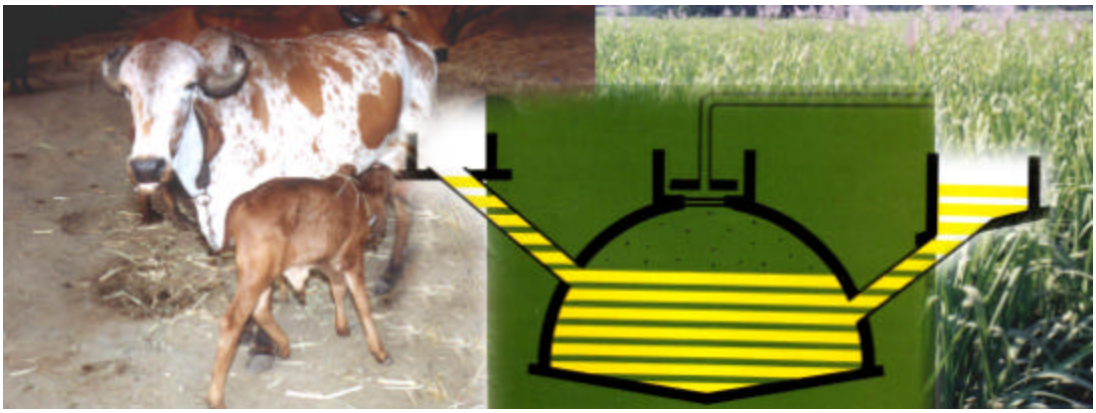
SOCIO - ECONOMIC AND ENVIRONMENTAL IMPACT OF BIO GAS PROGRAMME

WITH SPECIAL REFERENCE TO THE KARUNAPURAM AND KANCHIYAR PANCHAYATHS OF IDUKKI DISTRICT.



March 2004

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By

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Abstract

Socio - economic and environmental impact of Bio Gas Programme with special reference to the Karunapuram and Kanchiyar Panchayaths of Idukki District was undertaken with the support of Kerala Research Programme on Local Level Development, Centre for Development Studies, Thiruvananthapuram. Malanadu Development Society is a Non Governmental Organisation having its headquarters at Kanjirapally, was involved in implementing Biogas Programme since early 1980s. Its area of operation is Kottayam, Idukki and Pathanamthitta districts. The location of the study is Karunapuram and Kanchiyar, two Panchayaths in the Idukki district. Biogas Programme is a spectacular success in Karunapuram Panchayath, while its performance in Kanchiyar was quite dismal. The purpose of the study was to assess the social, economic and environmental impact of the biogas on the adopters on the one hand and to document the experience of MDS in planning, implementing and organizing biogas programme

MDS used a host of simple but innovative techniques to popularize the biogas programme. Its achievement in Biogas nearly comes to one third of the total achievement of the State of Kerala. MDS helped in simplifying and demystifying Biogas technology. It has contributed substantially to cost reduction of Biogas Programme, thus enabling large-scale adoption even by small and marginal farmers.

Biogas has revolutionized both the kitchen and the garden, generating fuel and manure. Women have been the greatest beneficiaries of getting this clean and efficient fuel in the kitchen. The men are attracted more towards the excellent bio manure produced by the biogas plants. The bio slurry is an excellent soil conditioner and immensely benefits the productivity and disease resistance of crops. Bio slurry provides a hope for the dwindling agriculture in the highrange villages. Though MDS has been successful in the extension aspect of the biogas programme, it is yet to generate sufficient knowledge base to develop learnings and market the learnings for the good of the State. MDS has been concentrating more on the implementation of the programme as an activity and less efforts have been made on generation of knowledge. This is a weakness in its otherwise spectacular and successful programme.

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CHAPTER I

1 INTRODUCTION

1.1 Statement of the problem:

Energy is a means for performing activities. For the humanity, energy is a vital component of development. There are two types of energy sources on the Earth: a) Conventional Energy Sources and b) Non-conventional energy sources. Conventional energy is obtained from a static storage such as fossil fuels, nuclear reactions etc. It remains static bound in position until it is released by human actions. These are finite and non renewable. On the other hand, non-conventional energy is obtained from natural sources, which can continuously form a current in the environment. These sources are known as renewable sources of energy. Solar energy, wind energy, geo-thermal energy and bio energy fall into this category. Non-conventional energy sources are pro-rural, decentralised, infinite, locally available and safe when out of action.[1.1]

There are several factors that prompted humanity to search for non-conventional forms of energy; the oil crisis of the 1970s, the realization of the exhaustiveness of conventional sources of energy, problems of pollution and a concern for developing appropriate energy sources for the rural population are to name a few of those factors. The key concerns that guided the search for alternative energy sources were that such alternative energy sources need to be renewable, safe, locale specific, cheap, decentralised and appropriate. Biogas, as an important source of alternate energy finds its place here.

[1.1] Integrated Energy Planning-Rathore N.S.& Others.

Biogas has become a popular rural energy form in India as well as in the villages of Kerala thanks to the efforts of both the governmental and non-governmental sector. The involvement of the non-governmental sector in promotion of biogas programme began in the early 1980s in India as well as in Kerala.

Malanadu Development Society [2.1] began promoting biogas programme in the early 1980s. Rural population in the highrange villages of Kerala, especially in the Idukki district, enthusiastically adopted it. There exists a situation of severe fuel wood shortage in most of these highrange villages, furthering the pressure on the remaining greenery in the area. Deforestation for domestic fuel supply and other commercial purposes add to the environmental crisis. Some of the dimensions of this crisis manifests in scarcity of fuel, water, change of micro climate and sustainability threats to the agricultural activities. This in turn jeopardizes the livelihood of the rural population.

Thus 'Socio - economic and environmental impact of Bio Gas Programme with special reference to the Karunapuram and Kanchiyar Panchayaths of Idukki District' is an effort to assess the impact of the biogas programme in the rural areas of the highranges and the role of MDS in popularizing the programme. Karunapuram and Kanchiyar are two Grama Panchayaths in the highranges of Idukki district. Karunapuram Panchayath lies bordering Tamil Nadu and is flanked by Nedunkandam, Pampadumpara and Vandanmedu Panchayaths. Kanchiyar Panchayth is on the other hand surrounded by Ayyappancovil, Upputhara, Kattappana, Kamakshy Panchayths on three sides and by the Idukki reservoir on the fourth side. Both the Panchayaths have predominant settler communities who have migrated as early as 1950's.

[2.1] Malanadu Development Society- (MDS) is a registered charitable society (No- K-201/77 dated 18th July 1977) under the Travancore Cochin Literary, Scientific and Charitable Societies Act 1995. MDS is the official agency for social and development work in the diocese of Kanjirapally.

1.2 **Specific Objectives:** There are two objectives to the study

1) Documentation of the experience of Malanadu Development Society in implementing Biogas Programme, focusing on adoption and process of adoption of Biogas based energy system in the selected area- the diffusion, problems of operation, technology modifications at the level of various stakeholders and management of the biogas programme.

2) To analyse the impact of Biogas programme on the lives of the rural communities, especially focusing on

   Biogas programme and gender sensitivity.

   Biogas and agriculture

   Biogas and rural energy

   Cost benefit analysis of Biogas Plants

1.3 **Method of Study**:

Both qualitative and quantitative methods were employed in conducting the study. The qualitative methods chiefly consist of Participatory Research Methods and tools such as Review of secondary data, Review of internal documents and data at Malanadu Development Society, Reconstruction of local history in selected highrange villages and Focus Group Discussions. For obtaining quantitative data, a questionnaire was used to conduct structured interviews with selected programme beneficiaries.

1.3.1. **Primary Listing of Households**: After the area was identified and selected, all households, which had either biogas plants or kept cattle were listed. Volunteers and research assistants did this through house visits. A single page questionnaire was used to record the information.

The information from the primary listing of households was tabulated using excel spreadsheets. Following this, a list of households which keep livestock either

cows or buffalos were identified. It was possible to make a classification of biogas plant owning households, providing ward wise distribution of plants, agency of construction, functionality of biogas plants, size of the biogas plant and year of construction. The information collected from the primary listing was submitted to KRPLLD. A Statistician was consulted for comments and guidance on choosing the final sample and method of sampling. On the basis of the above details and expert comments from the Statistician, a sampling frame was designed for conducting the final survey.

1.3.2 **Sampling plan**: Stratified sampling design was adopted. Three strata were proposed for the time periods such as a) prior to 1990, b) 1991-95 and c) 1996-2001. Within each of the strata, further sub-strata are formed to take into account the variables such as size of biogas plants. A total of 5 sub strata were proposed to take care of the size sampling. Together with the time period classification and size wise classification, there were 15 strata for each of the Panchayath.

321 biogas plants were listed in the Karunapuram Panchayath and 88 in Kanchiyar Panchayath. 100 plants were chosen from the Karunapuram Panchayath and 33 from the Kanchiyar Panchayath as samples for survey.

Table 1: **Sampling frame for Karunapuram Panchayath**

Allocation of sample size to different strata and sub-strata- Karunapuram						
Size class of plants	Up to 1990		1991-1995`		1996-2001	
	Total population size	Sample size	Total population size	Sample size	Total population size	Sample size
1 M^3	1	1	2	2	14	4
2 M^3	5	2	24	8	53	16
3 M^3	16	5	59	16	144	44
4 M^3	0	0	1	1	0	0
10 M^3	1	1	0	0	0	0
All sizes	**23**	**9**	**86**	**27**	**211**	**64**

Thus a total of 100 samples out of 321-biogas plant owning households were selected for the survey. Of these, 100 biogas plants, 9 were constructed before 1990, 27 Nos between 1991-1996 and 64 between 1996-2001. No biogas plant constructed after 2001 is considered in the sample survey.

Table 2 – **Sampling frame for Kanchiyar Panchayath**

Allocation of sample size to different strata and sub-strata- Kanchiyar						
Size class of plants	Up to 1990		1991-1995`		1996-2001	
	Total population size	Sample size	Total population size	Sample size	Total population size	Sample size
1 M^3	0	0	0	0	13	4
2 M^3	1	1	5	2	25	8
3 M^3	2	2	10	4	29	9
4 M^3	0	0	0	0	1	1
10 M^3	0	0	1	1	1	1
All sizes	**3**	**3**	**16**	**7**	**69**	**23**

Kanchiyar Panchayath on the other hand has a total of 88 biogas plants in the four selected wards and of these, 33 plants are selected for detailed survey. A sample format of the preliminary listing survey and detailed survey are attached at the end of the report as separate annexure.

1.4 Study Area

The study area comprises of two Panchayaths Karunapuram and Kanchiyar, in the highranges of Idukki district. The original plan was to study the impact of biogas programme focusing on the Karunapuram Panchayath in Idukki district, where rural households substantially adopted the biogas programme. However, as the methodology got refined, it was decided to take up one more Panchayath, named Kanchiyar in the highlands of Idukki. This was on the ground that though both the Panchayaths fall into the operational area of MDS, Karunapuram had fared much

Fig I Map of Idukki district with Grama Panchayaths

better while the achievement in biogas programme in the Kanchiyar Panchayath was poor. Hence it was decided to study a case each of successful and poor performance. The following wards were selected for the study

Table 3: Wards selected for the study in Karunapuram and Kanchiyar GPs

Name of the Panchayath	Wards selected for the study
Karunapuram	V,VI, VII & VIII
Kanchiyar	III, IV, VI & IX

The wards selected were contiguous and is considered to be a miniature representation of the Panchayaths concerned.

Fig- 2 Ward-wise map of Kanchiyar and Karunapuram Panchayaths

1.5 **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.

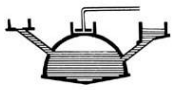
It is hoped that the study will bring forth useful clues that can go a long way in improving agriculture in Kerala, especially in the highranges of Kerala. It gives MDS, other NGOs, Panchayaths and Research Institutions useful insights on sustainability, replicability and scaling up the programme and draw lessons from it for the whole of Kerala.

1.6 Organisation of the Report

The background of the study and the problems raised are mentioned briefly in Chapter I. Chapter II gives an introduction to Biogas Programme and presents a brief history of the same in India. Chapter III documents the efforts made by Malanadu Development Society in implementing Biogas Programme in Kerala. Chapter IV presents the analysis of the impact of Biogas Programme on the lives of rural communities, the gender sensitivity of the programme, the relationship of biogas programme with agriculture and rural energy together with a cost benefit analysis of the programme in the context of the rural Kerala. Chapter V gives the conclusions, learnings and recommendations.

1.7 Limitations of the study

The study has been conducted using Participatory Research Methodology and questionnaire based survey. Orally transmitted stories of migration to the highranges and the history of settlement in the highrange villages have been collected and documented and this forms the socio-economic background of the Panchayaths where the study has focused. Oral history has been triangulated and documented to the extend possible, but cannot be substantiated in the study by documentary evidences. Theory testing and modification are not attempted in the study. At best, this turns out to be process documentation, coupled with a first level assessment of the impact of the Biogas Programme.



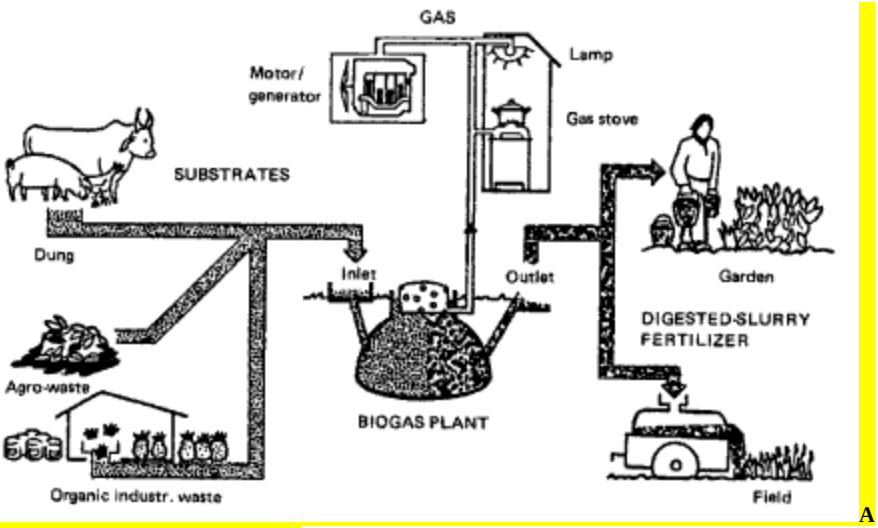
CHAPTER II

Biogas Programme in India

2.1 Biogas Basics

Biogas originates in the process of bio-degradation of organic material under anaerobic (without air) conditions. The natural generation of biogas is an important part of the biogeochemical carbon cycle. Methanogens (methane producing bacteria) are the last link in a chain of micro-organisms, which degrade organic material and return the decomposed products to the environment. Biogas tends to occur naturally wherever high concentrations of wet organic matter accumulate in the absence of dissolved oxygen, most commonly in the bottom sediments of lakes and ponds, in swamps, peat bogs, intestines of animals, and in the anaerobic interiors of landfill sites.

Biogas is a mixture of methane, carbon dioxide, and numerous trace gases. The most prominent constituent of biogas is methane (50%-80%) followed by carbon dioxide (20%-50%), and trace levels of other gases such as hydrogen, carbon monoxide, nitrogen, oxygen, and hydrogen sulfide.



A typical biogas system configuration
Source: OEKOTOP

Figure – 3 – A System configuration of Biogas.

2.1.1. Digester Designs

The biomethnation takes place in an anaerobic digester. Anaerobic digesters are made out of concrete, steel, brick, or plastic. They are shaped like silos, troughs, basins or ponds, and may be placed underground or on the surface. All designs incorporate the same basic components: a pre-mixing area or tank, a digester vessel(s), a system for using the biogas, and a system for distributing or spreading the effluent (the remaining digested material).

2.1.2. The Digestion Process

Anaerobic decomposition is a complex chemical process. It occurs in three basic stages as the result of the activity of a variety of microorganisms.

Table 4: Stages of Digestion in Biogas generation

Stage	Actor	Result
I	Cellulolytic Bacteria	Convert Polymers to sugar
II	Acetogenic Bacteria	Convert sugar to Acetic Acid
III	Methnogenic Bacteria	Convert Acetic Acid to Methane

2.2 Biogas Programme in India

2.2.1. **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	Mr M.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

2.2.2 The evolution of biogas technology

Biogas plants in India were experimentally introduced in the 1930's, and research was principally focused around the Sewage Purification Station at Dadar in Bombay, undertaken by S.V. Desai and N.V. Joshi of the Soil Chemistry Division, Indian Agriculture Research Institute, New Delhi. The early plants

developed were very expensive and were not cost effective in terms of the gas output. Indeed the early models were not producing enough gas to supply a small family (KVIC, 1993). Some of the early models were also prone to burst; so overall, the technology was not viable for dissemination.

Jashbhai Patel designed and made several small-scale biogas digesters, envisaging farm labourers as the user. Although other individuals and institutions were also designing biogas plants. The Khadi and Village Industry Commission chose in 1961 to promote Patel's design, which, although more costly than other models, was more productive, had a longer life, and required minimal maintenance (KVIC, 1993).

The basic plant, which came to be known as the KVIC model, consists of a deep well, and a floating drum, usually made of mild steel. The system collects the gas, which is kept at a relatively constant pressure. As more gas is produced, the drum gasholder consequently rises. As the gas is consumed, the drum falls. Thus the pressure of gas in the plant is demonstrated by the rise and fall of the gas holding drum. The biomass slurry moves through the system, as the inlet is higher than the outlet tank, creating hydrostatic pressure. Only completely digested material can flow up a partition wall, which prevents fresh material from 'short-circuiting' the system, before flowing into the outlet tank. Dimensions of the plants depend upon the energy requirements of the user (Lichtman, 1983). By the early1980's, there were thought to be about 80,000 systems built by KVIC.

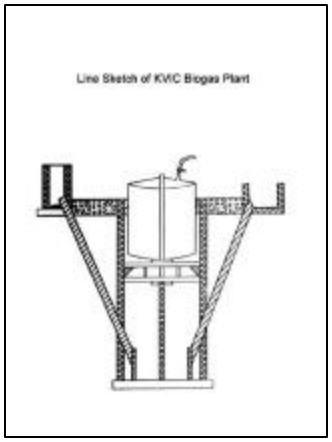


Fig: 4
Line sketch of KVIC Biogas Plant

Fig: 5
Gas Holder filled with gas in KVIC Plant- gas holder floats above the ground level

Research into anaerobic digesters continued around the country, and the Planning Research and Action Division (PRAD) based in Uttar Pradesh, developed the 'Janata' fixed-dome plant, based on a modified design widely used in China. Key features of the Janata model, is the fixed-dome, in contrast to the floating dome of the KVIC model. With this design, the inlet and outlet tank volumes are calculated for minimum and maximum gas pressures based on the volumes displaced by the variation of gas and slurry within the system. The Janata system is about 30% cheaper to construct than a KVIC model of the same capacity with added advantages that there are no moving parts, making local construction possible and maintenance easy. Anaerobic digester design has continued to evolve over the years, but systems are generally variations around the theme of the floating-dome and the fixed-dome design. Often construction materials vary, or loading positions differ.

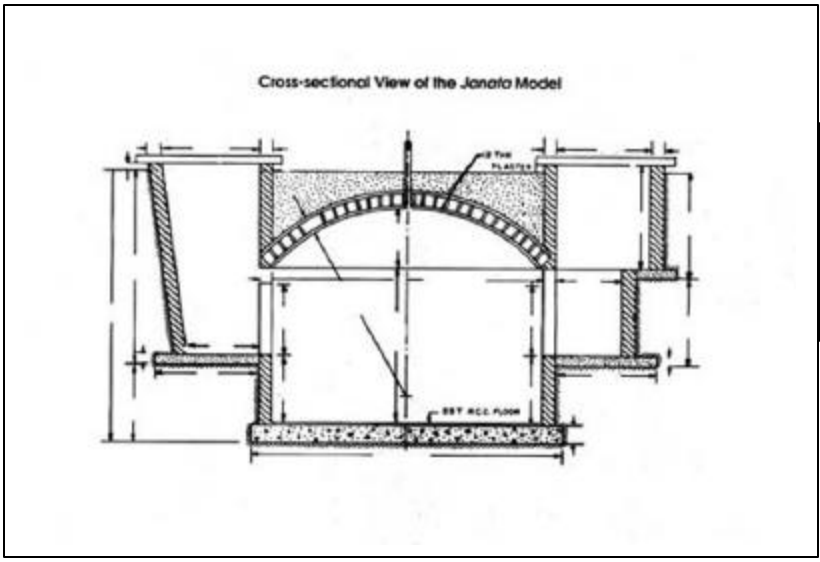


Fig: 6
Cross sectional View of Janata Model Biogas Plant

On the whole, the evolution of biogas technology was slow prior to 1973. There were two grounds for why biogas was not given a prominent place in the development agenda of the country; firstly, the import price of fossil fuels was cheap and affordable even for a country like India. Biomass fuels were still abundant as in early 1970s and therefore the need for developing an alternative fuel did not receive serious attention. The 'oil shock' of 1973 altered the situation drastically. The involvement of Government of India in biogas research, extension and investment was much on a higher scale than before. Table 6, below, shows some of the most common biogas plants that are recognized by the government.

Table 6: Different Types of biogas Plants recognized by MNES- Government of India

1. Floating – drum plant with a cylinder digester (KVIC model)
2. Fixed dome plant with a brick reinforced moulded dome (Janata model)
3. Floating – drum plant with a hemisphere digester (Pragati model)
4. Fixed – dome plant with hemisphere digester (Deen bandhu model)
5. Floating- drum plant made of angular steel and plastic foil (Ganesh model)
6. Floating-drum plant made of pre-fabricated reinforced concrete compound units
7. Floating-drum plant made of fibreglass reinforced polyester
8. Deenbandhu biogas plant constructed with ferrocement material and technology

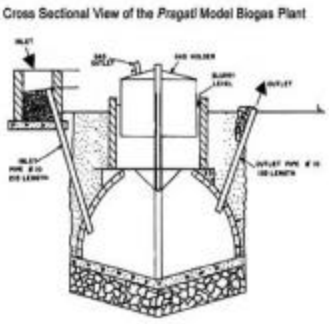


Fig: 7
Pragati Model Biogas Plant

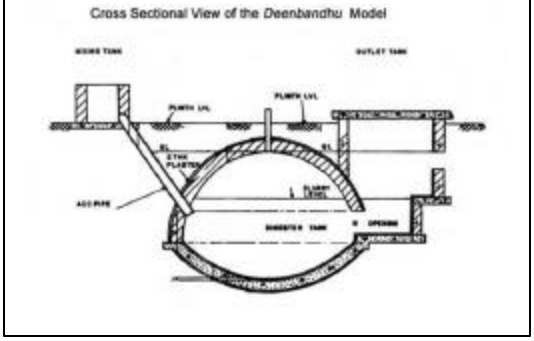


Fig: 8
Deen Bandhu Model Biogas Plant

2.2.3 Direct involvement of Government of India in the Dissemination of biogas systems:

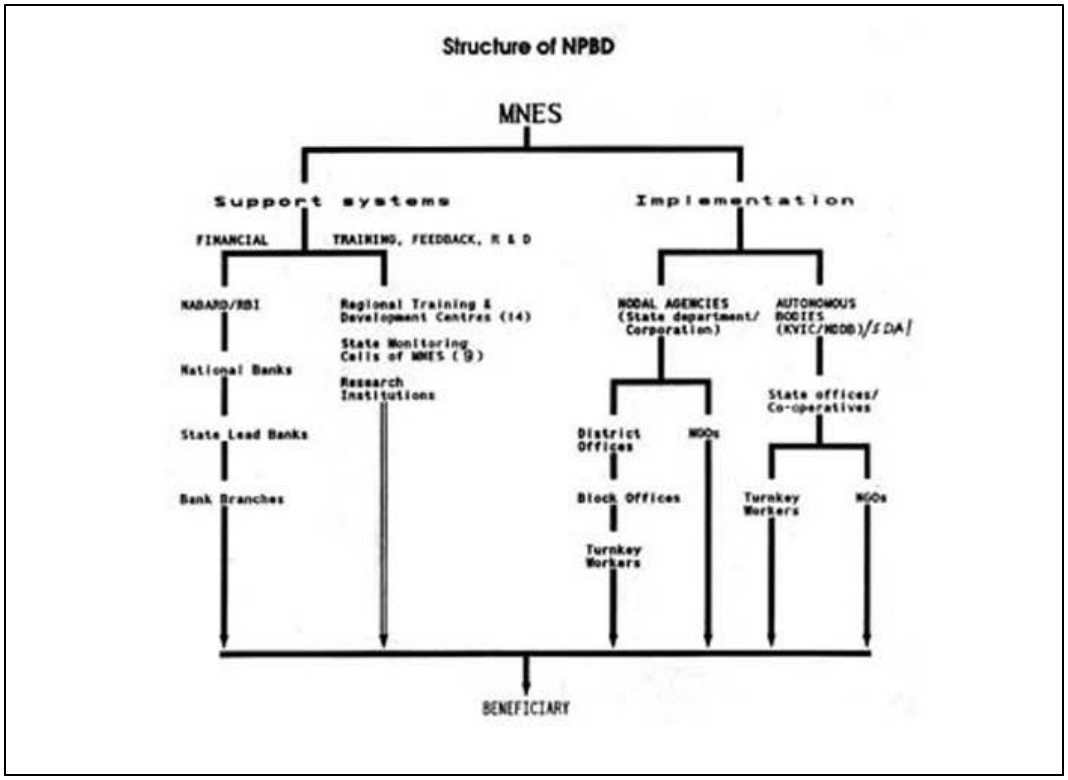
Biogas programme is the largest and most prominent of all the rural renewable energy programmes implemented by Government of India[16.1]. (Biogas the Indian NGO Experience-Soma Dutta and others- TERI) Dissemination of Biogas programme began to receive the direct attention of the Government of India since 1974. Shri. E. F. Schumacher studied the impact of biogas on the lives of the rural population and brought it to the attention of Mrs. Gandhi, the then Prime Minister of India. She took up the dissemination of the programme in right earnest since 1974. The National Project for Biogas Development (NPBD) was launched in 1981. Another important development was the formation of the department of Non-conventional Energy Sources – DNES under the Ministry of Energy-Government of India.

[16.1] Biogas-the Indian NGO Experience-Soma Dutta and others
TERI-New Delhi.

2.2.4. National project for Biogas Development

NPBD was launched in 1981 to provide a focused impetus to the promotion of biogas mostly as a rural energy system. Special financial provisions to support the implementation of NPBD such as a subsidy to the individual households adopting biogas, turn key fees to corporate bodies, registered societies and private entrepreneurs to help promote biogas in the country, additional central subsidy for linking toilets with biogas plants, promotional cash incentives to village functionaries and approved workers, service charge in lieu of staff support to state governments, KVIC and other institutions, repair charges for rectification of defective plants, introduction of various training programmes at different levels from users to planners and award of prizes to implementing agencies and institutions etc.

Fig: 9 Structure if National Project on Biogas Development



MNES recognized three options for biogas under the NPBD. These are

1. The Family size plant- meant for small family of 5 to 7 members and keeping 2 to 5 cattleheads.
2. The Institutional Plant meant for Institutions and Ashrams with their own livestock
3. The Community Plant which is meant to serve a community or neighbourhood, connecting all houses/kitchens with the community gas grid [18.1]

Currently, there are thought to be about 3.3 million biogas plants installed around the country though the potential of large-scale implementation of biogas technology remains unrealised[18]. The Tata Energy Research Institute, New Delhi, estimates that 12 million biogas systems in total could be installed over the subcontinent, while GATE, an alternative NGO based in Germany and promoting alternate energy, estimates the total potential number of plants that could usefully be employed to be 30 million household-size, and nearly 600,000 community-size plants, one for each village.

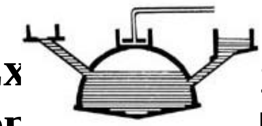
Implementation of biogas technology is overseen centrally by MNES, but actual dissemination is devolved to the state governments, public corporations, such as KVIC, the National Dairy Development Board (NDDB), and also NGO's. Although there will be differences between states, the general approach to disseminate biogas technology is based on a system of subsidies and concessions, to encourage uptake.

Subsidies are granted on plants upto $10m^3$ (a large family-sized system), and for the models recognized by the government, though there may be regional differences. The extent of the subsidy is dependent on the size of plant, socio-economic status of the user, and geographical region. India is divided into three areas according to altitude; the mountainous north-east is where the highest allowances are paid. Mountainous, or high altitude areas in other states form the second category, and the remaining states make up the last category. Here, socio-economic status largely determines the size of the allowance, with priorities for scheduled caste and tribe, and smallholders.

[18.1] Annual Report 2002-03 MNES- GOI

Subsidies certainly appear to have encouraged up take, and participation seems to be high amongst target groups, such as marginal and smallholders.

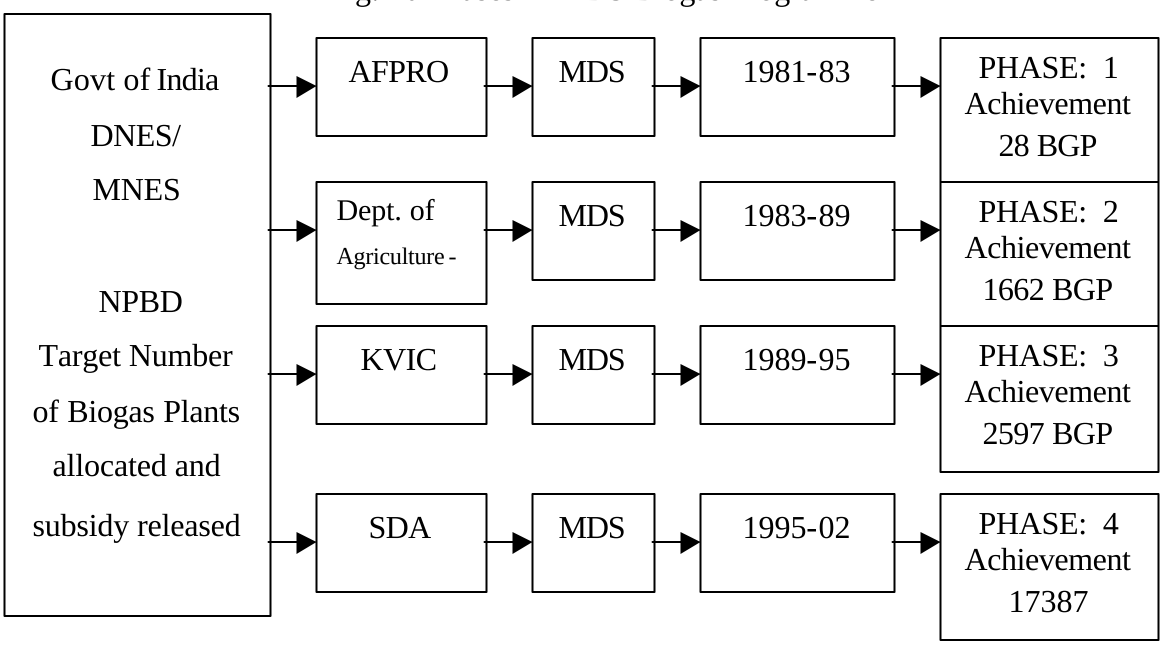
Chapter

Biogas Development and Ex  gramme in Malanadu Develop ty

3.1. **Introduction**

MDS ventured into the Biogas programme in 1981. Learning the technology from Action for Food Production- AFPRO, a Delhi based, NGO, MDS has become instrumental in diffusing the biogas technology in tens and thousands of households in rural Kerala. There are four phases in the Biogas programme of MDS and are presented as follows.

Fig: 10 Phases in MDS Biogas Programme



Fr. Mathew Vadakkemuriyil founder and Secretary to MDS from 1977 to 2001, nearly 25 years, was hand picked to head the department of social works in the diocese of Kanjirapally. He recalls his venture into the biogas programme.

" I was Assistant Parish Priest at Arpookara from 1968 to 1970. It was during this period that I came into contact with the Khadi and Village Industries Board and its District Project Officer, Mr. T. V. Varghese. He told me about Biogas plants and its potential to solve rural fuel shortages. But KVIC was more concentrating on building biogas plants in institutions and not so much in the households. There were very few takers for biogas at the household level as well. Through his intervention, an institutional biogas plant was constructed at Kurumbanadam convent, giving me also an opportunity to see the plant and its functioning.

KVIC built only floating drum type plants at that time. I was transferred to Kanyakumari in 1970 and Biogas got out of my mind for a while. I was brought back to the diocesan headquarters as Secretary to Changanassery Social Service Society (CHASS) in 1974. I revived my contacts with the KVIC/ KKVIB. I must mention that the officers of these two bodies were committed and religiously did their duties. Mr. Poolani Thomas and Joseph Pinan were also involved in the biogas extension programme those days. KVIC had already supported CHASS in founding a Bee Keeping programme and it had taken off well. Therefore, when they mentioned about the biogas, I had no second thoughts at all. But the technology of the floating drum plants appeared complicated and costly. After three years, the diocese of Kanjirapally was erected and I was appointed Director of Social Works in the new diocese. We founded Malanadu Development Society (MDS) in 1977 July. While I was involved with the activities of MDS in 1977-78, Late Mr. Joseph Parambil (Kunju), Erumely parish showed me a design of biogas plant which looked like the Janata model biogas plant. I do not know how and where he came across the same from. I started looking for more details on the same. I was advised to contact Ministry of Agriculture, Government of India. The first contact was with Dr. K. C. Kandelwal. He put me in touch with PRAD – GGRS – Uttar Pradesh and AFPRO. I failed to get any information from PRAD. But Raymond Myles and JB Singh at AFPRO were extremely helpful. AFPRO transferred technology of Janata Biogas Plant and later Deen Bandhu Biogas Plant to MDS. Mr. Myles came down to Parathode and conducted the first Masons

Training Programme. The NPBD was already underway and AFPRO gave a small target of Biogas Plants from allocation it received from DNES to MDS in the early years. Thus MDS learnt the first lessons of technology and management of biogas from AFPRO[21.1]

3.2 MDS and AFPRO

Action For Food Production (AFPRO) is a non-governmental, socio-technical development organisation that has been working to reduce rural poverty in India. It was set up with Christian inspiration in 1966. It was providing technical guidance and back-up support to grassroots-level NGOs in implementing environmentally sound food production and livelihood related projects. AFPRO's core competencies are in land and water management, agriculture, livestock, fisheries, renewable energy and forestry. AFPRO reaches out to poor communities through 6 field units and 3 task forces, strategically located in 9 different states of India. It had a field unit at Coimbatore and Bangalore. NGOs in the Kerala and Tamil Nadu states were coordinated by the Coimbatore office of AFPRO.

Contact by MDS resulted in AFPRO's decision to associate with MDS and to share the technology of the new model plant. AFPRO was actually on the lookout for dedicated agencies capable of popularizing the low cost, efficient new model biogas plant, the technology which it had already obtained from PRAD in UP. By then the new model was selected after successful tests in the field level and was christened 'Janata Model' Biogas plants.

In 1981, Government of India announced the National Programme for Biogas Development (NPBD), with Rs.50 crores outlay in the 6th Plan period. AFPRO was selected by the Government of India as one of the agencies to implement NPBD through its existing network of NGO partners throughout India. Thus MDS became an AFPRO partner in Kerala for implementing NPBD.

[21.1] Personal conversation with Fr. Mathew Vadakkemuriyil

3.2.1 **The First Biogas Training Programme in Kerala**

As a first step towards the promotion of the new biogas technology in Kerala AFRPO proposed to conduct a Regional Training Workshop for Master Masons. MDS readily accepted the idea. It proposed to organize the event which, included construction of demonstration plants of the new model at its Parathode Training Centre, Kottayam. MDS knew that this was going to be the first ever biogas training programme undertaken by any voluntary agency in Kerala, the plants constructed being the first ever models of the new design in the entire State. Therefore, it made conscious efforts to disseminate the idea of biogas programme throughout Kerala, organizing a massive pro- publicity campaign for creating awareness about the programme through All India Radio, articles in all vernacular dailies and personal letters to Heads of all prominent social service organizations of Kerala.

The participants in this pioneering programme were carefully selected after screening the applications received from all over Kerala. A total of 14 persons were selected from voluntary as well as Governmental agencies. They included representatives from Nehru Yuvak Kendra, Alleppy, Mithra Nikethan - Trivandrum, APCOS Chakkupallam, Dakshina Kerala Mahayidavaka, Trivandrum, K L M Milk Society Moolamattom, Diary Farm Adoor, Socio-Religious Centre Malapparambu, besides nominees from AFPRO and Malanadu Development Society. The Janata biogas plant training was conducted at MDS Training Centre, Parathodu from 31-08-1981 to 20-09-1981 for 21 days. Fourteen master masons were trained and 2 demonstration Janata Plants of $2m^3$ and $6m^3$ capacity were constructed.

AFPRO provided technical and financial support for the first mason training programme and construction of the demonstration plant. It continued to regularly allot further mason training programmes, user's conscientization programmes with financial assistance to MDS.

Table No- 7

Details of Masons Trained Organised by MDS with the support of AFPRO

Period/ Duration	Training Type	Venue	No. of Persons Trained
September 1981	Master Masons Trg	Parathode	14
Oct- Nov 1982	Mason Training	Changanassery	14
November 1982	Mason Training	Kanjirapally	23
December 1982	Mason Training	Anakkara	23
November 1983	Masons Training	Anakkara	10
Total			84

A total of 84 masons were trained directly under technical expertise and guidance of AFPRO between 1981 and 1983.

From1981-82 onwards AFPRO channeled assistance under NPBD programme of Government of India to MDS. AFPRO recommended MDS to Government of Kerala in 1983 as a turnkey agent for the implementation of the NPBD scheme in Kerala and for its subsidy scheme. The Government of Kerala approved MDS as an agency for implementing the programme in Kerala on 23-09-83.

AFPRO forwarded a project proposal from MDS to Canadian Hunger Foundation (CHF), with its recommendation for infrastructural assistance on 11-03-1983. CHF has been involved in supporting rural energy project in India. The proposal included a provision for additional subsidy to the poorest of the poor to construct biogas plants besides assistance for infrastructural support. CHF approved the proposal and MDS got the first CHF grant in the same year. The above assistance enabled MDS to appoint a full time Engineer and Supervisors and to acquire a

vehicle for its biogas department. When the Deenbandhu biogas technology was perfected, AFPRO offered the same to MDS for adoption in Kerala. Thus in the first phase of biogas development and extension at MDS, it received full support from AFPRO. The support included skill transfer and technical know how, financial assistance to conduct trainings, construction of demonstration plants and conduct large number of awareness programmes among the people. MDS was able to construct 28 biogas plants during this period.

3.3 MDS and Department of Agriculture - Government of Kerala

Government of Kerala recognized MDS as a turnkey agency through its communication dated 23-09-83. It followed the following process for implementation of Biogas Programme. Applications would be collected from prospective beneficiaries, expressing their interest to construct biogas plant. A paper containing the terms and conditions of constructing the biogas plant would be sent to the beneficiaries. The beneficiaries have to read and understand the contents of the 'Terms and Conditions', sign the same for approval and compliance and forward it to MDS office. Thereafter, MDS personnel would initiate construction of biogas plant and the completion of the same would be reported to the department of Agriculture. There was a processing period ranging from a few weeks to a few months before a responsible officer in the department of agriculture would come to inspect the functionality and other bonafides of the plant. Once this is convincingly proved, the inspecting officer would recommend the plant owner as eligible for subsidy from Government of India channeled through department of agriculture, Government of Kerala. The subsidy amount was released to MDS in bulk. MDS would convene a meeting of beneficiaries and the subsidy amount is released to the beneficiaries only in the meeting. If the bonafide beneficiaries do not come, the subsidy amount is retained until such time the real beneficiary is able to come and collect the amount in person.

Another milestone in the collaboration between MDS and Department of Agriculture was the construction and commissioning of a 36 M^3 KVIC type

biogas plant at Kundala near Mattupetty in the tribal colony. This project was successfully implemented by MDS for Dept. of Agriculture.

Table-8 Year wise Achievement of Biogas Plants by MDS in collaboration with Dept. of Agriculture, Government of Kerala

S No	Year of Operations	No. of Biogas plants constructed	Collaborating agency
1	1983 – 84	84	Dept of Agriculture Government of Kerala
2	1984 – 85	369	
3	1985 – 86	155	
4	1986 – 87	148	
5	1987 – 88	384	
6	1988 – 89	522	
7	Total	1662	

Table No-9

Comparative achievement between MDS and Dept of Agriculture- GoK.

Year	No. Of Biogas Plants constructed by Dept. of Agriculture	No of Biogas Plants constructed by MDS	Total Under each phase for MDS
1981-82	00	4	Phase I Collaboration with AFPRO 28 Biogas plants
1982-83	00	24	
1983-84	513	84	Phase II Collaboration with Dept of Agriculture. (Figures of achievement of Department of Agriculture includes the figures achieved by MDS) 1662 Biogas Plants
1984-85	2750	369	
1985-86	2277	155	
1986-87	1973	148	
1987-88	1810	384	
1988-89	2424	522	
1989-90	2503	397	Phase III Collaboration with KVIC 2597 Biogas Plants
1990-91	2662	307	
1991-92	2818	495	
1992-93	2882	475	
1993-94	2821	367	
1994-95	1955	556	
1995-96	1250	972	Phase IV Collaboration with SDA 17387 Biogas Plants
1996-97	1013	1789	
1997-98	1527	1341	
1998-99	993	390	
1999-00	1123	5459	
2000-01	1265	4686	
2001-02		2750	
Total	34559	**21674**	

It is interesting to note that Department of Agriculture under Government of Kerala has installed a total of 34559 biogas plants under the NPBD. The comparative achievement of MDS in the same period shows that MDS began on a modest scale a couple of years prior to Department of Agriculture began participating in the NPBD. However over a period of time, the achievement of MDS and Department of Agriculture are quite comparable, considering one as a NGO and the other having a statewide network of offices and institutional support.

3.4 MDS and KVIC

KVIC began to vigorously implement biogas programme by late 1980s. Officials of the KVIC were sent to MDs to do liaison talking and attract MDS as well as other NGOs actively operating in the Biogas sector to the side of KVIC. NGOs had some dissatisfaction at the operational style of the department of agriculture. The procedure of releasing subsidy was cumbersome and was causing inordinate delay. KVIC promised to remedy this delay. So there was a switch over from Department of Agriculture to KVIC in 1989. KVIC approved MDS as a turn key organization to construct, commission and transfer biogas plants to households and institutions.

Table No-10: Achievement in MDS – KVIC collaboration

No	Year	No. of Plants	**MDS and KVIC**
1	1989 – 90	397	
2	1990 – 91	307	
3	1991 – 92	495	
4	1992 – 93	475	
5	1993 – 94	367	
6	1994 – 95	556	
	Sub Total	**2597**	

The shift of NGOs from the fold of Department of Agriculture is evident from the comparative achievement figures of Biogas plants before and after 1989. The collaboration between KVIC and MDS lasted for 6 years. A total of 2597 plants were constructed during this period by MDS with the assistance of KVIC. The

process of releasing subsidies to the beneficiaries of biogas became faster and simpler during the collaboration with KVIC.

3.5 MDS and SDA

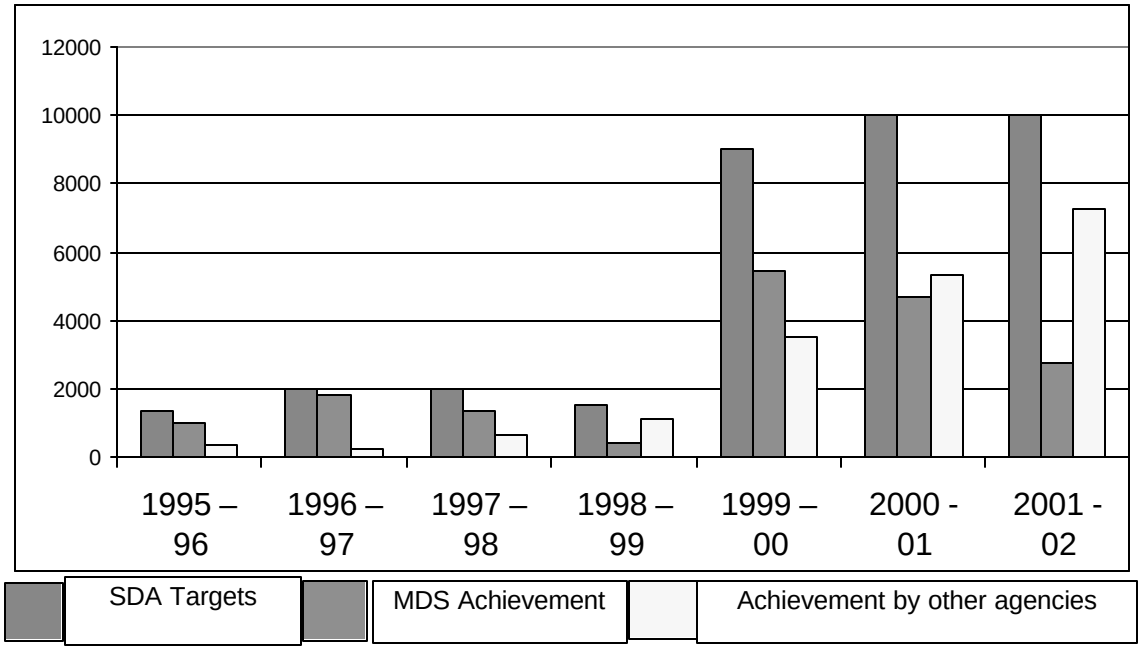
As already mentioned, AFPRO had established six field units and an equal number of Regional Council Groups of NGOs implementing Biogas Programme. Of these the southern group under the leadership of Fr. Mathew Vadakkemuriyil got itself registered into a legal entity in 1993 under the TCLSCS Act of 1955. This registered network of NGOs, functioning more or less like a federation of NGOs in rural and renewable energy was named SDA- Sustainable Development Agency. There are 52 NGO partners in the SDA network today. MDS was one of the most experienced and leading NGO partners in SDA. Riding on the experience and organizational strength of MDS, SDA applied for 'direct target allocation' to the Ministry of Non- conventional Energy Sources- MNES and the same was granted in 1995. SDA thus became a nodal agency like KVIC or Dept of Agriculture. MNES opened the direct target allocation to NGOs by early 1990s. Agha Khan Rural Support Programme and All India Women's Conference were some of the first NGOs, which were able to obtain 'direct target allocation'. The benefit of the direct target allocation was that central government subsidy would be advanced upfront as in the case of the State Government nodal departments and institutions like KVIC. This would mean that there would be no delay in getting the subsidy released to the farmers.

Fr. Mathew Vadakkemuriyil was elected chairman of SDA in 1993 and it was due to his lobbying that SDA was able to get direct target allocation in 1995-96. The following table gives a summary of the direct target allocation to SDA from MNES, Government of India and the achievement of MDS in the construction of Biogas Plants through its association with SDA.

Table No- 11- Achievement in MDS – SDA collaboration

No	Year	Targets allocated to SDA	Biogas Plants constructed by MDS in association with SDA.
1	1995 – 96	1350	972
2	1996 – 97	2000	1789
3	1997 – 98	2000	1341
4	1998 – 99	1500	390
5	1999 – 00	9000	5459
6	2000 - 01	10000	4686
7	2001 - 02	10000	2750
	Total	**35850**	**17,387**

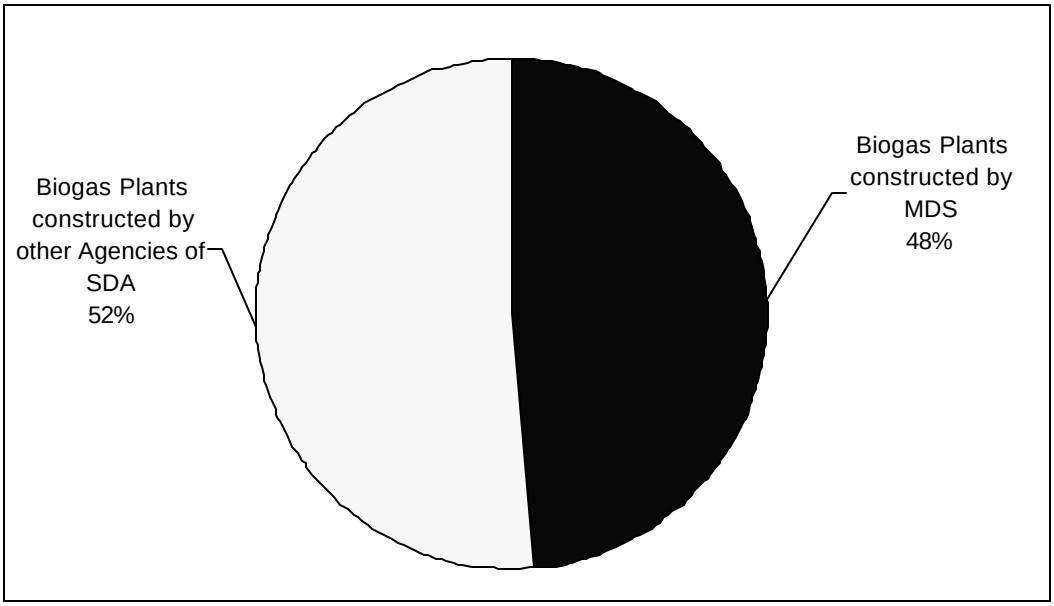
Fig: 11 Comparative Allocation of Targets and Achievement by MDS and SDA



It is evident from the above table and chart that MDS implemented bulk portion of the targets allocated to SDA. The strategy of Fr. Mathew Vadakkemuriyil was to strive for substantially higher and unprecedented targets. Having got the targets, declare war and usher in a state of emergency in the biogas department to complete the targets. Though several of his colleagues thought that the strategy would not work and would boomerang, it did not. On the other hand, it succeeded quite well. Several agencies came up and adopted biogas as one of their programmes. The flexibility permitted by the NPBD to the nodal agencies,

simplification of procedures went to a large extent in realizing such higher achievements. Achievement of MDS was the major chunk of the SDA target in till 2000. The cumulative achievement of other partner agencies was slightly higher than MDS thereafter. 51other partners of SDA achieved 52% of the target allocated to SDA, while MDS accounted for 48% of the allocation to SDA.

Figure- No-12 Achievement by MDS and other SDA Partners

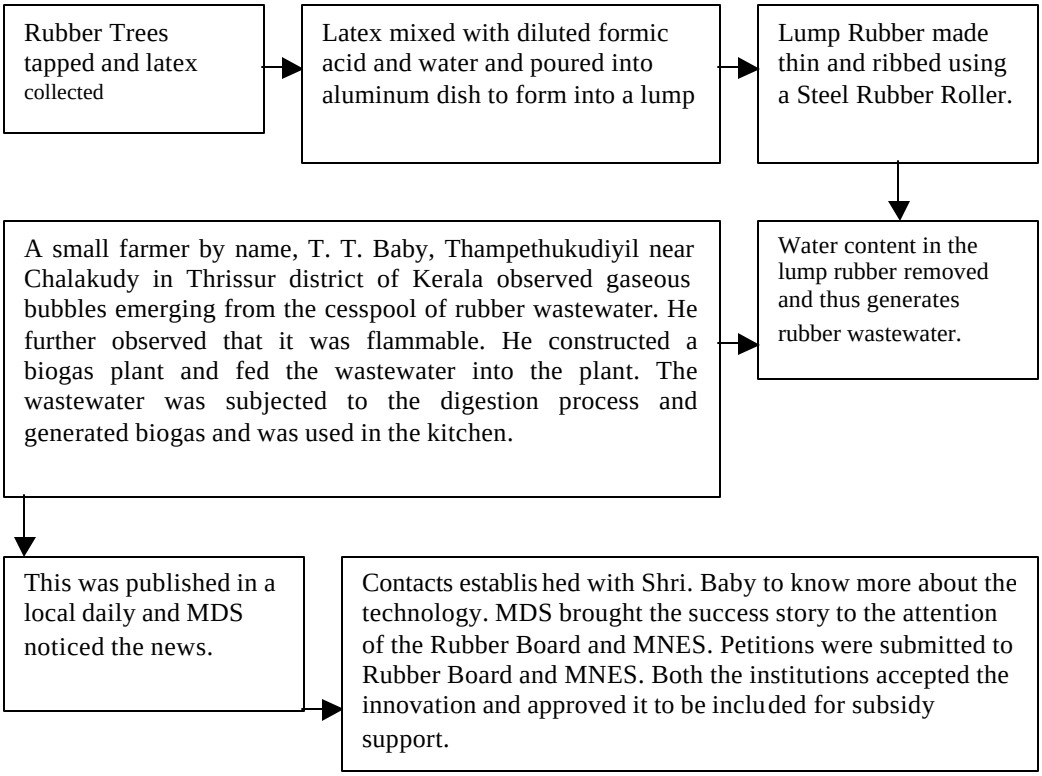


It is estimated that Kerala has completed and commissioned a total of 70,000 biogas plants. Out of this, a total of 21674 biogas plants is the achievement of MDS. This works out to a total of 31 % of the total number of biogas plants constructed in the State of Kerala.

3.6 MDS and Rubber Board

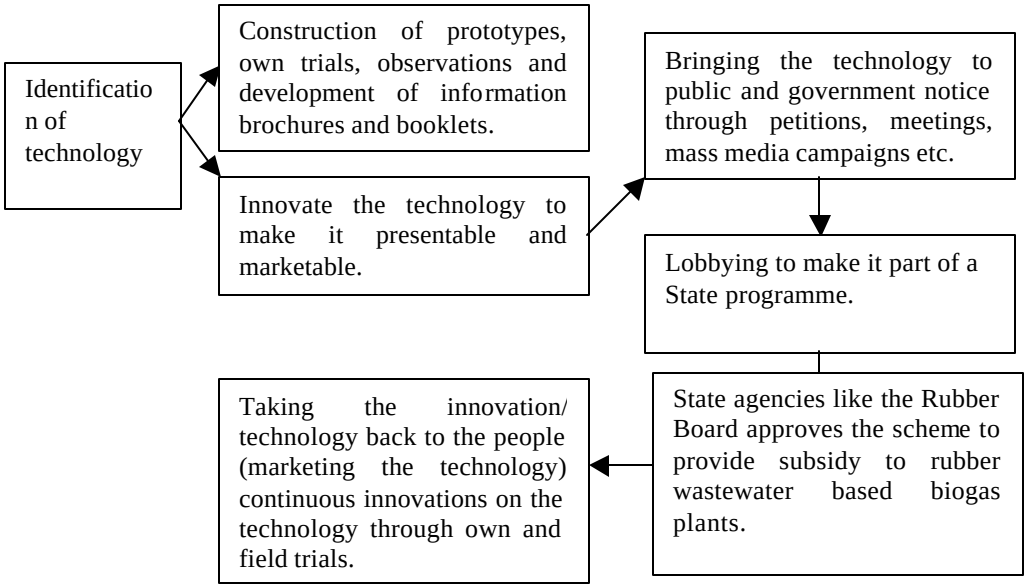
Another significant move in the history of biogas development programme was the linkage established between MDS and the Indian Rubber Board. Kerala is known for the extensive rubber plantations, both at the smallholder and large estate levels. Rubber latex is mostly converted into RSS (Ribbed Smoked Sheets) grade dry sheets at the level of the smallholder farmers. Conversion of latex into dry sheets is done through a process that generates wastewater. This becomes a

pollutant; it generates stink and foul smell as well as pollutes the ground water through percolation. A process flow representation is given below to illustrate the generation of wastewater and its 'biogas connnection'.



It was observed by researchers at Rubber Board that the biogas generated from the rubber waste water (serum) contained hydrogen sulphide a little more than the case of cow dung feed based gas. This gas causes foul smell, corrodes metals and building materials and is detrimental to both plant and animal health. MDS in collaboration with Rubber Board, Tamil Nadu Agricultural University and scientific expertise from BORDA- Germany, developed a gadget which desulphurises biogas. The gadget consisted of a 4" PVC pipe with a filter containing slag iron. The iron oxide reacts with hydrogen sulphide to form iron sulphates/ sulphites. The iron slag has to be replaced after some time. This gadget was fixed as part of the gas-transporting pipe, allowing the gas to pass through the gadget, and in the process eliminating hydrogen sulphide. MDS was recognized as the authorized agency to construct and commission biogas plants using rubber wastewater (serum). The subsidy from the Rubber Board was treated as an

investment measure to reduce pollution caused by wastewater. The subsidy provided by Rubber Board was equivalent to the subsidy provided by MNES. A total of 300 Biogas plants received subsidy thus in the year 1996. Thus the role of MDS in such cases as the popularization of rubber wastewater based biogas plant could be illustrated as given below.



3.7 **Management Strategies used by MDS in popularizing biogas technology**: The achievement of MDS in popularizing biogas technology is spectacular. What has been behind this achievement? The strategies adopted by MDS in diffusing biogas technology is collected and compiled into a matrix as given below.

Table No- 12 Management strategies adopted by MDS in popularizing biogas

No	Management strategy	Description
1	Making Levy Cement available	In the early 80's cement was a scarce commodity the non-availability of which hampered the construction of biogas plants. MDS petitioned the State and Central Governments for allotment levy cement for plant construction. After numerous memoranda Government allotted a quote of levy cement for the purpose. The construction of biogas plants could go on without any hindrance, as levy cement was available.
2	Bank Loans	The subsidy provided by Government of India through one or the other agencies usually reached the farmer well after the construction of the plants. Therefore an interim financial assistance was an urgent need. The prospect of meeting the entire expenditure upfront deterred many. MDS referred the farmers who needed interim credit, to local banks. MDS had to undertake a lot of liaison work at the level of State and Central Governments to persuade the banks to cooperate. The Government of India sent a circular to all lead banks explaining the importance the Government attaches to the programme and the need to extent liberal credit to the farmers without even demanding title deeds or other collateral assets. In certain cases, MDS made an incentive deposit with the banks. This had encouraged banks to provide loans to prospective beneficiaries.

3	Linking the Farm sector to Bio energy programme	Bio energy programme is specifically woman friendly. When it was observed that bio slurry is a valuable bio manure, MDS made it a campaign point, appealing to men and women at the same time that biogas plant has dual benefits of supplying energy to the kitchen and manure to the farm. The experiences of farmers who have had spectacular results by applying bio-manure was disseminated.
4	Intra-institutional support of MDS subsidiaries	MDS has promoted several farmer networks and societies such as the Malanadu Milk Programme (MMP) and the Malanadu Farmers Society (MFS). MMP networks 16,000 small farmers and collects milk from them through 150 village based milk societies. These village based MMP societies have their own credit union; wherein they deposit 10% of their milk sale proceeds every week and uses it as a revolving fund among the farmers. The employees of these Milk collection societies were given annual targets in biogas plant construction. This was beneficial in a three-pronged way; it gives a biogas plant to the farmer, brings additional financial benefits to the Milk Society employees and thirdly helps MDS to attain targets. Similarly, rural branches of MFS also are used to promote biogas plants. MDS has developed several farmer societies in the last 25 years and all these outfits are used to promote biogas. Since the mid 1990s, organisation of Self Help Groups (SHGs) became prominent in the programme of MDS. Meetings of SHGs and the services of the SHG leaders were also used to promote biogas programme. It is also worth mentioning here that at one point of time, the provision to support the village level animators of MDS

		by providing them monthly salary got exhausted. Donors were not willing to continue the support any more. MDS devised another method for meeting the crisis. It could not lay off the village animators as their services was most essential for the grassroots level development programmes. Therefore, MDS did try to make use of its skills, capabilities and other programmes to support the village animators. They were asked to learn about biogas programme and become biogas supervisors. By using MDS label, it was easy for them to canvas prospective beneficiaries to build biogas plants. MDS provided training to the village animators to become skilled and proficient in biogas implementation. With the training of village animators, the biogas workforce of MDS multiplied several fold and MDS was able to take the programme to all nooks and corners of its operational area as well as outside, enlarging the scope and reach of the programme. Some village animators began to make a living out of implementing biogas programme as well.
5	Using good offices of Parish Priests and Local Church Institution	Being part of the Catholic diocese of Kanjirapally, MDS has successfully used the good offices of the local parish priests to promote biogas plants among the farmers. MDS carefully selected local parish priests who had an aptitude for such socially beneficial activities and used them to speak in favour of the biogas programme to the church congregations during Sunday services and other occasions.
6	Small Biogas loans to prospective beneficiaries & Biogas Lotteries	MDS was encouraging several people based non-banking financial intermediary institutions in the villages of its area of operation. Such programmes included 'People's Credit Union', 'Village Chit funds' and 'Small Savings Programme'. The functioning of these financial

		institutions was simple and informal. These provided loans to the members to construct biogas plants. Several villagers were able to construct biogas plants in this manner. Another innovation in extension of biogas programme was that the members of the village credit union would come together and contribute a weekly fund for the construction of biogas plant. A lot was drawn in the meeting of the local Grama Vikasana Samithy and those who won the lot was given the total weekly collection to construct biogas plant. The collection of the next week was given to another beneficiary. After several weeks, the number of biogas owners also increased.
7	Village Biogas Campaigns	There were atleast two instances for this in the history of Biogas Programme of MDS. A network of seven villages were formed in the Grama Panchayaths of Karunapuram, Vandanmedu and Chakkupallam in the Udumbanchola Taluk of Idukki district and a campaign was made to promote it a Bio village network. The involvement of the Indian Spices Board was also sought to make it an organic spices growing zone. The Bio village experiment did not carry much forward, but bioslurry was decided to be the vehicle of organic spices production and therefore, the promotion of biogas programme received a boost in the bio village. In a second instance, Kuzhitholu, a sleepy village in the Karunapuram Panchayath witnessed an intensive campaign in biogas promotion. Fr. Mathew Panachikal was the parish priest at Kuzhitholu and he provided strong support to the biogas campaign. The objective was to declare Kuzhitholu a 100% biogas village. All households rearing cattle were encouraged and canvassed to join the village biogas campaign. This

		yielded a substantial result and nearly 100 biogas plants were constructed in a short period of two months. A function was later organized to declare Kuzhitholu a 100% biogas village.
8	Canvassing additional subsidy by Government of Kerala	Late Mr. V. K. Rajan, Minister for Agriculture in the Government of Kerala (1996-1998) was invited to Kuzhitholu village to declare the village as a 100% biogas village. The Minister did make it to the programme and Fr. Mathew Vadakkemuriyil, secretary MDS, through a memorandum requested him to support biogas programme with an additional subsidy from Government of Kerala. The instance of the Government of Karnataka providing such similar subsidy was pointed out. The Minister promised to look into the matter and he later got an order brought out pledging an additional subsidy of Rs. 1000/ biogas plant irrespective of size.
9	Canvassing additional subsidy from Rubber Board	As mentioned already, when the potential to construct serum based biogas plants was realized, MDS got into the business of actively promoting the same through its biogas programme. MDS was getting an opportunity to enlist an entirely new and different constituency of farmers raising a demand for biogas plants. Hence this opportunity to construct biogas plants using rubber wastewater as the biofeed was grabbed by MDS with lot of vigour and enthusiasm. Rubber Board and MNES were petitioned. Rubber Board sent its scientists to study the innovation and later on set apart an amount of Rs.10, 00,000 as a first instance to provide a subsidy for 300 biogas plants based on serum. This was a major breakthrough as MDS succeeded in bringing in an entirely new constituency of farmers into the biogas plant owning strata.

10	Additional Subsidy from Grama Panchayaths	The People's Planning campaign under the decentralization programme commenced in Kerala in 1996 as part of the 9th Five Year Plan. 35 to 40 % of the State Plan Funds were directly given to the three tier Panchayathi Raj Institutions and this amount could be spent on the basis of the plans emerging from Grama Sabhas at the ward level. This was a new experience for Grama Panchayaths, as they had to invest their funds in the broad sectors of Production, Services and Infrastructure development. Many Grama Panchayaths had no experience and neither innovative ideas on how to expend the funds. Hence some of the MDS field workers engaged in the promotion of Biogas plants sold the idea of supporting the construction of Biogas plants in the Panchayaths with an additional subsidy from its funds. Hence several Panchayaths set apart funds to provide additional subsidy for 50 to 100 plants in a GP. The Grama Sabha selected the beneficiaries of the biogas programme. This became handy for MDS to achieve its higher targets during its collaboration with SDA.
11	Centralized supply of materials	MDS organized supply of materials at its central depot as well as at several other locations in its area of operations so that there was no dearth of materials for the construction of biogas plants. Materials were collected from wholesale dealer or directly from the factory. This made the materials cheaper than market rates. Any farmer who wanted to construct a biogas plant did not have to purchase the materials on his own from far away towns. This was beneficial to MDS as well as the farmer.
12	Continuous training of masons and	MDS realized the need for large number of trained masons to carry out the programme in an unhindered manner.

	supervisors	Therefore, when it started getting higher targets through its association with SDA, it started training large number of masons. This was on the ground that traditional masons who are engaged in the usual construction work would not be available to construct biogas plants. To construct biogas plants, the masons would have to travel far outside one's locality, which was difficult for an experienced mason with a family. Therefore, MDS made an effort to create an entirely new segment of workforce to cater to the needs of the Biogas plant construction. It would announce training programmes frequently and recruit new trainees as masons. These newly recruited mason trainees would be provided a week long training at MDS compound, which mainly includes the preparation of the ferrocement framework of the dome part of the biogas plant. The Trainees were also given classroom theoretical inputs and measurement details of the plants. On satisfactory completion of the training, they would be placed as mason trainees in the field along with a master mason. Such on the job training would go on for three to four weeks until the trainee has developed sufficient confidence, skills and expertise to construct plants on one's own. After the training is completed, the masons are given a test to examine their skills and expertise and all those who clear the test are allowed to take up construction of biogas plants independently. MDS not only trained masons for itself, but it readily extended such training assistance to other NGOs and organizations, which placed a request for the same. It also sent its master masons to other parts of Kerala to train masons through the above process.

13	Continuous efforts to innovate and make the BGP cost effective.	MDS never rested happy with the economic costing of the biogas plant. It was always trying to reduce the cost of construction so that it could attract more and more farmers to adopt biogas plants. Therefore, continuous efforts were on to innovate and improve construction techniques and reduce cost of construction. Thus when faced with the scarcity of quality bricks for the construction of biogas plants, it developed the ferrocement based biogas plants. Through a series of smaller innovations, MDS reached a stage where it was able to get MNES to approve the innovated model through SDA. This single experiment made a sea of difference in the history of biogas plant construction in Kerala, making the construction simpler, cheaper and faster. Another effort was in replacing the pipe for conveying biogas. Initially only GI pipes were used. PVC pipes replaced GI pipes and further good quality flexible HDP pipes were identified in the market and this was promoted in the programme, further reducing the cost.
14	Developing Entrepreneurs in Biogas Programme-	There was a continuous effort for developing biogas supervisors throughout the history of biogas programme in MDS. Being a NGO with large number of interventions and activities, there was a general impression that MDS could provide substantial job opportunities. Who so ever met Fr. Mathew Vadakkemuriyil with a request for an employment or an introduction from an influential person for employment, Fr. Mathew had a ready challenge to pose. He would request them to become a biogas supervisor. He would canvas a couple of plants and give to him to instill confidence and attach him/ her to an experienced supervisor or technician for on the job

		training and development of skills. Several persons have made a livelihood and some of them even a fortune by involving in the promotion of biogas programme. Thankamony Thankachan is one such example of a successful biogas entrepreneur. He made a fortune in a few years time by engaging himself in the promotion of biogas programme. There are also other cases including women who have become successful entrepreneurs in biogas development programme. Several persons earned a successful living by being a biogas supervisor.
15	Acceptance of high target from SDA/ MNES	The target allocated to MDS by Department of Agriculture and KVIC was lesser than 1000 Nos. prior to SDA getting recognized as a nodal agency. But once SDA was recognized as a nodal agency, MDS was forced to take higher targets. This was on the ground that MDS and SDA wanted to be recognized as leading biogas-implementing agency with MNES. Hence the target sought and accepted was always on the higher side than existing capacity. Once the higher target is given, MDS would begin to struggle and develop additional capacities for the completion of the target. More number of masons and supervisors would be recruited and trained. Innovated management strategies would be added or invented to meet the pressure of a higher target. It so happened that the smaller partners of SDA would not take the risks of accepting a higher target than they could easily achieve. Hence it became the responsibility of MDS to shoulder the responsibility for taking over higher targets, which includes the unaccomplished targets of smaller partners as well. This became a boon in a different way as MDS achievement in biogas plant construction became admirable during its

		collaboration with SDA. From a target, which was more or less around 500 plants, until mid 1990s, it rose to a situation where it undertook an annual target of 5000 plants and completed it.
16	Expansion of Operational Area	MDS used to operate only in the districts of Kottayam, Idukki and Pathanamthitta, which otherwise forms the limits of the diocese of Kanjirapally. Later on it expanded its area of operation beyond the diocesan limits and took the programme to other districts and regions of Kerala. The northern part of Kerala did not have any substantial presence of biogas programme. It was then that MDS opened a regional center at Chittarikal in the Kasaragod district and placed large contingent of workforce there. In a couple of years, MDS was able to construct several thousands of biogas plants in the districts of Kannur and Kasaragod, besides training and equipping large number of local technicians.
17	Exhibition on Biogas and Bio Products	Shri. Tomy Paikkara, now serving in the local Milk Collection Society of MDS at Karunapuram recalls how he had sold the advantage of bio slurry to the local population; He came across an unusually large 'Yam' "Amorpha Phallus" that was harvested in 1991 at Cumbummettu near Karunapuram by Shri. Appachan Vaniyapurackal. It was cultivated with bio slurry. He brought this yam to Karunapuram and kept it exhibited for several weeks at the village center of MDS as well as during the parish church feast. Large number of people was attracted and they got an idea what they could do with bio slurry in agriculture. That was an innovative way in which biogas programme was sold to the local community at Karunapuram.

18	Regular Weekly Review with Biogas Supervisors	MDS had a practice of conducting regular meeting of its staff members on every Monday. It was made a practice that all biogas supervisors also attended these meetings and appraised the progress of their work and present the issues and problems they faced in the field. This became an opportunity to learn about the progress and problems in Biogas Programme and a means of organizational owning up of the programme.
19	Promoting Women Biogas Supervisors	Women were specially encouraged to become biogas supervisors and given training. It so happened that several women supervisors emerged and some made significant contributions to their households by earning substantial additional income from biogas supervision and canvassing. They were given additional turnkey fees at the rate of Rs. 100/ plant in addition to what was admissible to men supervisors. Two women supervisors were even given sewing machines as a complementary gift for outstanding performance in biogas achievement.
20	Special Incentives to men supervisors	Motor Bikes were offered to the most outstanding men supervisors for extraordinary performance in promoting biogas programme. V.C. Chandy Valliamthadam thus was given a Hero Honda Motor Bike. Another special incentive was that men supervisors would be given interest free loans to purchase motorbikes for the promotion of biogas programme. Quick mobility was a critical factor in promoting biogas plants and travel by Motor bike was very feasible. MDS did not want to maintain its own vehicle, as it believed that society's vehicle is treated as nobody's vehicle and would be carelessly managed and used. Hence private motorbikes were encouraged.

21	Robbing Peter to give more to Paul	MDS found it tough to attract the poorest people into the biogas programme. It decided to enhance the subsidy to the poorest households by an additional Rs.500. It raised Rs. 500 from internal resources. The Biogas supervisors were asked to contribute Rs. 100 from their supervision charges and they were asked to reduce their plumbing charges by Rs. 50. Thus Rs. 150 came from the supervisors. MDS contributed Rs. 350 from its profits, margins and fees in implementing biogas plants.
22	Mobile Biogas Repair and Maintenance Unit	Two trained biogas supervisors were maintained at the central office of MDS to cater to the calls for repair and maintenance help. As soon as a complaint is received, one of these two supervisors would immediately reach the venue with a tool kit and directly repair the plant or advice as to what is to be done to set right the plant.

3.8 INNOVATIONS MADE BY MDS IN BIOGAS

MDS has two decades of experience in planning and implementing biogas programme in association with various agencies in the governmental and non-governmental sector. All along there has been a thinking in MDS that the technology of biogas has to be simpler, user friendly and costing less and less. It therefore began a series of innovations in the technology, the social promotion and delivery mechanism. Biogas plants used to be constructed with wire-cut bricks till the mid 1990s. Good quality bricks were becoming scarce in Kerala. The price of bricks was also becoming costly. These two aspects were found to adversely affect the pace of progress in biogas programme. Therefore, some efforts were made to substitute material and technology in construction of a biogas plant. Fr. Mathew Vadakkemuriyil had taken 'innovations' a mission in his life and pursued it vigorously. The most important efforts in innovations with regard to the Biogas Technology are given below

3.8.1 **Material substitution in the construction of Biogas Plants**

1 MDS implemented Janata type of biogas plants only for three to four years. An effort was made to construct the (digester) well of the Janata biogas plant with reinforced cement concrete rings. But the model was not perfect to be popularized. Not much effort was given to the Janata model, as the Deen bandhu model had been marketed by AFPRO by mid eighties.

2 Development of ferrocement technology to substitute brick masonry in the construction of Biogas plant digester of Deen Bandhu[44.1] Biogas plant began since early 1990s. . The main component of a biogas plant is its digester. Bulk of the material, labour, time, skill and money is spent on the construction of the digester. The digester itself can be divided into two portions; the portion below and above ground level. The innovations in material replacement and cost reduction efforts were concentrated on the above ground portion of the digester. MDS picked up the idea of applying ferrocement technology[44.2] from Centre for Scientific Research – Auroville[44.3] in Pondicherry. The noteworthy efforts to innovate on the Deen Bandhu Biogas plant are listed below.

Keeping the Deenbandhu technology as the base, the MDS team tried to fabricate the digester dome in ferrocement. It developed a segmented, pre-fabricated ferrocement shell structure for a conventional model biogas plant. The individual skills or otherwise of the mason was of little importance in this method because much of the accuracy and finesse in the design and build is already achieved in the central location itself. However, transportation of the segments in tact to the

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[44.1] Deen Bandhu biogas plant was developed by AFPRO at its Research and Development Wing. As the name suggests, Deen Bandhu is a friend of the poor in all sense as it brought down the cost of construction of biogas plants substantially, thus making it affordable even to the poorest.

[44.2] Ferrocement is a mixture of ferrus and cement (iron mesh and cement) The reinforcement in ferrocement is provided by dense package of chicken and square welded mesh. It is both cheap and strong.

[44.3] Auroville- means Aurobindo's Village. Auroville is an International settlement founded by Meera Alfasa, popularly known as The Mother. She founded Auroville in the name of Aurobindo, who was a freedom fighter, poet, philosopher and reformist. The settlement is about 16 km from Pondicherry city. There are several communities in Auroville and CSR is one such community/ center, pursuing R&D in ferrocement technology among other things. Auroville belongs to the humanity and is not owned by any one in particular. It is administered on the basis of the Auroville act passed by Indian Parliament in 1986.

construction site was the problem. The segments had to be transported by vehicles and with the condition of the village roads, it was tough to transport the ferrocement segments of the plant to the site without getting it cracked or fractured. The segments were also heavy to be carried to the construction site from the vehicle. Therefore, this effort was given up after a few field trials.

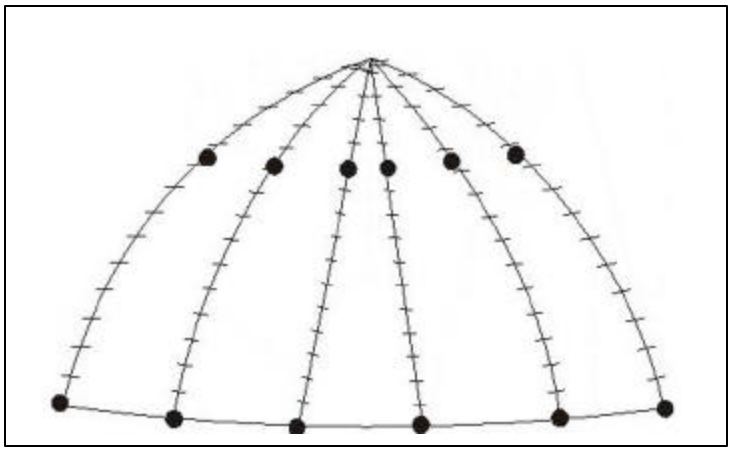
Casting the first biogas plant in ferrocement material. A final breakthrough in this direction came in 1996. A Deen Bandhu model biogas plant was completely built with ferrocement technology. The dome, the base, the inlet, outlet tank were constructed exclusively by ferrocement technology. The materials used were iron chicken mesh 4mm thick, iron wire with 4mm thickness and cement mortar of 1:3 ratio. The trial and error attempts went through the following stages.

1. Preparation of a mud mould exactly in the shape and size of the biogas digester, compacting the mud mould and covering the mud mould with newspaper. Having done so, cement mortar was spread on the paper. Then the chicken net was spread on the cement mortar. Another coat of cement mortar was given above the spread of chicken net. The plant was allowed to cure. After the structure became stable, the mud heap now in the digester of the plant was removed through the outlet of the plant. This was very cumbersome and not at all user-friendly.

2. The next effort in this direction was that an angle iron based mould was assembled. The mould was taken to the construction site, assembled into the form of a digester framework using nuts and bolts as given below in Fig.13. Chicken net was spread on the assembled mould and was plastered with rich cement mortar on the external side. After the structure had become stable, the mould was dismantled from inside the digester and the ribs were taken out through the outlet portion. The material of the mould for one plant weighed 150 kg. The transportation of the mould to the hinterland rural interior locations was a problem. The plant supervisors who are the key people in disseminating the biogas technology was resisting the effort to carry the

mould to such difficult locations. Also, large number of plants had to be constructed and there needed several dozens of plant moulds. Several hundreds of biogas plants were constructed through this method. But the demand for biogas plants far exceeded the construction capacity, using this method and had to be improved.

Fig No- 13 A line sketch of the Angle Iron Mould for the construction of ferrocement Biogas plant, a forerunner model of the present practice



3. The breakthrough in applying ferrocement technology to Deen Bandhu biogas plants came with another innovation. A framework in the shape of the 'above ground portion of the biogas digester' was made with 4mm iron rods. Since the thickness of the 4mm rods was such that it was flexible, could be bent and easily manipulated to the shape of the digester structure. This framework made of 4mm iron rods was prepared at site and the chicken mesh was spread and tied to the 4mm iron rod structure. Thus the framework made of 4 mm iron rods and covered by chicken net was a stable structure, which could be plastered from inside and outside the digester.

4. Building the Inlet and Outlet of the Biogas plant with ferrocement material. In addition to the biogas digester, the inlet and outlet was constructed with ferrocement.

The Deen Bandhu biogas plants constructed with ferrocement technology has since been approved by Ministry of Non-conventional energy sources, Government of India. SDA has prepared a manual on ferrocement Deen bandhu biogas plants as per the request of MNES. SDA / MDS combine has given training to other agencies all over India in the construction of ferrocement Deen Bandhu type biogas plants.

3.8.2 Development of Malanadu Biogas based Electric Generator

MDS did make efforts to develop a Bio- electric generator, which is entirely fed on biogas. As was the case with all innovations in MDS, the development of bio electric generator was also the result of efforts by an ordinary person who applied scientific mind and common sense. Mr. Benoy Sebastian, hailing from Palavayal village in Kasaragod district was responsible for the effort. The intention of MDS was to develop electricity from biogas and project it as a solution even to the energy crisis of Kerala. If biogas could be used as fuel in a generator to generate electricity, it could very well meet electricity needs of isolated households as a stand alone system. Hence a 1.5hp enfield engine was effected with slight changes in the stroke time. The Carburetor was removed and a connection of biogas given. The result was a 350-watt output at 230 volts and the total cost was around 7,500 per unit. MDS exhibited the model for the visitors for several months. Later on, this technology was copied on a larger scale at Koyinadu, a remote and isolated village hamlet near Kanayankavayal in the Peermedu taluk of Idukki district, to supply electricity connection to a group of 52 households. This system worked for 2 years before it became defunct due to problems relating to the institutional arrangements.

3.8.3 **Modified 1cm^3 Deenbandhu Ferrocement BGP**

MDS was trying to develop a small biogas plant, which would cater to the normal cooking needs of a small household at economical costs. It achieved a breakthrough in designing a biogas plant, which is larger than 1m^3 and smaller than 2m^3. In effect, the cost of this modified and innovated 1M^3 biogas plant was comparable with the normal 1M^3 plant and the output was almost as good as 1.8M^3 Plant. It generated gas, which could continuously burn for 1 hour and 45 minutes. This was done by modifications and slight alterations in the dimensions under Deenbandhu plant design. This was most useful for those farmers who own just one cattle head. The idea behind this effort was to develop biogas plants, which can cater to the needs of households that possess just one cattle or a few goats, poultry, pig etc. The cost of such a small plant is around Rs. 3500 and the household has to find only Rs. 1200 after subsidy to construct the plant. 1M^3 biogas plant based on ferrocement material has to be plastered by standing inside the plant. But there was not sufficient space for a normal man to stand erect inside the plant. Hence the masons were unwilling to take the risk of constructing the 1M^3 plant. MDS found an answer to this problem by deepening the saucer shaped bottom of the plant. Once the bottom was deepened the mason constructing the plant could stand erect inside the plant and construct the same. The purpose behind developing the 1M^3 biogas plant was to convert it into a domestic plant, which can be constructed for households even without cattle heads. Instead, kitchen waste and other bio degradable wastes of the household could be fed into this plant and treat it as a pollution treatment system and generate energy.

3.9 **MDS support to other NGOs in Kerala and outside**

MDS did not limit itself to the area of operation of the diocese of Kanjirapally. It provided meaningful support to a host of NGOs all over Kerala to acquire the skill and capacity to take up and implement biogas programme. The following table gives a list of such NGOs in and outside

Kerala, which have received support from MDS. It is noteworthy that all districts of Kerala are covered by NGOs trained and capacitated by MDS. These NGOs together with MDS, account for 80 to 90 % of the annual achievement of biogas in Kerala.

Table No- 13 NGOs Trained by MDS in Biogas Programme

No	Name of Agency	District/ State of Operation
1	Thalassery Social Service Society-TSSS	Kannur, Kasaragod
2	Shreyas- Sulthan Bathery	Wayanadu- Malappuram
3	Women's Welfare Association- WWA	Wayanadu
4	Centre for Overall Development- COD	Kozhikode
5	New Star Arts and Sports Club	Malappuram
6	People's Service Society- PSSP	Palakkad
7	The Andhyodaya	Ernakulam
8	The Welfare Services	Ernakulam
9	Bio- Nirman- Thodupuzha	Idukki
10	Kothamangalam Social Service Society	Ernakulam and Idukki
11	Changanassery Social Service Society	Kottayam
12	Pala Social Service Society	Kottayam
13	Sandhya Development Society- Elivally	Kottayam
14	Kuttanadu Vikasana Samithy	Alapuzha
15	KIRDEP- Kuttanadu	Alapuzha
16	Pazhakulam Social Service Society- Adoor	Pathanamthitta, Kollam
17	Anavoor Mahila Samajam- Anavoor	Trivandrum
18	The Dale View	Trivandrum
19	Indian Farmer's Movement- INFAM	Kerala State- all Districts
20	CRESHE	Andhra Pradesh

3.10 **Participatory Technology Development for Sustainable Agriculture (PTD for SA)**

Participatory Technology Development for Sustainable Agriculture is a farmer led agricultural experiment being undertaken by MDS in the Karunapuram Panchayath. There are 60 farmers engaged in this programme. What binds them with the Biogas programme is that 20 farmers who began the PTD experiment four years back are using various combinations of bio slurry in their experimental plots. Cardamom and Pepper are the crops subjected to the Participatory

Technology Development in Agriculture. Various combinations of bio manure in which bio slurry is a constituent or an additive are tried for the crops of pepper and Cardamom in the study area. Such combinations of bio slurry are used as a soil conditioner and as a pest repellent. The combinations of bio slurry are as follows

1 Application of bio slurry directly to the crops in experiment
2 Neem cake, Groundnut oil cake, and slurry
3 Slurry, cow dung and urine fermented for seven days and diluted and applied to the trees/crops

The experiments have provided positive results

Chapter IV
Impact of Biogas Programme

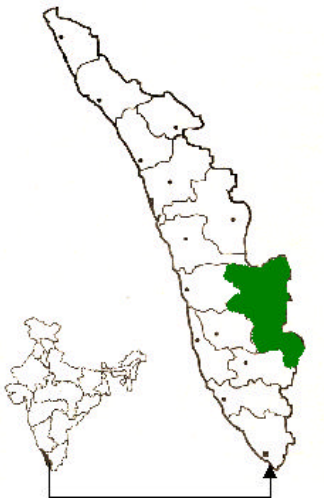
4.1 The Study Area

4.1.1 General: Kerala is one of the smaller Indian states. Its geographical contours can be described as an elongated strip of land, cushioned between the Western ghats and the Arabian sea. Kerala is located between 8°-15‘ N Longitude and 75°-77' E Latitude. It is in the humid tropical region. Kerala is divided into three geophysical divisions based on the average mean height of landscape from the sea. These three regions are the Coastal region, the Midlands and the Highranges. Table-14 provides the average mean height of the natural regions of Kerala from mean sea level. Karunapuram and Kanchiyar Panchayaths, which form the location of the present study, are in the Highlands.

Table –14 Geo Physical Divisions of Kerala

Geo Physical Divisions of Kerala		
Region	Percentage of total area	Height from sea level
Coastal Region	10 %	Up to 10 Meters of Height
Midlands	34 %	10 to 75 Meters of Height
Highranges	56 %	75 Meters and above of Height

4.2 Geographic Location of the Study Area: The study area comprises of two Grama Panchayaths in the Udumbanchola taluk of Idukki district.



Karunapuram

East Theni district of Tamil Nadu
West Pampadumpara Panchayth
South Vandanmedu Panchayath
North Nedunkandam Panchayth

Kanchiyar GP

North Kattappana-Kanjikuzhy GPs
South Ayyappankovil GP
East Kattappana
West Periyar/Idukki reservoir.

Fig 14 Location of the Study Area

4.3 History of Migration to the Highranges

Three strains of human history can be observed in the Highranges. The history of the Adivasies and the history of two migrations, the Tamils migrating from the Cumbum valley and the Malayalees migrating from the midland plains of Kerala. Cultivation of spices and or plantation crops are intertwined with the history of migration.

Table No.- 15 stages of migration

Stage	Socio-economic processes of Migration
I 1945-58	First Trickles of migration. The men folk come alone. Father and grown up sons or men of few families jointly arrive. Bus service was available in the summer months from Pala to Vandanmedu via Ponkunnam, plying on the katcha KK road. People cleared forests and practiced livelihood agriculture, cultivating tubers, paddy and vegetables. The virgin vigour of the soil was good and the yield was excellent. Wherever possible, people converted the low lying narrow valley portions between hillocks into paddy fields. People lived in the initial days on Tree Houses. A fire made of logs of wood was made infront of the hut or tree house to ward of the wild animals and to save from cold weather at night. Light drizzling rains were available almost throughout the period. There was a collective insecurity among the people. Group cultivation, group travel to Cumbum, group clearance of the forests and almost every family was trying to attract friends or neighbours or relatives from the ancestoral neighbourhood to migrate. Efforts were made to find land and give it to the newly migrated families. Some clever people made it a business opportunity. They would encroach land and call it theirs and attract new people to purchase it for a price, as if they were the owners.
1958-70	Women and Children join the menfolk. Semi permanent houses constructed with grass-thatched roofs. Cash crops such as Pepper and Coffee planted. Ginger cultivation introduced. Coconut and Arecanut

	trees planted, when it was sure that wild Elephants would not destroy the crops. Efforts are on to build mud roads, get schools established, bring establishments such as Post Office etc to the new settlement villages. The first effort of any Christian settler community was to get a church established and get a priest appointed to the church. Cattle rearing were introduced during this stage. There was no market for milk, but people kept livestock to supplement the domestic nutrition. With the introduction of cash crops, there was a dwindling of land for cultivating food crops like tubers and vegetables. The virgin vigour of the soil was steadily on the decline and that was another reason for introducing cattle so that cow dung could be applied as a manure. This period also witnessed some powerful political struggles such as the Amravathi struggle against efforts to evict migrants
Post 1970	Problems surface. Pepper facing diseases and decaying of the vines. Fertility of the soil drastically reduced. Cattle rearing increased to supplement food and income by selling milk. Milk collection cooperatives of the MILMA established in the villages. MDS founded its milk cooperatives parallel to MILMA in the 1990s. Biogas Plants introduced in the late 80s and early 90s. Experienced the positive effect of applying bio slurry and people are attracted to biogas plants on two grounds; first the fertility of the soil is steadily on the decline and there needs to have a soil conditioner. Secondly, the days of fuel wood abundance was gone and fuel wood became scarce, often compelling people to go out of one's compound to collect fuel wood. [53.1]

[53.1] In personal conversation with Thomas Kongamala

A pattern can be seen in the process of migration at all settlement villages. The most important features of the settlement pattern are mentioned below

- Efforts to bring as many families as possible to a location after settlement of the early birds
- Collective efforts to clear vegetation and undertake cultivation
- Collective efforts to guard the crops from the wild animals
- Build katcha roads to link with other villages
- Establish schools and other establishments in the villages
- Establish a place of worship in the village- This is especially true with the Christians. Once there is a community in a village, they would immediately contact the nearest parish church to provide them religious service.
- Leadership roles of catholic priests to lead the community in establishing schools, building roads, getting other institutions in to the villages, liaisoning with the diocesan headquarters, building bridges of influence with the political leadership and bureaucrats etc. Other roles of the catholic priests included settling of conflicts and cases and leading struggles against the government, influencing government in establishing modern facilities like electricity, roads, telephones, post offices and banks. The presence of priests gave confidence and assurance to people of all religious following.
- Some political leaders and catholic priests had supported and encouraged migration to the high ranges due to poverty and famine in the plains.
- Establishment of political institutions and local self-governments (Panchayaths).
- Withdrawal of religious institutions and priests from active leadership after establishing sufficient clout in the settler community and allowing the laity leadership to continue social leadership.[54.1]

[54.1] In personal conversation with Fr. Mathew Mancherrikalam, formerly parish priest at Erattayar near Karunapuram, in the diocese of Kothamangalam.

To ward off the animals, fire was arranged in almost every plot of occupation and this also consumed large number of trees. There were other instances where people have said that they used salt and petrol to burn the vegetation. Firewood became scarce in the Karunapuram Panchayath by 1990s. This is one of the reasons for the adoption of biogas plants as an alternative energy source. There is also another reason for the adoption of Biogas plants; the vigour of the soil, rather the virgin soil was lost due to indiscriminate agricultural practices. There had to be some ways by which the organic vigour of the soil can be retained and use the same to meet the livelihood needs of the population. The bio-slurry came in as a handy and cheap organic manure which was very useful to support agricultural operations. Biogas programme thus supported the women with the alternative energy source and the men with the enriched bio-manure. Livestock keeping and maintenance was a common practice in the highrange villages. There are several agencies that collect milk from the farmers, such as the State owned MILMA and other private/NGO led agencies such as the Malanadu Milk Cooperatives. Nearly 50% of the small and marginal farmer households keep livestock as an alternative source of income and livelihood to support the seasonal agricultural income.

4.4 **The Introduction of Biogas Programme in the study area**: To analyse the impact of the Biogas programme, it was first necessary to know the extent to which it had spread in the selected Panchayaths. Both Karunapuram and Kanchiyar were selected the study area on the assumption that Karunapuram had done well in biogas while Kanchiyar had performed poorer compared to Karunapuram. It was decided to do a primary listing of the total livestock owning households in the study area. The study area was limited to the Panchayath wards, 3, 4, 6 and 9 in the case of Kanchiyar Panchayth and wards 5, 6, 8 and 9 in the case of Karunapuram Panchayath. A single page questionnaire was used to elicit the information

4.4.1 **Primary listing survey of Biogas Households**:

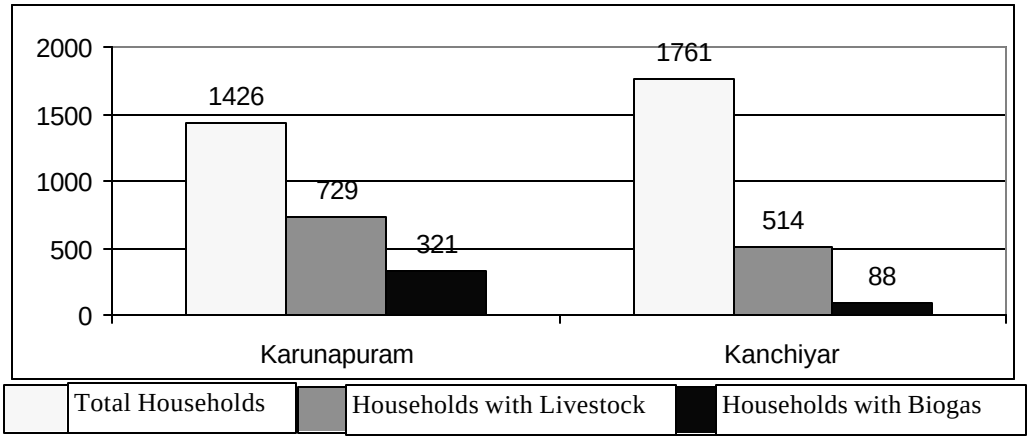
Table No. 16

Summary of Livestock keeping and biogas owning households

No	Description	Karunapuram	Kanchiyar	Total
1	Total Households in the wards selected for the study	1426	1761	3187
2	Total number of households having cattle/ livestock	729	514	1243
3	Total number of households having biogas plants	321	88	409

The listing suvey revealed that 51.12% of the total households in the study area of Karunapuram Panchayath owned livestock. The 'livestock keeping households' in the context of study means those households that keep cows or buffalloes, either milch or dry. Further, it was brought out that 44.03% of the cattle owning households in Karunapuram Panchayath had opted for and were owning biogas plants. On the other hand, only 29.18% of the total housheolds surveyed had livestock in the Kanchiyar Panchayath and only 17.12% of the livestock keepers had opted and owned biogas Plants. The initial assumption that Karunapuram Panchayath had fared much better in adopting biogas programme was proved right by the listing survey.

FigureNo -15 Bar Diagram comparing Households, Livestock keepers and biogas plant owners



4.4.2 **Size distribution of Biogas Plants**: The table given below brings out the size class distribution of biogas plants in the Karunapuram and Kanchiyar Panchayaths. It is seen that the preference of the households in both the Panchayaths were for a plant either in the size of $2m^3$ or $3m^3$. 28% of the plants surveyed were of $2m^3$ size and 63% were of the $3m^3$ size.

Table No- 17

Size of Biogas Plants surveyed in Karunapuram and Kanchiyar Panchayaths

Name of Panchayath	$1m^3$	$2m^3$	$3m^3$	$4m^3$	$10m^3$	Total
Karunapuram	17	81	222	0	1	321
Kanchiyar	14	34	37	1	2	88
Total	31	115	259	1	3	409

4.4.3 **Agency of construction**: The listing survey revealed the presence of three agencies implementing biogas programme. Of these three, two agencies, KVIC and Dept of Agriculture were government agencies and MDS on the other hand was a NGO working in the study area since 1977. Of the 409-biogas plants listed in the primary survey, MDS accounted for 94.62% with the KVIC and Dept of Agriculture sharing the remaining 5.38% of the plants.

Table No- 18

Agencywise construction of Biogas Plants

Agency of Construction	Karunapuram	Kanchiyar	Total
MDS Malanadu Development Society	303	84	387
Krishi Bhavan (Dept. of Agriculture- GoK)	15	2	17
KVIC Khadi and Village Industries Commission–	3	2	5
Total	321	88	409

4.4.4 Functionality of Biogas Plants

Table No- 19

Functionality and Non-functionality of Biogas Plants

Functionality of Biogas Plants	Karunapuram	Kanchiyar	Total
Functional Biogas plants	298	81	379

Non-functional Biogas Plants	23	7	30
Total	321	88	409

7% of the plants surveyed in the Karunapuram Panchayath and 8% of the plants in Kanchiyar Panchayath were not functioning at the time of the survey. An agency-wise functionality of biogas plants is provided in the table given below.

Table No.- 20

Agency-wise details on Functionality of Biogas Plants

Agency of Construction	Karunapuram		Kanchiyar		Total	
	Functional	Non Functional	Functional	Non Functional	Functional	Non Functional
MDS	283	20	76	8	359	28
Total plants constructed	303		84		387	
Krishi Bhavan	12	3	1	1	13	4
Total plants constructed	15		2		17	
KVIC	3	0	2	0	5	0
Total plants constructed	3		2		5	
Grand Total	298	23	79	9	377	32
Total constructed	321		88		409	

MDS also accounted for the largest number of non-functioning biogas plants. 7.23% of biogas plants constructed by it was not functioning at the time of the survey. However, 23.52% of the plants constructed by Dept of Agriculture was defunct and not functioning, while all KVIC plants were functional at the time of the survey.

4.4.5 **Land-class based distribution of Livestock keeping:** Five-land class divisions were made among the livestock keepers, ranging from less than 25 cents of land to above 250 cents of land. 33.47% possessed one acre to 2.5 acres of land while, 27.19% possessed half an acre to one acre of land. These two land class owners had the largest concentration of livestock keeping and biogas plants. The survey reveals a trend that as the size of the land holding increases, the tendency to keep livestock appears less.

Table No- 21

Land-class based distribution of Livestock keeping households

Name of Panchayath	Distribution of households into Land class					
	<25cents	26-50 cents	51-100 cents	101-250 cents	>250 cents	Total
Karunapuram	58	107	223	267	74	729
Kanchiyar	72	75	115	151	101	514
Total	130 (10.45%)	182 (14.64%)	338 (27.20%)	418 (33.63%)	175 (14.08%)	1243

4.4.6 Land class based distribution of biogas plants

Table No- 22

Land class based distribution of biogas plants

Name of Panchayath	Households with biogas plants distributed into Land-classes					
	<25cents	26-50 cents	51-100 cents	101-250 cents	>250 cents	Total
Karunapuram	13	29	76	150	53	321
Kanchiyar	3	2	16	37	30	88
Total	16	31	92	187	83	409

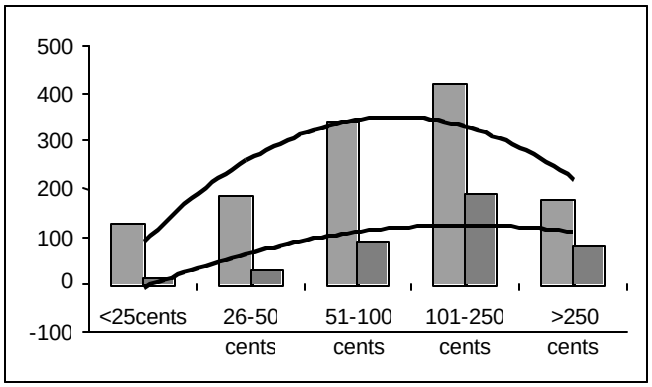


Figure No 16
Comparative Trend line in livestock keeping and biogas adoption

There is a similarity among Biogas owners as well as livestock keeping households showing the relationship between the extent of land held by the household and the livestock keeping as well as the adoption of biogas plants. The tendency to maintain livestock and adopt biogas plants decrease among the households, which have more than 2.5 acres of land holding. As farmers move

into small category from the marginal category, the livelihood security issues are different and hence do not compel them to keep livestock and tap biogas energy.

4.4.7 Influence of Subsidy from the Government on the Construction of Biogas Plant: This is another very pertinent question asked to the respondents. Would they have adopted Biogas plant, if the subsidy offered by the Central Government did not exist? 39 households have replied in the positive saying that they would have constructed Biogas plants even without subsidy support from the government, while a vast majority of 94 households think that it is the subsidy that attracted them to construct a biogas plant. When a household makes its decision to adopt biogas plan, it does so on the basis of a variety of reasons and rationalities and in the case of the present survey, nearly 71% still consider the subsidy grant as an enticing factor in the adoption.

4.4.7.1 **Method adopted for releasing subsidy:** All 133 households have received subsidy due from the Government. 129 households received the same without any troubles, while 4 households had some problems in getting it. 79 households got the subsidy in cash while 54 households got in the form of materials for the construction of biogas plants. The reason for providing the subsidy in materials included the following.

- Supervisor arranged the materials from MDS
- Inadequate local market facilities to buy Plant construction materials
- Low price and good quality of materials supplied by MDS, as it got advantage from bulk purchases

4.5 Adoption of Biogas Plants

An effort was made to look at the socio-economic and environmental impact of the Biogas programme, taking a shorter sample for closer analysis. Details of the sampling frame adopted the survey are given below.

4.5.1 Social background of the respondents

Some of the aspects of enquiry in this category included, housing status, latrines, extent of land owned by the households, nature of ownership of land, major income sources and details of the water sources of the households. All the 133 sample households had own house, 28 of them having concrete, 103 tiled / asbestos and two of them having modern lite roof houses. Of the total sample of 133 households, 106 were electrified. 121 households had own well-built latrines, while 12 households had temporary latrines or practiced open defecation. Only two households of the sample had their latrines linked to the biogas plants. The respondents of the survey belonged to the following land class distribution

Table No- 23

Land-class distribution of Respondents

Land class	5-50 cents	51-99 cents	1 to 1.5 acres	1.51 to 2 acres	2.1 to 2.5 acres	2.51 to 3 acres	> 3 acres	Total
No. of Households in each class	12	19	20	17	15	16	34	133

The study area is predominantly agrarian and the major sources of income of the sample households are as follows

Table No- 24- Occupational distribution of Respondent Households

Major source of income	Hhs in each category
Agriculture	78 (58.62%)
Livestock keeping	10 (07.52%)
Business	9 (6.77%)
Other Callings	36 (27.09%)
Total	133

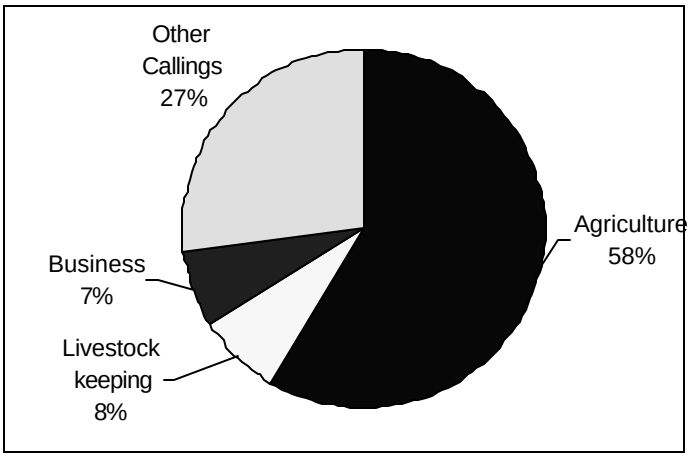


Fig- No 17
Occupational
Distribution of
Households

There is close relationship between Biogas plant operation and availability of water. Without sufficient quantity of water it is not possible to operate a biogas plant. Therefore, the water availability of the sample households was looked at

Table No- 25- Water Source of the Respondents

Sources	Drinking	For bathing and washing needs	Irrigating crops
Own well / spring / pond	94	87	67
Commonly used Private well/spring/ pond etc	29	30	2
Common well/spring/pond	2	5	1
River/stream	-	2	2
KWA/Common tap	8	9	-
Not irrigating	-	-	61
Total	133	133	133

It was found that 71% of the respondents possessed own wells, while 22% depended on privately owned but commonly used wells for meeting the water needs. 50% of the households surveyed had scope of irrigating their gardens. The table indicates that unless water is available near the household, it was not viable to operate the biogas plant. Water and biofeed have to be mixed in the ratio of 1:1 and hence the relationship between water and biogas.

Year of construction of Biogas Plants: Construction of biogas plants in the study area dates from 1986 onwards. However, bulk of the plants has been constructed during the period 1996 to 2001.

Table No- 26

Age of the Biogas Plants

Size class of plants	Up to 1990	1991-1995`	1996-2001	Total
1 M^3	1	2	8	11
2 M^3	3	10	24	37
3 M^3	7	20	53	80
4 M^3	0	1	1	2
10 M^3	1	1	1	3
All sizes	12	34	87	133

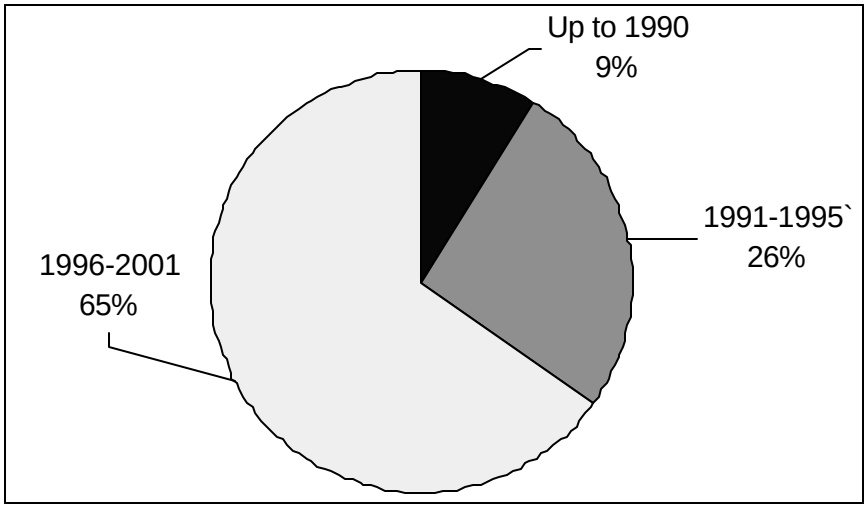


Fig- No- 18
Age of Plants

Only 'early birds' had constructed biogas plants until 1990. However, the number of plant owners began to increase after 1990, particularly marking a success after 1996. This goes along the fact that two important events in the history of biogas programme in MDS have significantly influenced the construction of Biogas Plants. Firstly, MDS started getting enhanced allocation of targets from Sustainable Development Agency-SDA. Secondly, construction of biogas plants became simple and easy with the adoption of the ferrocement model of biogas

plants. Of 133 plants, 127 are Deenbandhu types and 6 are of KVIC type. 88 plants are constructed using ferrocement technology and 45 with brick masonry.

4.5.2 Adoption Process and source of first information for the Households regarding Biogas Plants: The field level contacts of MDS are evident from the fact that 85% of the households, which have been surveyed, received their information on Biogas from MDS.

Table No- 27- Source of First information about Biogas

No	Source of Information	No. of Households
1	From Krishi Bhvan and other Government agencies	13
2	From MDS	115
3	Neighbours and relatives	5
	Total	133

Cowdung stirring triggered the decision to adopt biogas Plants

Shri P.I. Mathew, resident at Karunapuram recalls. "I had gone to attend a unit meeting of the MDS Grama Vikasana Samithy in early 1990. Fr, Mathew Vadakkemuriyil, secretary MDS was present in the meeting. Fr. Mathew spoke about the biogas programme. The participants raised several doubts. Thee were some misapprehensions about biogas. If biogas plant is constructed and gas connected to the kitchen, then there will be smell of cowdung in the kitchen always. After the meeting, Fr. Mathew came to my house. He took a bamboo pole and stirred the cow dung deposited in the pit. He told me to hold a burning piece of coconut leaf above the place where he stirred with the bamboo pole. There was a sudden and rising flame just above the place where cowdung was stirred. He told us the burning gas is methane and this gas will be collected from the plant and brought to the kitchen through a pipe and connected to the biogas stove. I

"Tomy Paikkara was MDS micro level unit secretary at Karunapuram. He joined the services of MDS in 1983. His designation in MDS was 'village animator'. There were several animators like him placed in the different parish villages of the diocesan limits of Kanjirapally. He came to know that the Anakkara village animator was implementing large number of biogas plants at Anakkara and

surrounding areas. Such work was bringing him substantial income as well. Tomy also decided to try his luck in implementing biogas programme. He attended the next training and went along with other supervisors to know their modality of work and learn for himself in the process. Back in his village, Karunapuram, he spoke to 15 progressive minded individuals about adopting biogas. All of them agreed to adopt. He therefore called a meeting of all these 15 persons who had initially consented. Only 10 persons came for the meeting. All of them decided to adopt biogas plant and authorized Tomy to purchase materials in bulk for them and bring it to a common point, from where the respective households would transport the materials by head load.

Tomy went on a war footing to complete the work, lest he was afraid that some of them might change their mind and drop out. Work of the 10 plants was completed in a record time. Their applications for subsidy were sent to the KVIC. When the subsidy was allocated to MDS, Tomy organized a small function at Karunapuram to distribute the subsidy. Fr. Mathew was invited to distribute the subsidy. He came to the meeting and spoke of the advantages of having a biogas plant in the context of highrange villages. All the first adopters were happy about the performance of the plant and they in turn spoke well about this new energy source to their neighbours, friends and relatives" [65.1]

The Yam Connection to Biogas

"It was at this instance that Tomy came across the success of Appachan Vaniyapurackal at Cumbummettu in cultivating Yam with bio slurry. Tomy went and met Appachan and saw the remarkable growth of the Yam (Amorpha Phallus) He purchased one Yam from Appachan. He brought it to Karunapuram. He carried the Yam on head during his 3 km journey to Karunapuram from Cumbummettu. People were amazed to the size of the Yam. He got it weighed in the presence of a small crowd of people who gathered to see the Yam. It weighed 40 kg. Karunapuram parish had its annual feast in the following week. Tomy

[65.1] FGD with former biogas supervisors

opened a small stall, where he put up various MDS Products for sale. The Yam was also exhibited with a banner announcing that it was produced applying bio slurry. Hundreds of people saw the yam during the three day feast. The Krishi Bhavan came to know of the incident. They came and purchased the Yam from Tomy and took it to Thodupuzha for another exhibition. Tomy was able to supervise the construction about 700 biogas plants in Karunapuram Panchayth from 1990. He remembers that Fr. Joseph Palathinkal was parish priest during those days at Karunapuram. He used to announce about Biogas Programme and urge people to adopt biogas during his Sunday sermons. This was a positive influence on the Christian community to adopt biogas plants. Tomy believes that his meticulous care, hard work, careful planning, implementation of the work which would bring maximum convenience to the user and personal involvement in the programme helped biogas to become very successful".[66.1] There were several committed and efficient village animators and workers for MDS in the Karunapuram Panchayath. The physical area of Karunapuram was divided by MDS among these village animators to avoid competition and conflicts in canvassing plants. Roy Joseph was given Third Camp, Tomy Paikara was given Karunapuram and Kuzhitholu, Shajan was given Moonkippallam, Tomy Mathew was given Ramakalmettu, Philip was given Kochera. All these parish villages fall into the Karunapuram Panchayath, making it the Panchayath with the largest biogas plant concentration in Idukki and perhaps in the whole of Kerala.

Rate of satisfaction among users of BGP:

86.5% of the biogas plant owners are either very satisfied or satisfied about the performance of the plant while only 13.5% are dissatisfied about the performance.

Table No- 28- Rate of Satisfaction among respondents

Very Satisfied	Satisfied	Not satisfied
68 (51.12%)	47 (35.33%)	18 (13.53%)

[66.1] FGD with former biogas supervisors

Table No- 29

Reasons for dissatisfaction

Inadequate quantity of cow dung	Inadequate quantity of gas generation	Construction defects	Other reasons
10	6	1	1

The reasons for dissatisfaction are largely due to inadequate quantity of biofeed and hence reduced gas generation. Households sell off their cattle heads and thus face shortage of dung to feed the plant, which will reduce the quantity of gas generation. The Plant owners recognize that the plant is working satisfactorily by seeing outflow of slurry or the generation of gas and its availability in the kitchen.

There is sufficient skills and capacities to repair defective plants in all the villages of the study area. Of the 133 plants surveyed, 10 defective plants have been repaired.

Table 30

Details about repairing of Biogas Plant till date

Problem	No. of plants	Repaired	Not repaired
Break in the doom	2	10	2
Break in the outlet	2		
Non availability of gas	5		
Break in the main doom	3		
Total	**12**		

Table No 31

Use of Bio feed in the Biogas Plant

No	Biofeed	Most predominantly used	Partially Used	Very less quantity
1	Cow dung	133	-	-
2	Pig manure	-	2	-
3	Rubber Waste water	-	2	-
4	Kitchen waste and other materials		1	3
5	Night Soil		2	

Cow dung is the most significant source of biofeed. Other feeds have been used on a limited basis and these include fish waste and organic wastewater. Any fermentable wastewater is put into the plant. The study came across a household at Cumbummettu where the household has a biogas plant but do not have cows.

Biogas without keeping Livestock

Is it possible maintain a biogas plant without keeping livestock. Yes, Chellamma Kalayathany at Cumbummettu has proved it by her experience. She is a part time sweeper in the nearby Sales Tax check post. Some of her innovative practices in maintaining the biogas plant are as follows.

1. Collecting cowdung from the ground near the sales tax check post where she is a sweeper and feeding the plant with the dung. This ground is the resting place for cattle brought from Cumbum in Tamil Nadu. Every week there will be two batches of slaughter cattle at the ground and hence fresh cow dung is available that day.
2. Collecting urine from a neighbouring cattleshed in a plastic container and feeding it into the plant
3. Fish waste parts and fish wash water used as feed material into the plant
4. Spreading jute bags on the plant dome and covering it with hay to protect the plant in rainy and cold seasons. This practice increases gas yield
5. Depositing leaves of Glirisidia trees into the plant. She vouches that Glirisidia leaves have tremendous gas production potential
6. Another innovative management practice followed by this household is interesting. If cooking is in progress and the gas supply reduces, which will affect the cooking, they will go out to the plant, collect two buckets of slurry from the outlet tank and pour it into the inlet. By the time, she comes back to the kitchen, it would have produced sufficient gas to continue cooking. She has experimented with the pouring of water into the plant to produce instant gas, but further says that it will solve the problem in the short term but will increase the water content in the plant, adversely affecting gas production later.

Table No- 32

Initiative for plant construction

Male Head of the Household	House wife	Supervisor
100 (75.19%)	32 (24.06%)	1 (0.75%)

The initiative to construct the biogas plant in a majority of 75% has come from the male head of the family and in nearly 25% cases, the initiative was from the part of the housewife.

Canvassing a Biogas Plant

Mrs. Leelamma Thankachan from Kanayankavayal felt encouraged by MDS secretary to become a biogas supervisor. She got trained and began the work in the year 2000. She has completed 225 plants under her supervision in three years time. When she began to visit houses to canvas prospective biogas beneficiaries, the people would usually ask; "You are so vocal about the advantages of Biogas Plant. Have you constructed a plant in your house?" When she said, 'No' she got rebuked. One lady asked her, why don't you construct one in your house first and later promote it in the villages. Then she decided to construct a plant for herself first. She did this on a priority and began with added vigour as she became confident of facing such uncomfortable questions. She learnt repairing of stove by dismantling the stove in her house and reassembling it.

She used a host of other techniques to canvas plants

1. Approaching relatives and friends of relatives
2. Approaching the houses of children she has taught in the nursery school
3. Speaking to parish priests and getting them to introduce biogas programme during the sermons on Sunday.
4. Befriending the key decision maker at a household and influencing through her/him. She says because of frequent interaction with people, the moment I interact with somebody at a house, I understand who can be approached to get a decision in favour and I do accordingly

There are mainly two uses for which biogas is used, for cooking and lighting. All households use biogas for cooking while four households use for lighting as well.

Table No- 33

Bank finance for the construction of Biogas Plants

Financing Institution	No. of members obtained loan	Repayment completed	Repayment continuing
Local Cooperative Banks	31	31	-
Nationalised Banks	6	6	
Scheduled Banks	3	3	
MDS local credit unions	13	11	2

40% of the households responded to the survey have taken loans from banks to construct biogas plants. The source of credit is both formal banking and informal non-banking sources. Except two households, all others have repaid the loans.

4.6 The Impact of Biogas Programme

4.6.1 **Impact of Biogas as a rural energy source on the Households**: One specific area of impact is concerning the type of fuel used by the respondent household. There is substantial difference in the use of fuel wood before and after the construction of the plant. 132 respondents depended on fuel wood as their main and only source of domestic energy and only one household had a LPG connection in the pre-biogas plant era. However, after the construction of the biogas plant, the use of fuel wood has got reduced and it has become a partial source or an insignificant partial source. In the pre biogas days, these households had a struggle to collect the firewood. Twigs and parts of trees grown in the compound was one source of firewood. These had to be collected always ahead of time and kept dried for burning. Any delay in doing so will make cooking a struggle with damp fuelwood emitting smoke and refusing to burn. The Biogas Plant brought about a change in this situation. The table given below provides details of the pre-plant and post plant scenario.

Table No—34

Comparison of fuel wood use before and after the Biogas Plant

Energy type	Cooking before the Biogas Plant			Cooking after the Biogas Plant		
	Most significantly used	Partially Used	Very Little	Most significantly used	Partially Used	Very Little
Firewood	132	1	-	5	30	93
Kerosene	-	-	-	-	-	-
L.P.G	1	-	-	2	33	-
Electricity	-	-	-			
Biogas	-	-	-	126	4	

When we speak of the source of fuel wood, it has to be borne in mind that these very same villages had set fire to the trees to burn and dispose them or converted into charcoal and sold it for meeting the livelihood needs. These very same villages began to face acute scarcity for fuel wood since atleast a decade. It affected very small holdings, as the land and its cultivation practices had very limited options for producing fuel wood. There is no practice of growing trees in the highranges, which can be used for fuel. Trees are grown if that supports any one of the crops or only hard wood trees are preferred. Thomas Kongamala revealed that there was sufficient wood chips to be used as fuel wood for two years when they occupied the land. These wood chips were of the hard wood trees that were cut and removed before they occupied the land. The source of fuel wood for the small and marginal farmers who responded to the survey are summarized in the table given below.

Table No- 35

Source of firewood collection before and after plant construction

No	**Source of Firewood**	**No. of households**	
		Before Biogas Plant construction	After Biogas Plant construction
1	From own farm	82 (61.6%)	111 (83.5%)
2	From neighbour's farm	11 (8.3%)	7 (5.5%)
3	From distant forest	11 (8.3%)	3 (2.25%)
4	From own & neighbour's farm	10 (7.5%)	2 (1.5%)
5	From own farm & distant forest	12 (9.%)	9 (6.5%)
6	From own farm & Buying	7 (5.3%)	1 (0.75%)

Another key indicator used to assess the impact of the biogas programme was the distance, the members of the household had to travel to the source of fuel wood. There is some marked reduction in the distance one has to travel before and after the construction of the biogas plant.

Table No- 36

Distance traveled for collection of firewood

No	**Distance traveled in metres to collect firewood**	**No. of households**	
		Before Biogas Plant construction	After Biogas Plant construction
1	Up to 100 metres	101 (76%)	113 (85%)
2	100 to 200 metres	16 (12%)	12 (9%)
3	201 to 500 metres	0	1 (0.75%)
4	More than 500 metres	16 (12%)	7 (5.25%)

Firewood storage houses before and after biogas plant construction: This is one of the indicators of the impact of Biogas plant. If a household does not have biogas or other alternative energy source, then such households always make it a point to store sufficient stock of firewood for the rainy season. Therefore, every year the firewood storage house is also repaired and kept in tact. Personal observations made during the survey have shown that households do not keenly follow the practice of storing fuel wood for the entire rainy season at the end of the summer. The quantity stored also has been reduced. The fuel wood house itself has been given up in several households. The corner of the cattle shed or other small extensions of the house itself are used for storing small quantities of fuel wood. The following table shows that the number of households that maintain firewood storage house has drastically dropped after opting for biogas plants.

Table No- 37: Maintenance of Firewood storage in a special shed

No	**Maintenance of Firewood storage in a special shed**	**No. of households**	
		Before Biogas Plant construction	**After Biogas Plant construction**
1	Firewood storage maintained	88 (66%)	40 (30%)
2	Firewood storage not maintained	45 (34%)	93 (70%)
	Total	133	133

The percentage households maintaining a fuel wood storage has fallen from 66% before biogas plant stage to 30% after constructing the biogas plant. The season of collection of firewood before the BGP was always the pre-monsoon summer weeks. Now the firewood collected and stored has decreased in volume. The maintenance of the firewood storage house has become less and households do not consider that as a major concern. Men used to put in their efforts to maintain the storage and collect and store firewood. After the BGP is installed, firewood collection is mainly left to the women, as women can meet the volume and effort required for it.

Table No: 38

Details about daily availability of biogas

Up to 1 hour	1-2 hours	2-3 hours	3-4 hours	4-6 hours	Above 6 hours
1	**2**	**9**	**53**	**58**	**10**
0.75%	**1.5%**	**6.75%**	**40%**	**43.6%**	**7.5%**

One of the widely discussed points in the focus group discussions was the actual cooking time spent in the kitchen. The general consensus was that houses with school going children are present, 3 hours of cooking time in the morning and 2 hours of cooking time in the afternoon was sufficient. Other type of houses require around four hours of cooking. On an average, a house requires to have biogas flame or fire in the oven going for 4 to 5 hours. Now, a well maintained 2 M^3 biogas plant can generate sufficient gas to supply gas for 3 to 4 hours a day. If continuous cooking is not done, all cooking needs of the house can be met with the biogas. Aleykutty Ayilukunnel at Karunapuram made an observation that she does not cook continuously with biogas and if cooked continuously, the gas will not be sufficient to do entire cooking. Therefore, what she does is, she allows gaps of 10 to 15 minutes between two cooking sessions. For eg, after rice is boiled, she allows a gap, before the next dish or curry is placed on the stove. She has observed that this type of management ensures that all cooking needs can be met from biogas.

Table No- 39

Details of fire wood savings due to the usage of bio gas plants.

Up to 30 %	30 to 50 %	Above 50%
3	**63**	**67**
2.25%	**47.37%**	**50.38%**

Wood savings are estimated to be above 50% of total requirements by 50.38% of households. However, households did not have a clear idea on this as no measurement has been done and observations made on the basis of that.

Table No- 40

Management of biogas for domestic purposes

Tea / coffee	Snacks	Rice	Tapioca	Rice based snacks	Side dishes	Cattle feed	Boiling water
133	133	129	123	127	128	22	83

Wide variety of items is cooked on biogas. In a general sense, all food items that require short duration cooking have been shifted to biogas. Women using biogas have been unanimous that in a day, several small cooking sessions occur. Most of the cooking are short duration cooking. Kindling the fire each time for a small cooking need was a real botheration and biogas has salvaged them from it. When fuel wood is used, kerosene is needed to kindle the fire each time. If kerosene is not used, then lot of firewood will go waste, as a fire beneath a coat of ash will have to be maintained, by keeping one or two pieces of firewood in the chulah.

4.6.2 **Impact of Biogas on Agriculture** : It was revealed through the discussions with various focus groups that the fertility of the soil began to deplete nearly 10 to 15 years after the migration. Depletion of soil fertility had a telling effect on the crops; the productivity and production got reduced, crops began to experience diseases. It became unviable to continue cultivation of crops like pepper, cardamom and coffee. By 1990s, the agricultural scenario of the highrange

villages reached an alarming situation. No body had any solution as to how to face and solve it. The emergence of biogas programme on a wider scale just coincided with the crises facing the agricultural situation. The early birds had received good harvests from the application of bio-slurry. The above mentioned Yam story readily attracted lot of farmers to adopt biogas.

The major commercial crops cultivated among the respondents of the survey included Cardamom, Pepper, Coffee and Coconut. Of these Pepper was the most prominent crop.

Table No- 41

Details about agriculture - Commercial crops cultivated by the households

Item	Major	Subsidiary crop	Partial cultivation	No cultivation
Cardamom	17	65	115	29
Pepper	105	16	3	9
Coffee	12	95	25	1
Coconut	Nil	4	74	22

Table No-42

Food crops cultivated by the households

Item	Major	Subsidiary crop	Partial cultivation	No cultivation
Tapioca and other tubers	109	109	124	11
Banana	16	43	59	15
Vegetables	1	8	103	1

All adopters of biogas plant follow the practice of applying bio-slurry for their commercial and food crops. Every one had positive trust in the effectiveness of applying slurry. The yield and productivity has enhanced since the practice of application of slurry began and the instances of diseases have reduced.

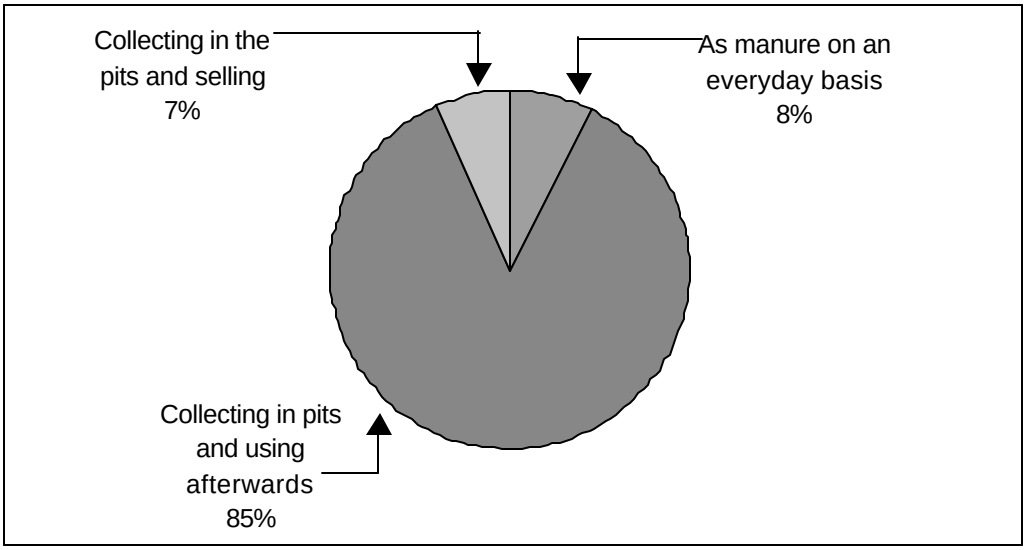
Table No- 43

Details of fertilizer application

Level of application	Chemical Fertilizers	Cow dung	Dried cow dung	Bio slurry	Compost	Other bio fertilizers
Predominantly	Nil	1	4	130	Nil	Nil
Partially	4	Nil	46	Nil	11	103
Very Little	25	7	21	Nil	35	20

98% of the respondents have agreed that bio slurry is the most prominent manure used by them after the plant has become operational. The farming community has hope that if the demand for the organic products rise and a price difference is offered for organic products, then the biogas plant owners will benefit from such opportunities as they have already converted their farming practices into organic methods.

Fig No- 19 Method of applying bio-slurry



The most common and widely practiced method was to collect the slurry and apply it to crops in intervals as per the convenience of the farmers and this constituted 85% of the respondents. Only 7% applied slurry on an every day basis and this is the healthiest way of applying slurry. There were some very small holders, which did not have scope for applying slurry in own garden. They converted the slurry into dry manure and sell it for a price. There is a problem

with regard to the application of bio slurry after collecting the same in the pit and applying it later. Some of the nutrients are lost when it is stored and used later. The ideal method of application is therefore, what is followed by the 8% of the respondents, ie, applying slurry as fresh manure on an everyday basis.

4.6.2.1 Impact of the adoption of Biogas plant on the cropping pattern.

There is evidence for some impact as households have adopted new crops into their land with the hope of applying bio slurry and taking advantage of the bio manure availability. Cardamom is the crop, which is most responsive in the opinion of the farmers to bio slurry. This is a popular belief on the basis of the experience of the farmers in the highrange villages. 99 households(75% of the respondents) have adopted or newly planted cardamom after constructing plant.

4.6.3 Gender sensitivity of Biogas Plant

67% of the households have answered that women have benefited the most from the construction of the biogas plant, while 33% households think both men and women have gained out of the construction of the biogas plant. The reasons for the pro women sensitivity of biogas plants was focused in the survey as well as in the FGDs. The most prominent comments received were the following

- Kitchen works become much easier.
- Smoke inhalation has reduced.
- Time for dish washing has reduced.
- Easy to cook. Cooking in between meals have become much easier. If a guest comes to the household, then tea or coffee has to be provided. But if one is to make the fire in the oven and prepare tea, it is going to take longer time. With the biogas, it is matter of few minutes and tea can be got ready. The Housewife can go and join the discussions with the guest. The firewood and wooden stove would keep the housewife entangled in the kitchen itself.
- Since the work time has reduced to a considerable rate the time thus saved can be utilized to earn livelihood or to look after children.

- Women are involving more in agriculture related activities.
- Drudgeries to collect and store firewood have reduced.
- The overall impact of the biogas plant is that the health of the women has improved.

Table No-44

Operational Responsibility of the Biogas Plant

No	Operational Responsibility	No. of Hhs
1	By the male members of the household	58
2	Housewife or female members of the household	59
3	Servants	4
4	Husband and wife	9

Biogas is definitely an advantage as far as women are concerned. Atleast some of them had an apprehension whether this facility will increase their work burden. However, out of experience, now women say that their work burden has not increased, because of adopting biogas plant. Men and women share the responsibility of mixing cow dung and feeding the same into the plant. Cleaning and cattleshed and removing dung into the pit used to be done by women even earlier. The cattleshed and biogas plant are so positioned that the dung need not be carried and deposited into the plant. Dung can be easily placed into the mixing tank. Biogas supervisors in Karunapuram Panchayath foresaw this difficulty and while doing the setting out and designing of the plant they had addressed this issue of not having to carry cow dung far and mix the same into the plant.

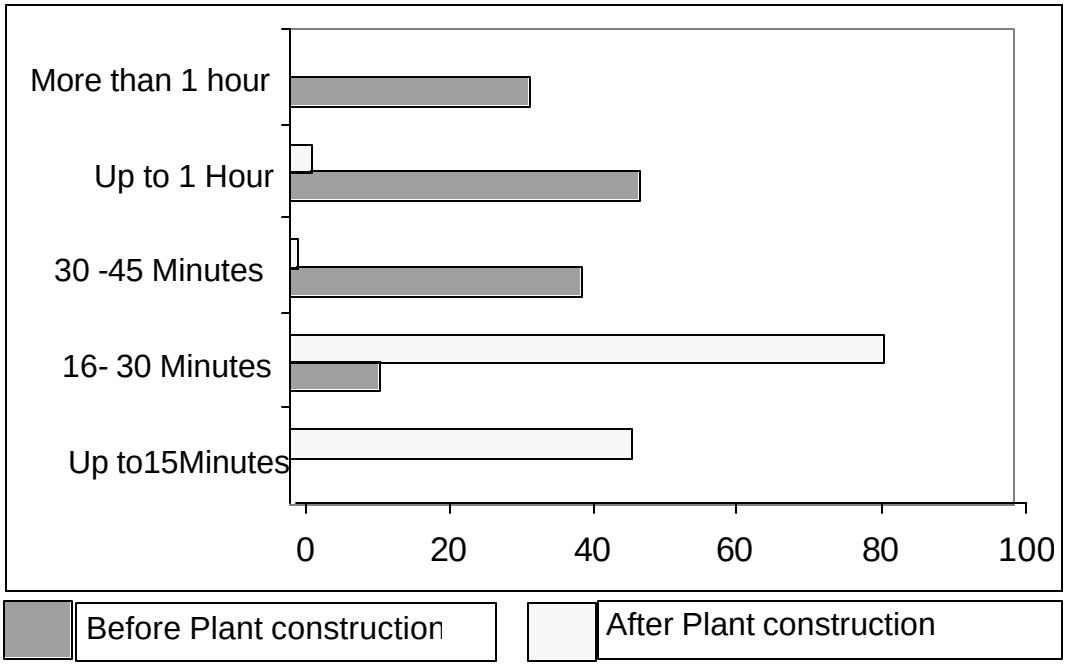
4.6.4 Time saving due to the construction of Biogas plant: The most significant contribution of biogas plant to women is that it is giving them more leisure and time to relax as well as concentrate on other works. The time taken for fuel wood collection is taken and compared with the before and after construction period of biogas plants. The following table gives a comparative picture.

Table No- 45

Comparison of Time spent on fuel wood collection before and after Biogas plant

Time	Number of Households	
	Before plant construction	After plant construction
Up to15Minutes	--	47 (35.34%)
16- 30 Minutes	12 (99%)	82 (61.66%)
30 - 45 Minutes	40 (30%)	1 (0.75%)
Up to 1 Hour	48 (36%)	3 (2.25%)
More than 1 hour	33 (25%)	-

Fig No- 20 Comparative Bar diagram showing time spent on collection of firewood after the adoption of Biogas Plant



4.6.5 Biogas plant and influence on health

All 133 households have answered that the Biogas plant has helped in improving the health of the women members of the household. The respondents feel following changes after the biogas plant has become operational.

Table No- 46

Changes experienced after the construction of bio gas plants.

Areas	Men	Women	Men and Women
Reduced the time for firewood collection	Nil	95	18
Reduced physical hazards	4	128	1
Household activities become much easier	Nil	133	
Increased the physical labour	Nil	Nil	Nil
Other changes after the plan construction	**Households**		
Reduced fuel expenses	63		
Reduced pollution	4		
Reduced fuel expenses and pollution	66		

Table No- 47

Problems faced in operation of Biogas Plants

Life of the plant	Problems					
	Insufficient gas generation	Reduction in the volume of gas	Trouble with the stove	Pipe/Plumping fault	Operational problems	No Problems
Beginning	4	-	-	-	-	129
Middle	9	-	39	14	-	71
Present	-	14	9	4	1	105

Some households have taken the bold initiative to get the system repaired, while others have called for help from the biogas technicians and supervisors. 6 households however, did nothing to set right the problem and live with it.

4.6.6 Overall impact on the life brought about by Biogas plant

1. It has improved the health of women and reduced the drudgery of cooking
2. It helped to reduce the consumption of firewood.
3. Cattle rearing become inevitable and trying to make the same profitable.
4. Slurry is used as a major fertilizer.
5. More attention is paid to agriculture.
6. Reduced the rate of chemical fertilizers considerably.
7. Women are getting more time for social interaction and relationships

4.6.7 User Dissemination of Biogas Plants

105 households have answered in the positive that they have tried to propagate biogas plants among friends and relatives and spoke positively about the good performance of the plant. On the other hand, 28 households haven't made any substantial efforts in propagating biogas plants.

4.7 Benefits of Biogas Programme

Men and women value the benefits of biogas differently. The following table illustrates the gender-varied perceptions on the benefits of biogas.

Table No- 48 Benefit perception on Biogas by Men and Women

	Men	Women
Individual Level	Information on Biogas plant, its construction, operation, maintenance Saves time and energy in not having to split logs of fuel wood into small and usable pieces Do not have to buy chemical fertilizers for the garden and crops	Information on Biogas plant, its operation and maintenance Improvement in health Reduction in inhaling smoke from kitchen Drudgery in collecting sufficient fuel wood, keeping it dry for the rainy season etc reduced Less worries on collecting firewood Clean cooking fuel Convenient to cook small meals, snacks, preparing tea and entertaining guests etc becomes easy Gives leisure for women Less washing of cooking vessels Can cook easily, light the stove etc even when the women have infants in their house/or when holding infants in hand. Women do not have to remain near the cooking pot always, unlike in the case of fuel wood stoves, where the constant attention is needed to mend the fire and keep it burning in the right place. Faster cooking and timely meals

Household Level	Availability of cost free organic manure in the form of bio slurry. It is a soil conditioner Reduced diseases of plants and crops after applying bio slurry Improved productivity of crops Monetary savings as Biogas replaces other purchased fuels like LPG. LPG is even available in the villages of the study area now. Biogas provides an equally efficient fuel like LPG at no cost and minimum effort in a renewable way.
Community /Village Environment level	Reduced felling of trees for firewood Reduces /stops methane from going to the atmosphere by capturing it and using it in the kitchen

4.8 Cost of Biogas Plants and Economic Rate of Return in the context of the study area

Biogas makes sense as a socially useful facility and is gender sensitive enough that it has eased their burden and made life easy for them. Does investment in biogas make economic sense? If yes, what is the benefit a plant can provide and if it is a bad investment, where does it fail? We sought to examine this question by analyzing the cost and benefits of Deen Bandhu type biogas plants made of ferrocement technology.

4.8.1 **Costs and Benefits of Biogas Plants**

Table No- 49 Benefits and Costs of Biogas Plants

No	Description	$1M^3$	$2M^3$	$3m^3$
1	Cost of construction of Biogas plant inclusive of labour, materials and installation inclusive of all equipment	5500	7500	10000
		Cost of construction is assumed taking the conditions at Karunapuram and Kanchiyar		
2	Subsidy grant from MNES	2000	2000	2000
3	Net cost to the farmer/ household	3500	5500	8000
Operating Costs on a per annum basis				
1	Cost of labour for operating the plant	1825 @Rs.5/day for 365 days	2555 @Rs.7/day for 365 days	3650 @Rs.10/day for 365 days
2	Cost of dung balanced against cost of slurry	00.00	00.00	00.00
3	Repairs and Maintenance assumed at 3% of construction cost on a per annum basis	165	225	300
	Total Operating costs	1990	2780	3950
Annual costs on capital				
1	Interests on capital investment @12% (Interest is calculated on the entire amount incurred on the plant including the subsidy given by Government)	660	900	1200
2	Depreciation @ 4%/Annum Calculated on the entire capital cost including the government subsidy	220	300	400
	Total annual costs (Includes cost of labour for operation, repairs and maintenance, interests on capital and depreciation on the capital asset)	2870	3980	5550

4.8.1.1 **Annual Gas Production and Replacement value of biogas**

Table No- 50: Annual Gas Production and Replacement value of biogas

No	Description	$1M^3$	$2M^3$	$3m^3$
1	Total annual usable gas generation (Assumes gas production of 2 M^3, $4M^3$ and $6M^3$ per day for 1, 2 and 3 M^3 biogas plants respectively	$730M^3$	$1460M^3$	$2190M^3$
2	Fuel replacement Assuming 1 M^3 of biogas equivalent to the calorific value of 0.5 litres of Kerosene	365 Litres	730 Litres	1095 Litres
3	Fuel replacement value, assuming Rs. 10/litres of Kerosene	3650	7300	10950
4	Total monetary gains on the above assumption in Rs.	780	3320	5400

Therefore, the net benefit of a biogas plant is Rs. 780/PA for $1M^3$, Rs.3320 for$2M^3$ and Rs. 5400 for $3M^3$ plant. We have assumed a life period of 25 years for one Biogas plant. The total returns therefore would be as follows for the above capacity plants. [84.1]

[84.1] **Assumptions**

Price of kerosene is assumed as Rs. 10/Litre as available in the ration shops of the Public Distribution System in the selected Panchayaths

Gas generation assumed as $2M^3$, $4M^3$, $6M^3$ for $1M^3$, $2M^3$, $3M^3$ capacity biogas plants. The capacity of BGP refers to the rate of biogas production per day/24 hours for a simple hydraulic digester, using animal manure, which can be easily mixed and made into slurry. The biogas plant is designed and constructed to store one third of the total gas production during 24 hours. This means that a $1M^3$ biogas plant will generate 3 M^3 of biogas in 24 hours. But its storage capacity, ie, $1M^3$ is sufficient to store the gas generated in 8 hours. It is assumed that gas generated at night alone is needed to be stored and gas generated during the daytime will get consumed almost simultaneously. Therefore, it is assumed that the total usable gas generation in a $1M^3$ biogas plant is $2M^3$ of biogas.

4.8.1.2 **Summary of Benefits of Biogas Plant over its life cycle**

Table No- 51 Returns on Biogas Plant – Annual and Life Cycle basis

Description	$1M^3$	$2M^3$	$3m^3$
Net Annual Returns after interest on capital, depreciation and annual operating costs	780	3320	5400
Net Life Returns at current rate	19500	83000	135000

Biogas not only makes sense, it makes very positive economic sense as well, considering only the fuel aspect. The enriched biomanure can be considered a bonus.

Considering the fact that MDS has built a total of 21674 biogas plants and assuming on an average a production of $4M^3$ of gas production per day is contributing substantial benefits to the nation. We take the same assumption as applicable in the case of Karunapuram that 93% of the plants constructed by MDS are functioning satisfactorily. Therefore, the total number of plants functioning satisfactorily at any given time is taken as 21674 x 93%=20,157 plants.

Table No-52

Total Fuel Replacement Value of Biogas Plants constructed by MDS

No		Benefits assumed for one biogas plant	Benefits assumed for 20157 plants on a per annum basis
1	Fuel replacement value, assuming Rs. 10/litres of Kerosene for a $2M^3$ plant is	7300	7300 x 20,157 = Rs.14, 71,46,100
2	Less Operational Cost of BGPs	3980	3980 x 20157= Rs. 8,02, 24,860
3	Total monetary gains on the above assumption in Rs.	3320	Rs.6, 69,21,240

Scientific calculations have assumed that one Kg of fuel wood is equivalent to $0.34m^3$ of biogas[86.1]. Therefore, the total biogas generation in the State from biogas plants installed under the initiative of MDS is equivalent to a fuel wood

[86.1] Calculations based on the figures provided by MNES vide its annual report 1989-90 page 6

replacement of 4294 kg of fuel wood /plant x 20157 = 8,65,54,158 kg in a year. Fuel wood prices are assumed at the rate of say Rs.075/kg. Therefore, the economic saving for wood is equivalent to Rs.6, 49,15,618 a year. Similarly, these biogas plants contribute to the production of enriched bio manure. Each functioning biogas plant is capable of generating 66 Kg of wet manure. Assuming a price of Rs.0.10/kg of enriched manure, the total annual economic return in the form of enriched bio manure is to the tune of 20,157 plants x 66kg of bio manure/day for 350 days a year= 46,56,26,700. Therefore the economic return from the production of enriched manure is Rs.0.10/kg manure x 46,56,26,700 = Rs. 4,65,62,670. The total gain for the national economy in a year from biogas plants constructed by MDS can be calculated as follows

Table No- 53 Comparison of monetary gains between Biogas and Kerosene and Firewood

Production of biogas equivalent to					
Replacement of Kerosene			Replacement of Fuel wood		
Quantity in litres	Unit rate per litre of kerosene assumed in Rs.	Total economic value	Quantity in Kg	Unit rate per Kg of fuel wood assumed in Rs. /kg	Total economic value
14714610	10	14,71,46,100	86554158	0.75	6,49,15,618
@ 730 litres/BGP for 20157 Biogas plants			@ 1Kg of fuel wood replacing 0.34M^3 of biogas. Hence, 1460 M^3 / 0.34 = 4294 kg of wood x 20157		

4.8.2 **Employment generation**: It is very true that Biogas programme has proved itself to be viable and beneficial to the user and to the nation in several ways. It also generates substantial employment in the process of construction and commissioning of the plant. Following table gives a summary of the person day requirements for constructing plants of various sizes

Table No- 54 Employment generation in Biogas Plant construction

No	Description	Plant Capacity		
		$1M^3$	$2M^3$	$3M^3$
1	Mason Days required to construct a plant	4	6	8
2	Unskilled support labour for digging pit, supporting construction etc	9	10	12
3	Plumbing works	1	1	1
4	Filling the Plant	2	2	3
5	Total person days of employment generated	16	19	24

Considering the plants constructed to be of $2M^3$ capacity, and assuming that each plant has generated 19 person days of employment, MDS has generated a total of 4,11,806 person days of employment. (Total number of plants = 21674 x19)

4.9 Difference between Karunapuram and Kanchiyar in achievement of Biogas

Both Karunapuram and Kanchiyar Panchayaths have been in the operational area of Malanadu Development Society since 1977. Both had equal opportunities in developing biogas programme. However, Kanchiyar is far behind Karunapuram as regards the achievement in biogas is concerned. This naturally raises a question as to why this has happened. This aspect was discussed with former workers involved in implementing biogas programme in both the Panchayaths, officials who were looking after biogas in Malanadu Development Society including its top leadership. The summary of discussion with the concerned is given below in a matrix.

Table No- 55 Criteria based rating of Karunapuram and Kanchiyar[88.1]

No	General characteristics and details	Karunapuram	Kanchiyar
1	Commitment of village animators	XXX	X
2	Support from Parish Priests	XXX	X

[88.1] Criteria developed in discussion with the Biogas Department personnel in MDS and the village level workers

3	Management entrepreneurial skills	XXX	X
5	Number of Biogas Supervisors	XXX	X
6	Credibility of the Biogas Supervisors and village animators	XXX	X
7	Linkage with Banks	XXX	X
8	Bio village programme	XXX	0
9	Intra-institutional support of MDS subsidiaries	XXX	X
10	Small Biogas loans to prospective beneficiaries & Biogas Lotteries	XX	X
11	Village Biogas campaigns	XXX	X
12	Centralized supply of materials	XXX	XXX[94.1]

XXX **Very Good** XX **Good** **Average to Poor X**

The performance of the MDS village level unit at Kanchiyar was poor and that has got reflected in the performance of the biogas programme of the Panchayath. One of the key things that went wrong in the case of Kanchiyar was that two biogas supervisors misappropriated funds and thus the public lost confidence in the programme because of this adverse publicity and that ultimately resulted in the poor performance of the biogas programme in the Kanchiyar Panchayath. On the other hand, Karunapuram had all advantages as mentioned above in the matrix and that contributed to the substantial achievement.

Chapter - V

Conclusion

There are two ways in which the Biogas Programme in MDS can be looked at. First, from the point of the end user, (the beneficiary perception) and secondly from a broader perspective at MDS, its achievement profile, the process of diffusion and its contributions to the Rural and Renewable Energy Sector in the State and Country. MDS has made formidable success with regard to the total achievement in terms of number of plants, the functional success of the plants and the fruitful management of the plants by the beneficiary communities. It is fully gender sensitive and the benefits have gone to the women, without causing them any additional burden.

MDS has continuously kept the end user in mind and efforts have been made to simplify the technology, make it cost effective and diffuse it among as many as possible. The fruits of its innovations have gone to the whole Nation. Had the innovation of ferrocement application in Deenbandhu biogas plants not been made, the diffusion of biogas plants would have probably grounded to a halt in Kerala, due to the scarcity of good quality bricks and prohibitive cost of construction.

The satisfaction at the level of the end user is good. Biogas Programme makes great economic and ecological sense as is clear from the field enquiries and analyses. Its social relevance is beyond doubt and is probably the only affordable beacon of hope for the small and marginal farm lands which suffer continuous outflow of nutrients. Farming operations will not take long to get unsustainable and come to a halt if such situation prevails. Biogas and Bio manure can help these small homestead gardens in maintaining fertility, productivity and sustainability. Agriculture is a combination of agro-sylvo-pastoral activities and if any of these elements is taken out, then it is bound to adversely affect and therefore the programme has to be encouraged by all means.

How did MDS achieve this success? It had very little professional support with in the MDS team. MDS professionalism is of a special type. It gives skill, confidence and capacity to ordinary people and get professional results out of them. The concentration of energy has been more on the end and less on the means. MDS never allowed the instrument to become the end, as in the government or other establishments. It is because of this attitude that MDS has completed nearly 22000 biogas plants, nearly one third of the total achievement in the State of Kerala.

Kerala has potential for constructing 300000 domestic biogas plants. The achievement till date is around 30% of the total achievable target. This means that scaling up of efforts and strategies have to be done to achieve the target. The learnings of MDS can be of immense value to the Government, other NGOs and Grama Panchayaths. With the decentralization of planning, distribution and investment of funds, Grama Panchayaths need strong support in copying successful models like the rural energy model of MDS. MDS can train Panchayaths in carrying out energy campaigns at the GP level and contribute to the State and Local economy, the environment and generate large number of employment. The technology behind Biogas is simple and adaptable.

It is opportune to attempt a SWOT analysis of the Biogas Programme in MDS.

Strength	Weakness	Opportunities	Threat
Trained pool of manpower	No systematic evaluation of the programme yet	Collaboration with GPs	Other NGOs
Rich experience of implementing the programme in all parts of Kerala	No documentation- Progress monitoring only No Process monitoring and documentation	Develop a soil waste/ liquid waste treatment plant for the urban areas	Variations in government targets
Training and capacity building facilities available	Focusing only on activities such as construction of biogas plants and not creating knowledge Hence the achievement is a lower level .	Funds with the GPs	Subsidy funds not reaching in time
Experience in transferring technology and training other NGOs	Not marketing the knowledge	PTD for Sustainable Agriculture is one superb opportunity to take the biogas into another dimension and sell the technology as a remedy for the ailing agriculture of Kerala.	
Experience of collaborating with Panchayaths, Dept of Agriculture, Other Govt departments, KVIC, MNES etc	The Duck Syndrome - Lays eggs but keeps quiet afterwards. On the other hand, when a hen lays an egg, it advertise that it has laid an egg		
Management capacity available in the organisation	No Institutional form to backup with continuous support		
	Inward looking character of MDS		

Weaknesses are internal. These have to be overcome using the strengths and opportunities. MDS has to concentrate on further innovations and knowledge building so as to handover the experience to other stakeholders at the governmental, non-governmental and community level.