STUDY ON NON-CONVENTIONAL ENERGY SOURCES IN THE TRIBAL SUB-PLAN AREAS OF ASSAM

Sponsored by

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ASSAM INSTITUTE OF RESEARCH FOR TRIBALS & SCHEDULED CASTES
GUWAHATI : ASSAM

PREFACE

The Assam State Council of Science, Technology and Environment, Guwahati, Assam has entrusted a study on 'Non Conventional Energy Sources in the Tribal Sub-Plan Areas of Assam - Problems and Prospects'. During this study fifteen villages in ITDP areas have been covered. These villages are inhabited mostly by tribals. After analysis of the data, various suggestions have been incorporated in the study. Various aspects of non-conventional energy have been examined in the study. We hope that the study will be useful for the planners as well as the officials engaged in implementation of the programme.

Dated Guwahati the,
26th March,1997.

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INTRODUCTION :

(a) Almost all the people inhabited in rural areas depend on firewood as a source of energy for cooking and keeping the house warm during winter season. In typical tribal villages, a huge amount of timber is also spent in socio-religious ceremonies etc. Because of indiscriminating use of timbers, the number of forests are decreasing day by day causing imbalance to our eco-system. So,this is right time to think about alternate or non-conventional energy source to cheek the indiscriminating destruction of forest product in theform of firewood. So,a research project has been undertaken by Assam Institute of Research for Tribals and Scheduled Castes. This research project has been entitled as "Non-Conventional Energy Sources- Problems and Prospects in Tribal Sub-Plan Areas of Assam". For this purpose, 15 villages inhabited by tribals of various ethnic groups from under 15 Integrated Tribal Development Projects are selected.

Objective of the Study :

The objective of the study is to ascertain how non-conventional energy sources like bio-gas,improved chulas etc.are beneficial in the tribal sub-plan areas and also to analyse the problems faced by the inhabitants in achieving their cherished goal. Keeping in view all these facts, data were collected from 15 villages in the form of village schedule and household schedule. It is also observed that if necessary financial assistance with proper motivation of the inhabitants and technical know how to run the bio-gas plant is imparted to the beneficiaries,it will not only help them from health and economic point of view but also help them to check the forest products from destruction theirby maintaining ecological balance.

CHAPTER - I

(a) FORE WORD :

The energy requirement for cooking or other domestic purposes, whether it is in the urban areas or rural areas is one of the most significant aspects of the existance of the man kind. At the same time, it is an outgoing problem so far as ecological and environmental conditions are concerned. How to make fire and to use it for different purposes are perhaps the major course of actions at initial phase of human history. In this context, it is worth mentioning that, the first use of fire has been reported from an occupational level of Middle Palacolithic people about 1.4 million years B.C. Perhaps they have learnt gradually how to use fire by seeing the natural fire. But the advancement of civilization, as well as the development of science and technology their application have brought changes tremendously. As far as the cooking energy is concerned it has changed specially in the urban areas. In India 80% of the population lives in villages. They mainly depends on fire wood for preparing food and other domestic purposes. The Tribal Sub-Plan Areas of Assam which are constituted by 19 Integrated Tribal Development Projects (ITDP) and which are inhabited by more than 80% of the plains tribal population. They also used fuelwood for day to day cooking and other domestic purposes. The purpose of wide ranging use of firewood are as follows :

(i) As a natural resource, forests are available in the Tribal Sub-Plan Areas of Assam.

(ii) Firewood can be collected easily from the forests/ jungles or it can be collected from one's own jungles or trees.

(iii) It can be stored for a considerable period of time, which rather increase its power to produce more energy for cooking.

(iv) Its use does not require any technical knowledge and it can be used by the persons of all ages except the infants and babies.

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(v) Most of the tribal people are not in a position to buy luxurious warm clothes. But burning of firewood in the hearth keeps the room in tribal hutments warm specially during winter season.

In recent years, the environmental polution is a common phenomenon thr ugh out the world. Due to the deforestation by indiscriminate cutting and felling of trees not only cause the environmental polution but also decreasement of fuel wood. Now fuel wood is becoming scarce commodity, which does not sustain more than 80% people living in the rural areas. On the other hand, the demand for fuel-wood has been increasing consistently due to the increase in the number of families as well as excessive growth of population.

The people living in the urban areas generally use L.P.G.,Electric heater,Kerosene stove for cooking food and other purposes. Kerosene used for cooking is not unknown in the rural areas. But so far as L.P.G. is concerned,it has yet to make an inroad into the rural areas. The tribal sub-plan areas of Assam are not exception regarding this. The Gas Companies have failed to fulfil the demand of L.P.G. in the urban areas. In this situation, they can't think of the people living in rural areas. Even if we assume that cooking gas could be made available to the tribal areas, they would not be in a position to install cooking gas in their homes. This is because of the fact that, the initial expenditure of installation of cooking gas (L.P.G.)is beyond the reach of the tribal people living in the tribal sub-plan areas of Assam.

It is also fact that, many tribal villages of tribal sub-plan areas have already been electrified,and sometimes electricity is brought nearer to their houses. But it is hardly possible for them to electrify their houses due to the high cost of electrification. It has already been mentioned that Kerosene oil is used by some tribal families spe-

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cially the Wealthy one for the purpose of cooking their food. But for the general people it is not possible because Kerosene is not only scarce commodity but also costly in the rural areas of Assam. The Kerosene oil thus procured is only used for lighting the houses at night. TTherefore it can hardly serve as a substitute for fire wood.

So the people living in the rural areas fully depend on fire wood. The use of fuel wood as a source of energy for cooking and other domestic purposes has led the tribal people not only to render decreasement of forest wealth to a considerable extent causing ecological imbalance. This is one of the cause of loss of man power in collection of fire-wood which could have easily been utilized for other productive purposes.

Keeping these points in view a research project on "Non-Conventional Energy Sources - In Tribal Sub-Plan Areas" about its problem and prospect is under taken by the Assam Institute of Research for Tribals and Scheduled Castes,Assam in 15 tribal sub-plan villages under 15 Integrated Tribal Development Project of Assam.

In view of these, an investigation is conducted in the selected scheduled villages for the collection of data. The report, outcome of this investigation,where an attempt has been made to present a coherent picture on some aspect of non-conventional energy sources of tribal sub-plan areas of Assam in general and the selected villages in particular.

Because of the limited resources, at our disposal the present work, obviously, could not cover all the 19 Integrated Tribal Development Project of tribal sub-plan areas of Assam. However, in future, with this humble attempt we shall try to extend our work to the hitherto uninvestigated tribal sub-plan areas comprising mostly the flood prone zone of Assam. Though installation of bio-gas in those areas seems to be a futile exercise yet improved chulas can be used to minimise the need of fire wood thereby making it feasible to protect forest products to a considerable extent.

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AIM OF THE PRESENT INVESTIGATION :

(b) About 40% of the total energy consumed in the country is in the rural areas. Of this 55-60% is attributed to the cooking and other applications in the domestic sector. While lot of efforts, have been made to meet energy requirement in the urban areas, the rural areas had never received adequate attention. This is primarily because bulk of this enerrgy demand is for cooking and met through non-conventional energy sources like fire wood agro-based residues and animal waste.

Inadequate attention towards this problem in the past has resulted in heavy decreasement of forests. The situation has now become alarming for maintaining required ecology and environment. Inefficient utilization of fuel-wood, coal, agro-waste and animal waste for cooking has also resulted in serious health/hygienic problems. In the overall scenario, inspite of various options available to reduce the consumption of fuel w od, the dependence of fuel wood will continue to play a pivotal role in meeting cooking and domestic requirements in rural areas. It is therefore, imperative that traditional and inefficient cooking stoves are replaced by more fuel efficient improved cooking devices with a view to conserve forests and fuel wood and also to improve the health and hygienic conditions, reduce druggery of women and to make an overall improvement in quality of life.

Assam is blessed with livestock resources. It has been seen that each of the tribal families possesses a number of cattle heads. Therefore, to provide each family with a non-conventional sources of energy, namely, bio-gas' or 'Gobar Gas ' plant improved chullas accordingly to the size of the family and the number of livestocks for the purpose of generating energy, or cooking and other domestic purposes is sure to be a practically plausible proposition. Even if we assume that raw-materials for bio-gas plant (cattle dung) would be

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available, we are to find out whether people will accept such plants which are not only new to them from socio-cultural point of view,but also installation of such plants depends on making technical knowledge easily available to them with sufficient monetary and material incentives. In view of above, the proposed investigation aimed to explore :-

(A) (i) Requirement of fuelwood of each tribal family in the selected villages,mandays/man hours spent in procurement of firewood, sources and distance, person engaged for it,quantity and value of fuel wood etc.

(ii) Actual requirement of fuelwood for cooking and other domestic purposes.

(iii) Total numbers of cattle heads,and actual quantum of cow dung,usual practice for the disposal of dung.

(iv) Justification of the size of Bio-gas plant according to number of cattle heads and number of family members.

(v) Cost of Installation of a Bio-gas plant.

(vi) Utilization of by products.

(vii) Sources of finance,so on and so forth.

(B) (i) The factors,responsible for proper implementation of the Biogas and other non-conventional energy sources.

(ii) Analysis of the data collected from different Tribal Sub-Plan Areas of Assam.

(iii) Recommendations/suggestions to be followed by Government/respective authorities during the implementation of such project and what types of Biogas plant or other non-conventional energy sources should be suitable for such areas.

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SELECTION OF STUDY AREA :

The present study is an attempt to throw some light on the problem and prospects of Non-conventional Energy Sources in Tribal Sub-Plan areas of Assam. For this purposes a list of villages having 80% or above plains tribal population was collected from 15(Fifteen) Integrated Tribal Development Projects of Assam (Table-I). It is worthmentioning that, the Tribal Sub-Plan Areas of Assam are constituted into 19 Integrated Tribal Development Projects. The 4 (four) Integrated Tribal Development Projects which are not included in this study are flood-prone. The installation of bio-gas plants in such areas will simply be a wastage of money and man-power since during flood the installed plants are likely to be submerged making them ineffective. We,therefore, propose to bring under coverage of the study only 15 (fifteen) Integrated Tribal Development Projects. Only one village from each Integrated Tribal Development Project will be selected for our study and each household and the village as a whole will be surveyed as per the household/village schedule. Further, it is also worth mentioning that,among the fifteen villages identified so far,four villages Bikrampur,Majdalpa, Rajabari II and Upper Deori gaon are flood-prone. As it was already selected for the study,so we have collected data from those villages also.

During our field study we have faced some problems regarding the size and the population growth of the villages. The project villages are selected on the basis of 1971 Census report. Now most of the villages, population size -wise and structure-wise has been changing considerably. For example, in the village Majgaon under Udalguri I.T.D.P. It was a small village having 210 population, out of which 90.47% are tribal population. At present, the village comprises three hamlets having total population around 1200, out of which 95% or above are tribal population. Therefore, in a time bound research project it is very difficult to cover such

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a big village. As a matter of fact, we have selected one of the hamlet known as Khakklachuba in particular and the whole village (i.e. Majgaon) in general. Similarly, the village Khagrabari of Kokrajhar I.T.D.P. comprises three hamlets viz. Uttar Khanda, Madhyam Khanda and Dakhshin Khanda. For the present investigation we have selected Madhyam Khanda only.

Contd.8.

TABLE - I

NAME OF THE SAMPLE VILLAGES WITH POPULATION
(ACCORDING TO 1971 CENSUS)

Sl. No.	Name of ITDP	Name of Gaon Panchayat	Name of sample village	Total population of the villages	Scheduled Tribe	Percentage
1.	Barpeta	Hastinapur	Major kuchi	261	234	89.65%
2.	Dhubri	Parbat jowar	Maltighora	209	209	100.00%
3.	Dibrugarh	Jamira	Kachari gaon	223	213	95.51%
4.	Goalpara	Jakhili	Chalapara	200	200	100.00%
5	Golaghat	Mohura	Maj Dalapa	351	236	67.25%
6.	Guwahati	Goreswar	Auguri No.2	121	108	89.25%
7.	Guwahati	Rani Bhala gaon	Jimiri gaon	215	215	100.00%
8.	Jorhat	Hazari Baligaon	Upper Deori gaon	467	338	72.37%
9.	Kokrajhar	Dotma	Khagrabari	721	712	98.75%
10.	Mangaldoi	Udalguri	Majgaon	210	190	90.47%
11.	Marigaon	Silpukhuri	Tupgaon	222	222	100.00%
12.	Nalbari	Dakhin Kumari Kata	Ka Danga	200	195	97.50%
13.	Sibsagar	Pani Dihing	Rajabari II	221	214	96.83%
14.	Silchar	Hari Nagar	Dharma Nagar	231	201	87.01%
15.	Tezpur	Kalabari	Bikrampur	216	174	80.55%

DURATION OF STUDY :

It is proposed to complete the survey and report writing within a period of one year. Out of which 5 (five) months are alloted for data collection and analysis. Accordingly to which, data were collected in between January 1993 and April 1993. Data collection; took a lot of time due to bad communication, considerable distances of the villages from the headquarters, and big sizes of the villages etc. Inspite of unlimited hurdles, data collection come to an end in the last part of April 1993.

Tabulation of data were started from last week of April 1993 and completed in the end of 1993 June. From the first week of July analysis, writing/drafting of the report is started. The last part of our study, namely study area (village profile), analysis and recommendation etc. came to an end in the last part of March 1994.

(C) METHODOLOGY :

For the collection of necessary field data required for the present study a household/village schedule was prepared. Accordingly as stated in the schedule, data were collected after interviewing the selected beneficiaries. The beneficiaries so far interviewed in the continuance of our systematic inquiry of the facts were selected at random.

Random sampling is the best method in this regard because of its simplicity and further, it is generally consider to be more representative because each unit has equal chance of being represented. Lottery method of random sampling was used for selecting the villages. Samples were selected separately for each Integrated Tribal Development Project so that they may have equal representation.

The selected villages were physically visited

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for gathering the information for the present study. All respondents who were heads of the households were personally contacted for conducting interview. In addition, necessary particulars of each village viz.location, transport and communication facilities,civic and educational facilities and other basic amenities were recorded in the village schedule.

It is worthmentioning that,the research work done in this part of North-East India about Non-Conventional Energy Sources is limited. However,a few attempt has been made to envisage into the implementation of the scheme by DRDA and K.V.I.C. They hardly pay any attention regarding the problem and prospects of non-conventional energy sources in Assam. Therefore, it is very difficult to get relevent references for consultation. Therefore, before report writing is started a considerable period of time has to be spent in the libraries. For the references the library of Assam Institute of Research for Tribals and Scheduled Castes and some official records of District Rural Development Agency, Khadi and Village Industries Commission,Guwahati,Department of Non-Conventional Energy Sources,Guwahati have been consulted.

After completion of data collection,time was fully devoted to processing and analysis of data. Side by side,report writing or drafting was also started alongwith tabulation and analysis of data.

Systematically processed, analysed and interpreted facts will be presented in the following chapters.

Chapter -I (a) Introduction and foreword
(b) Aims of the present Investigation.
(c) Methodology.

Chapter -II Non-conventional Energy Source
(a) Bio-gas or Gobar gas

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Chapter - III Recent development in bio-gas technologies in Assam.

Chapter - IV Study Area
Village profile.

Chapter - V Analysis, suggestions etc.

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CHAPTER - II

BIO-GAS : TECHNOLOGY AND DEVELOPMENT

1. INTRODUCTION : NON CONVENTIONAL ENERGY SOURCE

(a) Destruction and decomposition of waste, dead plants and animals are taken place due to the some biological processes. This decay or destruction is carried out by tiny micro-organism called bacteria. It is worthmentioning, that, when a heap of vegetable or animal matter and weed etc. die or decompose at the bottom of tank water or shallow lagoons that the bubbles can be noticed rising to the surface of water. Sometimes these bubbles burn with dancing flame at dusk. The phenomenon was noticed for ages which puzzled men for long time. It was only during last-hundred years or so this secret was unlocked by the scientiests as the decomposition process under absence of oxygen. The gas produced in this process is called "Marsh Gas". Now it is an established fact that the marsh gas is a mixture of Methane (CH_4) and Carbon-di-oxide (CO_2) and is commonly known as Bio-Gas. The technology of scientifically harnessing this gas under artificially created condition is known as Bio-Gas technology.

2. CHARACTERISTICS :

Bio-gas is colourless, odourless, inflamable gas produced by organic waste and bio-mass fermentation. The entire process is biological, which takes place in the absence of oxygen through which the organic materials is converted into essentially Methance (CH_4) and Carbon-di-oxide) (Co_2). It also gives excellent organic fertilizer and humas as by product. The indispensible requirement in production of bio-gas is an air-tight compartment. Bio-gas is produced only in anaerobic conditions. The air-tight container where bio-gas is produced is called digester.

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The composition of different gases in bio-gas is as under :

TABLE - 2

GAS	SYMBOL/FORMULA	PERCENTAGE
Mathane	CH_4	50-70%
Carbon-di-oxide	CO_2	30-45%
Hydrogen Sulphide	H_2S	Trace
Nitrogen	N_2	1-0%
Hydrogen	H_2	0-1%
Carbon-mono-oxide	CO	0-1%
Oxygen	O_2	0-1%

Biogas burns with blue flame. It has a neat value of about 4500-5500 Cal/M^3, when its methane (CH_4) range from 60-70%. The value is directly proportional to the amount of methane it contains and this depend upon the nature of raw material used in the digester. As composition of biogas is different, the burner designed for L.P.G. when used for biogas will give only about 35% efficiency.

Therefore, a specially designed biogas burner have to be used which gives thermal efficiency of as high as 60%.

3. EFFECT OF VARIOUS PARAMETERS ON BIOGAS PRODUCTION :

I. Airtightness : Decomposition of organic material in oxygeneted condition produce CO and in the anaerobic condition produce CH_4 (Methane). Therefore, it is essential to have biogas plant alright.

II. Temperature : The optimum temperature range for bio-gas production is 30-35 . Though the micro-organism producing methane can work in a wider range of temperature from 15-50 C. The bacterial action and gas production will stop below 10 C.

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III.P.H. : The bacteria perform best in neutral to slightly alkaline media. Optimum P.H. range for bacteria is 6.8 - 8. At P.H. below 6.2 they will become in(-)active. Similarly too high acidity will prevent the bacteria from functioning.

IV.Carbon,Nitrogen ratio: The bacteria need both carbon and nitrogen in proper ratio. Carbon content is important for high yield of methane and nitrogen is required for the growth of bacteria. The carbon to nitrogen ratio by weight should be about 30:1 as bacteria use up carbon 30 times faster than they use nitrogen.

V. Dentention Period : The dentention period is the time for which the fermentable material stays inside the digester. In India using mainly continuous feeding, the detention period is kept between 30-50 days depending on the climatic conditions of the area.

VI.Solid Content : The gas production from biogas plant depend on the concentration of solids in the influent slurry. This comes to be between 8-12% of solid in the slurry for optimum gas production. In an average this may be obtained by making slurry in the rationof 1:1 for cow dung and water.

VII.Nature of raw material : The amount of methane produced bears a direct relationship to the raw-materials used for digestion. The materials which are rich in cellulose and hemicellulose produce more gas.

VIII.Intimate contact of bacteria : Bacteria are microscopic organism and therefore have limited reach to obtain their food. In order to ensure maximum digestion efficiency it is essential that they are intimately mixed with the food available to them. This can be done by using mechanical stirring devices which can be operated manually. It has been observed that the gentle stirring improves digestion,while violent stirring retards it. Occasional stirring also helps prevent scum formation on the top layer.

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WHY A BIOGAS PLANT :

(i) For fuel saving.
(ii) It helps in reduction of smoke from the kitchen.
(iii) Reduces cooking and collection of fuel- wood time.
(iv) Can cook more than one at a time.
(v) It helps in upgradation of environment.
(vi) Reduces health/hygenic problems.
(vii) Bio-gas can be used for lighting houses at night.
(viii)The slurry can be used as manure.

4. DIFFERENT TYPES OF BIOGAS PLANT :

After adopting, National Programme on Bio-gas Development lots of experimentation have been done on bio-gas technology. As a result, several new types of bio-gas plant have come into existence. Among those, some of the types are approved by the Central Government. The common types of plant so far recommended are as under :

i. Khadi and Village Industries Commission type (KVIC)
ii. Ganesh type.
iii. Janata Bio-gas plant
iv. Dinabandhu type.

A brief description of proposed types are as follows:

(i) K.V.I.C.Type : K.V.I.C. is the most excellent kind of approved bio-gas plant by Central Government. The cost of installation of the plant is higher than the others. However, as far as the production capacity is concerned it is considerably significant. The whole plant is divided into two parts on the basis of its function viz, (a) Digester (b) Gas holder. The digester is constructed by using bricks, sand, stone chips and cement, while the Gas holder is made of M.S.Sheet. Each parts has many section with various functions.

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Different sections of Digester :
i. Inlet tank
ii. Inlet pipe
iii. Out let pipe
iv. Side walls of digester tank
v. Central Guide frame
vi. Partition wall of digester tank
vii. Out let tank

Different sections of Gas holder:
i. Central guide pipe
ii. Gas out let pipe
iii. Lead
iv. Stirring device made of Iron

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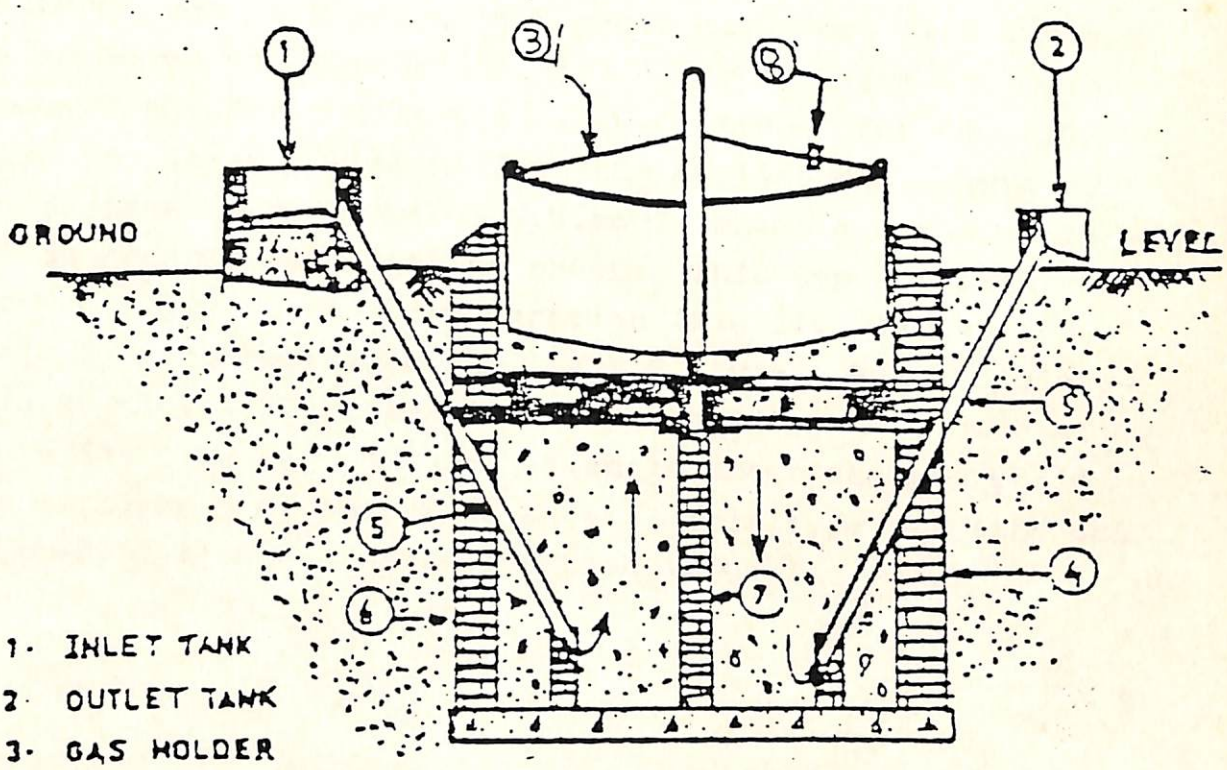
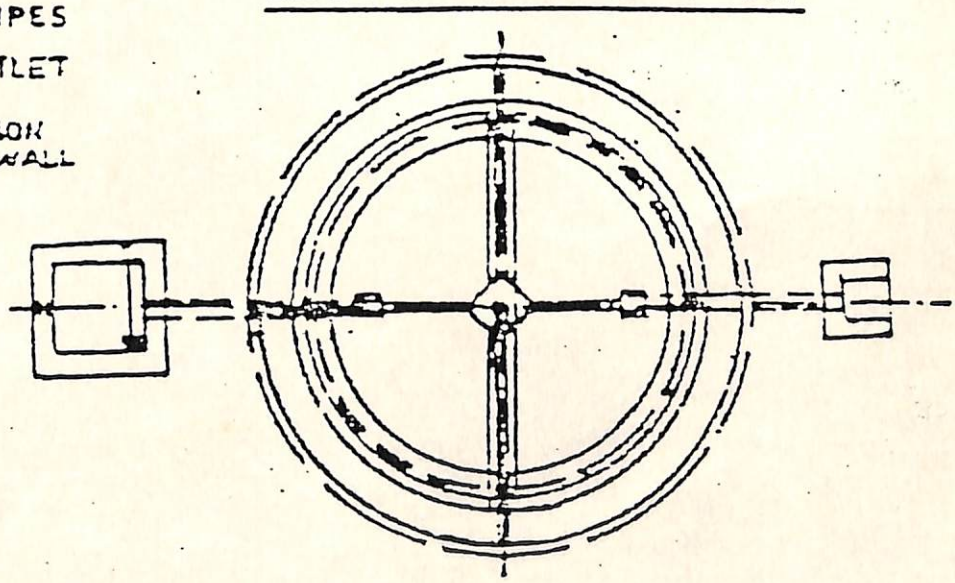


1. INLET TANK
2. OUTLET TANK
3. GAS HOLDER
4. DIGESTER WALL
5. A.C. PIPES
6. GAS OUTLET
7. PARTITION WALL

SECTIONAL ELEVATION



PLAN

(ii) GANESH TYPE : The Ganesh bio-gas plant has also divided into two parts viz.Gas holder and Digester. The gas holder is made of M.S.Sheet like the K.I.V.C. type. But the digester is completely different from the earlier one. Here at first a frame is made out of M.S.angle sheet and the whole frame is covered by polythene sheet. This type of plant can be installed within a short duration (Fig.2). Ganesh type is made of M.S.Sheet like the K.V.I.C. type. But the digester is completely different from the earlier one. Here at first a frame is made out of M.S.angle sheet and the whole frame is covered by polythene sheet. This type of plant can be installed within a short duration (Fig.2)

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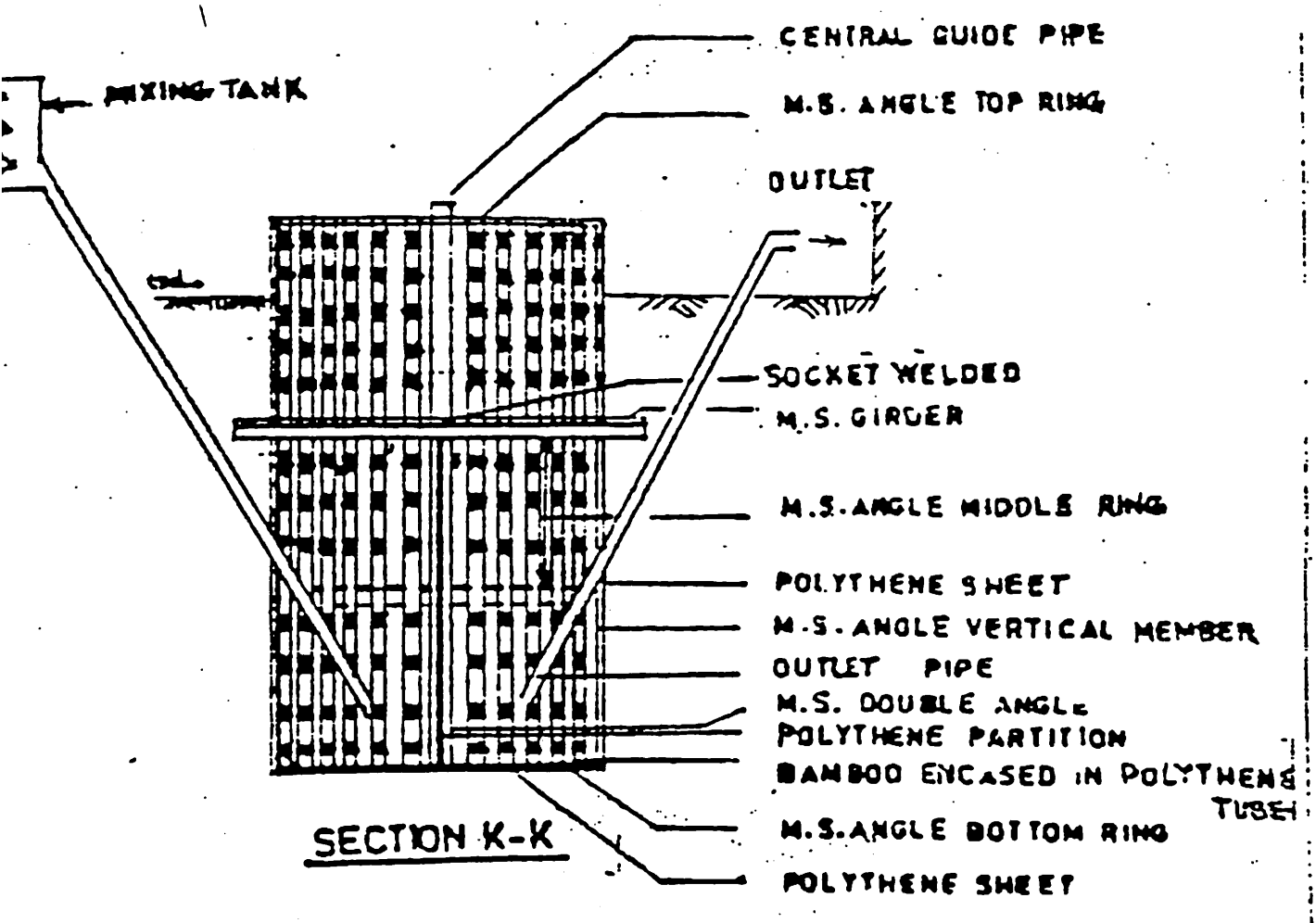
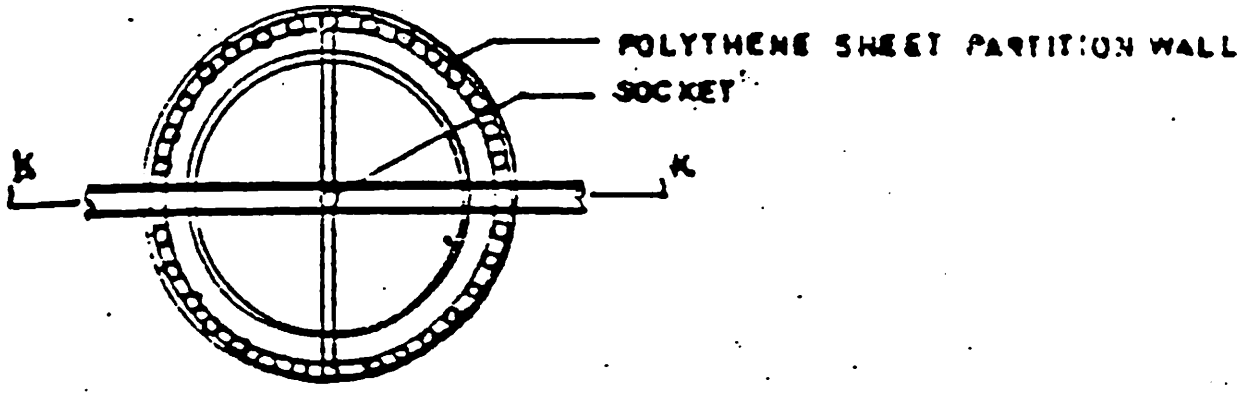


SECTION K-K



PLAN

JANATA TYPE :

In this type, the digester and the gas holder is made jointly,Bricks,sand, dust,stone chips and cement are the raw material for construction of this plant. The cost of installation of the janata type gas plant is about 20% less than K.V.I.C. However, it has some technological disadvantages like :

(a) Chance of gas leakage.

(b) Some difficulty arises during the time of using gas.

(c) Trained mason is essential, otherwise the plant may be demolished within a very short time.

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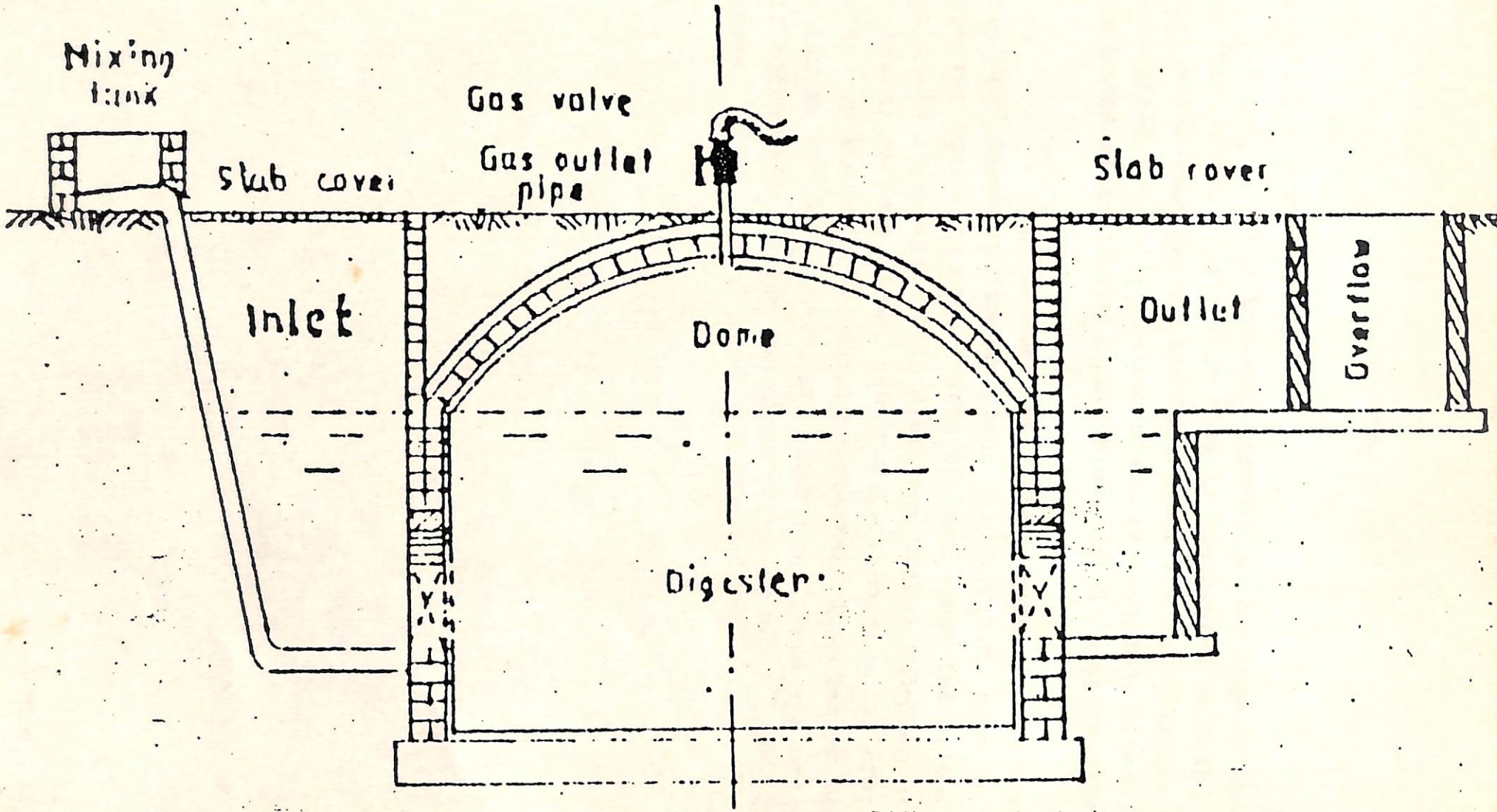
Mixing tank
Gas valve
Gas outlet pipe
Slab cover
Slab cover
Inlet
Dome
Outlet
Overflow
Digester

DINABANDHU TYPE :

The improved form of Janata type is known as 'Dinabandhu type'. This type is discovered by Delhi Action for Food Production Institute. For installation of this plant specially trained mason is required, otherwise the whole plant become functionless within a short time.

It is worth mentioning that, in all above mentioned types of bio-gas plant only K.V.I.C. type is the type for Assam and other parts of North-East India. During our field investigation in different Tribal Sub-Plan Areas of Assam, we come across only K.V.I.C. model which are installed by the District Rural Development Agencies of Assam. As far as the other types are converned, these are not at all suitable for Assam and other parts of North-Eastern Region.

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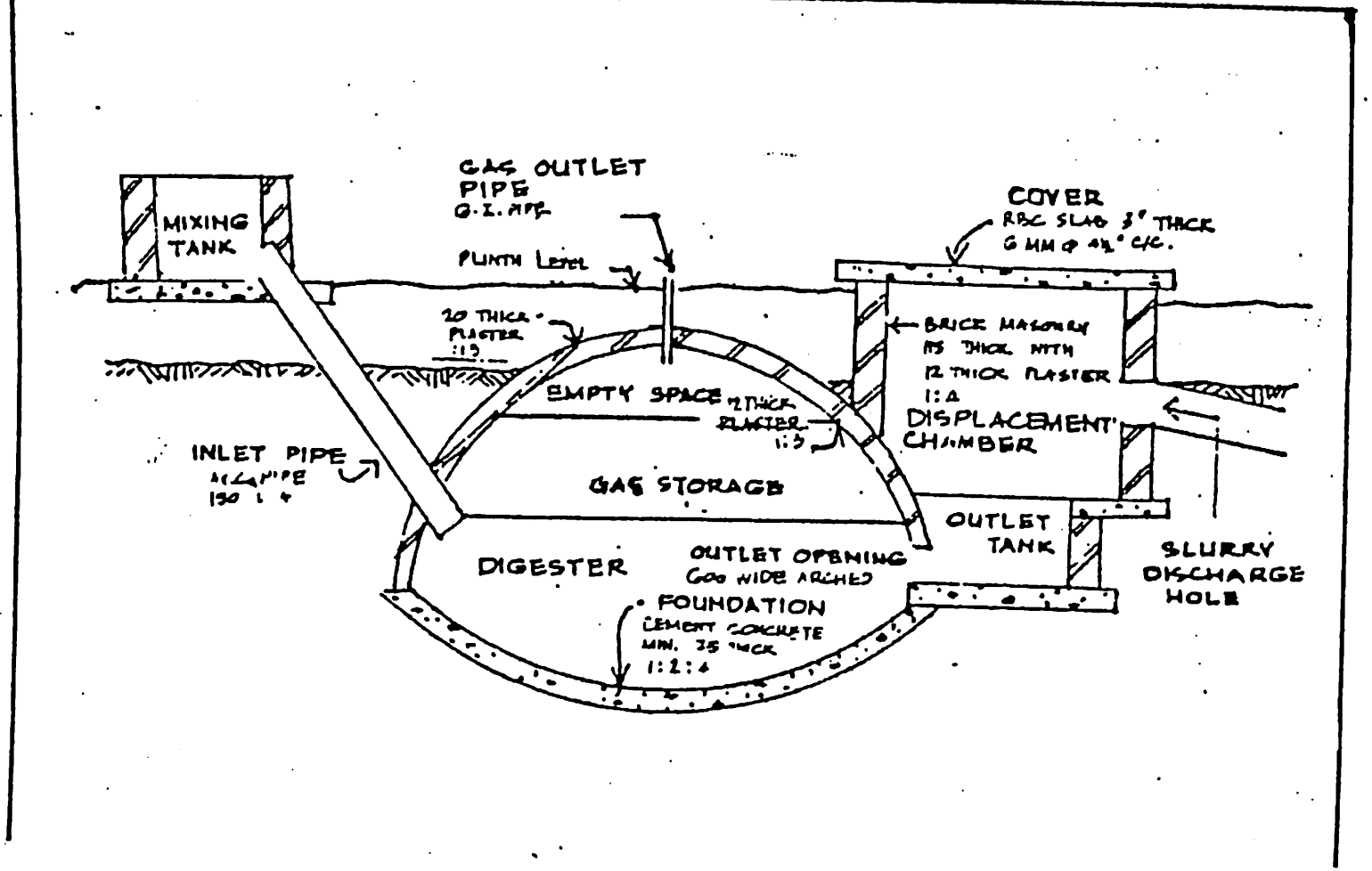

GAS OUTLET PIPE G.I. PIPE
COVER
RCC SLAB 3" THICK 6 MM Ø 4½" C/C.
MIXING TANK
PLINTH LEVEL
20 THICK PLASTER 1:3
BRICK MASONRY 15 THICK WITH 12 THICK PLASTER 1:4
EMPTY SPACE
12 THICK PLASTER 1:3
DISPLACEMENT CHAMBER
INLET PIPE
GAS STORAGE
OUTLET TANK
SLURRY DISCHARGE HOLE
DIGESTER
OUTLET OPENING 600 WIDE ARCHED
FOUNDATION
CEMENT CONCRETE MIN. 25 THICK 1:2:4

North East India belongs to sub tropical humid climatic zone and have experience frequent rainfall. The average rainfall is about 3350 mm. Such an area where rainfall is so heavy ; generally not suitable for installation of other bio-gas plants namely, Ganesh type, Janata type and Dinabandhu. In fact, in many states of India, per day $6M^3$ (per day) production capacity Dinabandhu plant is functioning suitably. According to experts on bio-gas, Dinabbandhu model having only $3M^3$ production capacity (per day) can be installed in Assam and other parts of North-East Region.

5. PLACE OF INSTALLATION OF BIO-GAS PLANT :

Before installation of a bio-gas plant one has to find out suitable place. Therefore, to find out the place one should be considered some of its basic aspects,which are mentioned below :

(a) Find out land where one can easily dig a pit of about 10-11ft. deep and 10-12ft. width.
(b) Avoid the very loose soil and shady place.
(c) It should be nearest to the cow shed.
(d) It should be within the 100ft.of the kitchen.
(e) The well or any drinking water sources should not be within less than 20 ft. from the plant.

6. RAW MATERIAL :

Generally agro-based residuces and animal waste are used as basic raw materials for bio-gas plant. Some of the aquatic plants like water hyacinth and water weed also used as raw materials. Besides,human faeces also good for bio-gas plant. It is interesting to know that,the average human faeces of one man can produce 1 f^3 gas. It is also observed that at least 15 persons faeces are essential for lighting a bulb continuously for three hours. So a good number of people are required for such plant where only faeces are used.

Contd.21

It is worth mentioning that,per kilogram of raw cow dung can produce 1.3 f^3 gas. Assam considered to be fortunate for having Livestock resources. Each and every families (tribal/non-tribal) living in the rural areas possesses a good number of cows and bufaloes. As a matter of fact, it is easiest for them to install a bio-gas plant in their houses. Therefore, if Government provides subsidy and other facilities to each family with bio-gas plant according to the size of the family and the number of live stocks for the purpose of generating energy for cooking and domestic purposes is sure to be practically fruitfull to them.

7. HOW RAW DUNG IS USED :

After the construction of the digester it should be kept at least 10 days for drying, than it becomes ready for functioning. The proportion of raw cow dung and water should be 1:1. At the first stage 40% more raw dung of per day requirement is essential for the digester. So,to sustain the plant at the initial stage one can use 20-25 days earlier raw dung.

Some precautionary measures should be taken when using raw dung and water into the digester :-

(a) The level of raw dung/water should be same in both the side of the partition wall. If the level is not maintained as well,it affects the partition wall.

(b) If possible,within one or two days digester should be filled-up with raw material.

(c) After using raw material into the digester one should not go inside of the digester,because sometimes poisonous gas is produced.

After filling up the digester with raw dung the gas valve of the gas holder should be tightened,because decomposition of organic material in presence of Oxygen produce

contd.22.

Co_2 and in the absence of it produce CH_4. Therefore, it is essential to have bio-gas plant air-tight. After confirming that there is no air than the gas holder is fitted into the digester through the central guide frame. As the gas valve is tight,than the gas holder is held up freely in the digester. If there is a leakage in the gas holder, it is devoid of any function.

Decomposition of organic material takes place after the bio-gas plant rendered air tight. It produces gas generally contains CH_4, Co_2, H_2S, N_2, H_2, CO and Oxygen in different proportions. Here some pre-cautionary measures have also to be followed:-

(a) First 2/3 days gas should not be used.
(b) Near the gas holder, do not make fire.
(c) Before using the gas, gas pipe,gas burner and light should be examined.

8. CAPACITY OF BIO GAS PLANT :

The efficiency of bio-gas plant is mainly depend on the availability of raw material and live stock. According to the production capacity of bio-gas plant, these are different in size. The size of the bio-gas plant according to its capacity are as follows :

TABLE - 3

No.of family members	Capacity	Required No. of Cattle	Required raw-dung (per day)
2 - 3	$1M^3$	2 - 3	25 kg.
5 - 6	$2M^3$	4 - 5	40 Kg.
7 - 8	$3M^3$	7 - 8	60 - 70 Kg.
10 -12	$4M^3$	10 -12	100Kg.
15 -16	$6M^3$	15 -16	150Kg
19 -20	$8M^3$	19 -20	200 Kg
25 -26	$10M^3$	25 -26	250 Kg

Fig- V,VI,VII, ...

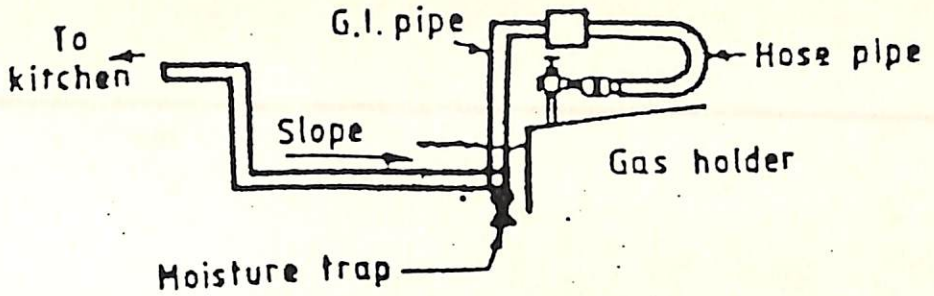
Contd.23.

Arrangement of Gas Pipe :

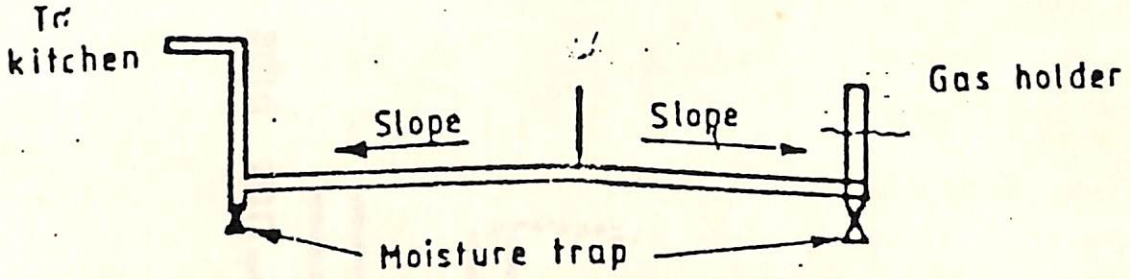
During the time of organic gas production some reactions have taken place, as a result of heat produce; Due to heat some portion of water is evaporated. The water vapour when transmitted through the gas pipe, transformed into water and deposited inside the gas pipe. So,generally the gas pipe is filled to the gas holder in an inclination position. Time to time the deposited water should be removed,otherwise some difficulty may arise during the time of using gas.

The diameter of the gas pipe is mainly depend on the distance of the plant from the kitchen and the place where plant is installed. Generally 1" - 2" diameter gas pipe is used for 30ft of distance,if the distance is more than 30ft.than 3"-4" diameter gas pipe is required.

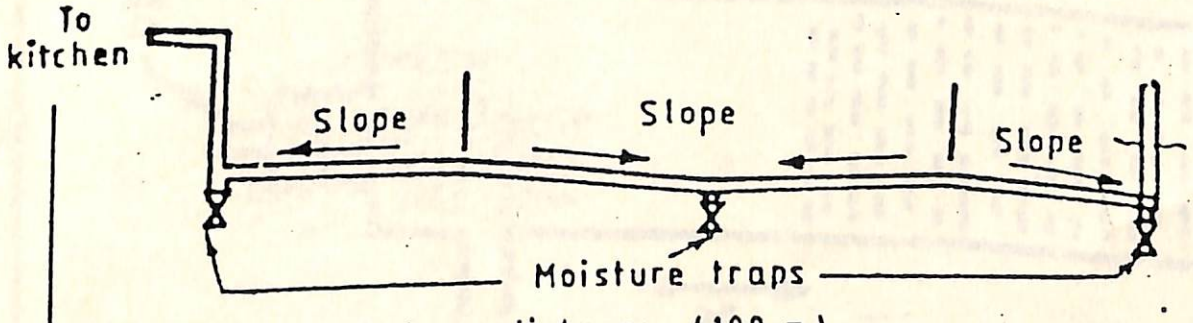
Contd.24.



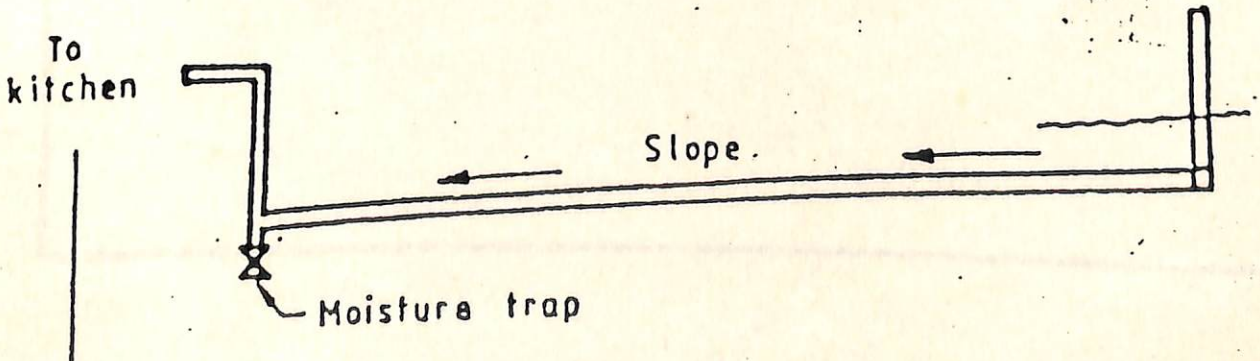
(a) Short distance (30 m)



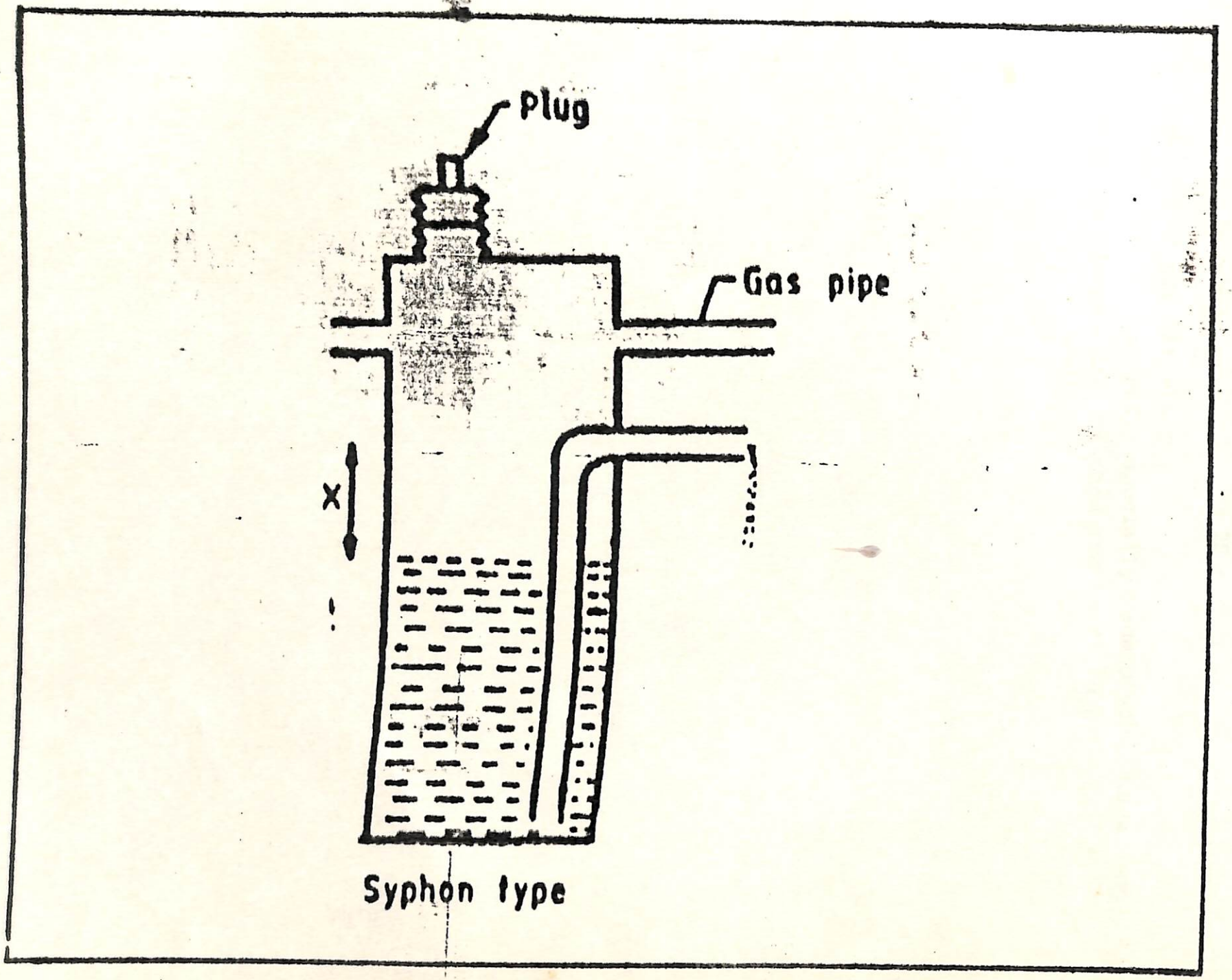
(b) Medium distance (50 m)



(c) Long distance (100 m)



(d) Hill side

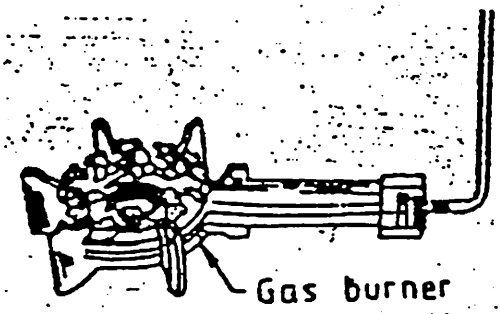


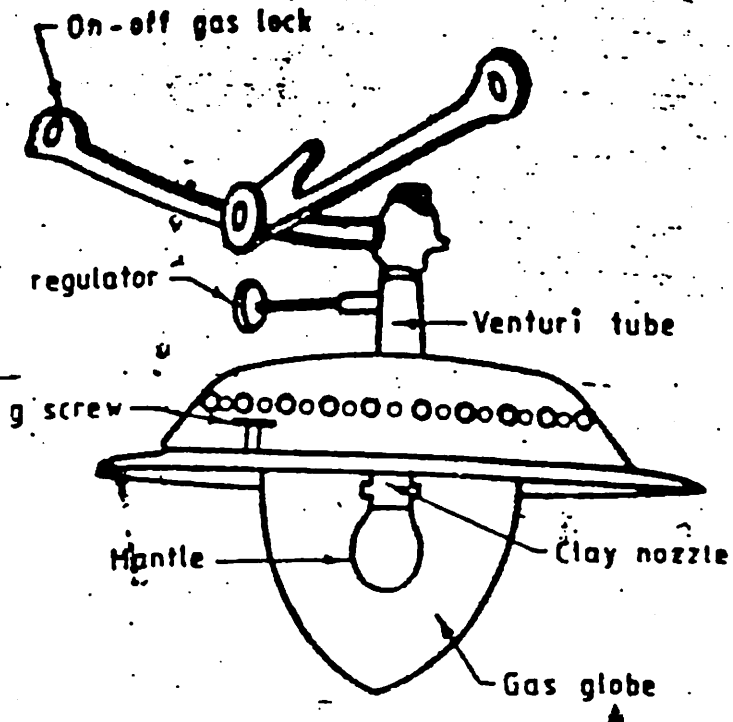
Syphon type

DEVICES OF BIO GAS PLANT :

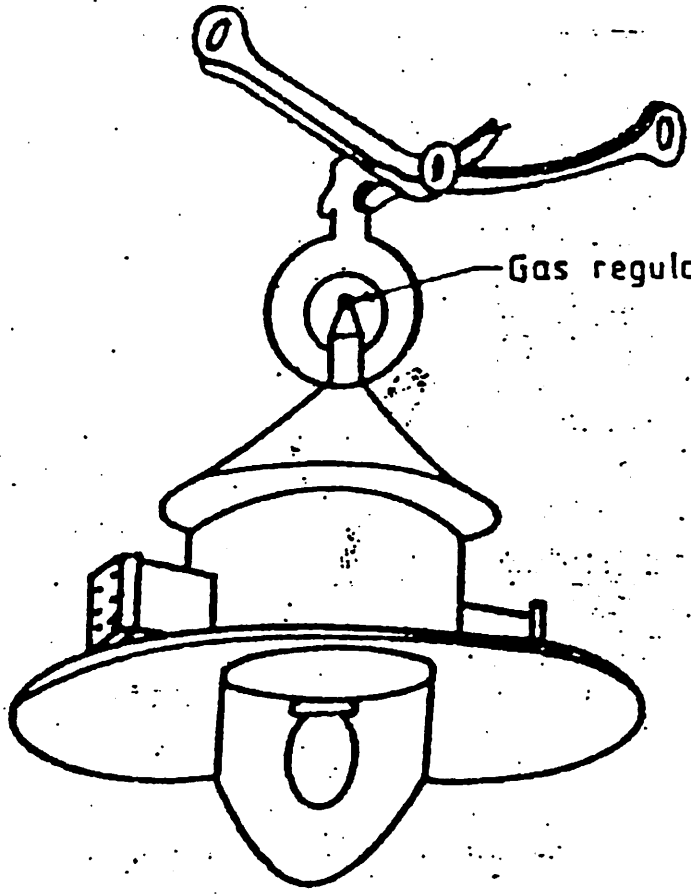
Generally specially made devices have been used for bio-gas some of them are as follows :

Contd.26.





(a) Inside type



(b) Outside type

BIO GAS AND MANURE :

The people living in rural areas generally thought that the fertility of sludge (dung) is reduced after using it in the bio-gas plant. It is in fact, not true at all. The by products of the plant (used dung) can be used as fertilizers and according to experts the by products as a fertilizer is much better than the raw dung. The use of the by products of the plant will,therefore, help the families in boosting up of their agricultural products. It is also fact that, the raw dung after being dried and the decompose dung (sludge) contains 0.75% and 1.5% Nitrogen respectively. But the by products of the plant contains 3% Nitrogen,besides phosphate, Patash and some minerals like Iron (Fe), Menganize (Mg), Zinc (Zn) which are the responsible minerals for the growth of plants.

Use of sludge also has some advantages like :

(i) Production increases up to 25% - 40%.
(ii) It keeps dampness of the soil.
(iii) It loses the soil.
(iv) Without experiment it can be used in the paddy field.
(v) It also prevent the growth of grassy plant (weed) in the paddy field.

The sludge can be used directly to the paddy field. It can also be used in the paddy by mixing it with irrigated water. But it is always not possible as irrigation is not available everywhere. Therefore, the sludge are generally thrown into some compost pit,and after decomposition it is better for use. These compost pits are connected with the out let tank of the plant. Generally two/three compost pits are dug out, because after the filling up of one such compost pit, the sludge should be dried up, as it is not possible to carry raw sludge to the paddy field.

After filling up of the first compost pit it should be closed,and automatically slurry goes to the

Contd.27.

2nd/3rd compost pit by slurry Channel respectively. By using this consecutive processes one can stop the wastage of manure.

The compost pit should be $3m^3$ in length and breadth and $1.5^3 m$ in depth. The base of the compost pit is better to leave it open or brick bats can be used. The height of the wall should not be higher than the sludge outlet pipe.

Contd.28.

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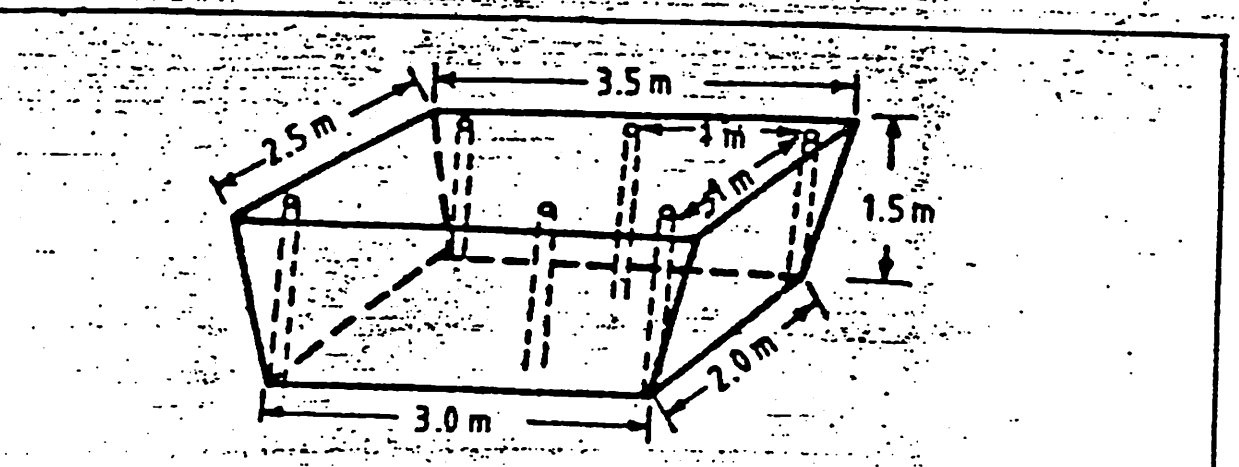
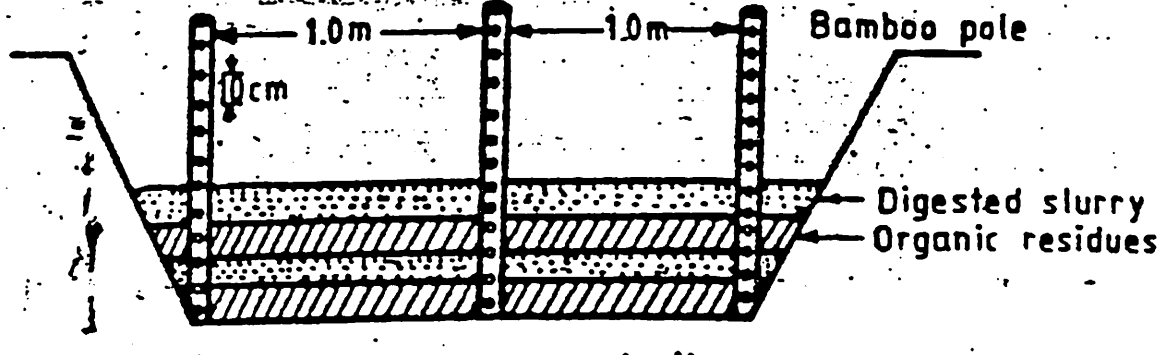
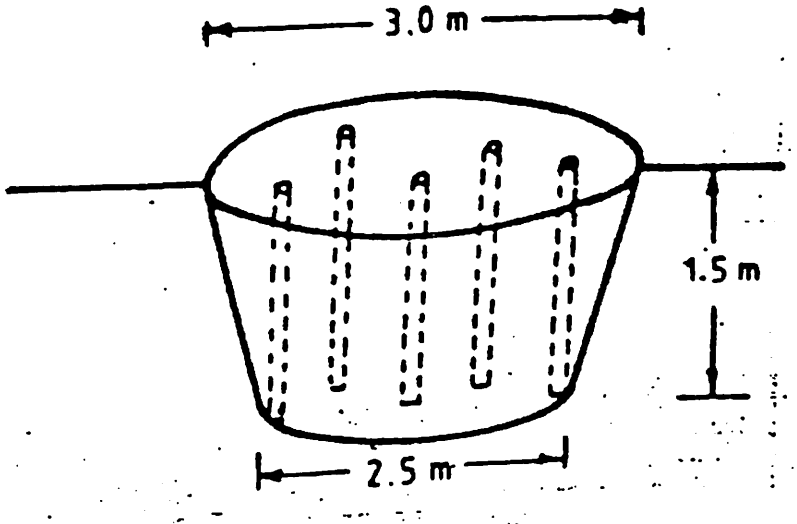
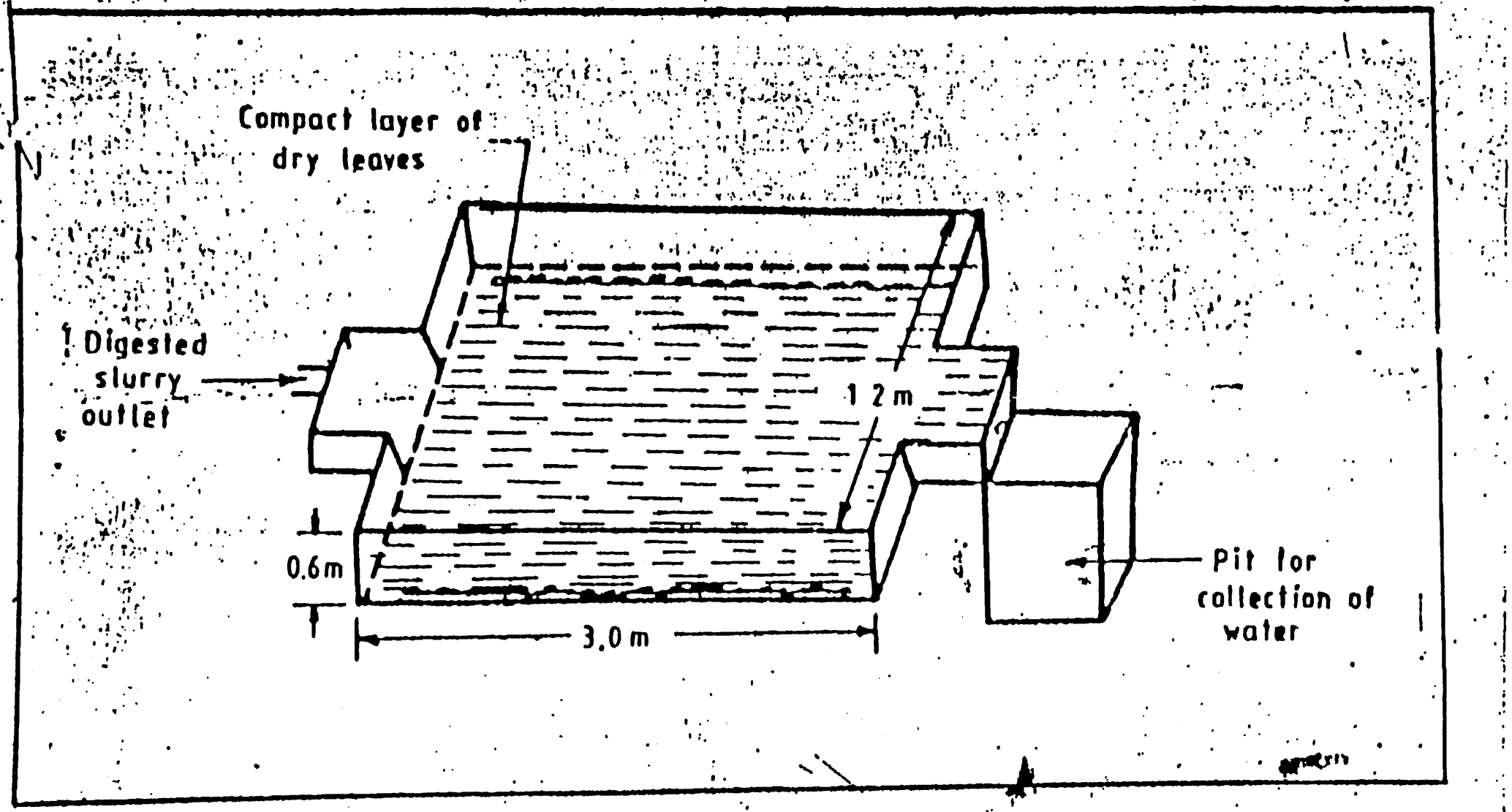




(a) Rectangular compost pit



(b) Circular compost pit


Compact layer of dry leaves
Digested slurry outlet
1.2m
0.6m
3.0m
Pit for collection of water

BIO GAS AND ENVIRONMENT :

Degradation of quality of environment, increasing polutions by growing industries ecological imbalances etc. are now growing concern, all over the world. Controlling population and maintaining environment quality still to have economic development for uplift of man is typically modern problem of most of the developed and under developed countries. Inadequate attention towards this problem in the past has resulted in heavy deforestation in India. The situation as now become alarming for maintaining required ecology and environment. In India, lots of efforts has been made by the Government to conserve the forest. As a result, various national programmes has been come into launching. One of such programme is National Bio gas Development Project launched during 1981-82. One of the main aim of this programme is to increase awareness of general people about this growing problem by providing some non-conventional energy sources to them. About 80% people lives in rural areas uded fire-wood for cooking food and other domestic purposes has resulted decreasement of forest wealth.

Installation of Bio-gas plant will not only improve the forest wealth but also the senitation of the household. It has been observed that in many families animal waste and agro-based residues are thrown away haphazardly or in a heap near the campus resulting in unhygienic conditions leading to environmental degradation. Besides installation of this plant will serve as a domestic health booster since constant burning of the hearth inside the house fills the atmosphere inside with smokes. The smoke contain Co which is not only ingurious to health of the family members but it also responsible for making every thing dirty inside the houses.

It is also a fact that, when animal waste, agro-

Contd.29.

based residue is started to decompose due to the direct contact with rain and sun light,produced CO_2. This is suitable place for flies and mosquitoes for laying eggs. Inspite of thrown away animal/agro-based waste in a heap if uses it in a biogas plant,reduces not only the CO_2 but also prevent the growth of mosquito and flies which are responsible for carrying some contagious diseases.

Contd.30.

CHAPTER - III

RECENT DEVELOPMENT OF BIO GAS TECHNOLOGY IN ASSAM

The development of Bio gas technology in India goes back to 1937. When a few scientists from Indian Council for Agricultural Research during their visit to the sewage treatment plant at Dadar,Bombay notice production of a peculier gas. This gas is identified as 'Marsh gas' or 'Bio gas'. Therefore, the scientists of Indian Agricultural Research Institute, New Delhi; Dador sewage purification station,Bombay and college of Agriculture, Pune started production of Biogas in experimental basis. The initial model developed by the scientists were very much helpful to demonstrate the idea of production of Biogas from cattle dung. About 30% of the cattle dung produced were burnt as dung-cake during those days. The early models though were able to produce gas,but efficiency of the same was low, of confronting with number of operational difficulties. The Directorate of Agriculture Extension, Ministry of Agriculture, Government of India sponsored a few gas plants through C.D. blocks during 1950's. Gram Lakhimi Gobar Gas Plant was one of the models developed in the initial period.

In 1961 the Khadi & Village Industries Commision foresight the significance of improving Rural Senitation and keeping ecological balance by conservation of conventional energy sources. It is in this context the K.V.I.C paid attention to Gobar Gas programme and adopted the model by Shri J.J.Patel (Gramlakhimi). It was the initial period when the K.V.I.C had to concentrate on propogation of the programme amongst the people about the usefulness of Bio gas plant.

Since the Biogas scheme was totally a new one development of suitable appliances such as Bio gas burner, lamp,etc also become of equal importance. The KVIC used to offer interest free loan and agrant of Rs.300.00 per plant as

Contd.31

incentive to the beneficiaries for installation of Bio gas plant. The programme could not make much headway till 1974. From 1975-76 with the advent of energy crisis Bio gas programme attracted the attention of scientists and planners. The Ministry of Agriculture, Government of India decided to implement the Bio gas programme on large scale through KVIC and State Government. At that time 20%-25% (of the cost of the plant) have given as subsidy. During this period banks also come forward to sanction loan for installation of Bio gas plants.

During 1979-80 to 1980-81, the bio gas programme was transferred to state sector due to unavailability of Central subsidy for KVIC. But KVIC used to continue this programme out of its own resources. The programme was again transfer-red back to Central Government, during 1981-82 and Government of India launched the National project on Bio gas Development (NPBD) as central sector scheme during the 6th plan period. A target of setting up of 4 Lakhs family size bio gas units had been fixed for the plan period for which outlay of 50 Crores had been provided.

The number of bio gas plants installed in Assam under KVIC during 1962-63 and 1980-81 is as follows :

TABLE NO.4

1962 - 1974	23 Nos.	(6858)
1974 - 1975	2 "	(2803)
1975 - 1976	4 "	(3617)
1976 - 1977	9 "	(8363)
1977 - 1978	4 "	(5230)
1978 - 1979	30 "	(7709)
1979 - 1980	44 "	(10689)
1980 - 1981	7 "	(7964)
Total :	123 Nos.	(53233)

(All India Figure in bracket)

Contd.32.

It had been observed that KVIC so far created infrastructure of installing about 15000 plants,per annum. So it was decided while launching the national project that implementation of the programme would be undertaken by the KVIC and a Department selected by the respective State Governmentsctaking seperate Annual target. Government of India created a new Department under the Ministry of Energy as Department on Non-Conventional Energy Sources to look after the Bio gas and other renewal energy programme. The programme has become popular among small and marginal farmers,scheduled Caste/Scheduled Tribe beneficiaries of far flung hilly areas like North Eastern Region.

In Assam the work of NPBD (National Project on Bio Gas Development) was actually started from 1982-83 when the State Government declared the State Rural Development Directorate as the Nodal Department for implementation of the programme. Since then, Bio gas programme has been imparted through the Districts Rural Development Agencies in each Districts of the State. Any person who has got sufficient quantity of cowding or animal/bird waste and who is willing to install a bio gas plant is to approach the office of district Rural Development Agency office at District Headquarters directly,through the local Senior Block Development Officer for technical guidance as well as subsidy. The Nationalised Banks are also giving loan for installation of bio gas plant. Loan upto Rs.10,000/- is given on personal security and period of repayment is 5 to 7 years. Thus a person can install a bio gas with bank loan and Government subsidy without spending any amount at the initial stage. With the participation of more field works and increase conciousness among the people about conservation of conventional energy sources. The bio gas programme has been getting momentum for the last few years. (**)

Contd.33.

TABLE - 5

The number of Bio gas plant installed in Assam under Rural Development Department & KVIC during 1982-83 & 1991 - 92 as follows

YEAR	PLANTS INSTALLED			SUBSIDY PAID		
	Under Rural Devp. Deptt.	Under KVIC	Total	Under Rural Devp. Deptt. (in Lakhs)	Under KVIC	Total (in Lakhs)
1982-83	5	17	22	0.40	-	0.40
1983-84	96	110	206	3.89	-	3.89
1984-85	382	299	681	18.14	-	18.14
1985-86	195	262	457	9.41	-	9.41
1986-87	733	517	1250	38.72	-	38.72
1987-88	1800	282	2082	91.25	-	91.25
1988-89	1668	365	2033	81.34	-	81.34
1989-90	1134	674	1808	53.25	-	53.25
1990-91	982	546	1528	46.86	-	46.86
1991-92	815	-	-			

Contd.34

MAN POWER DEVELOPMENT :

There is no traditional masons among the local people of Assam. The masons working in the State are mostly from Western State like Bihar and Uttar Pradesh and they are mainly engaged in construction of building and such other constructions where they get their employment for the whole year and mainly in the Urban areas. The Sub-Soil water in most of the places in the State remain high and as such the bio gas plants are to be installed during the period from December to May only. So sufficient numbers of persons are required for installation and repair of bio gas plants. The Directorate of Panchayat & Rural Development, Government of Assam conducted different Training Camps in different places of the State and trained local youth for the purpose.

Though the Government of India has approved different model of bio gas plant for implementation under national Project yet mainly KVIC model had been propogated in Assam due to some advantages of the model over the others. But from the current year Government of Assam has decided to switch over to Dinabandhu model plant which is difficult to install but found to be cheaper than the KVIC model.

The implementation of National Project on Bio -gas Development in Assam has been done through the District Rural Development Agencies of different Districts. Any body having sufficient quantity of digestable material and willing to install a bio-gas plant can install a bio-gas plant with technical guidance and financial support from the DRDA of their respective areas.

Contd.35.

TABLE - 6

ACHIEVEMENT OF INSTALLATION OF BIOGAS PLANTS IN ASSAM DURING 1992-93

Sl. No	Name of DRDA	Annual Target	No.of Plants installed	Achievement on Target in %
1.	Dhurbi	52	27	51.9%
2.	Kokrajhar	66	43	65.2%
3.	Goalpara	32	33	103.0%
4.	Bongaigaon	60	54	90.0%
5.	Barpeta	44	12	27.3%
6.	Nalbari	44	44	100.0%
7.	Kamrup	68	27	39.7%
8.	Darrang	40	26	65.0%
9.	Sonitpur	56	60	107.0%
10.	Lakhimpur	42	40	95.2%
11.	Dhemaji	24	4	16.6%
12.	Tinsukia	24	25	104.0%
13.	Dibrugarh	28	38	135.0%
14.	Sibsagar	36	40	111.1%
15.	Jorhat	32	29	90.6%
16.	Golaghat	75	56	74.0%
17.	Nagaon	76	46	60.5%
18.	Marigaon	12	15	125.0%
19.	Karbi Anglong	30	36	120.0%
20.	North Cachar Hills	20	4	20.0%
21.	Cachar	80	79	98.8%
22.	Hailakandi	20	40	200.0%
23.	Karimganj	39	32	82.1%
	T O T A L :	1000	810	81.0%

Contd.36.

CHAPTER - IV

STUDY AREA

1.A

Village Profile : To investigate into the problems and prospects of installation of biogas plants 15 (fifteen) numbers of villages inhabited by plains tribals of different ethnic groups are selected from each of the Integrated Tribal Development Projects. The following two tables show clearly the land holding pattern of each village and household separately.

TABLE - 7

HOUSEHOLD-WISE LAND HOLDING PATTERN OF EACH VILLAGE

in Bigha

Sl. No.	Name of the village	Number of household with land holding							Total house hold
		0-5	5-10	10-15	15-20	20-25	25-30	30-35	
1.	Auguri No.2	27	3	-	-	-	-	-	30
2	Bikrampur	N	A						45
3.	Chalapara	35	15						50
4.	Dharmanagar	23	14	9	2	1	-	1	51
5.	Ka-Danga	32	30	1					63
6.	Kachari gaon	21	14	7	2	1			46
7.	Khagrabari	5	29	26	9	6	2	1	78
8.	Jimirigaon	44	2						46
9.	Majorkuchi	24	19	1					44
10.	Maltijhora	18	18	13	1	1			53
11.	Maj Dalapa	-	1	2	6	7			19
12.	Maj gaon	23	24	14	12	5	1	5	87
13.	Rajabari-II	1	-	1	3	6	4	1	19
14.	Tup gaon	52	5						57
15.	Upper Deorigaon	1	-	3	13	31	12	5	70
		306	174	77	48	58	19	13	713

Sl.No	35-40	40-45	45-50
1.	-	-	-
2.	-	-	-
3.	-	-	-
4.	-	1	-
5.	-	-	-
6.	-	-	1
7.	-	-	-
8.	-	-	-
9.	-	-	-
10.	-	1	1
11.	1	2	-
12.	2	1	-
13.	-	2	1
14.	-	-	-
15.	2	3	-

From the table 6 it is clear that the village Auguri No.2 under Guwahati I.T.D.P. is composed of 30 households. Out of 30 households 27 households occupies land ranging from 0 to 5 bighas and other 3 households share land ranging from 5 to 10 bighas. In case of Chalapara 35 households occupy land ranging from 0 to 5 Bighas while 15 households occupy land ranging from 5 to 10 bighas. Out of the 15 villages 77 households from Dharmanagar, Ka Danga, Kacharigaon, Khagrabari, Majorkuchi, Maltijhora, Maj Dalapa, Majgaon, Rajabari II and Upper Deori gaon possess land ranging from 15 to 20 bighas. 58 households from Dharmanagar, Kacharigaon, Khagrabari, Maltijhora, Maj Dalapa, Majgaon, Rajabari and Upper Deori gaon possess land ranging from 25 bighas to 50 bighas. There are also 10 numbers of landless families in Dharmanagar village.

From Table No.7 it is clear that out of these 15 villages Upper Deori gaon under Jorhat I.T.D.P. occupies the largest area and Auguri No.2 under Guwahati I.T.D.P. possesses the smallest area. On the other hand, Upper Deori village possesses maximum area of cultivable land while Auguri No.2 under Guwahati I.T.D.P. possesses smallest area of cultivable land. While in case of No.of household Majgaon is comprised of maximum No.of households, namely, 89 households on the other hand, Rajabari II and Majdalapa jointly have the minimum number of households, that is, only 19 households each. It is also found that in Upper Deori village each household possesses maximum land holding area as much as 24.75 bighas per family with 23.36 bighas of cultivable land per family. Next to Upper Deori gaon comes Majgaon under Mangoldoi I.T.D.P. with 1190.8 Bighas of cultivable land. It is also found that in Upper Deori gaon each household occupies maximum land holding area

Contd.38

as much as 24.75 bighas per family with 23.36 bighas of cultivable land per family. Next to Upper Deori gaon comes Majgaon with 13.37 bighas of land per family with 11.20 bighas of cultivable land per family, Then Khagrabari comes in the third place with 12.44 bighas of landper family with 10.55 bighas of cultivable land per family. Then Rajabari II comes in the fourth place with 29.19 bighas of land per family with 27.31 bighas of cultivable land per family. After Rajabari II comes Bikrampur with 11.53 bighas of land per family with 9.82 bighas of cultivable land per family. In Auguri No.2 village, each household possesses the minimum area of land as low as 3.13 bighas of land per family with 1.73 bighas of cultivable land per family. From the analysis mentioned earlier from table I it is found that Upper Deori village, Majgaon,Khagrabari and Bikrampur village under Jorhat, Mangaldoi, Kokrajhar and Tezpur I.T.D.P. have the greatest potentiality for setting-up a bio-gas or Gobar gas plant on economic ground considering various aspects of land holding pattern, In case of other villages like Auguri No.2, Majorkuchi, Maltijhora, Jimirigaon etc. community bio-gas plant may be installed for better result and also improved chula can be used to minimise fire wood consumption.

Contd.39.

TABLE No. 8

Villagewise LAND HOLDING PATTERN

Sl. No	Name of the village	Total Nos of house-hold	Total Area of each village	Total area Under Cultivation	Total area under home stad	Others Fallow etc.
1	2	3	4	5	6	7
1.	Auguri No.2	30	94.1	52.0	31.1	9.0
2.	Bikrampur	45	519.0	442.0	77.0	-
3.	Chalapara	50	198.6	130.2	55.8	12.6
4.	Dharmanagar	61	439.51	363.5	76.01	-
5.	Jimirigaon	46	125.1	74.9	46.0	4.2
6.	Ka-danga	63	258.1	120.5	79.4	58.2
7.	Khagrabari	78	971.0	823.5	147.5	-
8.	Kacharigaon	46	345.8	230.3	68.0	47.5
9.	Majgaon	83	1190.8	997.0	143.6	50.2
10.	Majorkuchi	44	228.5	127.8	61.5	33.2
11.	Maltijhora	53	478.5	341.5	137.0	-
12.	Maj Dalapa	19	389.4	367.0	11.4	11.0
13.	Rajabari II	19	554.7	519.0	18.3	17.4
14.	Tupagaon	57	145.6	125.5	40.6	9.5
15.	Upper Deorigaon	73	1807.0	1706.0	54.6	46.4

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1.B

POPULATION PATTERN :

Out of 15 Nos.of villages Boro-Kachari group of people inhabitates in the villages, namely, Auguri No.2, Bikrampur, Kadanga, Majgaon, Majorkuchi, Maltijhora and Khagrabari, Upper Deorigaon and Rajabari II villages are inhabited by Deori group of people. Dharmanagar village is inhabited by Dimasa group of people while Majdalapa village is inhabited by Mishing group of people. Similarly, Chalapara and Jhimirigaon is inhabited by Rava group of people. Kachari gaon (Roumari) is inhabited by Sonowal Kachari while Tupgaon is inhabited by Tiwa group of people. The table No. III shows the population pattern of the villages under purview of our studies.

Contd.41.

TABLE NO . 9

ETHNIC GROUPWISE DISTRIBUTION OF POPULATION IN THE SELECTED VILLAGES

Sl. No.	Name of the dominant tribe	Name of the sample villages	Total No.of household	Total population	Male		Female	
					No	%	No	%
1.	Boro or Boro-Kachari	Auguri No.2	30	165	87	52.72	78	47.27
		Bikrampur	45	314	179	57.00	135	42.99
		Ka danga	63	343	174	50.72	169	49.27
		Majgaon	89	630	325	52.58	305	48.41
		Majorkuchi	44	309	161	52.16	148	47.89
		Maltijhora	53	337	188	55.78	149	44.21
		Khagrabari	78	436	219	50.22	217	49.77
2.	Deori	IUpper Deorigaon	73	738	346	46.88	392	53.11
		Rajabari II	19	251	160	63.74	91	36.25
3.	Dimasa	Dharmanagar	61	380	190	50.00	190	50.00
4.	Mishing	Majdalpa	19	222	140	63.06	82	36.93
5.	Rabha	Chalapara	50	272	142	52.20	130	47.79
		Jhimirigaon	46	290	147	50.68	143	49.31
6.	Sonowal Kachari	Kacharigaon	46	292	163	55.82	129	44.17
7.	Tiwa	Tup gaon	57	341	171	50.14	170	49.85

The maximum population is found in the Upper Deori (I) village under Jorhat I.T.D.P. with total population 738. Then comes Majgaon with total population 630. The total population of Khagrabari, Dharmanagar, Kadanga, Tupgaon, Maltijhora, Bikrampur, Majorkuchi, Kacharigaon, Jhimirigaon, Chalapara, Rajabari II and Majdalapa is shown in corresponding descending order as 436, 380, 343, 341, 337, 314, 309, 292, 290, 272, 251 and 222 respectively, Auguri No.2 under Guwahati I.T.D.P. is the village with minimum population of 165 only. It is also clear from the table III that Rajabari (Part-II) and Upper Deori gaon have the maximum percentage of males and females population with 63.71% and 53.11% respectively where as Dharmanagar has a balanced sex ratio.

Growth of Population : The growth of population is shown in table No.8. It is clear from the table that the growth of population at Upper Deori gaon under Jorhat I.T.D.P. from 1971 to present field study is 118.39 which is maximum amongst the fifteen villages under purview of our study. Dharmanagar occupies the second place with a population growth of 89.05. Population growth rate of Bikrampur and Kadanga is found to be 80.45 and 75.89 respectively. The reasons behind higher growth rate of these villages can be attributed to higher fertility rate and large scale immigration to these two villages. On the other hand, Rajabari II and Majdalapa have the minimum population growth rate such as 17.28 and 5.93 respectively. The cause of minimum growth rate can be attributed to natural calamities such as flood and epidemic. Some of the inhabitants of these two villages are shifting gradually to other convenient place for better livelyhood. It is worthwhile to mention that due to some unavoidable circumstances Khagrabari and Majgaon could

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not be completed and is partly investigated. Therefore, it is not possible to give a complete picture of population growth of these two villages. In the village Rajabari II the population growth rate is as low as 17.28 which can be mainly attributed to natural calamities such as flood. As this village is situated in flood prone area so most of the villagers are shifting themselves to other convenient places for better livelyhood. Similarly Majdalapa under Golaghat I.T.D.P. is also situated in flood prone area. During rainy season some of the inhabitants fall prey to water borne diseases because of flood havock. This is the only village where a decreasement of population is noticed from 1971 Census to present field study by 5.93.

Contd.44.

TABLE NO. 10

GROWTH OF POPULATION

Sl. No.	Name of the I.T.D.P.	Name of the selected village	Total population according to 1971 Census	Total population according to present investigation	Growth of population	Decreasement of population
1.	Guwahati	Auguri No. 2	108	165	52.77	
2.	Tezpur	Bikrampur	174	314	80.45	
3.	Goalpara	Chalapara	200	272	36.00	
4.	Silchar	Dharmanagar	201	380	89.05	
5.	Guwahati	Jhimirigaon	215	290	34.88	
6.	Nalbari	Ka-danga	195	343	75.88	
7.	Kokrajhar	Khagrabari	712	-	-	
8.	Dibrugarh	Kacharigaon (Roumari)	213	292	34.08	
9.	Mongaldoi	Majgaon	190	-	-	
10.	Barpeta	Majorkuchi	234	309	32.05	
11.	Golaghat	Maj Dalapa	236	222	-	5.93
12.	Dhubri	Maltijhora	209	337	61.04	
13.	Sibsagar	Rajabari II	214	251	17.28	
14.	Marigaon	Tupgaon	222	341	53.60	
15.	Jorhat	Upper Deorigaon	338	738	118.38	

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Collection of firewood : Out of 773 household of fifteen numbers of villages 62 nos.of household collects firewood on daily basis, 256 nos.of household collects on weekly basis. 188 nos. of household on monthly basis, 3 households on half yearly basis, 1 household annually, 38 households during winter season, 159 households collects firewood when required and 151 nos.of household collects firewood occasionally during flood season. Man hours spent in collection firewood is not calculated precisely due to unawareness, on the part of the informants. On assumption it may be said that average 4 hours are spent daily for collection of firewood.

Firewood Consumption : Firewood consumption in 15 nos.of villages is shown in the table No.IV. It is seen that consumption of firewood is maximum in case of Upper Deori gaon and minimum in case of Auguri No.2. A huge amount of firewood is also spent to observe socio-religious functions. A detail picture of firewood consumption in 15 nos. of villages is shown in the table No.8.

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TABLE NO. 11

FIRE WOOD CONSUMPTION

in kg.

Sl. No.	Name of the village	Total house hold	Total amount of firewood required per day per village	Average firewood required per day per house -hold	Total amount of firewood required for socio-religi -ous func- tions per year per village	Average firewood requir- ed for socio-reli- gious functions per household per year
1.	Auguri No.2	30	309	10.0	2375.0	79.0
2.	Bikrampur	45	522	11.5	9000.0	200.0
3.	Chalapara	50	408	8.0	17500.0	350.0
4.	Dharmanagar	61	516	8.5	27450.0	450.0
5.	Jimirigaon	46	527	11.5	12650.0	275.0
6.	Ka Danga	63	452	7.0	29962.8	475.6
7.	Kacharigaon	46	433	9.5	12880.0	280.0
8.	Khagrabari	78	867	11.0	42120.0	540.0
9.	Majgaon	89	1346	15.0	64569.5	725.5
10.	Majorkuchi	44	400	9.0	14300.0	325.0
11.	Maltijhora	53	542	10.2	13599.8	256.6
12.	Maj Dalapa	19	475	25.0	7296.0	384.0
13.	Rajabari II	19	530	27.0	7790.0	410.0
14.	Tup Gaon	57	555	9.7	15703.5	275.5
15.	Upper Deorigaon	73	1930	26.5	23097.0	316.4

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Livestock Population :

The importance of livestock population cannot be ignored for upgradation of village economy. Moreover, cow-dung is the essential raw material for a bio-gas plant. So adequate cow-dung is a must for smooth running of a plant. Therefore, implementation and as well as success of such a plant mainly depend upon the availability of livestock population such as cow,buffalo etc. The bullock and he/she buffaloes are used as dragged animals while cows and she buffaloes are reared for obtaining milk. Cow-dung is thrown into a heap inside or outside the household campus. After decomposition of cow dung they used it as manure in the agricultural field. Moreover, the villagers inhabited in the 15 Nos. of villages under purview of our study and field investigation are found to be rearing goats, ducks,pigeons,pigs and fouls. The table No.V shows the distribution of livestock population (only cows,bullocks and buffaloes) in the selected villages.

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TABLE NO. 12
LIVESTOCK POPULATION

Sl. No.	Name of the village	Total no. of house holds	Distribution of family according to the no. of Livestock populati							
			NIL	1 - 5	6 - 10	11 - 15	16 - 20	21 - 25	26 - 30	31 and above
1.	Auguri No.2	30	1	29	-	-	-	-	-	-
2.	Bikrampur	45	-	21	24	-	-	-	-	-
3.	Chalapara	50	2	48	-	-	-	-	-	-
4.	Dharmanagar	61	17	32	11	1	-	-	-	-
5.	Jimirigaon	46	3	40	3	-	-	-	-	-
6.	Kacharigaon	46	12	28	5	1	-	-	-	-
7.	Ka Danga	63	4	59	-	-	-	-	-	-
8.	Khagrabari	78	1	39	33	5	-	-	-	-
9.	Maj gaon	89	13	48	24	3	1	-	-	-
10.	Majorkuchi	44	-	43	1	-	-	-	-	-
11.	Maj Dalapa	19	-	2	5	4	4	2	2	-
12.	Maltijhora	53	10	30	8	3	1	-	-	1
13.	Rajabari II	19	1	-	-	1	3	3	3	8
14.	Tup gaon	57	6	46	5	-	-	-	-	-
15.	Upper Deorigaon	73	-	8	36	19	3	6	1	-
		773	70	473	155	37	12	11	6	9

Contd.49.

Availability of Cowdung :

Cowdung is available only in 704 household out of the total household 773 nos. in the 15 villages under purview of our study. Other 69 households possess no cattlehead and consequently cowdung also. In case of these 69 nos.of households. cow dung must be purchased as supplied at a subsidised rate by the Government or any voluntary social organisation for smooth running of the bio gas plant after installation work is over. 272 nos. of households possess cowdung in the range of 1 to 10 kg which is also found to be not sufficient to run the bio gas plant. Those household must be provided with cowdung 20 kg to 30 kg daily to run a bio-gas plant. It is found that in most of the villages total number of household and number of family members after close analysis is found to be 6 to 8 members per family. So, a bio-gas plants of 2 cubic meter to 3 cubic meter capacity are required to be installed in these households under purview of our study. For a 2 cubic meter capacity bio-gas plant requirement of cowdung is 40 kg. per day. And for a 3 cubic meter capacity bio-gas plant requirement of cowdung is 60 to 70 kg. per day. Now it is clear that out of the total 773 nos. of households in 15 different villages inhabited by Scheduled Tribe people, 2 cubic meter and 3 cubic meter capacity bio-gas plants are necessary and also justified. Number of households which are getting cowdung 40 kg. to 101 kg.per day are self sufficient in case of raw materials to run the bio-gas plant from 2 cubic meter capacity to 4 cubic meter capacity respectively. It is found that 77 nos. of household in 15 willages are getting cowdung ranging from 40 kg. to 101 kg. and above. These 77 nos.of households are quite self sufficient in relation to raw material for the plant. A detail picture of cowdung as raw material and its distribution is shown in table No.VI under purview of our present study.

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TABLE NO. 13
DISTRIBUTION OF COW DUNG

(in kg.)

Sl. No.	Name of the village	1-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-101	101& above
1.	Auguri No.2	25	4	-	-	-	-	-	-	-	-	-
2.	Bikrampur	3	24	17	1	-	-	-	-	-	-	-
3.	Chalapara	36	13	-	-	-	-	-	-	-	-	-
4.	Dharmanagar	25	133	-	-	-	-	-	-	-	-	-
5.	Jimiri Gaon	21	20	2	-	-	-	-	-	-	-	-
6.	Ka Danga	49	10	-	-	-	-	-	-	-	-	-
7.	Khagrabari	3	26	25	16	4	3	-	-	-	-	-
8.	Kacharigaon	18	11	1	4	-	-	-	-	-	-	-
9.	Majorkuchi	27	17	-	-	-	-	-	-	-	-	-
10.	Maj Dalapa	-	2	-	3	3	2	-	2	-	5	-
11.	Maj gaon	25	26	17	4	3	-	1	-	-	-	-
12.	Maltijhora	18	14	5	3	-	1	-	1	-	-	1
13.	Rajabari II	-	-	-	-	-	1	-	3	-	2	12
14.	Tup gaon	21	26	3	1	-	-	-	-	-	-	-
15.	Upper Deori -gaon	1	12	16	13	15	3	1	4	-	7	1
		272	223	87	45	25	10	2	10	0	14	16
		38.63%	31.67%	12.35%	6.39%	3.55%	1.42%	0.28%	1.42%	0%	1.98%	2.27%

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Typical householdwise distribution of energy consumption:

In the 15 nos. of villages under purview of our study it is observed that maximum number of household depend on firewood as the main source of energy for cooking purpose. In the 15 nos.of villages under purview of our study out of the total 773 nos.of households 766 nos.of households are found to be dependent on firewood as the main source of energy for cooking purpose only 1 family uses kerosine as the main source of energy for cooking purpose in Upper Deori gaon. Only 1 family from Kacharigaon uses L.P.G. as the main source of energy for cooking purpose. Only two families use bio-gas plants (KVIC type) though installed in the year 1988 was found to be out of order in Khagrabari village at the time of our investigation. Electricity is also found to be used by two families in Upper Deori village for cooking purpose. For lighting purpose, Kerosine is used by 663 Nos.of households. Likewise, electricity is used by 84 nos. of households for lighting purpose at night out of the total 773 nos.of households in 15 nos.of villages under the scope of our study. None of the families are found to use bio-gas for lighting purpose 46 nos.of families are found to be in use of both firewood and kerosine oil for lighting purpose at night. From this, we can come to this conclusion that due to lack of awareness on the part of the tribal villagers they are not giving proper thrust on the use of bio-gas or any other man conventional energy source to maintain ecological balance. The table No VII shows the typical distribution of energy sources both conventional and non-conventional in the tribal villages under purview of our study.

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TABLE NO. 14

TYPICAL DISTRIBUTION OF HOUSEHOLD IN RELATION TO CONVENTIONAL AND NON-CONVENTIONAL ENERGY CONSUMPTI

Sl. No.	Name of the village	Total household	Householdwise typical energy consumption								
			for cooking					for lighting			
			Firewood	Kerosine	LPG	Bio gas	Electricity	Kerosine	Electricity	Bio gas	Both Firewood & Kerosine
1	2	3	4	5	6	7	8	9	10	11	12
1.	Auguri No.2	30	30	-	-	-	-	30	-	-	-
2.	Bikrampur	45	45	-	-	-	-	45	-	-	-
3.	Dharmanagar	61	61	-	-	-	-	51	10	-	-
4.	Jimirigaon	46	46		-	-	-	27	-	-	19
5.	Ka-Danga	63	63	-	-	-	-	63	-	-	-
6.	Rajabari-II	19	19	-	-	-	-	19	-	-	-
7.	Khagrabari	78	76	-	-	2	-	78	-	-	-
8.	Upper Deori -gaon	73	69	1	-	1	2	38	35	-	-
9.	Chalapara	50	50	-	-	1	-	50	-	-	20
10.	Majgaon	89	89	-	-	-	-	78	11	-	-
11.	Kachharigaon	46	45	-	1	-	-	26	20	-	-
12.	Maltijhora	53	53	-	-	-	-	53	-	-	-
13.	Majorkuchi	44	44	-	-	-	-	36	8	-	-
14.	Tup gaon	57	57	-	-	-	-	50	-	-	7
15.	Maj Dalapa	19	19	-	-	-	-	19	-	-	-
		773	766	1	1	4	2	663	84	NIL	46

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Economic Status :

It is found that these villages are agrarian in nature. That is, their economy mainly based on agriculture, An attempt is made to show annual income and expenditure pattern of the 15 villages under purview of our study in the table No.15 below. Annual average income and expenditure is shown against each village.

TABLE No. 15

Annual Income and Expenditure

(in Rs.)

Sl. No.	Name of the village	Name of the I.T.D.P.	Average annual income	Average annual expenditure	Balance
1.	Rajabari	Sibsagar	52,578/-	37,158/-	15,420/-
2.	Bikrampur	Tezpur	17,155/-	16,071/-	1,084/-
3.	Upper Deori -gaon	Jorhat	25,520/-	20,054/-	5,466/-
4.	Maj Dalapa	Golaghat	11,673/-	10,268/-	1,405/-
5.	Chalapara	Goalpara	8,032/-	7,496/-	536/-
6.	Auguri No.2	Guwahati	9,667/-	8,737/-	930/-
7.	Dharmanagar	Silchar	22,622/-	15,029/-	7,593/-
8.	Jimirigaon	Guwahati	12,076/-	11,089/-	987/-
9.	Tup gaon	Mirigaon	10,974/-	10,289/-	685/-
10.	Majgaon	Udalguri	20,947/-	14,992/-	5,955/-
11.	Khagrabari	Kokrajhar	16,010/-	13,385/-	2,625/-
12.	Maltijhora	Dhubri	19,128/-	15,760/-	3,368/-
13.	Ka Danga	Nalbari	15,150/-	14,623/-	527/-
14.	Majorkuchi	Barpeta	20,363/-	19,043/-	1,320/-
15.	Kachari gaon	Dibrugarh	27,986/-	16,226/-	11,760/-

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Annual average income is found to be maximum in case of Rajabari II village under Sibsagar I.T.D.P.and minimum in case of Chalapara village under Goalpara I.T.D.P. From the table No. it is clear that each family maintains a surplus budget. Though income and expenditure is shown on average basis, yet we may consider that almost all the families are remained at least above the poverty line.

Information on Existing bio-gas plant :

Only 4 nos. of bio-gas plants are found in three villages, namely, Chalapara under Goalpara I.T.D.P., Khagrabari under Kokrajhar I.T.D.P. and Upper Deori Gaon under Jorhat I.T.D.P. In Chalapara under Goalpara ITDP one KVIC type gobar gas plant was established in the year 1987. D.R.D.A. offered Rs.5,000/- (Rupees Five Thousand)only as Government subsidy out of the total cost of Rs.12,000/- (Rupees Twelve Thousand) only. In Khagrabari village under Kokrajhar I.T.D.P. two KVIC type gobar gas plants were installed in the year 1988 with Rs.5000/- (Rupees Five Thousand)only as Government subsidy for each of the plants received from D.R.D.A. out of the total installation cost of Rs.12,000/- (Rupees Twelve Thousand) only. Due to mis-management both the plants are now out of order. Partition wall of the digester tank is spoiled by flood water. In case of Upper Deori gaon one KVIC type gobar gas plant was installed in the year 1990. This plant is functioning quite satisfactorily at the time of field visit.

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CHAPTER - V

Analysis : To analyse the problems and prospects of non conventional energy sources in Tribal Sub-Plan areas of Assam we must consider a few factors responsible in installation of bio-gas of Gobar plant.

Flood prone area :

Out of 15 villages inhabited by scheduled tribes (plains) it is found that three villages may be considered partly as flood prone areas. They are namely Majdalapa under Golaghat I.T.D.P., Khagrabari under Kokrajhar I.T.D.P. and Upper Deori gaon under Jorhat I.T.D.P. In the rainy season these villages are almost submerged by flood water, So, there is every possibility of damaging the gobar gas plant by flood water rendering the whole process a futile exercise. In these villages, of course, improved chulas can be used to minimise the amount of firewood consumption.

Keeping aside the villages of the flood prone area, the other villages may be provided with bio gas plants considering the economic conditions of the village households and number of cattle-head for required amount of cowdung to run the bio gas plant. In the villages under purview, of our study, it is found that more than 60% of the households depend on agriculture as the primary occupation only in Kachari gaon 52.17% of the total population depend on daily wage, service and business etc. as the primary occupation. Excluding the case of Kachari gaon all other villages are depending on agriculture as the main source of their livelyhood. It is found that out of 773 nos. of households only 67 households do not possess any cattlehead. 473 nos.of households possess cattlehead ranging from 1 to 5,156 nos.of households possess cattlehead ranging

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from 6 to 10. 37 nos. of families possess cattlehead ranging from 11 to 15. 12 households, possess cattle-heads ranging from 16 to 20, likewise 11,6 and 9 families possess cattlehead ranging from 21 to 25,26 to 30 and 31 nos.to above respectively.

For a family with 5 to 6 family members $2M^3$ capacity plant is required which can be operated with about 40 kg.of raw dungper day. This $2M^3$ capacity plant is ideal for most of the villages under purview of our study.

One of the critical raw materials for production of bio-gas is dung. Out of the total dung production, 69% is used for fertilizer, 29% for meeting need of domestic fuel and remaining 2% for other requirements.

People use dung for three purposes:First, to make dung cakes from the dung for meeting requirements of domestic fuel (very rare), Second, to produce fertilizer from collected dung at a particular place or pit. Third,to produce bio-gas and fertiliser from the dung. In the first process of dung, people loose benefits of fertiliser and health care. Likewise, in the second process people loose facility for domestic fuel and health care. In the third process people loose nothing. Due to installation of bio-gas plant,they get all three benefits of fuel for domestic needs,fertiliser for agricultural development and health care. During field visit, it was found that some villagers were not willing to set-up bio-gas plant because of some misconception about it. After processing of dung in the form of bio-gas it not only meets domestic fuel requirements but also generates benefits of fertilizer and favourable health condition as well as environment conditions.

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Indications of bio-gas production :

(a) Temperature : Gas production is conditioned by a certain degree of temperature. Functions of bactarias are affected by the temperature. Temperature between 35°C and 38°C creates a favourable condition for bacteria to produce maximum gas. Low temperature reduces the gas production capacity of bacterias. At 15°C temperature, bacteria become inactive in the process of gas production. Moreover, low level of temperature also takes more time in production of gas (Table Np.)

TABLE NO. 16

Relationship between Temperature and Gas p[illegible] Production

Temperature	Gas production from one M.ton waste(in cu-mt) per day	Duration required for production of gas from dung(months)
15°C	0.150	12
20°C	0.300	6
25°C	0.600	3
30°C	1.000	2
35°C - 38°C	2.000	1

To maintain the level of temperature several measures are adopted by experts. For example, (a) to use solar panels (b) to carry out experiment of hot water on gas holder, and (c) to process the dung in water in noon time.

(b) PH : Value of slurry

PH (Hydrogen ion Concentration) is a measure of acidity and alkalinity. PH value of 7 is neutral, anything lower is acidic, anything greater is alkaline. PH balance breaks the acids down into mathane and Carbon dioxide. Generally PH value of slurry must be maintained around 7. Acid producing bacterias can

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work upto 5.5 Ph value as they are quite hard. Whereas gas producing bacterias being quite soft. Can work actively if the PH value is 7. Old slurry generates more acidic elements whereas new slurry generates more alkaline elements. For optimum production of gas, the PH value must be ascertained from time to time and to be kept around 7 point (neutral point). During our field investigation, no such measures were found to be taken in case of existing bio-gas plants in the Tribal Sub-Plan areas of Assam.

C. Management of bio-gas plant : Trained personnels and experts are quite necessary for optimum gas production and management of bio-gas plant. The beneficiaries must be properly educated with technical know-how and management of the bio-gas plant. To motivate the villagers to install bio-gas plant from economic as well as health point of view, the formation of a advisory body is keenly felt. The advisory body may train the users to keep note of the following points for better result.

(a) To raise the temperature of the plant in the level of 30 C to 38 C through considering measures like heat exchanger through circulation of hot water, installation of solar collector, preventing heat looses through using glass cage on the drum etc.

(b) Stopping viable gas leakages from inlet and outlet pipes and joint junctions through adopting appropriate measures.

(c) Through checking of burner efficiency at KVIC laboratory.

(d) Analysis of gas composition at an appropriate laboratory.

(e) Ascertain of PH value of the slurry.

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(f) Installation of meters for accurate measuring of gas supply and gas utilization at family level.

(g) Analysis of bio-gas culture in the digester and slurry through contacting a micro-biologist.

(h) Installation of thermometers in the digester to maintain temperature records at different depths.

Suggestions :

1. To maintain ecological balance in the tribal sub-plan areas proper thrust should be given on the use of non-conventional energy sources like bio-gas and accordingly tribal people should be motivated to accept such new technologies.

2. Prior to implementation of the schemes relating to non conventional energy in the Tribal Sub-Plan areas feasible areas within the T.S.P. areas should be demarcated which are not flood prone.

3. Necessary infrastructural facilities should be made available to the beneficiaries within their reach for success of the scheme.

4. Necessary follow up actions after implementation of the schemes like bio-gas plants etc. should be taken up by the implementing agencies like D.R.D.A. to ensure the proper functioning of the schemes.

5. Rearing of cattle and collection of cow-dung in a scientific way should be encouraged among the tribal people so that bio-gas plants can be made more effective in the Tribal Sub-Plan areas. In this respect the Veterinary and Animal Husbandry Department can play an important role and help the implementing agencies like D.R.D.A in achieving their goal.

Contd.60

6. Prospect of establishment of Community bio-gas plants may be assessed in the Tribal Sub-Plan areas of Assam by D.R.D.A.

7. It has been observed in the course of our study that some of the tribal families are not willing to accept the bio-gas for their domestic use science they consider it unhygienic. Proper motivation is needed to make the people aware of the advantages of the bio-gas.

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