्हा परिषदेच्या यशवंतराव चव्हाण सभागृहात CTARA टिम IIT मुंबई (पवई) यांच्या समवेत बैठक आयोजित केली होती. त्यावेळी राष्ट्रीय बायोगॅस विकास कार्यक्रमाचे संगणक सादरीकरण करण्यांत आले.

राष्ट्रीय बायोगॅस विकास कार्यक्रम ही योजना ठाणे जिल्हयात कार्यान्वीत असुन सद्यस्थितीत ४ घनमिटर बायोगॅस बांधकाम करायचे असल्यास त्यासाठी लागणारे बांधकाम साहित्य उदा. विटा, रेती, वाळु, सिमेंट, शेगडी, पाईप, व्हॉल्व इत्यादी चा विचार करता प्रति सयंत्र रक्कम रुपये ३८,८०८/- इतका खर्च शेतक-यास करावा लागतो. खर्च जास्त होत असल्यामुळे शेतक-यास परवडत नाही आणि पर्यायाने विकासाच्या योजनेस कमी प्रतिसाद मिळतो. या संदर्भात सविस्तर चर्चा झाली आहे.

त्यानुसार आपल्या यंत्रणेमार्फत शेतक-यांना उपयुक्त ठरेल असे Low Cost Model बायोगॅस सयंत्राचे तयार करावे ही विनंती.

कृषि विकास अधिकारी,
जिल्हा परिषद ठाणे.

प्रत:- मा.मुख्य कार्यकारी अधिकारी, जिल्हा परिषद ठाणे, यांस सविनय सादर.

मा. उपमुख्य कार्यकारी अधिकारी, जि.प.ठाणे, यांस सविनय सादर

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Appendix II: Users' Manual for Ferrocement Based Deenbandhu Biogas Plant

(The main text of the manual is provided here)

बांधायच्या आधी तयारी

संयंत्राचे माप

- घरातील जनावरांच्या व माणसांच्या संख्येनुसार बायोगॅस संयंत्राची क्षमता ठरवावी.

जनावरे	रोजचे शेण	संयंत्राची क्षमता	माणसांचा स्वयंपाक
2-3	25	1	3-4
4-6	50	2	5-8
6-8	75	3	8-12

बायोगॅस संयंत्राची जागा:

- घर व गोठ्या पासून जवळ
  - शेण वाहून न्यायच त्रास कमी होतो
  - गॅस वाहक नळी ची लाम्बी कमी राहून खर्चात बचत व जास्त दाब मिळतो
  - संडास जोडला असेल तरीही डासांचा किंवा वासाचा त्रास होत नाही
- मोठी झाडे व बाम्बूच्या बेटांपासून लांब
  - मुळांच्या वाढीमुळे डोम्बाला तडे जाऊ शकतात
  - सावलीमुळे तापमान कमी राहून गॅस कमी मिळतो.
- खत वाहक खाच जमिनीच्यावर
- संडास जोडल्यास संडासाच्या भांड्याचा वरील पृष्ठभाग इनलेट पाईपपासून दीड ते दोन फूट वर असावा

खड्डा खणतांना

- खड्डा मारण्यापूर्वी तात्पुरत्या सावलीसाठी मंडप उभारावे
  - कामाच्यावेळेस उन्हापासून संरक्षण मिळते - शेतकरयास खड्डा खणताना व गवंड्यासही.
  - डोंबावर शेवट कोरया सिमेंटचे प्लास्टर करतात ज्याला उन्हाने तडे जाऊ शकतात.
- खोदकाम सुरू करतांना शेण जमवण्यास सुरवात करावी. ते सावलीत ओले राहील असे बघावे.
  - २ घनमीटरच्या संयंत्राला ४ बैलगाड्या शेण लागते.

    - एकत्र एवढे शेण मिळवणे अवघड असल्याने अनेकदा कमी प्रतीचे शेण भरले जाते. ह्याचा परीणाम गॅस निर्मितीवर होतो.
- खड्डा आधी उभा खणून घ्या व नंतर गवंडी सांगेल त्यप्रमाणे तव्याचा आकार द्या.
    - चुकीचा आकार झाल्यास सीमेंटमाल जास्त लागतो.
    - आकारामुळे धारणकाळ बदलतो व पुरेसा गॅस निर्माण होत नाही.

बांधकामाचे साहित्य

- वाळू चाळलेली घ्यावी. त्यात माती नसावी.
- सीमेंट काम चालू करतानाच आणावे, पाणी व हवा लागणार नाही असे साठवावे.
- सर्व सामान जमा करून, खड्डा खणून मग गवंड्याला बोलवावे

बांधकाम चालू असतांना

- बांधकामात सीमेंट वापरतात. त्यामुळे बांधकामावर नियमीत पाणी मारावे. काम पूर्ण झाल्यावर ही पुढील 15-20 दिवस पाणी मारणे आवश्यक आहे.
    - डोंबावर बारदाण घालून पाणी न मारल्यास तडे जाऊन गॅस लीक होऊ शकतो.
    - लहान व मोठ्या कुंडीला तडे जाऊन त्या तुटू शकतात.
    - दुर्लक्ष केल्यास भरलेले शेण काढून सफाई करून दुरूस्ती करावी लागते ज्याला खूप खर्च पडतो.
- कुटुंबातील व्यक्तीने गवंड्या बरोबर असावे. मापे तपासून पहावी.
- एका वेळेस खूप माल कालवू नये. कालवलेला माल संपोस्तोवर गवंड्याला काम करू द्या
- शेणटाकी बसवतांना खाली 3" काँक्रीटचा पाया करावा. पाईप खाली दगडी भराव टाकून त्यावर काँक्रीट टाकावे.
- इनलेट पाईप मध्येच मोडल्याने शेण टाकणे शक्य होत नाही.
- आऊटलेट टाकी झाकण्यासाठी गवंड्याकडून लाद्या तयार करून घ्या.
    - लहान मूल वा जनावर आत पडणार नाही.
    - पावसाचे पाणी आत शिरणार नाही.

फिटींग

- पुरेसे क्युअरिंग झाल्यावर पांढरे सीमेंट लावायला व फिटींगसाठी गवंड्याला लवकरात लवकर बोलवा.

- पाईप,व्हॉल्व्ह, इत्यादी एकामेकांत फिट बसतात ह्याची खात्री करून घ्या.
- गॅसवाहक नळी डोंबाच्या दिशेने उतरती ठेवावी.
    - नळी मधे साठणारे पाणी उलटे डोंबात जाईल व गॅसवहनात अडथळा होणार नाही.
- नळीला मधे घोळ ठेवू नका किंवा दुमडू नका.
    - पाणी साचून गॅस पुढे येणार नाही. ज्योत फडफडते व लालसर-पिवळी दिसते.
- नळीतले पाणी काढण्याची सोय करून ठेवा.
- हे किरकोळ फिटींग शिका म्हणजे प्राथमिक दुरुस्ती घरी करता येईल.

शेण भरणे

- क्युअरिंग नंतर फिटींग करून लवकरात लवकर शेण बरावे.
- 2 घनमीटर च्या संयंत्रात 4 बैलगाड्या (2000 किलो) शेण भरावे. त्यात 2000 लि पाणी मिसळावे.
- डोंबावरील गॅसकॉक बंद ठेवा.
    - अन्यथा डोंबाच्या पोकळीत गॅस साठणार नाही. इथे गॅस साठून निर्माण होणारा दाब शेणावर पडतो ज्याने ते खाचेतून बाहेर येते.
    - शेण बाहेर पडोस्तोवर गॅस वापरू नये.
- मंडप शेण खतवाहक खाचेतून बाहेर पडेपर्यंत ठेवा
    - उन्हामुळे डोंबाला क्रॅक पडणार नाही.
- शेजारील एखाद्या चालू संयंत्रातील स्लरी शेणाबरोबर सोडल्यास गॅस लवकर मिळू शकतो.
- बायोगॅस संयंत्रावर भराव टाकावा. छोटे दगडमिश्रीत माती एक एक फुटाच्या थराने ओढून पाण्याने गच्च भरावी.
    - कोरडी माती ओढल्यास ती पावसाळ्यात फुगून डोंबावर दाब पडून त्यास तडे जातील.
    - गॅस मिळणे सुरू झाले की डोंबाच्या वरील पृष्ठभागावर माती ओढावी. याने उन्हापासून संरक्षण मिळते व बारीक क्रॅक जाणार नाहीत.

रोजचे शेण धूणे

- 2 घ.मी. साठी रोज **50 किलो शेण व 50 लिटर पाणी** लागते, जे कालवल्यावर 100 लिटर होते.
- दिवसभराचे शेण गोळा करून ठेवतांना त्यातील माती, काडी-कचरा काढावा.

- शेण खूप कोरडे असल्यास त्यावर रात्री पाणी शिंपावे जेणेकरून सकाळी कालवायला सोपे जाईल.
- एक बादली शेणाला एक बादली पाणी घाला. पण संडास जोडले असल्यास थोडं कमी पाणी घ्या.
- इनलेट ची खाच बंद करा आणी मग टाकीत साठवलेल्या शेणात पाणी घाला.
- वर तरंगणारा काही कचरा असल्यास तो काढा.
    - ह्या कचरयाने ने साय धरते ज्यामुळे गॅस कमी मिळतो, तसेच शेण आऊटलेट मधून बाहेर पडणं कमी होतं.
- खाली बसलेले दगड ईत्यादी काढा
    - अन्यथा संयंत्राची क्षमता कमी होते.
- शेण धुतांना गेट व्हॉल्व्ह बंद ठेवा.
- गुरांच्या पाया खालचे मूत्रमीश्रित गवत संयंत्रात न टाकता आऊटलेट टाकीतून बाहेर पडणारया स्लरी वर टाका. त्याचे खतात रूपांतर होईल.

शेण पुरेसे नसल्यास

- गॅस कमी मिळेल
- साय लवकर धरेल व कालांतराने ती घट्ट होऊन गॅस निर्मिती कमी होईल.
- शेण वर पाईपमधे भरून गॅस मिळणे बंद होईल.
- रोज संयंत्राच्या खतवाहक खाचेतून शेण बाहेर न पडल्यास काहीतरी बिघाड आहे असे समजावे.
- कुंडा विरहीत कोंबडीची शीट मिळत असल्यास शेणाबरोबर मिश्रण करू वापरावी,
- बोकडांची अथवा डुकरांची लेंडी मिळाल्यास ताजी ओलसर वापरावी. सुकलेली सल्यास प्रथम पाणयात भिजत घालून नरम झाल्यावर शेणात मिसळून वापरावी.
- अन्न खरकटे, जनावरांचे मूत्र जास्त प्रमाणात अथवा पालापाचोळा घातल्यास आम्लता वाढेल. अश्यावेळेस थोढी चुन्याची निवळी घालावी.

संडास जोडले असल्यास

- संडास चे भांडे अथवा टाईल साफ करण्यासाठी कोणतेही केमिकलयुक्त पावडर वा द्रावण वापरू नका.
    - अन्यथा शेण कुजविणारे जीवाणू नष्ट होऊन गॅस मिळणार नाही.
    - बारीक चाळलेली राख वापरावी.

खतवाहक खाचेची काळजी

- शेण वाहून गेल्यावर खतवाहक खाचेच्या तोंडावर थोडे शेण वाळते. त्यामुळे दुसरया दिवशी शेण वाहण्यात अडथळा होतो.
    - हयाने काही दिवसांनी शेण बाहेर पडणे थांबून डोंबात वर चढते.
- रोज सकाळी गेट व्हॉल्व्ह उघडताना काठीने खाच स्वच्छ करावी.
- रोज शेण बाहेर न पडल्यास काहीतरी बिघाड आहे असे समजावे.
    - 1-2 दिवस गेट व्हॉल्व्ह उघडू नका. शेण बाहेर पडल्यास ठीक, अन्यथा दोष आहे आणी तो लवकर ठीक करून घ्या.
- खाच जमिनीच्या पृष्ठभागाखाली राहिल्यास तेथे पावसाचे पाणी साठून संयंत्रात जाते.
    - ह्याने घुमटात शेणाची पातळी वाढून ते वरील गॅसवाहक पाईपमधे गच्च बसते व गॅस मिळत नाही.
    - तात्पुरती खाच बंद करून पाणी आत जाणं थांबवा. आऊटलेट टाकीतले शेण पहिल्या टप्प्यापर्यंत उपसा.
    - गेट व्हॉल्व्ह खोलून सफाई करा.
    - पाणी साचणार नाही अशी काळजी घ्या, एक चर खणून घ्या ज्याने पाणी व खत आऊटलेट पासून लांब जाईल.
- दर आठवड्याला गॅस सुरू करण्यापूर्वी शेण आऊटलेट कुंडीत खतवाहक खाचेपर्यंत आले असता एका लांब बांबूने ढवळावे. बांबू संयंत्राच्या मध्यापर्यंत गेला पाहीजे. त्याला रवीसारखा लोखंडी भाग घट्ट जोडल्यास साय सहज मोडली जाईल.

बीघाड दुरूस्ती

लक्षण	**कारण**	**बीघाड**	**उपाय**
गॅस मिळत नाही	गेट व्हॉल्व्ह बंद आहे		
	गॅस तयार होत नाही		
	गॅस लीक आहे	पाईप खराब झालाय	
		डोंबाला तडे गेले आहेत	

इनलेट मधे शेण आत जात नाही	इनलेट मधे कचरा अडकलाय		
	इनलेट पाईप फुटलाय		
शेण बाहेर पडत नाही	गॅस लीक आहे	पाईप खराब झालाय	
		डोंबाला तडे गेले आहेत	
ज्योत फडफडते	गॅस पाईप मधे पाणी साठलंय		
	डोंब पाईप मधे कचरा आलाय		

Appendix III: MTP 2 Presentation

Practising Dissemination of Biogas:

Promoting a Low-cost Model and Developing a Manual

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27th June 2012

Outline of Presentation

- Background
- Objectives
- Attempts at Promotion
- Steps towards Cost Reduction
- Manual writing
- Insights
- Future Direction

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Stage 2 MTP evolved from Stage 1 work...

INTRODUCTION

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Click Factors in Dissemination Success

- Advertising and informing people
- Women empowerment and participation
- Institutional arrangements for loans, installations and maintenance & repair service*
- Training of local masons for technical perfection in construction*
- Management skills of the agency*

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Practising Dissemination

- Engagement with the community,
- Improving acceptability by providing allied services,
- Modifying existing technology to overcome on-field challenges,
- Cost reduction for cost sensitive individuals and
- Simplifying repair and maintenance for ease of users.

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Objectives

1. Promote low-cost FDBP
   a) In Manyali, Yavatmal, establish basic set-up
   b) In Thane ADO, as cost reduction
2. Explore cost reduction in existing FDBP, using
   a) Bentonite material for bottom
   b) Bamboo frame for dome
3. Propose a modified KVIC floating drum type biogas plant.
4. Develop a biogas manual: users' manual, mason's field-guide and guidelines for change agency, in Marathi, for FDBP.

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Initial enthusiasm and positive response doesn't guarantee success…

ATTEMPTS AT PROMOTION

Manyali and Thane basics

- Manyali, yavatmal – *Nirmitee Bahuudeshiya Sanstha*
- Rapidly developing, ripe for biogas dissemination
- Interest shown by people

- Thane - Agriculture Development Office
- Government agency responsible for biogas constructions in Thane district
- Interested in lowering cost of plants built in the district

Manyali, Yavatmal

- Plan of having masons' training to build FDBP
- Discussion initiated with government officials for fund arrangements
- Interaction with people to gauge interest and willingness, positive response
- Change agency and agents present, simplifying work.

Lessons

- Priorities of people can be different.
- Household water supply, Brick-cement houses, water for irrigation, milch animals, roads, and temples prioritised over biogas.
- Compressed development is changing lifestyle quickly, villagers need time to assimilate changes.
- Support from local leaders and government agencies is necessary.

ADO, Thane

- Have target to build 300 biogas plants in district every year.
- Cost of each 2 cu.m. plant is Rs 38,808 (MNRE estimates Rs 16,000)
- Changing model from Brick-based Janata to FDBP could reduce costs by 20-40%.
- Training of masons necessary for this, could be arranged at Bhagirath Gramvikas Pratishthan, Sindhudurg.

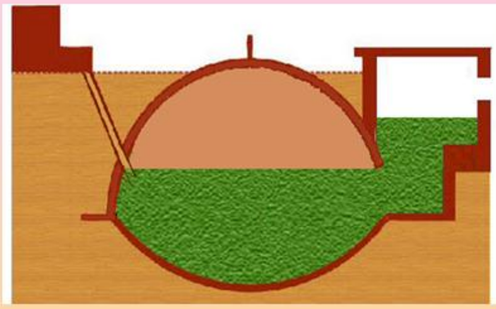
Lessons

- After showing annual savings possible, positive response.
- Not ready for training in Sindhudurg.
- Change of model, expenditure on training, re-establishing procedures, costing, etc. was a policy level change, not ready to take the risk.
- Author looked upon as an outsider, who could not gain trust due to short contact period.

Lower the cost, more affordable the technology and lesser the risk in case of failure...

COST REDUCTION

FDBP, current design



FDBP, current design

Bamboo Reinforcement

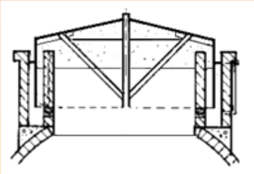
FDBP, current design

Bentonite Bottom

- Bentonite Sandwich Liner Model introduced in biogas plant base in Orissa in ‘95.
- Replaces bricks-concrete in base with bentonite and HDPE fibre, forming an impermeable layer.
- Reduces cost of base by 60 %, a saving of Rs 1700.
- But this is without the stone foundation.

KVIC Floating Drum

- The four functions served by KVIC floating drum can be divided into four components
  - Volume/structure and strength
  - Gas holding
  - Weight/pressure
  - Protection against damage



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Relevance

- The two modifications together can save 15% of material cost.
- Is the saving significant, compared to all efforts involved?
- Need of detailed cost-benefit analysis and infrastructure needs assessment.
- Need of building demo plants and exhaustive testing.

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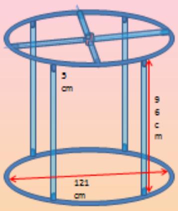
New Design

- Water jacket floating drum, external guiding frame with central gas outlet.
- 16 pipe-pipe joints welding of Galvanised Steel pipes.
- Assembly-on-site by push-fitting of joints, of m-seal and Teflon tape.
- Rubberised Nylon bag as used in flexi bag digestor.
- In current setup, flat wooden slabs can be put on the drum and weights put on the same.
- Transport volume 20% of fibre/steel drum.



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If everything else fails, read the instructions

USERS' MANUAL

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Users' Manual

- Existing manuals not user specific, hence ignored by end-user.
- Users' manual – step towards institutionalising
- Marathi manual for users of FDBP.
- Installation, operation, maintenance and eventual repairs.
- Shared with *Bhagirath Gramvikas Pratishthan* for further development and printing.

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छोटा मुंह बडी बात

- Initial plan of writing masons' manual and change agency's handbook cancelled as
  - Interaction carried out with only one agency
  - Masons' training was cancelled
  - Functioning, problems, solutions, nitty-gritties not explored
  - Author lacks any experience in the field
- Writing a manual is distilling all existing knowledge.

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This was an exercise at facing practical problems during dissemination

DISCUSSIONS

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Summing Up

- Shift from Studying dissemination to practising it – need to study biogas technology first.
- Promotion done at two sites, coordination.
- Three modifications explored,
  - 2 ready for on field testing
  - 1 being tested independently by Bhagirath
- Users' manual written, sent for printing.

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Major Lessons

1. Manyali: Community sets priority.
2. Thane: Policy decisions are delayed, longer contact needed while working with official systems
3. Manual: Practising needed before documenting.
4. Bamboo reinforcement: Adopting innovations needs infrastructure, resource availability, man-power and attitude
5. Bentonite: Demo necessary for acceptance by users
6. Assemble-on-site drum: Design changes with scale.

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Future Scope

- Compare Assemble-on-site frame and bag design with steel, fibre and flexi-bag gas holders
- Construct demo plants with Bentonite base.
- Test Bamboo reinforcement parameter and set up linkages.
- Interact with Thane ADO for adopting FDBP.
- Promote FDBP at policy level in Maharashtra.

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Other Insights

- Beyond dissemination?
- Community mobilisation, education, human development, conflict management, etc.
- Government system has best infrastructure, needs proper utilisation and monitoring with some flexibility.
- Reinvention of wheel – lack of interaction?
- Transient-student-problem syndrome

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Special Thanks to Bhagirath Gramvikas Pratishthan, Manyali villagers, Various experts and all my friends!

THANK YOU!!!

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"The smallest act of kindness is worth more than the grandest intention."

- Oscar Wilde

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Yatin RS Diwakar

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