Final Report of UGC MRP

(No. 0679/13-14 KLKE 004/UGC-SWRO) carried out at SN College, Cherthala, Kerala

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'A Case study on Utilization of Biological Debris for Bio-energy'

Period of Investigation

25th July 2014 - 25th August 2016

INTRODUCTION

Biogas is unique in several aspects when compared to its alternate fuel counterparts. The commendable factor that makes biogas unique is that its substrate is not only absolutely free (*kitchen waste and faeces*) but also something that we always wanted to get rid off, the bio-waste. So installing a biogas plant naturally becomes 'two birds in one shot' type of achievement. Probing further we come across the positive facts that it is non-explosive, non smoky flame, regulatable just like an LPG stove, tank available at subsidized rate, almost repair free, portable, no complicated technology, flame strength equivalent to that of LPG, one hour flame guaranteed for every 3 to 4 kg biowaste per day, space requirement not more than a normal water tank, any non-fibre and non-acidic biowaste can be raw material etc. Biogas is one of the most economical ways to cook or light a home in rural areas of the world when other power sources are unavailable.

Apart from guaranteed features, it has added benefits too. One of the added advantages of a biogas facility is that the unspent slurry is a rich source of nitrogen rich manure for vegetable crops. Since cow dung is required only during the initial stage; user is free from the menace of cattle breeding. Moreover, unpleasant odour of dung lasts for the first 3 or 4 months only. Another advantage revealed from our study is that the bio-energy tank in continuous use was found to retain its activity even after keeping idle for up to four months. This means the nuclear family who own an active biogas tank can go for anguish free holidays for months together! The greatest advantage for a budget family is that along with doing away with garbage, they are now able to save their LPG cylinder for an extra month or two. This means savings not only for them but the whole nation. Now in real quantitative terms let us see what the savings is in Indian rupee. Suppose you are a person using 8 LPG cylinders per year. By using LPG it is reduced to 6. You straightly save approx. Rs. 800/- (*400 x 2*) for yourself and 600/- (*300 x 2 in terms of subsidy*) for the nation. Just multiply with crores of citizens and we happily arrive at the magic of biogas in bringing national level savings to the tune of multicrores which can be diverted for better infra structure across the country which as a natural byproduct of biogas usage, would have already become almost garbage free too.

This being the crystal clear truth however, according surveys conducted by us during 2012 and 2015, initiative from the governing bodies could only increase the percentage of

biogas users from 0.6 during 2010 to a meager 1.2 after a span of five years. At the same time households who wish to install a biogas tank in their premises has increased from 68 to 79 per cent.

Future prospects of this investigation suggest a modified version of biogas usage for urban users and flat dwellers which involve cultured vials of anaerobic methanogenic bacteria developed through research.

Relevance of the study: Biogas is one of the first programmes undertaken by Malanadu Development Society. No systematic evaluation of the programme has yet been made till date. There are also other biogas implementing agencies in the Governmental and Non-governmental sector. Comparative efficiency of these agencies needs to be evaluated. The study makes an attempt to enquire into the strengths and weaknesses in implementing the programme. Another relevance of the study is that biogas programme is popularly believed to have deeply influenced energy and agricultural sectors. This study provided an opportunity to verify the basis of such popular notion. Looking at biogas programme as an activity of local change, the study makes an effort to find out the options of replicability and scaling up of the biogas programme. It is hoped that the study will bring forth useful clues that can go a long way in improving agriculture in Kerala, especially in the highranges of Kerala. It gives MDS, other NGOs, Panchayaths and Research Institutions useful insights on sustainability, replicability and scaling up the programme and draw lessons from it for the whole of Kerala.

Brief history of the Biogas Programme in India: Biogas has a known history of slightly more than 100 years of application in India. The most prominent milestones in biogas extension in India are given below vide table 5 Table 5- Milestones in Biogas Development in India No Year Experiments, innovations and findings 1 1897 Bombay Experiment Ackworth Leper Home Matunga, Bombay; Biogas from septic tanks was used for lighting 2 1907 Ackworth Leper Home Matunga, Bombay; Operated an engine generator with biogas as well as gas used for cooking 3 1920 Calcutta Experiment. Dr Pal and Dr Ghosh of the University College of Science& Technology. Biogas produced from water hyacinth 4 1923 Waste materials like

banana peals, leaves etc used as feed materials at the experiments conducted by Dr. Joshi and Dr. Fowler at Indian Institute of Science – Bangalore. 5 1937 IARI Experiment by Dr S.V Desai. Cow dung used for gas production 0.6cubic foot gas/pound of dung. The Dadar sewage purification plant based on biogas fermentation method set up at Bombay 6 1944-45 MrM.Renaudot's Experiment Cattle dung and agro waste digester produced 15-25 cum gas/day and compressed gas used to run Tractors. 7 1946 Indian Agriculture Research Institute designed the first family size biogas plant 8 1949 Mr Jashbai Patel Experiment with the development of the forerunner of the KVIC plant. Osmania University, Hyderabad Negotiable cover used as gasholder for the first time Input=30l kg dung+30l litre water Capacity=20cubft gas/day 9 1952 Development of the floating drum type biogas plant. It was named 'Grama Laxmi- III' by Jashbai Patel, a Gandhian worker from Gujarat. 10 1961 KVIC adopted biogas programme for dissemination, deciding to disseminate the model of Gramalakxmi-III. PRAD- Planning Research and Action Division (PRAD), a separate division under the UP State Planning Board sets up GGRS- Gobar Gas Research Station at Ajitmal in UP. 11 1963-64 `KVIC began providing financial assistance to farmers in constructing biogas plants. This was a departure as it used to support only khadi institutions to construct biogas plants in the period 1961-63. 12 1967 KVIC completes 10,000 biogas plants 13 1974 60,000 plants completed. An impact assessment of biogas programme made and Government of India takes up implementation of biogas programme in right earnest. 14 1977 Janatha biogas plant with a fixed dome designed and constructed by GGRS, a wing of Planning Research and Action Division (PRAD) of UP State Planning Institute in their research station at Ajitmal in UP to overcome the disadvantages of the KVIC type –floating drum model 15 1981 NPBD- National Project on Biogas Development launched by Government of India. 16 1982 DNES- Department of Non-conventional sources of Energy created under the Ministry of Energy – Government of India. NPBD brought under DNES. Biogas programme included in the 20 point programme of the Prime Minister. 17 1984 Deen bandhu biogas plant designed by AFPRO- Action for Food Production a Delhi based NGO. 18 1987 Government of India approves Deen Bandhu model Biogas Plants and extends subsidy benefit to it. 19 1992 DNES upgraded into a Ministry and named it as MNES

STATUS OF FOSSIL FUEL

Fossil fuels are fuels formed by natural process such as an aerobic decomposition of buried dead organisms .fossil fuels contain high percentage of carbon and include coal,petroleum and natural gas. It was estimated by the energy information administration that in 2007 primary sources of energy consisted of petroleum 36.0%,coal 27.4%,natural gas 23.0% amounting to an 86.4% share for natural fuels in primary energy consumption in the world

Non fossil sources in 2006 included hydro electric 6.3% nuclear 8.5% and others (geothermal,solar,tide,wind,wood,waste) amounting to 0.9% world energy consumption was growing about 2.3% per year.

Fossil fuels are non renewable resources because they take millions of years to form and reserves are being depleted much faster than new ones are being made .the production and use of fossil fuels raise environmental concerns.a global movements towords the generation of renewable energy is there for under way to meet increase the energy needs.the burning of fossil fuels produces around 21.3 billion tones of CO2 per year ,but it is estimated that natural processes can only absorb about half of that amount,so there is a net increase of atmospheric CO2 per year .CO2 is one of the green house gases that contribute to global warming ,causing the average surface temperature of the earth to raise in response,which the vast majority of the climate scientists will agree will cause major adverse effects

INTERNATIONAL STATUS

In developing countries cookers /stoves,lamps,refrigerators are appliances commonly fuelled by biogas .biogas can be converted to electricity using fuel cell, through this is still considered a research area due to the need for very clean gas and the cost of cells. In contrast using biogas to fuel a compution engine and in turn an electric renerator is a proven means of producing electricity, given the wide availability of suitable generators. For example in India a well studiedcommuity bio gas digester was used to fuel a modified diesel engine and run an electrical renerator.

Biogas burns with a clean , blue flame and stoves have been considered the best means of exploiting biogas in rural areas of developing countries .

Worldwide, effective and wide spread implementation of domestic biogas technology has occurred in countries where governments have been involved in the subsidy , planning , design , construction , operation and maintenace of bio gas plants . There are several such contries in asia , where in particular china and India have seen massive campaigns to popularize the technology . Surveys in various regions of India have the proportion of functional plant to be from 40% to 81% . It should be noted that although not always started, digester age is a significant factor in performance.

Up to half the UK's domestic gas heating could be met by turning waste into biogas , according to a report from National Grid . The report looks at how all the biodegradable waste streams such as sewage , food and wood could be turned into biogas and injected into the gas distribution system. At the moment there is a small quantity of production of biogas in the UK coming from land fill and sewage plants, but it is being used to generate electricity . The National Grid says these valuable waste resources could be used more efficiently by turning thenm into bioethane.This could meet 50% of the domestic gas needs and helps achieve renewable energy targets for 2020.

Compressed natural gas (CNG)as also biogas aare commercially used as vehicle fuel in New Zealand and Italy. Conversion kit for biogas fuelled vehicle is virtually the sme as for CNG which is marketed as an automotive fuel in many parts of the world .these kits permitschange over form gas to liquids fuel and vice versa at a short notice .As methane is only half of the weight of the air, dispersal of the leaking gas is faster .This makes biogas as safer fuel than either LPG or Pertorl.

Ibadan ,the second largest city in Nigeria is the center of a large agricultural region in Oyo state . since the 19^{th} century , fierce intertribal rivalries and other political unrest have pushed large influxes of refugee and military populations into the city. This chaotic growth has discouraged the kind of municipal infrastructure thatis taken for

granded in the developed world.soon , however ibadan's power needs at least will get a boost from a relatively simple but extremley finding favour across Africa :biogas.theibadan plant will be one of the larger biogas installations in Africa

Bengladesh is endowed with plentiful supply of renewable sources of energy. Out of the various renewable sources ,solar and biomass and to a limited extend ,wind and hydropower are effectevleyused.the effective source of renewable energy is biomass.Under this category improved stoves,biogas plant and biomass briquetting are note worthy. According to an official estimates there is a cattle population of 24 million and poultry population of 75 million .This can produce about 3m biogas .The Local Government Engineering Department (LGED)and IFRD are working to install the biogas plants in the r ural areas .So far a total of 19,596 plants have been installed.

NATIONAL STATUS

India's consumption of energy is expected to double in the near feature .The national advisory board for energy in India has published a report forecasting the required quantity and the manner for supply of energy in the feature .The boards estimate that India has enough resources to sustain 16-22 Mio small biogas plants with 2m2 reactor volumes ,each to supply sufficient energy for a farmer family with 4 cows

In plants in India , the substrate ,cattle dung and biogenous waste ,are manually mixed with water in a ratio of 10% dry matter to 90% water .The mix is filled in to the digester by simply pushing.The reactor is neither heaten not isolated ,enabling the fermentation process to take place at temperatures in the region of 14 o c during winter and 25 o c during summer.In the reactor itself , a substrate is mixed by a simple mixer which is operated manually.After a dwell time of the substrate in the reactor of around 100 days the fermented residues is removed with buckets or scoops.pumping systems are not used.In general , such a small biogas plant coast around 50000 Indian rupees per cubic meter of digester.The plants are constructed with the help of local artisans who receive a daily wage of 50 rupees.

The construction of more biogas plant has revealed several beneficial sideeffects.Such as a significant reduction in the exhaustive cultivation of forests.Unexpected success were noted in medical sector also .Since respiratory systems and eyes were no longer exposed to aggressive wood smoke fromefire,the number of cases of acute asthma and eye diseases was significantly reduced (DIETER DEUBLEIN AND ANGELIKA STEINHAUSER)

A metropolitan city like Calcutta daily accumulates 2000 tonnes of garbage which can be converted into biogas.12 kg of garbage produces 30 liters of methane gas in a mini mint.The coast of the plant is 3 lakhs.production is still on an experimental basis. Daily 500 kg of garbage will produce 300 liters if methane. Mathene may be used as cooking gas or to genarate electricity or can be transformed into alcohol.

Biogas from the glue industry wastes is thought in India. For various reasons the Biogas plant programme has not yet gained great momentum in India. One of the reasons is the lack of requisite quantity of cattle dung.

Ther are a number of goshalas, dairies,and village communities having Large number of cattle, which have the potential for installing biogas enrichment and bottling system. In urban areas large quantity of biogas can be produced in sewage treatment plants using an aerobic digestion. The Okhlm sewage treatment plant in New Delhi is an example where more than 10000 cubic meters of biogas is produsedevery day. Due to rising cost of petroleum products and environmental concerns it has become imperative to make use of local resourcesas an altrnate to petroleum fules. Therefore it is worldwide trend to explore and make use of biogas as an alternat fuel (Biogas-enrichment and bottling technology for vehicular use,Dr:Virendrakumarvijay)

SolankiVijanbhaiMaldebhai runs a small milk processing plant in Junagadha district of Gujarat, buying and processing about 200 litres of milk daily. Processing of milk leaves a foul smelling liquid which is dificult to dispose. This was at time when AKRSP was trying to motivate people in village to motivate biogas plant. This innovative farmer who had adequate cattle decided to install and run a biogas plant on dairy waste. He apporached AKRSP staff and after some initial hestation, a biogas plant was constructed, which is operating completely on dairy waste. It take care of the cooking fuel needs and more importantly, helps him to dispose the foul smelling dairy waste in hygienic way (Biogas-The Indian NGO Experience,Somadutta et.al)

Biogas technology has been use in India for nearly a hundred years. However its dissemination began in a concreted manner only in 1981 with the launching of the National Project on Biogas Development (NPBD), and its subsiquentincluions in the Primr Ministers Twenty –Point Programme. It further gained momentem with the3 establishment of the Department(now Ministry)of Non conventional Energy sources (MNES) in 1982.

The Minister adopted a decentrelized multi agency and multi model implementationstategy for NPBD. At the state level programme is implimented through the nodal agency(Council for Science technology, Energy Development agency etc.) which is primarly responsible for achievingtargets, managing finances, monitering etc. other agencies involved in the implimentation at the district level and below are several government bodies such as District Rural Development Agency (DRDA), Block Development Office(BDO)local enterpreneurs,ruralnanogovernmental organizations(NGOs),gramapanjayath,dailycooperatives,etc.Further the National banks are also involved in the programme by providing soft loans to beneficiaries to partially meet the coast of construction.

To provide support to the implementation of NPBD, the ministry has created a network of 17 Regional Biogas and Training Centers (RBDTCs) across the country. These centers impart training and provide technical support to various groups of people involved in the implementation process. MNE has also setup an eight regional offices which provide guidance to the state nodal agencies and monitor the progress of the programme (Somadutta, Ibrhin H Rehman, PreetiMalhotra, VenkataRamanaP,2006)

Significant regional variations were observed in the fuel consumption levels across the country. The choice and level of use of particular fuel is governed primarily by its access to woody biomass. This in turn is determined by factors like local climate, vegetation type etc…

Types of biogas plants

BRICK TANKS

Tanks can be built from clay bricks. When preparing the ground for the tanks, the base must be particularly well rammed. For the base plant the following materials are applicable.

- Quarry stones with cement mortar filling and screed
- Brick work with screed or concrete

Bricking of curved bowl is simple. One needs only a center. E.g.: from a heap of stone, which is removed afterwards, and a radius stick. In contrast to this, concreting is more difficult because a flame work is necessary.

Brick work and mortar: Mortar and bricks should have about the same strength. Bricks of low quality require thicker walls.

Mortar for brickwork consists of sand, water and binding agents. Cement as binding results in smooth elastic mortar. In order to get good water proof brick work, a mixture of cement and lime should be used as binding agent. The sand for bioreactor brick work must be finally sieved. It must be clean and should not contain loam, dust, or organic components.

REINFORCED CONCRETE TANKS

The reinforced concrete must be free of cracks and resistant under the special conditions during fermentation over the entire period of utilization.

With reinforced concrete, the acidic substrate, can penetrate to the reinforcement and corrode if CO2 containing air also penetrates to the reinforcement. CO2 converts calcium hydroxide in the concrete to calcium carbonate. The pH value in the concrete around the reinforcement's decreases to values below 9 and the steel begins to corrode.

In order to prevent such damage, the local laws stipulate a quality supervised concrete with high resistance to strong chemical attack when the concrete is exposed to pH value below 4.5 over longer periods. The parts of structure can consist of water – repellent concrete with high frost resistance.

TANKS OF NORMAL STEEL METALS WITH ENAMEL LAYER OR PLASTIC COATING

An enamel layer protects the entire steel surface durably. It is glass like and extremely resistant.

Such tanks are completely pre fabricated from steel sheet segments. For enameling, the segments are prepared in different dipping baths. ie., cleaned, derusted etc. Then the enamel powder is blown on in an even layer, in the klin (the heart of an enamel factory), the powder coated single metal is heated up to 860^0C so that enamel powder melts and forms a strong bond with the surface of a metal. The single metal sheets are connected together by means of special screws. Such tanks are easy, fast and safe to construct.

TANKS OF STAINLESS STEEL

Stainless steel tanks usually consist of welded stainless steel of the quality 1.4301, 1.4404, 1.4436, 1.4435, 1.4571, but they are occasionally built from stainless steel plates screwed in to a steel structure made up of hot galvanized profiles. The plate segments are sealed to each other with methane - gas tight elastic PU sealing bands. Screws, nut etc have to be made from stainless steel.

According to the elastic requirements, such tanks have either curved covers or flat covers with appropriate stiffening. In the latter case a static proof has to be adduced.

FIXED TYPE BIOGAS PLANTS

In fixed type biogas plants which first developed in China, gas is stored in the upper part of the digester. In this design there is no separate gasholder and upper portion of the digester pit itself acts as gasholder. Displaced level of slurry provides requisite pressure for release of gas for its subsequent use. The plant works on both plant waste and animal waste materials and is convenient work within both continuous and batch mode. Normally animal wastes are fed daily whereas residues are fed in batches. As the plants does not involves any steel parts and it can be built with local materials, its construction costs are low and operation cost virtually nill. Beingunderground, space needs are also minimal Materials like lime – clay, lime – concrete, concrete, bricks, stones etc can be used for plant construction.

Based on Chinese design, Gobar Gas Research station developed the first ever fixed dome biogas plant in India in 1922 which was come to be known as Janata plant. It involves an underground cylindrical digester and a hemi spherical dome but without man hole cover. The dome is fitted with a GI pipe through which the biogas is taken out. It is made of bricks, cement and concrete. Following construction, digester walls and dome are cured for several days for imparting requisite strength to the plant.

MOVABLE 'DRUM' TYPE PLANT

It basically comprises an underground brick masonary digester connected with an inlet and outlet and covered by a movable steel gasholder for gas collection. Gas holder moves up and down guided by a central guide pipe depending upon accumulation and discharge of gas.

Movable gasholder made of mild steel alone accounts for some 40% of the total plant cost and accordingly these plants are much more expensive than fixed dome type. Maintenance costs of these plants are also high in view of much the need to paint gasholder every year to prevent corrosion. Based on series of chronological developments in India, JARI and KVIC developed two plant designs which have come to be known as the IARI and KVIC models.

'DEENABANDHU' BIOGAS PLANT

Action for food production (AFPRO) an NGO in 1984 developed a low cost fixed dome plant called Deenabandhu model meaning friend of the poor. It ia appropriate for using all types of wastes and minimizes biogas losses from inlet chamber and ensures maximum utilization of digester volume there by making the plant operates at designed HRT. t is 30% cheaper than Janata model. Storage capacity is 33% of daily gas production. It has curved bottom and a hemispherical top which are joined at their bases with no cylindrical portion in between. Displaced slurry following fermentation moves to the outlet displacement chamber as there is no displacement space on the inlet side. An inlet pipe connects mixing tank with the digester.

Cattle dung slurry prepared in 1:1 ratio with water is fed up to the level of second step in the outlet tank which is also the base of the outlet displacement chamber. As the gas generates and accumulates in the empty portion of the plant, it presses the slurry of the digester and displaces it into outlet chamber it starts rising. This fall and rise continuous till the level in the digester reaches the upper end of the outlet opening, and at this stage the slurry level in the outlet tank reaches the height of discharge opening. Any unused gas beyond this stage escapes through the outlet tank.

'GAYATRI' MODEL

Gayatri model was developed by Govt: implements factory Bhubaneswar. It eliminates the use of brick dome; a pre- fabricated fiber glass reinforced plastic (FRP) dome of the same dimension is used for gas collection.

'TNAU' MODEL

Tamil Nadu agricultural university at Coimbatore evolved 4 the designs of biogas plants with a view to achieve among other reduction in retention period. One of its model is similar to the fixed dome plant of the Janata type with a flat bottom where as the other model resembles the

Nepalese version of the Chinese model with curved digester bottom and Ferro-cement dome. Special feature of the plant is low retention period of 15 days which is achieved by periodic addition of microorganism which speed up the digestion process.

'KRISHNA' BIOGAS PLANT

The plant consists of a digester with its dome and lower cylindrical portion cast monolithically in reinforced cement concrete (RCC). The inner surface of the structure that comes in contact with biogas under varying pressure is coated with an epoxy paint to prevent possible gas leakage. In addition a single compensatory slurry displacement tank also cast in RCC is provided over the dome to account for increase in gas pressure. The coast of the Krishna model is lower than the KVIC model.

It is possible to connect a latrine unit to the biogas plant so that night soil could be digested along with the cattle dung.

' MANIPAL' MODEL

This model has features of both Indian and chinese models. It has a rectangular digester with an inclined RCC roof. There is no separate gasholder unlike in earlier Indian designs and larger inclined space above the slurry level provides storage area for resulting biogas to accumulate. Digester can be built particularly inside or fully above ground depending upongroundconditions variation in pressure is achieved a shallow ferro-cement cover dipped in water seal on sloping roof slabs. Intlet pipes are selected according to the feed material availability and desired mode of plant operation. Resulting biogas is taken out with the help of a pipe .

REVIEW OF LITERATURE

According to studies Carried out at the central Mechanical Engineering Research Institute in Durgapur, 1kg of dry water –hyacinth can produce4-6litres of gas following fermentation at temperature between 30-35 degree celcius. About 10 cm long chopped stem and evenly crushed material with moisture content ranging between 50-60% is appropriate for biodegradation ,chopping of lower part of stems is helpful in quick drying to the desired level of moisture content. Gas yield becomes maximum after 13-15 days of anaerobic fermentation during summer and after 18-20 days during winters.

Gopalakrishnan et al (1979) carried out studies at IIT, Madras for analysing the economics of power generation from water- hyacinth based biogas plants. Efficiency of the system can be improved by recovering part of heat generated during the process and gainfully utilizing it for warming up digester contents for obtaining higher gas yield.

A pioneering study with water-hyacinth as feed was carried by N.Sreeramulu and B.N Bhargava (1980) at the Jawaharlal Nehru Technological University which was sponsored by the Department of Science and Technology. Water-hyacinth used in the study was collected from Hussain Sagar, an open lake situated between the twin cities Secunderabad and Hyderabad in Andhrapradesh.

Unni et al (1981) working at the biochemistry division of the Regional research laboratory carried out a study to analyse it the kinetics of biogas yield from water –hyacinth digested in unstinted condition. Agitation of water-hyacinth based slurry is particularly desirable to prevent stratification which is not checked creates problems in digestion. Initially the fermentation was started with animal dung slurry which was subsequently mixed with increasing quantity of water-hyacinth in powdered form and finally with fresh chopped water-hyacinth. Proportion of methane in biogas was found to increase with rise in retention period

Central Institute of Fisheries Technology, Cochin developed a harvester which is manufactured by a Maharashtra firm, Vardhman Industrial Engineering Pvt.Ltd.,Kolhapur . Application of the machine makes waste removal faster.

Algae are abundantly available on different parts of India. Y.A. Doshi and A.V Rao (1980) made estimates of sea weeds availability in different parts of India. Although coastline of India extends over 5700 km, sea weeds are mostly limited to narrow littoral belts of country's marine environment. Seaweed resources are limited to rocky coral formations in Gujarat, Andhra and Tamil Nadu states, Andaman and Nicobar. Seaweeds can be used for producing variety of chemicals, minerals, vitamins,amino acids and proteins . They contain a variety of polysaccharides which constitute an industrially important group of phycocolloids. This group forms 10-65% dry weight of harvested seaweeds.

S.J. Sarawadi and V. D. Chauhan (1980) carried out experimental studies at the Central Salt and Marine Chemicals Research Institute, Bhavnagar, for producing biogas from sargassum genus, brown seaweed that was collected from the coastal Gujarat and stored in dried conditions. Before drying, the collected brown algae were cleared off extraneous materials such as sand and salt by working in water.

Venkataraman and Kaushik (1975) carried out studies to analyse the effect of adding algae on feeding on biogas yield from a biological plant primarily running on cow dung slurry as feed stock. Algae used in these experiments was collected from piraña sewage oxidation ponds in Ahmedabad city which includes several species like Oscillatonriachalybea , euglena, spirulina etc. (biogas systems principles and applications-K.M Mital).

In past Balasubramania, et al. Carried out experimental studies at the cotton Technological Research Laboratory (CTRL) in Mumbai to analyse the pattern of biogas yield from willow- dust consumes less water, accommodates more fermentable material per unit space and generates improved quality of readily usable bio manure .

Wise et al (1986). Described o low capital cost batch type digestion process which can convert all of a town waste such as garbage, sewage, food processing waste etc.

According to West et al the fourth steady phase of methane production occurs much later producing 50-70% methane. Microbial activity can be intensified by recycling leachate through the decomposing refuse.

According to Bowman, et al(1976) , maximum and nearly half of gas production occurs with in 2-3years of land filling completion . R.C. Merz and R.stone (1964) found that surface irrigation of land fill affects gas generation rate. Stages of biogas production in relation to the age of a land fill can be divided in to four phases. The aerobic phase is short one leading in to second phase of high carbon dioxide production at approximately a molar equivalent to oxygen consumed so that little nitrogen is displaced.

Bowerman (1976) provided estimates of carbon dioxide percentages at varying intervals such as after 11days 70%, after 23days 50% and 40 days 90% carbon dioxide was formed. In third phase, methenogenesis activity begins causing methane concentrations to increase with reduction in carbon dioxide and hydrogen levels. J.N. Ramaswami reported that this steady phase state normally occurs about 180 days after the disposal in land fill begins. F.A. Rovers, et al (1973) estimated this period as 250 days where as R. Bell he estimated it as high as 500 days.

The action for food production – Canadian Hunger foundation (AFPRO-CHF) net work, comprising a total of over 100 NGOs, has been unique experiment. It involved the governmental/ voluntary sector in dissemination of biogas technology. By installing over 97000 biogas plants in different parts of each country over a decade, this net work has enabled a wider reach of technology. This publication is an outcome of a study conducted by the Tata Energy Research Institute to assess the impact of the biogas programme implemented by the AFPRO-CHF network. The study was conducted for six months from December 1996 to 1997. In depth case studies of 12 NGOs were conducted to document the experience of the network and to share them with other organizations and Institutions (soma et al.).

MATERIALS AND METHODS

The present study is aimed at revealing the status of awareness about biogas and actual usage thereof among the local population, as an alternative fuel for domestic cooking purpose. In the present day the twin evils that require immediate solution are fossil fuel depletion and bio-waste disposal. The government has realized well ahead that installation of a biogas plant in each and every independent family could be the right answer to address both the crisis in one shot. The programs like AFPRO are shining paradigms as proof of our planning ability. Proven credibility of biogas in hassle free disposal of bio-waste at the source of origin itself was behind this idea. Biogas is economical too in more than one way. Besides having no recurring expenditure, biogas plays a supportive role that leads to the extended the use of LPG. However, when it comes to execution, we Indians find ourselves grouping in the dark. That is way, in spite of moving in the right direction at the right time; both the above mentioned problems unfortunately remain unsolved till date.

The suspected reasons of failure of implementing this noble cause are lack of follow up at the grass root level and over reliance on existing data in this aspect. We apprehend that the on hand data are unempirical and intuitive. Scientific data on the following aspects are inevitable for the successful implementation of government policies on biogas: these are, actual level of understanding, will of people and their expectations from the governing bodies regarding assistance for installation of biogas tanks and also its worth. True data on these could be obtained only by direct interview with a cross-section of the society. Therefore our investigation was carried out in the form of a survey.

Area of assessment included panchayats namely Kanjikuzhy north, Punnapra north, Mararikulam north and Kidangapparambu area of Alappuzha municipality where biogas plants were installed. We collected information using an initial questionnaire comprising of 38 questions relevant to the title of the project. Observing the response, comments and suggestions from the people at the receiving end, the questionnaire was customized for users of biogas with 18 questions (Appendix-I) and non-users of biogas with 5 questions (Appendix-II). Further information was collected using the modified feedback form. About 200 households per panchayath were quizzed.

Method of interrogation was direct with the head of each family with the prepared questionnaire having multiple choice closed ended questions. In situations where the family members were busy, an appointment was fixed and visit was repeated. In any case ample time and mood was ensured so that data acquired was genuine. The fact that survey type research studies usually need larger samples owing to low percentage of responses was born in mind while carrying out the survey. So visiting individual houses was perceived to be quite a time consuming exercise. Therefore towards the later stage of survey, questionnaires were distributed to school and college students at their institutes and were collected back the very next day. This was done with prior permission and involvement of principals to ensure accountability .

We prepared questionnaire for users and non users of biogas. Malayalam version of the questionnaire was supplied to the natives. Since most of the people got annoyed with too much of questions we limited the number of questions to ten avoiding apparently repetitive ones in the second stage of survey. Once the survey was completed the data was consolidated manually and transferred to the MS Excel spread sheet for refinement. The questionnaire included questions to reveal the awareness of Biogas among people and their willingness to install Biogas plant at their premises.

For the ease of survey we divided into houses and institutes. Houses were further divided into rural, urban and semi urban based on degree of crowdedness and area possessed by individual household for waste disposal. Institutions included Hospitals, Schools and Hostels. Total of about 150 houses and 30 institutions were covered per panchayat area.

Whereabouts of users of biogas were collected from various biogas agencies and they were located for interview. In the next and final stage of information collection, we mustered details of efforts from the government through panchayats and municipalities on the subject of biogas, its awareness and installation. This was done through right to information. The copy of questions drafted is displayed in Appendix-III.

Right to information: We got very valuable information through Right to Information from Kanjikuzhi, Alappuzha, and Punnapra panchayat.

Method of survey conducted:

1) Panchayat area was divided into five parts.

2) Each area was again divided into two parts.

a) Houses

b) Institutions

3) Houses are again divided into three.

a) Rural (More than 15 cent)

b) Semi urban (More than 5 cent)

c) Urban(Less than 5 cent)

4) Institutions

a) Hospitals

b) Hostel

c) School

5) Total houses=30x5=150

Total Institutions=30

Apart from survey, the project had aimed to find out some correlation if any between content of proteins and carbohydrates of vegetable and fruit inputs to biogas plant. A possible list was identified among fruits as well as vegetables the waste of latter being used raw and cooked.

The method followed was simple spectrophotometric using a visible automated spectrophotometer manufactured by 'Systronics'.

METHOD SUMMARY for total protein in veggies:

The pellet of vegetable tissue is treated to remove lipids *(the tissue sample is homogenized with 18 volumes of a mixture of hexane/2-propanol (3/2) for 1 minute, the suspension is filtered and the filter rinsed with 3 x 2 vol of the same solvent. The whole liquid phase is evaporated and the dried extract dissolved)* then allowed to dissolve in 0.1 N Sodium

Hydroxide (NaOH) for 15 minutes to generate a crude protein extract. The solution is centrifuged, and duplicate 0.1 milliliters (mL) aliquots are pipetted into separate test tubes. The protein content is determined on these duplicates using the Bicinchoninic Acid (BCA) method. This involves mixing the sample with reagents which react to form a product with a color intensity that is proportional to the amount of protein in the sample. The color is quantified as an absorbance reading in a spectrophotometer at a wavelength of 562 nanometers (nm). To normalize enzyme activity, the determination is made directly on a portion of the same crude extract assayed for enzyme activity. Duplicate 0.1 mL aliquots are pipetted into separate test tubes and also assayed by the BCA method. For any purpose, when protein is determined on unknown samples, solutions with known protein are used as standard.

METHOD SUMMARY for total carbohydrate in veggies:

Anthrone method is the colorimetric method of determining the concentration of the total sugars in a sample. Sugars react with the anthrone reagent under acidic conditions to yield a blue-green color. The sample is mixed with sulfuric acid and the anthrone reagent and then boiled until the reaction is completed. The solution is then allowed to cool and its absorbance is measured at 620 nm. There is a linear relationship between the absorbance and the amount of sugar that was present in the original sample. This method determines both reducing and non-reducing sugars because of the presence of the strongly oxidizing sulfuric acid. Like the other methods it is non-stoichemetric and therefore it is necessary to prepare a calibration curve using a series of standards of known carbohydrate concentration.

RESULTS

The use of biogas is still limited to few individuals in spite of enough awareness programs from the government. The answer could only be obtained through house to house survey. Initial survey was done during 2012 and later during 2015. Primary data obtained from the surveys are presented here.

In the amateur survey conducted during 2012 we found that people depending on LPG as the lone source of cooking fuel (46.67%) far out numbered those using other fuels like firewood electrical equipment etc (Table 1). However, people who use both LPG and firewood users registered 43.33%which was immediately close to LPG alone users. Only a small number of people were found to use electrical equipments along with LPG (6.3%). Urban and sub-urban population who depend upon firewood alone registered only 3 per cent. None of the households were detected using biogas as the main cooking fuel. It was revealed that even those who use biogas as a supportive of supplementary fuel source with LPG and other equipments were negligible.

In the survey area covered by us, percentage of people who are concerned about how long a single cylinder of LPG lasts was 93.67% (Table 1.3). A minority do not bother to have such a check. Table 1.4 shows that in 83.67% of households, the general duration of usage of one cylinder ranged from 1-3 months. A small number users up LPG in less than one month time (4.33%) and the percentage of those who use it for more than three months was found to be 5. It was interesting to note that although 93.33% of people were worried about the present rate of LPG, only 74.33% believe that the rate of the LPG rate may hike up to rupees 1000/- within a year. About 5% did not respond to this question.

From the survey it was found that 70.33% of people felt problems in rebooking and in the availability of fresh cylinder of LPG (Table -1.7) Almost 56% (Table-1.8) feel the need of at least one more none-electrical source of fuel for domestic cooking as convenient as LPG. The survey also revealed that 31.3% do not have enough land to dispose their kitchen waste (Table-1.9). Table 1.10 shows that 90.33% of people believes kitchen waste can be useful in some or other way, but not sure exactly how.

Percentage of people who had an alternative idea for LPG was found to be 55.33% (Table-1.11). A minority (1.67%) did not answer to this question. It was good information we found from this survey was that 92.33% of people have heard about biogas through media (51%), studies (7%) exhibition (11%) etc (Table-1.13). But only 2.67 % of people said they were informed through panchayats / municipalities about biogas.

As expected , majority of people (96.33%) had no clear idea about different types of biogas tanks available (Table-1.14). Only 0.33% were aware about cement tanks and 2.34% on gobar gas plants . From the table1.15 it was clear that 87.67% people considered biogas tank in their house. The reason they showed for their unwillingness are lack of enough waste (12.33%), lack of space (13.33%) etc. People who were willing to install biogas tank exposed the reason too. It was mainly to save LPG (13.67%) and to dispose waste (19.7%) (Table-1.18).

The results of survey conducted during 2015 January onwards proved that people of urban Alappuzha are largely interested in using biogas at their households. The efforts of Municipality and special interest of Dr. Thomas Isaac, MLA has played a major role in the pro-biogas mindset of people of this town. However, the initial momentum in the installation of biogas tanks was not maintained towards later periods. Table 1 show that maximum percentage of people (37.8 %) are still in the 1 year segment regarding the duration of use of biogas.

About 83 per cent users say biogas plant does not need much repairs. Mode of putting the waste is by chopping by most of the users. But those who do not chop also find no significant drop of performance of the biogas system. There were difference of opinion in the source of waste and hike of performance (Table- 6). Table number 7 reveals that users of biogas are quite satisfied by the role of biogas in both waste disposal and as a safe supplementary cooking fuel. The negligible minority who had complaints projected reasons like bad smell and low performance compared to its cost. The most important aspect was that 21% of users were able to extend the use of LPG cylinders by up to 2 months and 41 % up to one month. About 9 % people claimed to have extended LPG by five months (Table-9). Table 10 answers to the question on whether dung recharge was required. While 5 % did not require any recharge at all, 40 % did it twice a year and 17 % needed to recharge only once. Also majority of them claimed to have observed enhancement in the effectiveness of their bio energy plant. However it was not

clear whether people went for dung recharge due to real need or a precaution based on speculations. Almost all the users agreed that a biogas system is highly useful in disposal of organic wastes with (Table-12) special reference to food waste that is left over (Table-13). People of Alappuzha town and suburbs feel that Government agencies are taking ample initiatives inn the household installation of biogas tanks. They also opined that keeping biogas tanks at individual premises is always a better practical option than using it as a common facility. In table -17, about 58% users were found to register a contradictory statement that biogas tanks do have many drawbacks while in table-2 they agreed that no frequent repair was encountered. The source of knowledge regarding biogas was local self governments as reported by 63 % citizens as is clear from table- 18. This percentage was less than 3 during 2012 survey.

Apart from the survey, the project had also aimed to find out some correlation if any between content of proteins and carbohydrates of vegetable and fruit inputs to biogas plant. A possible list was identified among fruits as well as vegetables the waste of latter being used raw and cooked (Tables given).

We could not draw any correlation of biogas inducing property of vegetables and fruits with their respective protein contents. However carbohydrates did give some clue in this regard.

It was seen that among fruits, Jackfruit had the second highest quantity of carbohydrates (23.5 gram per 100 gram tissue) after extreme high in Dates (64) and the least was shared by Orange and Water melon (6 gm each). Pine apple (3.8 gm) and Dates (3.6) hit the top of fruits chart for protein content and lowest protein carriers were found to be Grapes (1.09), Mango (1.06) and Papaya (0.85).

Among vegetables, beans, cauliflower and amaranths shared the least carbohydrate content (1 gm each). In the case of protein content in veggies, Soya and green gram registered the highest (11 gm).

Analysing these results, the property of jack to induce a sudden boost in the biogas generation may be attributed to its high carbohydrate content combined with high moisture content. The reason behind Dates as an average biogas performer despite its very high carbo content, may be attributed to being a dry fruit coupled with the fact that it is available in Kerala house holds as a processed one.

DISCUSSION

The thought of a survey on usage of biogas was raised out of twin problems that we face today. First one is the fast depleting LPG source and its hiking cost as the natural consequence of depletion. The second issue is that of waste disposal which continues to be permanent head ach to society and local self governments. At this juncture, biogas could be and should be the right alternative both the concerns. First of all, biogas is highly economical as the recurring cost is almost zero. This is because, source of energy in biogas plants is the readily available domestic kitchen waste discarded from each household. For the same reason, waste disposal at public places is also taken care of automatically. However, use of biogas is still limited to few individuals in spite of enough awareness programs from the government. The answer could only be obtained through house to house survey. Primary data obtained form individual house holds were consolidated and analyzed. This was done to get and idea on lapse between government moves and the level of its actual implication or effect in the society regarding environmental issues

The fact that the urban and semi - urban population depend solely on LPG for cooking purpose is definitely a dangerous issue. This fuel is supplied by the government in a highly user friendly from through an orderly sysyem for the past so many years. Therefore the new generation families have become over dependent on it without realizing the fact that it is a vestige gas and may not last household near future owing to its fossil status. The survey results showed that people who use both LPG and firewood was also not too less. That situation is also risky for the already delicate greenery we enjoy today. No one is planting new trees these days but go on cutting down existing ones. Even educated citizens and those who advocate environment friendliness in the public also are among the culprits clandestinely. A small number of people use electrical equipments also which because regarding production of electricity we are still a poor nation.

The percentage of people who are bothered about duration of usage of a single cylinder of LPG was 93.67 % (Table1.3).Only a minority was found to be not anxious in this regard. Also, nearly 84% of house holds were found to be concerned in careful usage of the fuel .They use a single cylinder for up to 3 months. Although majority of the natives were worried about the present rate of LPG, only 74.33% believe that the rate of LPG rate may hike up to rupees 1000/-

within a year. Many of them regularly have problems in rebooking and in the availability of fresh cylinder of LPG (Table 1.7). Half of the population feels the need of at least one more non-electrical source of fuel for domestic cooking as convenient as LPG. All these data when put together gives the notion that people are really concerned and reasonably aware of the predicament that may arise in the near of regarding availability of fuels. They also seem to be conscious of the need of environment friendliness in this approach.

The question left is that why an eco-friendly fuel like biogas is not at all implicated in a place when people are mindful about the need for something like that. More over the government is also not in the dark but are regularly updated about the alarming situation. Being an urban to semi urban population throughout the length and breadth of this tiny state garbage disposal is becoming that most dreadful arena. Leaving apart the plastics among the garbage, what is filled in the plastic carry bag thrown out to the public road are mostly bio degradable waste only .The finding from the survey revealed that 31.3% do not have enough land to dispose their kitchen waste (Table-1.9).Table 1.10 show that 90.33% of people believe kitchen waste can be useful in some or other way. Once again the answer is Biogas. But when we say that it must be clear that actual installment of a biogas plant in each house hold will only and definitely solve the above mentioned crisis. Ironically, what is happening in reality is that everybody including into green fuels and each campaigner leave all the responsibility for others. This is due to the obvious fact that all the promotional activities are passive and have became just a fashion of the times rather than aggressive and with fidelity.

The data in tables 1.11 to 1.13 indicate the knowledge of general public on biogas and its use. The have gathered the information through media (51%), studies (7%), exhibitions (11%) etc. Only a minor section of the society was informed through Panchyaths and Municipalities about biogas. This is unacceptable since India is one among the pioneering nations to establish bogas. This is clear from the fact that although most modern biogas tanks are available today majority of people (96.33%)are still not aware of it (Table-1.140.only 0.33%was aware about cement tanks and 2.34% still think biogas could be run by regular supply of cow dung only .Another notable aspect is that 87.67% people considered biogas as something beneficial but only 68% were interested in installing it in their house. The reasons they showed for there unwillingness are lack of enough waste(12.33%),lack of space (13.33%)etc .people who were

willing to install biogas tank exposed the reason too .It was mainly to save LPG (13.67%) and to dispose waste (19.7%) (Table-1.18).

This survey is meant for analyzing the actual data collected from common man who has revealed the gap between facilities extended by the government and its actual reach to its citizens. About 43 .33% population were found ready to invest Rs 5000/- or below for the biogas plant. While 38.67%did not respond to this question. Only a small number of people (6%) were ready to spend 10,000/- and above also. It was great to know that 78.67% are aware on the source from which biogas were produced. We found that 78.33% was ready to install, the biogas tank if there were subsidy. But majority (65.67%) of them had no idea about actual cost of the biogas plant.

The survey investigation was extended to Panchyaths and municipalities through right to information. While the attitude of the public towards a greener fuel was to positive, it was shocking that many local self governments have not even applied for projects related to biogas even after realizing its importance in today's scenario. And those Panchyaths which actually procured subsidy based projects on the aim of installing biogas tanks in each house hold unfortunately could not achieve the setting up of a single one (appendix-VII).The result was such that the entire amount meant for this noble cause was lapsed.

The present study hints to the truth that the people of the current generation are severely over reliant on the fossil fuel, LPG. Although government is supplying this fuel in a systematic way without many problems today, the apprehension exists on the possibility of its acute storage and hiked prices in the near future. The problem of waste disposal is also on the climb which is an expected outcome of over increasing population. Both the government and its people realize biogas as an eco-friendly and economical alternative to these issues. The know-how, financial support from government and accessibility of modern equipments are also aplenty.

If still biogas are not implemented in each and every house hold to sweep away the twin problems of fossil fuel shortage and bio-waste disposal it is only because of the lack of aggressive move from the authorities to provide the bio-energy plants at affordable rates to individual household .The establishment of community model pants will not prove successful because it requires constant watch and guard right from the sorting of waste materials dumped in.

On the basis of this we advocate installation of biogas tanks in individual houses since waste s will be taken care of at its source itself More over, individual attention from the owners can be assured because the biogas tanks not only provide them a good option to dispose off the decaying bio-waste in a healthy manner but also provide them a supportive cooking fuel totally free of cost. As an added benefit the modern biogas plants are almost maintenance free and provide ready to use nitrogen rich organic fertilizer in the from of slurry without any extra effort or expense. There for if in the future ,the amount allocated in budgets for waste disposal give maximum thrust to imply establishment of biogas tanks in each house hold by making it mandatory by law, this program will surely hit huge success and will give us a waste free and clean public roads.

Of the many agencies interviewed, three were private teams and one owned by the state government. All of them have claimed to have sold more than ten tanks per month in the current financial year, the prices range from INR 11,500/- to 35,000/-. This shows that the costs are quite unaffordable to common man. Response to the question on awareness programmes conducted most of them replied in the negative. The agencies are not genuinely interested in knowing the opinion of users oh biogas. That is why they do not keep a track record of feed back collection systematically.

All these clearly points to the need of a cooking fuel which is environment friendly and economical. The government and noted activists are constantly publicizing this need and suggest alternatives like biogas through versatile media .This is being continued for decades but with little effect. The survey revealed that none of the households use biogas as the main cooking fuel. Even those who use biogas as a supportive and supplementary fuel source with LPG and other equipments were also negligible. In the mean time awareness programmes from the ruling bodies continue as usual as a ritual. Everyone know that such programmes in public interest cannot be done free of cost. They definitely eat up a major share of revenue meant for upbringing the social life .As long as convenient facilities are available to people they will not bother about long term consequences. Being a highly government dependent society we almost forgot to find out new vistas with a vision for self help. Cooking fuel is such an issue today. Therefore mere awareness programmes will not do. Keeping a long term goal the Government must make use of biogas in each house hold, mandatory by law.

Summary and conclusion

Biogas is unique in several aspects when compared to its alternate fuel counterparts. The commendable factor that makes biogas unique is that its substrate is not only absolutely free (*kitchen waste and faeces*) but also something that we always wanted to get rid off, the bio-waste. So installing a biogas plant naturally becomes 'two birds in one shot' type of achievement. Probing further we come across the positive facts like: it is non-explosive, non smoky flame, regulatable just like an LPG stove, tank available at subsidized rate, almost repair free, portable, no complicated technology, flame strength equivalent to that of LPG, one hour flame guaranteed for every 3 to 4 kg biowaste per day, space requirement not more than a normal water tank, any non-fibre and non-acidic biowaste can be raw material.

Apart from guaranteed features, it has added benefits too. One of the added advantages of a biogas facility is that the unspent slurry is a rich source of nitrogen rich manure for vegetable crops. Since cow dung is required only during the initial stage; user is free from the menace of cattle breeding. Moreover, unpleasant odour of dung lasts for the first 3 or 4 months only. Another advantage revealed from our study is that the bio-energy tank in continuous use was found to retain its activity even after keeping idle for up to four months. This means the nuclear family who own an active biogas tank can go for anguish free holidays for months together! The greatest advantage for a budget family is that along with doing away with garbage, they are now able to save their LPG cylinder for an extra month or two. This means savings not only for them but the whole nation. Now in real quantitative terms let us see what the savings is in Indian rupee. Suppose you are a person using 8 LPG cylinders per year. By using LPG it is reduced to 6. You straightly save approx. Rs. 800/- (*400 x 2*) for yourself and 600/- (*300 x 2 in terms of subsidy*) for the nation. Just multiply with crores of citizens and we happily arrive at the magic of biogas in bringing national level savings to the tune of multicrores which can be diverted for better infra structure across the country which as a natural byproduct of biogas usage, would have already become almost garbage free too.

This being the crystal clear truth however, according surveys conducted by us during 2010 and 2015, initiative from the governing bodies could only increase the percentage of biogas users from 0.6 during 2010 to a meager 1.2 after a span of five years. At the same time

households who wish to install a biogas tank in their premises has increased from 68 to 79 per cent.

Being a highly government dependent society we almost forgot to find out new vistas with a vision for self help. Cooking fuel is such an issue today. Therefore mere awareness programmes will not do. Keeping a long term goal the Government must make use of biogas in each house hold, mandatory by law. Future prospects of this investigation suggest a modified version of biogas usage for urban users and flat dwellers which involve cultured vials of anaerobic methanogenic bacteria developed through research.

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