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REACHING THE UNREACHED: CHALLENGES FOR THE 21ST CENTURY

A study on biogas technology in Bangladesh

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THE ANAEROBIC DIGESTIVE method has the advantage of low or no energy consumption in operation, less sludge left and small land occupancy. The use of anaerobic digestive method for the treatment of various organic wastes from domestic, commercial, industrial and agricultural sources generates biogas (a mixture of methane and carbon dioxide, which is being used as energy) and preserves the nutrients which are recycled back to the agricultural land in the form of slurry. The relevance of biogas technology in Bangladesh lies in the fact that it makes the best possible utilization of various organic wastes (which have no or little economic value at the present moment) as a renewable source of clean energy in the rural and semi-urban areas. The implementation of biogas technology has a great potential of mitigating several problems related to ecological imbalance, minimise crucial fuel demand, improve hygiene and health and therefore, there is an overall improvement in quality of life in rural and semi-urban areas. This paper is aimed to highlight the potential of biogas technology in the Bangladesh context, and to identify the problems and research needs in this field.

Biogas technology

The biogas production technology has been available since the early l900's when it was used for the stabilization of organic sludge produced during the treatment of domestic sewage (Stuckey, 1983). It has also been used in India since 1923 (Prasad et al., 1974) and in China for a period of nearly sixty five years (APH, 1989). During the last 50/60 years this technology has not realised its full potential due to a number of factors (Stuckey, 1983). Recently, there has been increasing interest in this technology, especially in the developing world. The governments of some Asian countries such as China, India, Nepal, Thailand have paid varying degree of attention to biogas technology. More than 90 per cent of presently existing biogas plants are of family size and the rest are at the farm and industrial scale. The potential of biogas technology for the replacement of traditional energy sources is highest in China (about 80 per cent) and that of India, Nepal and Thailand is about 10 per cent (Tentscher, 1986). Studies on biogas technology in Bangladesh are still at research level. At present about 120 fixed dome Chinese-type and about 80 floating dome Indian-type biogas plants are operating in Bangladesh. The estimated potential for generation of biogas in Bangladesh shown in Table 1 indicates that the best possible utilization of organic wastes through biogas generation can supply clean energy to cook three meals for a population of about 76 million, which is about 66 per cent of the total population of Bangladesh. The daily fertilizer contribution would be equivalent to 2,785 tonnes of urea, 7,030 tonnes of superphosphate and 1,280 tonnes of muriate of potash (Rahman, 1996).

Experimentation

Available literature on biogas technology indicates that the functional design of biogas plants based on mixed-feed is still empirical. A few experimental plants based on human excreta have been installed, but documented data about their performance are lacking (Sinha, 1984). In this section, an attempt has been made to evaluate the performance of a biogas plant constructed at Sreepur Shishu Palli, Gazipur, and to study the behaviour of different organic kitchen wastes in the context of biogas production.

The biogas plant at Sreepur Shishu Palli is underground fixed dome (Chinese model) type construction. This was constructed with brick walls and reinforced concrete top dome. The volume of the plant is $41m^3$. This plant serves for a population of about 550 with sanitary waste disposal system. The feed raw material is human excreta. The plant has been operating well with the biogas production rate of about $6m^3$ / d since November 15, 1994. The construction cost of this plant was Tk. 1,05,000 (US$ 2,625). The biogas generated in this plant has been used for cooking purpose. This replaces 51,000kg of firewood per year which costs about Tk. 1,02,000 (US$ 2,550). The use of this technology minimises indoor air pollution caused by the burning of fire wood in the kitchen of Sreepur Shishu Palls, provides environmental sanitation for excreta disposal, treats huge amount of polluted water in excreta disposal system and will provide soil nutrients during the time of disposal of sludge from the biogas plant.

Laboratory scale experiments have been carried out by the authors to study the gas generation pattern with different waste material collected from the kitchen of Sreepur Shishu Palli. The gas production rates from different wastes are presented in Table 2. It is evident from Table 2 that the huge amount of organic solid wastes from kitchen (which is the main component of solid wastes in Bangladesh, Rahman, 1993) can be successfully used to generate biogas.

Table 1. Potential of biogas generation in Bangladesh (Rahman, 1996)

Feed material	*Total population ($x10^7$ nos)*	*Waste disposal rate (kg/head/day)*	*Gas production rate* (m^3/kg)	*Amount of gas ($x10^6$, m^3/day)*
Cattle dung	2.42	11.50	0.03	8.35
Sheep and goat dropping	3.33	1.50	0.04	2.00
Poultry manure	13.79	0.18	0.06	1.49
Human excreta	11.50	0.40	0.07	3.22
Municipal solid wastes	2.25	0.22	0.06	0.30
Rural solid wastes	9.25	0.07	0.06	0.39
Total volume				**15.75**

General discussion

In the anaerobic fermentation process, various kinds of nutrient contents basically remain in residue except that such elements as carbon, hydrogen and oxygen decompose stepwise and finally transform into methane and carbon dioxide. Some water solubles remain in digested slurry while some insoluble organic and inorganic solids in digested residue, whose surface adsorb a great amount of effective nutrient content. As a result, the nutrient of biogas fertilizer are higher than those of the compost and the manure in open dump / farm yard. During digestion inside a digester, the majority of the harmful microbes present in the feed stocks are inactivated and killed and at the same time the wastes are stabilized to a significant extent. The digested sludge is less prone to flies and other insects. In fish culture of China, human and animal excreta have always been applied to fish ponds as a forage and a manure source. The application of raw organic wastes sometimes causes severe shortage of oxygen in fish ponds (APH, 1989). The use of biogas fertiliser minimizes this problem by conserving the dissolved oxygen in fish ponds. Therefore, in China a great achievement have been made in the comprehensive utilisation of biogas and its by-product manure. According to UNICEF & DPHE (1994), 33 per cent rural households in Bangladesh have sanitary latrines (i.e. on-site sanitation system) and the rest 67 per cent do not have access to sanitation system. Again, the disposal of solid wastes in Bangladesh is conducted in an uncontrolled and unsanitary manner. The main components of these solid wastes are organic food wastes (Rahman, 1993). Therefore, the anaerobic digestion of these organic wastes and human excreta can produce biogas (see Tables 1 and 2) by providing environmental sanitation to the rural, semi-urban and slum population. Our model study at Sreepur Shishu Palli indicates that construction of biogas plants is a cost-effective process provided the plants are maintained properly. The cost of the biogas plant constructed at Sreepur Shishu Palls was recovered within one year of construction. Therefore, this technology needs to be integrated with the existing sanitation and energy development program in the rural areas of Bangladesh. This should be a part of total rural planning which has to be preceded by an estimation of energy needs, requirement of environmental sanitation, possibility of obtaining feed materials and along with the population survey of who can afford and be willing to accommodate this technology. The program can be initiated on a pilot basis in selected areas with close supervision and monitoring and on the experience gained after their implementation modifications may be effected. So the Government and different donor agencies should pay proper attention to diffuse this technology in Bangladesh as a component of sanitation and rural energy development program.

Table 2. Biogas production from different organic wastes

	Gas production 1/kg of dry matter at different digestion period		
	Digestion period days		
Organic wastes	25	50	75
Cowdung (100 per cent)	117.5	264.6	294.9
Cowdung (50 per cent) plus cooked wastes (50 per cent)	83.5	118.3	149.6
Cowdung (20 per cent) plus cooked wastes (80 per cent)	79.6	102.8	121.8
Cowdung (70 per cent) plus uncooked solid wastes (30 per cent)	96.9	243.6	328.8
Cowdung (50 per cent) plus uncooked solid wastes (50 per cent)	58.6	153.4	211.1
Cowdung (20 per cent) plus uncooked solid wastes (80 per cent)	11.0	132.4	211.1

At present different implementing authorities (Table 3) in Bangladesh are mainly active in promoting this technology without proper attention to research and development to renovate and optimise the design by suiting them to the local condition. It is evident from an internal report of the Local Government Engineering Department in 1992 (see Table 3) that about 75 per cent of the constructed biogas plants did not operate properly mainly because of design, construction and maintenance problems. The different implementing authorities in Bangladesh have limited research and development capabilities and there is limited coordination among the researchers and implementing authorities. There is also a very limited follow-up action program. At present the administrative and technical infrastructure are not developed well enough

Table 3. Biogas plants constructed by different organizations in Bangladesh

Organization	*No of biogas digester*				*Present condition*
	Fixed dome	*Floating dome*	*Bag*	*Total*	
BAU	—	5	—	5	not working
BARD	—	1	—	1	not working
BSSIR	22	35	—	57	50% not working
EPCD	110	109	—	219	85% not working
BSCIC	—	92	—	92	80% not working
BADC	—	5	—	5	not working
LGED	89	8	—	97	10% not working
DANIDA	2	4	4	10	60% not working
Other	6	73	1	80	90% not working

to cope with this technology in Bangladesh. Therefore, the success of application and extension of biogas technology depends on:

- Prediction of realistic benefit of this technology.
- Opportunities for users' oversight and feedback (meaningful public involvement is essential).
- Social mobilization (construction of demonstration plant and popularization of the technology in the rural and semi-urban community).
- Public awareness (this should have objectives to pass the relevant information of this technology to each person of the community, to increase awareness to minimize the non acceptability of biogas from human excreta and from other organic wastes).
- Experience of biogas plant management and service reliability (successful operation, repair and maintenance services, and user benefit-gas distribution and fertilizer application scheme).
- Availability of standard specification for design, construction and maintenance of biogas plants for the specific area.
- Institutional measures (there should be comprehensive sanitation and energy development policies for the rural semi-urban communities. This should include, among others, provision of soft term loans and / or subsidization of this technology as a integral part of the sanitation program which currently exists in Bangladesh).

Conclusion

The relevance of biogas technology in Bangladesh lies in the fact that it makes the best possible utilisation of various organic wastes as a renewable and perpetual source of clean energy in the rural and semi-urban areas and provides environmental sanitation. Thus the quality of life in rural and semi-urban communites; can be improved by providing comprehensive sanitation and energy development policies. However, present experience of implementing this technology in Bangladesh indicates that there is an urgent need to develop an indigenous technical expertise, together with strong national coordination among different implementing authorities and research institutions to diffuse the technology in a meaningful way.

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