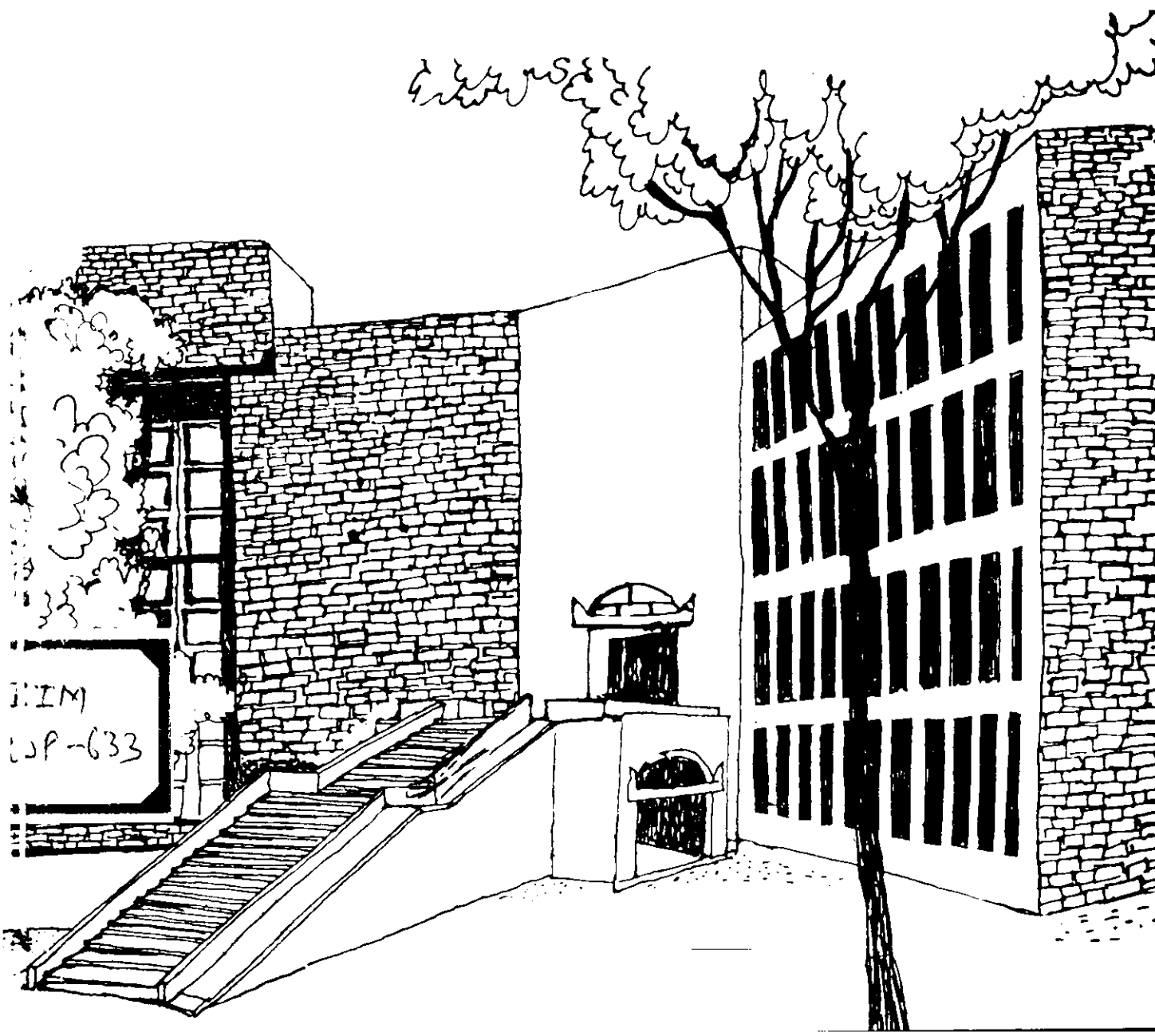
Working Paper



COMPARATIVE EVALUATION OF OPERATING PERFORMANCE OF KVIC AND JANATA MODELS OF BIOGAS PLANTS IN INDIA

By

T.K. Moulik
&
P.R. Shukla

W P No. 633
October 1986

The main objective of the working paper series of the IIMA is to help faculty members to test out their research findings at the pre-publication stage.

INDIAN INSTITUTE OF MANAGEMENT
AHMEDABAD-380015
INDIA

COMPARATIVE EVALUATION OF OPERATING PERFORMANCE OF KVIC AND JANATA MODELS OF BIOGAS PLANTS IN INDIA.

Abstract

This paper gives a comparative evaluation of operating performance of KVIC and Janata Model Biogas Plants in India. The comparative analysis is based on the extensive field survey of KVIC and Janata Model Plants in five States in India. Comparison is based on cost, operating problems, usage of gas, maintenance, feed stock types etc. Role of implementation agencies in success of the biogas plant installation is also studied.

Authors acknowledge IDBI for its sponsorship of this research.

1. Background

Biogas is an important national programme, particularly, for rural energy supply in India. Until 1978-79, there was only KVIC model of biogas plants beings promoted in India. Since about last 5 years, Janata plant based on Chinese design was actively promoted under the national programme. Table 1.1 gives the number of biogas plants installed in India of both KVIC and Janata type. The major consideration to introduce Janata plant was its cost advantage over the KVIC model. However, the government pursued the multi-design and multi-agency approach in the biogas programme in the sense that several agencies were involved in promoting either KVIC or Janata designs based on their experiences and preferences. As a result, there has been continuing debate about the comparative operating efficiencies and techno-economic suitability of these two models with concomitant claims and counter-claims. In many cases, these debates did create confusion resulting serious impediments in the implementation of the biogas programme.

In recent times, it is commonly agreed by all concerned, - planners, policy makers, implementing agencies - that an unbiased and objective techno-economic evaluation of these two models of biogas plants under operating field conditions is absolutely necessary in order to put an end to the conflicting demands and resulting confusion. Even the Department of Non-Conventional Energy Sources (DNES) and

...2...

TABLE 1-1 NUMBER OF BIOGAS PLANTS INSTALLED IN THE COUNTRY

STATE	Pre NPBD*(UPTO 1980-81)		NPBD (FROM 1981-82)		TOTAL		GRAND TOTAL
	(a) KVIC	(b) JANATA	(c) KVIC	(d) JANATA	(a+c) KVIC	(b+d) JANATA	(a+b+c+d)
1. ANDHRA PRADESH	2854	-	25217	6176	28071	6176	34247
2. UTTAR PRADESH	20225	7658	-	71166	20225	78824	99049
3. HARYANA	10277	-	47	7797	10324	7797	18121
4. MAHARASHTRA	11933	-	58408	29803	70341	29803	100144
5. BIHAR	9826	-	13481	7612	23307	7612	30919
6. KARNATAKA	7799	-	11027	9745	18826	9745	28571
7. PUNJAB	5612	-	4899	-	10511	-	10511
8. TAMIL NADU	6565	-	16590	15315	23155	15315	38470
9. GUJARAT	9185	-	12378	10571	21563	10571	32134
10. MADHYA PRADESH	3652	-	13213	3186	16865	3186	20051
11. WEST BENGAL	2413	-	6273	-	8686	-	8686
12. KERALA	1587	-	6488	-	8075	-	8075
13. ORISSA	622	-	5338	562	5960	562	6522
14. RAJASTHAN	409	-	3837	10467	4246	10467	14713
15. DELHI	51	-	182	-	233	-	233
16. ASSAM	75	-	1101	-	1176	-	1176
17. OTHER STATES/UT	470	-	5015	-	5485	-	5485
TOTAL	93585	7658	183494	172400	277049	180058	457107

• Ref: *National Program on Biogas Development.

the Energy Advisory Board recommended such objective and comparative assessment of the two operating models of biogas plants. The present authors conducted a study in response to this crucial question regarding the comparative techno-economic performance of the two models of biogas plants under operation in field conditions.

2. Objectives and Scope:

Broadly, this study is aimed to find out the comparative advantages of the KVIC and Janata models of biogas plants in relation to important techno-economic parameters operating under varying field conditions.

Specifically, the study is aimed at assessing the comparative advantage of one model or other in terms of costs, operating parameters including total failures, maintenance requirements, usage of gas, adaptability to alternate feed stocks etc.

The costs include costs of material, labour, transportation and accessories. Operating parameters include amount of feedstock ratio of feedstock to water, water drainage system on etc. Maintenance issues are consideres as related to design, Construction, accessories, operating practice and supervision. Role of implementing agencies is considered in relation to supervision, mason trainings, user educations and follow-up.

....4...

3. METHODOLOGY

A field survey using a detailed questionnaire was conducted to study the performance of plants under field conditions.

3.1. Coverage:

Survey was conducted in five States namely Gujarat, Bihar, Andhra Pradesh, Orissa and Utter Pradesh. Observations were taken in may districts and several villages in each district of these States. These five states provided wide ranging field conditions - i.e. different climatic conditions; coastal and inland areas and different implementing agencies and in their levels of implementation experience.

3.2. Sampling considerations:

The overall sample size of about 200 was considered to be adequate for the purpose of the study. The plants to be observed were selected by random sampling of districts in each state in which biogas plant installation program was implemented. Within each district, the villages to be visited and the plants in a village to be observed were selected randomly. The overall sample size in a state was roughly pre-decided before random sampling of plants within the state.

As Janata plant implementation in the country has started recently, i.e. last three to four years, for comparative purposes, the age of the plants selected was usually within five years and mainly the plants of 2 cum, 3 cum, 4 cum, 6 cum and 8 cum plants were sampled for both models of plants for comparability. The number of plants sampled of each model in each state is as in Table 2.1 below.

...6...

TABLE 3.1

Number of Plants of Each Model sampled in Each State

State	Plant type		Total
	KVIC	JANATA	
Gujarat	35	40	75
Bihar	12	20	32
Andhra Pradesh	28	15	43
Orissa	12	21	33
Uttar Pradesh	-	13	13
	87	109	Grand Total 196

The number of plants of KVIC and Janata models of different sizes and in different states are as in Table 3.2 and 3.3.

The number of plants of KVIC and Janata models of different age are given in Table 3.5 and Table 3.5.

....6...

Table 3.2

Number of Plants of KVIC model of different sizes sampled in different states.

	2 M^3	3 M^3	4 M^3	6 M^3	7 M^3	8 M^3	10 M^3	15 M^3
Gujarat	-	3	18	10	3	1	-	-
Bihar	1	-	2	1	-	2	-	6
Andhra Pradesh	1	5	2	10	-	9	1	-
Orissa	3	6	2	1	-	-	-	-
Uttar Pradesh	-	-	-	-	-	-	-	-
Total	5	13	24	22	3	12	1	6

Table 3.3

Number of Plants of Janata Model of Different sizes sampled in Different states.

	2 M^3	3 M^3	4 M^3	5 M^3	6 M^3	7 M^3	8 M^3
Gujarat	-	5	23	2	9	1	-
Bihar	9	2	1	-	8	-	-
Andhra Pradesh	2	5	7	-	1	-	-
Orissa	2	9	8	-	1	-	1
Uttar Pradesh	2	6	3	-	2	-	-
Total	15	27	42	2	21	1	1

....7...

Table 3.4

Number of Plants of KVIC of Different Age sampled in Different States

State	Age				
	Upto 1 yr.	1-2 years	2-3 years	More than 3 years	Total
GUJARAT	12	5	6	12	35
BIHAR	7	3	2	0	12
ANDHRA PRADESH	13	4	2	9	28
ORISSA	9	1	2	0	12
UTTAR PRADESH	0	0	0	0	0
TOTAL	41	13	12	21	87

Table 3.5

Number of Plants of Janata Model of Different Age sampled in Different States.

State	Age				Total
	Upto 1 yr	1-2 yrs	2-3 yrs	More than 3 yrs.	
GUJARAT	7	17	12	4	40
BIHAR	3	10	7	-	20
ANDHRA PRADESH	5	8	1	1	15
ORISSA	7	12	1	1	21
UTTAR PRADESH	3	5	4	1	13
TOTAL	25	52	25	7	109

....8

3.3 Field observations and Questionnaire

Each plant sampled was studied and datawas collected by visiting the actual plant site in each case, By administering questionnaire to each plant owner. At selected places, a separate questionnaire was administered to some masons.

3.4 Implementing Agencies:

In each state, different and multiple agencies implemented plant installation. The implementing agencies induced:

a. Government and non-government agencies; and agencies.

Exclusively implementing KVIC

Exclusively implementing Janata and

Rx Implementing both KVIC and Janata models.

4. Field Experiences and Observations:

A summary of field experiences and observations in all five states for both the models of plants is given here. The description here only pertains to overall experiences and observations made while conducting the field survey. An analysis of field results is given in the subsequent section.

4.1 Classification of Plant problems:

Field experiences and observations are summarized in each state in terms of the types of problems resulting in inefficient plant use or plant stoppage, different foodstocks used, different uses of gas and implementation practices. Plant problems are classified into - (I) minor problems, (II) major plant related

problems causing very low efficiency or plant stoppage and (III) major external problems (i.e. not directly related with plant construction, design or operation) causing very low efficiency or plant stoppage. In each of the abve three category, the problems considered are as follows:

I. Minor problems

i) Frequently water entering pipeline

ii) Defective accessory

iii) Minor leakage at joints.

II. Major plant Related Problems

i) Construction related problems

ii) Design Related problems

iii) Operational problems

III. Major External problems

i) Plant location

ii) Socio-economic

iii) Implementation Related problems.

Implementation related experiences are also briefly summarized for each state and each model. Detailed analysis of implementation practices are, however, presented in later section.

4.2 GUJARAT: Fie-ld experiences and Observations

4.2.1 KVIC Model: Summary of Plant Problems

Thirty five KVIC plants were observed in Gujarat. Table 4.1 gives a summary of number of plants working trouble free or

...10...

with minor problems, with major plant related problems and major external problems. Six plants have major plant related problems. In three plants, partition wall had broken. In one of these plants, partition wall broke when plant was being initially charged since all dung was charged on one side of the wall. In two other plants partition wall broke together with major cracks in digester walls. In two other plants, there was hole in the steel drum. These plants stopped functioning for sometime and after repairs have been restarted. One other plant stopped due to clogging and is out of operations.

Table 4.1

NUMBER OF PLANTS WORKING (I) TROUBLE FREE OR WITH MINOR PROBLEM, (II) HAVING PLANT RELATED MAJOR PROBLEMS AND (III) HAVING MAJOR EXTERNAL PROBLEMS.

STATE: GUJARAT

Model	Problem Category	Trouble free or Minor problem	Major problem Plant related	Major external problems	Total sample
KVIC	28	6	1		35
% of KVIC plant	80%	17.14%	2.86%		
Janata	25	15	0		40
% of Janata Plant	62.5%	37.5%	0%		
Total	53	21	1		75
% of total	70.67%	28%	1.33%		

Table 4.2

NUMBER OF PLANTS USING DIFFERENT TYPES OF FEED STOCKS AND WITH DIFFERENT USES OF GAS.

STATE: GUJARAT

Plant Model	Food Stock*				Use			Total sample
	Dung	Potato/ green veg.	Human excrta	Agri. waste	Cooking	Light	Duel Fuel engine	
KVIC	31	2	3	1	31	1	1	35
Janata	31	2	5	1	37	1	-	40

* One Janata Plant also was fed with poultry droppings.

...12...

One plant stopped due to external problems, the reason was that some boys threw a lot of sand in the inlet pipe which there was clogging and the plant stopped functioning. Since then it is not restarted for one year as owner could not get it cleared.

Twenty seven plants were working trouble free or with minor problems, Most plants are under fed. In few cases, substandard accessories was also a problem.

4.2.2 KVIC Model : Uses of gas and Feed-stocks:

As given in Table 4.2, most plants owners used dung. In two plants, potato and green vegetable waste was also used. In three plants, human excreta is used and in onecase agriculture waste is used mixed with dung as feedstock to the plant. Mainly the use of gas is for cooking. In one case each gas is used for lighting and for motive power.

4.2.3 Implementation and Operations Related Experiences and Observations: KVIC Model.

. In most plants, under-feeding is observed. Construction of plants and drums have been of good quality. Implementors maintain reasonable contact with the plant owners. As accessories and pipes etc. are not supplied by implementors, in some cases substandard material has been purchased by the owners. Users have been reasonably knowledgeable about the plant operation. Most users belongs to upper income rural families. All users felt that there was less production of gas in winter approx. about 40 to 50 per cent less daily. Users do paint the drum frequently on the outside but rarely on the inside.

...13...

4.2.4 JANATA MODEL : Summary of Plant Problems

Forty Janata plants were observed in Gujarat. A summary of number of plants trouble free or having minor problems or having major plant related or major external problems is given in Table 4.1. Fifteen plants out of fortyone are found having major plant related problems. There were no plants with major external problems. The type of major problems observed in these fifteen Janata plants were as follows:

Two plants were having continuous problem of slurry entering the gas pipe line and thus blocking gas. In one of these plants, owner had effected repairs as per the guidance of the implementing agency several times without any improvement in performance. In one other plant, considerable water had seeped into digestor wall through cracks in digester. Plant gradually produced less gas and stopped functioning. Plant need major construction repairs of digester walls.

In one other plant, slurry was very thin and gas production very low. Continuous underfeeding and too much feeding of water is observed in this case. Gas leakage through dome is observed in five plants reducing overall gas availability considerably. In one plant with lavatary connection, there was some blocking in lavatory connection which reduced gas production. Besides this plant has small dome cracks further reducing gas availability.

....14...

In four other plants, there have been problems from the beginning of less gas production and construction problems. One of these plants have cracks in dome. All these four plants are nearly two years old with same design implemented through some agency. All worked dissatisfactorily.

In general, construction problems (mainly dome leakages), wrong operational practices (constant underfeeding and too much water) and design problems caused major problems in the plants. Most plants had their domes not covered by sand.

4.2.5 Janata Model: Uses of Gas and Feedstocks.

Number of plants with different uses of gas and using different feedstocks is given in Table 4.2 below. Dung is most commonly used feedstock. In two plants vegetable waste is used. Five plants are connected to lavatory. One plant uses agricultural waste (rice husk, flour waste from flour mills etc.) mixed with dung. One plant is fed besides dung with poultry droppings. Gas is used exclusively for cooking except in one case where gas is also used for lighting besides cooking.

4.2.6 Implementation and operations Related Experiences and Observations: Janata Model

A high percentage of Janata plants are having major plant related problems. Three different implementing agencies have constructed plants in our sample and each was working independently with its own design and modifications. Janata plant designs of older plants have been designed by each agency as per its

.....15...

own experience. Thus, varities of designs (at least four different) with major variations and several more with minor (such as dimensional, construction details and methods) changes exist. Dome construction methods are varied considerably even with different individual contractors and promotors of the same implementing agency. In some cases, there is considerable use of steel rods in dome structure. Several plant owners prepared to use more cement than recommended. The general implementation picture is thus varie with several designs and varied construction approaches. Implementation agencies have been trying design modifications.

Operating practices show continuous underfeeding in case of most of the plants. Users have been aware of the overall operational instructions. Construction in many cases, is handled by experienced but untrained (for biogas plant construction) masons. Implementation agencies maintained fair contact with plant owners after construction. Most plant domes have not been covered. Most plants owners felt that daily gas production in winter is reduced by 25 to 40 per cent compared to summer.

4.3 BIHAR: Field Experiences and Observations

4.3.1 KVIC Model : Summary of Plant Problems

Twelve KVIC plants were observed in Bihar. Out of these, two plants had no trouble, and other ten had minor problems e.g. four plant had frequently water entering the pipeline, one had defective stove. Two major problems to be seen, however

....16....

were (i) oversize plants, (ii) considerable underfeeding. Most plants were oversize considering the family requirement the dung availability with the owner. In most 15 c.m. plants feeding of dung was from 10 kg to 30 kg. In other plants of 4 m^3, 8 m^3 etc also dung feeding was very low. A summary of number and per centage of KVIC model plants (i) trouble free or with minor problem, (ii) with major plant related problems and (iii) with major external problems is given in Table 4.3.

4.3.2 KVIC Models Uses of Gas and Feedstocks.

Most plant owners used gas for light as electricity situation is erratic, as light is necessary for safety as well as status. In one case gas was used for pumping water and thrashing using dual-fuel engine. Plant owners did not attempt to use any fuel other than dung mainly due to the perception that in KVIC plant feeding other biomass such as green vegetable waste, potato, agricultural waste etc. will cause problem as these will get struck in the inlet pipe-line which is very small in diameter. Perception of most plant owners about using feeds other than dung was that the Janata model is to be used if other feeds are used. A summary of different users of KVIC model plants and feeds are given in Table 4.4.

4.3.3 JANATA MODEL: Summary of Plant problems.

Twenty Janata plants were observed in Bihar. Three plants

....17...

were trouble-free or with minor problems. Seven plants had major plant related problems and ten had major problems due to external factors. The minor problems in plants related to small amount slurry sometimes entering the gas pipe line, bad gate valve and leaking pipe joint.

Four plants with major plant related problems had considerable leakage of gas from inlet and outlet and in joints. Plant produced satisfactory amount of gas for first year and then after about one year the gas production has been reduced to less than fifty percent of the earlier level. Problem could have been caused by too much feeding of water (Dung: Water = 1 : 3) in these plants together with underfeeding. In another plant, gas production has been considerably low after first few months of operation. The problem, according to the mason is that the gas pipe in the dome is lower than it should have been and slurry level which has risen after few months of operation has been blocking the gas pipe. Lots of gas also leaks out from inlet and outlet. One plant has a construction problem, soil under the outlet portion had shear movement resulting in the crack in the outlet fit. In one other plant, the gas outlet pipe rusted within six months and broke. The plant has remained out of operation since then as owner could not get plant repaired locally.

Ten Janata plants out of twenty were having major problems

Table 4.3

NUMBER OF PLANTS WORKING (I) TROUBLE FREE OR WITH MINOR PROBLEM, (II) HAVING PLANT RELATED MAJOR PROBLEMS AND (III) HAVING MAJOR EXTERNAL PROBLEM.

STATE : BIHAR

Model	Problem category	Trouble free & Minor problem	Major problem Plant related	Major external problem	Total
KVIC		12	0	0	12
% of KVIC Plant		100%	0	0	
Janata		3	7	10	20
% of Janata plant		19.05%	33.33%	47.62%	
Total		15	7	10	32
% of total		46.87%	21.88%	31.25%	

Table 4.4

NUMBER OF PLANTS USING DIFFERENT TYPES OF FEED STOCKS AND WITH DIFFERENT USES OF GAS

STATE : BIHAR

Plant Model	Feed Stock				Use			Total No. Of plants
	Dung	Potato/ greo Veg.	Human Exerta	Agri. Waste	Cooking	Light	Duel fuel Engine	
KVIC	12	0	0	0	11	11	1	12
Janata	8	2	2	0	10	9	0	20

...19....

due to external factors several of these plants belonged to very poor, harijan families who were beneficiaries of government scheme. In one case, a plant was not restarted after a major flood caused water to remain above the plant for ten days. The plant thus, stopped operating as slurry was wasted out and was not restarted. The flood also caused minor cracks on the inlet wall. Two plants were inoperative as the families owning the plant lost their cattle in a epidemic after the floods. In one case, the plant was not operated as the water source was very far (400 meters) and the old couple could not fetch water after their only son left for job in the city. In this case and in two other cases, the plant owners were not interested in starting the plant as they sold dung cakes earning Rs.5/- per day which was a major income source for the family. In one other case, a plant stopped operation after the first monsoon as the plant is situated in the low lying area and all water gets accumulated around the plant submerging it as there is no drainage around. In one case a big land owning family owning the plant was not interested as they had alternate fuels easily available and several servants. In one case a plant was never started in a harijan basti after inauguration as joint ownership and lack of organization resulted in not specifying responsibilities for operation and sharing of gas manure. In onecase, as the plant was located far from the stove,

..... 20 ....

frequent problems with the open pipe being damaged by children, cattle resulted in the owner stopping to use the plant. A summary of number and percentage of plants (i) trouble free or with minor problems, (ii) with major plant related problems and (iii) major external problems is given in Table 4.3.

4.3.4 JANATA MODEL: Uses of Gas and Feedstocks.

All ten working plants are used for cooking and five are also used for lighting. Gas is not used for running engine. Eight of the ten working plants used dung as feedstock. In one plant, exclusively potato and cabbage green is used as feedstock. In one other case, plant was operated by vegetable and kitchen waste and water hyacinth. In two other plants, green and dry agricultural waste was used together with dung. A summary of number of plants using different feedstocks and having different uses for gas is given in Table 4.2.

4.3.5 Implementation and Operations Related Experiences and Observation: KVIC Model:

Most family size KVIC plants in our sample were very big - more than half were of 15 m^3 size. Almost all plants have been underfed considerably. Thus most plants have been under-utilized . Also ratio of dung to water is much higher than recommended resulting in undigested slurry and thus reducing the gas production leading to further under-utilization of plants. Most plants were located in families with

.....21 ...

high economic status in the village. Experience of users with high light was satisfactory especially as mantel lasted for two to four months. In most plants owners felt that daily gas production in winter was about 40 to 50 per cent less than in rest of the year. Users rarely paint drums from inside.

4.3.6 Implementation and operations Related Experiences and Observations: Janata Model

Half of the Janata plants in our sample were having major problems due to external factors. The people owning the Janata plant were usually from middle to lower economic status. Most of the inoperative plants could have been restarted but for the lack of post-construction visits by implementing agency personnel. Plant construction, in most cases was done through untrained but experienced village mason. Thus, in several cases, construction though physically strong, did not follow the precise design specifications. Some of the latest design modification of Janata model have not been introduced even in recent plant. Most domes were not covered by sand on the top of the dome. Experience of users with light was not very good as in most cases mantel lasted only for two days to a week. Expertise with implementing agency personnel to detect defects and take corrective action was very week. Four plant owners out of twenty in our sample used feed stocks other than dung with satisfactory plant performance. In several plants, owners complained of reduction in gas output to less than fifty per cent of the original gas production, even in summer months,

.....2....

after about one year of plant construction. In these plants, we found a very thin slurry and a high water to dung ratio. In most cases users had experienced about 30 to 40 per cent less daily gas production in winter compared to summer. In one plant using potato and cabbage scares, however, the plant owner emphatically observed that gas production in all season was the same.

4.4 ANDHRA PRADESH : Field Experiences and Observations

Forty three plants were observed in Andhra Pradesh - twenty eight of KVIC Model and fifteen of Janata Model.

4.4.1 KVIC Model : Summary of Plant Problems

Table 4.5 gives a summary of number of plants working trouble free or with minor problems, with major plant related problems and major external problems. Only one of the twenty eight KVIC plants was having major problem in our observations. This plant had digester walls cracked. Mason constructing the plant was not trained for biogas plant construction. Soil in which plant is constructed is black-cotton type. Brick joints were not properly filled with cement in fact, mostly filled with sand. The digester cracked on four sides and circumferential wall became deformed within three months of construction. Plant was being reconstructed at an estimated reconstruction cost of Rs.4000/-. Rest twenty seven plants were trouble free or had minor problems. A consistent practice

....23 ..

of under-feeding the plants is observed in most plants. In some plants water entered the gas pipe frequently and drain cocks (taps) are rarely installed, water drainage has to be done by removing the pipe from gas stove joint. Due to under-feeding and excess water, in some plants we observed the slurry coming out was not fully digested.

In most cases painting of drum from outside is done by the owners but not from inside. One of the plant in our observation had cement concrete digester with mild steel dome, another one had cement concrete digester with ferro-cement dome and yet another had fibre glass dome. All these plants were working trouble free since several years.

4.4 2 KVIC Model : Uses of Gas and Feed Stocks

As given in Table 4.6, most plant owners used dung. In three plants poultry droppings have been also used together with dung. These plants were connected to latrine. Two plants used vegetable or agricultural waste with dung. Gas from plants is used for primarily cooking. Four plant owners also used gas for lighting. Gas is not used for motive power. As electricity is available in most villages application of gas for lighting and motive power is not made.

Table 4.5

NUMBER OF PLANTS WORKING (I) TROUBLE FREE OR WITH MINOR PROBLEMS, (II) HAVING PLANT RELATED MAJOR PROBLEMS AND (III) HAING MAJOR EXTERNAL PROBLEMS.

STATE: ANDHRA PRADESH

Model	Problem category	Trouble free & Minor problem	Major problem plant related	Major external problem	Total
KVIC		27	1	0	28
% of KVIC Plant		96.43%	3.57%	0%	
Janata		10	5	0	15
% of Janata plant		86.67%	6.67%	0%	
Total		37	6	0	43
% of Total		86.05%	13.95%		

Table 4.6

NUMBER OF PLANTS USING DIFFERENT TYPES OF FEED STOCKS AND WITH DIFFERENT USES OF GAS

STATE : ANDHRA PRADESH

Plant Model	Feed Stock				Use			Total No. of Duelplants
	Dung	Poultry dropping	Human Exerts	Dry & Green Agri.Waste	Cooking	Light	fuel Engine	
KVIC	28	3	3	2	28	4	0	28
Janata	14	0	1	1	13	8	0	15

....25 ...

4.4.3 Implementation and operations Related Experiences and Observations : KVIC Model:

Most plants have been over sized considering the family size and cattle available with the owner. In fact, most plants were considerably underfed. Implementation agencies have reasonable contact with the plant owners. Most plant owners belong to economically upper section of rural population. Operational information is provided to the plant owners by the implementing agencies, however, these are not strictly followed. Most users felt that about 40 per cent less daily gas was produced in winter compared to summer. In general users have been satisfied with plant performance. Domes have been made centrally. One of the implementing agency also fabricates dome. As they have sufficient technical manpower, they can attend to repairs also easily. Accessories are supplied in some cases by implementing agencies, however, plant owners do some time got their own accessories - auxiliary gas stove and many places substandard stoves are found.

4.4 JANATA Model : Summary of Plant Problems

As shown in Table 4.5 fifteen Janata model plants were observed in Andhra Pradesh. Of these five plants had major plant related problems. In one plant, dome collapsed at the time of construction only. This plant was constructed by village mason not trained in construction of biogas plant. Dome construction was supervised by the implementing agency's field supervisor, however, construction materials and construction methods were not properly handled and thus dome fall. No repair wase executed and plant was never started.

One another plant also failed due to design problem and improper construction. Since starting the gas production was very little as dome had leakages and inlet and outlet was not correctly positioned. Implementing agency did make some repairs and lowered the outlet level, however, problem did continue. Very little gas production was found and in winter months gas production was negligible. In one another plant, plant stopped operating after six months of operation. Since beginning this plant did not operate satisfactorily and produced insufficient gas. There were complaints of water entering pipe frequently. After installation, on two occasions implementing agency technicians came and suggested changes and lowered outlet but problem continued. Gas leakage was there from outlet also. One another plant had a problem that slurry entered the pipe frequently. Insufficient gas was produced and gas leaked from inlet and outlet. A special attachment (condenser type) was fixed with gas outlet pipe to drain the slurry. Plant worked after this but still produces insufficient gas. In yet another plant two years old gas production decreased gradually over last six months and very little gas is produced at the time of an observation. Minor dome leakage is there but there could be cracks in digester or scum formation.

Other ten plants are trouble free have only minor problems. Underfeeding is observed in most plants. In some plants,

..27 ..

water was entering gas pipe and as drain cocks are not there in many plants frequently gas pipe had to be removed to drain water. This practice caused bulging in gas pipe and causing leakage. In most plants domes were not covered by sand.

4.4.5 JANATA Model : Uses of Gas and Feed Stocks

Table 4.6 summarises the number of plants making different uses of gas and feed stocks. Dung is used as feed stock in all plants. One plant is connected to latrine. Agriculture waste is used in one plant mixed with gobar. Gas is used in all plants exclusively for cooking. No lights are burnt on gas. Also gas is not used for motive power.

4.4.6. Implementation and Operations Related Experiences and Observations : Janata Plant

Three Janata plants constructed by APIL in our observations have been all failures. Lack of trained masons and field supervisors and technicians knowledgeable about Janata plant construction have been the main reasons for failure of these plants. Most plant owners belonged to middle income level families. Implementation agencies maintain fair contact with the plant owners. Plants in Guntur district are comparatively recently made. Some recent design changes have been introduced in Janata plants in this region. Construction of plants in Guntur was very goood, however, technical support to remedy problems in the field was not strong. In few plants some

....28....

problems have been developing such as less gas production than earlier and as most plants are relatively new later such problems may develop. Implementing agencies hence must be in constant touch with plant owners to understand the problems. In general, however, in Guntur district, Gram Shri had properly trained masons for construction of Janata biogas plants and construction problems were not present.

Most users flet that in winter they got 30 per cent less gas daily than in summer. As most plants are near sea coast, Janata plant was preferred by owners as steel drum of KVIC corrodes very fast in sultry atmosphere.

4.5 ORISSA : Field Experiences and Observations

Thirty three observations were made in Orissa of which twelve were for KVIC plants and twenty one are of Janata plants.

4.5.1 KVIC Model : Field Experiences and Observations

Table 4.7 gives the number of plants troublefree or with major plant related problems or external problems. Of the twelve KVIC plants observed in Orissa, two had major plant related problems. One plant had one inlet connection from kitchen via pipe besides another inlet for gobar. Too much water comes from kitchen into the plant and thus slurry is very thin. As very little gas is produced, drum does

....29 ...

not lift and water and slurry is even on the top of the drum. Plant does not produce gas since this has happened. In another plant very little gas is produced. Slurry is not digested fully. Inlet pipe is choked with gobar becoming solid and particularly choking the inlet. Plant is not functioning properly with only intermittent gas production.

Ten other plants were trouble free or had only minor problems. Under feeding is observed in most plants. Substandard accessory - especially stove were found in some cases. During construction in some plants outer support of the guide was kept too low. The drum rising due to gas had resulted in bending the support. However, there was no damage or problem to plant functioning due to this. In two plants bamboo (locally available) were used as guide and outer support for the guide.

4.5.2 KVIC Model : Uses of Gas and Feed Stocks.

All working plants used mainly dung. In one plant agriculture waste is also mixed with dung. Gas is used in all cases exclusively for cooking. Gas is not used for lighting or motive power.

4.5.3 Implementation and Operations Related Experiences and Observations

Implementation agency maintains good contact with the plant owners. Operating instructions are known to plant owners. A

....30...

A card is given by the implementing agency which a plant owner can send back in case of a problem. One other card is given which has to be filledup by the field supervisors during subsequent visits. Drum fabrication is done centrally by fabricators. Implementation agency gives help also in accessory purchase. Trained masons and supervisors has ensured good plants.

4.5.4 JANATA Model : Summary of Plant Problems and Implementation Practices

Most Janata plants in Orissa are constructed in last two years. Only one plant out of twenty one in our observations was not working and that also due to non-plant relate (external) problem. The owner of this plant had lost some cattle and could not feed the plant and stopped it since three months. All other plants worked well. Several plants were underfed. Domes of most plants are not covered from top. Construction of all Janata plants was good. Trained masons and technically well acquainted field supervisors worked during plant construction. Implementation agencies maintain good contact with the plant owners. As most plants are relatively new, long plant history is not yet developed while KVIC plants, however, at present our observation suggest that the Janata plant implementation is successful. A summary of number of Janata plant trouble free or with minor problem, major plant related problem and major external problem is given in Table 4.7. Most plant owners felt that in winter 30 percent less gas is produced than in summer.

... 31 ..

Table 4.7

NUMBER AND PROPORTION OF PLANTS WORKING (I) TROUBLE FREE OR WITH MINOR PROBLEM, (II) HAVING PLANT RELATED MAJOR PROBLEM AND (III) MAJOR EXTERNAL PROBLEMS

STATE: ORISSA

type	Problem Category	Trouble free & Minor problem	Major problem plant Related	Major external problem	Total
KVIC		10	2	0	12
% of KVIC plant		91.67%	8.33%	0	
Janata=		20	0	1	21
% of Janata plant		100%	0	4.76	
Total		30	2	1	33
% of total		90.91%	6.06%	3.03%	

Table 4.8

NUMBER OF PLANTS USING DIFFERENT TYPES OF FEED STOCKS AND WITH DIFFERENT USES OF GAS

STATE:- ORISSA

Plant Model	Food Stock*				Use			Total No. of plants
	Dung	Potato/ Green Veg.	Human Excreta	Agri. Waste	Cooking	Light	Dual Fuel Engine	
KVIC	11	0	0	0	11	0	0	12
Janata	21	0	0	2	21	1	0	21

* In one plant urine is also used with dung.

...32 ...

4.5.5. JANATA Plant: Uses of Gas and Feed Stocks

As given in Table 4.8, dung is used in all plants as main feed stock. In two plants agricultural waste is also used together with dung. Gas is used mainly for cooking and only one plant owner also used lights. Gas is not used for running engine.

4.6 UTTAR PRADESH: Field Experiences and Observations

All plants in our sample in Uttar Pradesh are Janata model type.

4.6.1 JANATA Model : Summary of Plant problems

As shown in Table 4.9, thirteen Janata Plants were observed in U.P. All of these are in Aligarh district and implementation of all the plants is done by APFRO. A summary of number of plants working trouble free or with minor problem, with major plant related problem or major external problem is given in Table 4.9. Two plants were having major plant related problems. Both those plants had leakage in domes. Bothplants are more than three years old. Plants have been now repaired. In one plant, repairs required wax coating and plastering. In another, dome had to be completely dismantled and reconstructed. Two other plant had major external problems. In both cases plants were constructed by the owners under pressure from B.D.O. as a target number of plants needed completion. In case of one owner, there was very little space near the house for slurry pit as house is

.... 33 ....

Table 4.9

NUMBER OF PLANTS WORKING (I) TROUBLE FREE OR MINOR PROBLEM, (II) HAVING PLANT RELATED MAJOR PROBLEMS AND (III) HAVING MAJOR EXTERNAL PROBLEM.

STATE : UTTAR PRADESH

Type	Problem category	Trouble free & Minor problem	Major problem plant related	Major External problem	Total
JANATA		9	2	2	13
% of Plant		69.2%	15.4%	15.4%	100%
Total		9	2	2	13

Table 4.10

NUMBER OF PLANTS USING DIFFERENT TYPES OF FEED STOCKS AND WITH DIFFERENT USES OF GAS

Model	Feed Stock				Use			Total Sample
	Dung	Potato/ Green Veg.	Human Excreta	Agri. waste	Cooking	Light	Dual Fuel Engine	
JANATA	13	0	2	1	11	9	-	13

....35 ..

4.6.3 Implementation and Operations Related Experience and observations

For most plants, construction was good. Implementation agency was in good contact with plant owners. Implementation agency has very skilled technical manpower in all aspects of biogas plants. Under-feeding of plants is a problem. Construction of new plants was done by trained masons and some plants were constructed as a part of mason training program. Some of the latest design modifications in Janata plant design are introduced and even further experimentation was being done. One of the plants in our sample is a spherical "Deenbandhu" design plant constructed six months ago and was working satisfactorily. Though plant design and construction was good, in most of the activities which are left to the user, there were problems - e.g. pipe line laying was improper, even pipes were substandard, accessories - both stove and light were not of good quality and even though implementation agency specifically suggested to owners most plant domes were not covered by sand. Also underfeeding and mixing of excess water with dung was found. In most cases plant owners experienced about 30 to 40 per cent loss daily gas production in winter compared to during other season.

4.7 Summary of Plant problems for Total Sample

A summary of number of plants working trouble free or with minor problems, having major plant related problem and major external problem is presented in Table 4.11. This summary obviously represents the sum of the numbers in each category for each stage.

36 ..

Table 4.11

NUMBER OF PLANTS WORKING (I) TROUBLE FREE OR WITH MINOR PROBLEM (II) HAVING PLANT RELATED MAJOR PROBLEMS AND (III) HAVING MAJOR EXTERNAL PROBLEMS.

Model / Problem Category	Trouble free & Minor Problem	Major problem Plant Related	Major External problem	Total
KVIC	77	9	1	87
% of KVIC plants	88.51%	10.35%	1.15%	
JANATA	67	29	13	109
% of Janata Plants	61.47%	26.61%	11.93%	
Total	144	38	14	196
% of Total plants	73.47%	19.39%	7.14%	

4.8 Summary of uses of Gas and Food Stocks for Total Sample

A summary of uses of gas and food stocks for entire sample is given in Table 4.12 below. The numbers in table 4.12 obviously represents the sum of the corresponding numbers for five states.

Table 4.12

NUMBER OF PLANTS USING DIFFERENT TYPES OF FEED STOCKS AND WITH DIFFERENT USES OF GAS

TOTAL SAMPLE

Plant Model	Feed Stock				Use			Total No. of Plants
	Dung	Potato/ Green Veg.	Human Exerta	Agri. Waste	Cooking	Light	Duel Fuel Engine	
KVIC	82	5	6	4	81	16	2	87
JANATA	87	4	9	5	92	16	0	109

4.9 Implementation Agency-Wise Summary of Plant problems

Table 4.13 and 4.14 gives a implementation agency-wise summary of number of plants trouble free or with minor problems, having major plant related problems and major external problems for KVIC and Janata Model Plants respectively.

The tables show that for each plant model, the influence of implementation agency on plant failures or plant problems is significant. Also across the two plant models, the performance of the same ø implementation agency vary considerably.

Table 4.13

IMPLEMENTING AGENCY-WISE TABLE FOR NUMBER OF KVIC MODEL PLANTS (I) TROBLE FREE OR MINOR PROBLEM, (II) MAJOR PLANT RELATED PROBLEM AND (III) MAJOR EXTERNAL PROBLEM.

STATE	Implementing Agency Number	Trouble free or minor problem	Major problem plant related	Major External problem	Plant Implemented
GUJARAT	1	6	1	0	7
	2	15	4	0	19
	3	6	1	0	7
	4	1	0	1	2
BIHAR	1	5	0	0	5
	2	7	0	0	7
ANDHRA PRADESH	1	17	1	0	18
	2	10	0	0	10
ORISSA	1	10	2	0	12
TOTAL		77	9	1	87

....39...

Table 4.14

IMPLEMENTING AGENCY-WISE TABLE OF NUMBER OF JANATA MODEL PLANTS (I) TROUBLE FREE OR MINOR PROBLEMS, (II) MAJOR PLANT RELATED PROBLEM AND (III) MAJOR EXTERNAL PROBLEM.

STATE	Implementing Agency Number	Troble free or Minor problem	Major problem Plant related	Major External problem	Plants Implemented
				& & &	
GUJARAT	2	18	6	= -	24
	3	5	4	-	9
	4	2	5	-	7
BIHAR	1	3	7	10	20
ANDHRA PRADESH	1	-	3	-	3
	3	10	2	-	12
ORISSA	1	3	-	-	3
	2	17	-	1	18
UTTAR PRADESH	1	9	2	2	13
TOTAL		67	29	13	109

4.10 Costs of Biogas Plants in the Field are discussed here based on our experiences and observations. Different costs, namely (1) materials cost (2) Labour cost (3) transportation cost (4) Operation and maintenance costs (5) Cost of accessories are discussed. As fixed subsidies and allotment of Cement is made by the government, and as the loans obtained from banks are fixed, and as implementation agencies have to constitute plants within these amounts, the plant costs are controlled around the official figures.

Table 4.15

COST ESTIMATES FOR KVIC AND JANATA MODEL PLANTS

Model of Plant	Size of Plant				
	2 M^3	3 M^3	4 M^3	6 M^3	8 M^3
KVIC	5600	6800	7900	9700	11500
JANATA	4300	5300	6400	7800	

Source: Circular No. 5 5/85 - Biogas. dated 16.10.1985 of DNES.

However, in several places, local innovations are found. Eg. in Andhra, Karimnagar District, many KVIC plants had digestors made of stones available locally rather than bricks. In Gujarat, many Janata plant owners preferred to use steel rings, in the dome and higher preparation of cement and thus incuring higher costs.

....41...

4.10.1 Materials Requirements and Costs:

Material requirements for various sizes of KVIC and Janata plants is largely predetermined and prespecified by their basic design. As implementing agencies have considerable control during construction stage, in all states, the materials used for construction of the two types of biogas plants generally are close to recommended materials. However, in the local conditions improvisations are made in use of different materials for either model. In general however we find that the major difference in materials requirements for two plants is that KVIC plant requires steel dram where as for Janata model the dome is made of cement and bricks. The price of materials for KVIC plants is more, essentially due to steel drum. In Janata Plant, the dome construction is done differently by different implimenting agencies. E.g. in Gujarat at some places, in dome construction steel rods are used. In black cotton soil, the digester construction is done using concrete for foundation at some places. In Andhra, stones are used for digester construction of KVIC plants in some districts instead of brick. Thus in some cases construction materials do depend on the local conditions. In case of KVIC drums also apart from Mild Steel, materials such as ferrocement and fibre glass are used occasionally. Variability in mild steel sheet gauge of KVIC plant is also observed at different places. Instead

....42....

of recommended gauge of Mild Steel. sheet, thinner sheet is used in some cases. In case of Janata plants, new designs which are tried by some agencies recently, eg. Deenbandhu model by APFRO, require much less materials than equivalent sized standard plants. In general however, we find that the price of materials for equivalent sized KVIC plant are about 20 percent more than Janata plant mainly due to cost of steel drum.

4.10.2 Accessories Cost

The cost of accessories are equivalent for both models. However, the quality of accessories in our observation are not of standard quality in many cases. This resulted in inefficient use of gas.

4.10.3 Labour Requirement and Cost

The labour cost for both plants depend upon the size of the plant. For equivalent size of plant, the labour cost are primarily for digging the digester pit and constructing the digester walls. The major differences here is due to the fact that KVIC model requires a steel drum requiring labour skilled masons for dome construction. The steel drums for KVIC model are fabricated centrally and hence various machines are used for production. Thus different model has different type of labour requirement.

....43....

4.10.4 Transportation Requirement and Cost

Transportation of construction materials i.e. bricks and cement is required in case of both models. However in case of KVIC plant, transportation of steel drum requires separate arrangements. The transportation costs of materials depend largely on the location of a sight. Transportation costs in our observation are around ten percent of materials cost in most cases. However, the range can be from five to thirty percent. For a remote villages without proper approach roads, transportation of steel drum causes considerable difficulty. Especially, the steel drums of 4 cum higher sized plants causes considerable transportation problems if handling even for some distance has to be done by physically carrying it. In Orissa, in a trihal district, we found that biogas plant construction in a tribal village in hill, the materials was to be carried individually by people. In such a situation, to carry a steel drum was almost impossible and hence Janata Plant was preferred. In Andhra at one place we saw that the drum was damaged during transportation at the time of unloading. Also as steel drums are manufactured in towns, separate long distance transportation is needed for them. Thus, we find that the transportation for KVIC plants is more difficult and more expensive.

4.11 Training of Masons and Supervision

In the construction of biogas plant, trained mason and proper

....44.....

supervision is very important. In our observation, improper mason training and supervision attributed to majority of the plant related failures esp. in Janata plants. As gas retaining structure in Janata plant, i.e. dome is a masonery, structure, Janata plant construction requires superior mason training, better control of construction material and supervision. In our observation, in many places we found village masons, not properly trained for biogas plant construction, actually constructing plants. As discussed earlier, for this reason we observed even the dome had collapsed during construction at one village. Due to improper training, construction practices also varied considerably across the states, implementation agencies and even from village to village, in some cases. Apart from the masonary work of the plant, the understanding of the masons about the importance of desigr specifications was also not adequate in many places. Also due to frequent changes in designs and dimensions of the Janata plant, masons who were trained four years ago tend to continue with the same design. Proper mason training and supervision in our observation requires the following:

(1) Understanding of the plant design by the supervisor and knowledge of latest design.

(2) Close supervision of critical dimensions of the plant and construction material specifications.

(3) Mason skill for construction, esp. dome in case of Janata plant.

In our observation, different implementing agencies for Janata biogas plant has differentdesign variants and construction approaches whereas standardization of design and construction practices in KVIC plant were more uniform across the states and implementing agencies, standard quality of construction materials bricks and cement also contributed to improper masonary work.

From our field experience across six states and large number of implementing agencies, wefind that mason training and supervision during construction are vital for both models of biogas plant construction but more so far Janata plant. Standardization of design, construction materials and construction practices should be given priority by the implementing agencies and should train masons to follow standard practices. Of course some variations due to local conditions will have to be accepted, however standard design and adherance to design and standard construction practices must be made an important part of mason training.

4.12 Stage of Digestion of the Slurry

During observations in the field, we found many plants where digestion was incomplete. As we have not analysed

.....46.....

composition of the slurry from each plant, we cannot give precise information on stage of digestion however by observing bubbles in the slurry, small of the slurry, colour of the slurry, we could conclude broadly about the stage of digestion of the slurry. Incomplete digestion in our observation was closely related with saperatively practices. Improper feeding, underfeeding in most plants together of the slurry. In some plants, overfeeding and irregular feeding practices also contributed to incomplete digestion. In our observation we found that the problem of incomplete digestion was more frequent in Janata model plants thea in KVIC plants. In some older Janata Plants, where we observed incomplete digestion of the slurry, our discussion with masons and implementing agency suggested that the positioning of inlet and outlet in the old design of Janata Plant resulted in short circuiting and incomplete digestion of the slurry. Even in present design of the Janata model, it is reported that short circuiting will occur and complete digestion of slurry will not result, unlike for KVIC plant. This aspect would however require scientific and controlled study to compare the comparative merit of two models of biogas plants.

4.15 Use of Human Excreta

Field data from our observation on the uses of alternate feed stock are already presented earlier. However a separate

.....47....

mention is made here of our observation about the use or non-use of human excreta in practice. Use of human excreta we found in our observation is as in Table 4.16 below.

Table 4.16

Number and Percentage of Plants using Human Excreta in Different States.

State	Gujarat	Bihar	Andhra Pradesh	Orissa	UP	Total sample
Number of Plants	8	2	4	0	2	16
% of Plants	9.67	6.25	9.30	0	15.38	8.12

In general, very low proportion of plants, i.e. 8:12 percent are found to use human excreta. In all these plants latrine is attached to the plant. Resistance to using human excreta comes from aminly existing cultural and social beliefs. In some cases, lack of latrine facility near the plant site also contributes to non-use of human excreta. Prompting the biogas plant owner for using human excreta would require primarily change in beliefs. Understanding of the fermentation process and gas composition etc. may help in removing incorrect beliefs that gas from human excreta smalls fouls etc. However, we did find biogas plant owners who were willing to consider

....48....

use of human excreta and sixteen plant owners in our sample even used human excreta inspite of the existing social beliefs and tapoos, a fact which can be used to further practice of using human excreta. Use of human excreta by the owner however was not influenced by the type of biogas plant model.

4.14 Uses of Gas

As already discussed, earlier, biogas produced from the plant is used mainly for (1) cooking (2) lighting and (3) motive power using dual-fuel engine. As is wellknown, gas flow from KVIC plant is by design at constant pressure around (8 to 10 cms of water column) where as from Janata plant gas flow is at a higher pressure (upto 90 cms of water column) and pressure is variable. From our field observations we find that KVIC plant due to its low and constant pressure gas release has several advantages. In cooking with KVIC plant, as pressure remains constant, frequent adjustments of the nob to control the gas is not needed. Also as gas pressure is low, loss due to leakages could be less. In lighting, mantel of the light breaks more frequently with Janata Plant as gas pressure is higher, though water content with the gas is a major cause in breakage of mantel irrespective of the plant model. Non-constant pressure of gas from Janata Plant also requires frequent adjustment of

light. Similarly, in running dual fuel engine, one important parameter to get fuel efficiency is the ratio of mixture of gas to diesel. Due to constant pressure of gas from KVIC plant constant ratio of gas to diesel can be maintained without any adjustments where as in Janata Plant gas flow will vary with the gas pressure and hence gas to diesel ratio can not remain constant. In this case also frequent adjustments of gas flow is required with Janata Plant. High pressure of Janata Plant however can be advantageous in case where gas has to be delivered to a longer distance.

6. SUMMARY AND CONCLUSIONS:

Following are the summary and conclusions from the study of comparative analysis of KVIC and Janata model biogas plants under filled operating conditions.

1. In the Indian biogas programme, two distinctly different plant designs are promoted: floating dome or KVIC model and fixed dome or Janata model. While the promotion of the floating dome KVIC model dates back to about three decades the fixed dome Janata model came into picture only for the last 5-6 years. Apart from the fact that the two plant designs have their unique technological and design parameters, there has often been some controversies about the actual operating performance of the respective model of biogas plants in the field. The present study has been conducted in order to dispel the controversy on the basis of a scientific evaluation.

.....50....

2. A total of 196 family-size biogas plants of varying sizes and ages were randomly selected covering 5 states of India. Each one of the biogas plants were investigated in details along with intensive interviews of biogas plant owners, masons and implementing agencies. The findings of this report are essentially based on these actual field investigations carried by the authors themselves.

3. Of the total 196 biogas plants investigated, about 20% of the plants were found to be non-operational in the sense that they had major constructional or design defects, which either made them disfunctional right from commissioning of the plants or serious problems arose within the first year of this operations. In other words, assuming the sample of 196 biogas plants as true representative of the total population of family size biogas plants in India, about 20% of the plant population could be assumed to be failures or non-operational at any given point of time due to some major constructional or design defects.

4. About 7% of the total sample of 196 biogas plants were found to have some major external problems, such as, wrong selection of location, wrong selection of customers without adequate feedstock resources or non-interested customers etc. As a result, these plants were found to either

.....51....

operate partially or left non-operative after initial operation for a short time.

5. As high as 73% of the total number of plants investigated were found to be operating almost trouble free.

6. Between the KVIC and Janata models, the field performance of the floating dome KVIC model was observed to be conspicuously better as compared to the fixed dome janata model. As high as 88.5% of the KVIC plants were found to be operating trouble free as compared to 61% of the Janata plants. To put it in a different way, while only 10% of the KVIC plants were non-operating due to major plant defects, as many as 27% Janata plants were found to have similar defects. Similarly, only about 1% of KVIC plants had major external problems as against 12% of the Janata plants.

7. There are two aspects which need to be emphasized in the above mentioned findings. Firstly, while the performance or failure rate of the KVIC plants was found to be independent of their age, failure rate of Janata plants was significantly higher among the older plants, that is, plants of 2-3 years old. There are clearly three reasons for such differential performance of the two models of plants:

.....52...

(i) Relatively much higher mesonary skills required to build Janata Plants, which were not adequately available during the initial years of popularization of Janata Plants.

(ii) Initial plants design itself has its inherent defects which in later years are attempted to be corrected. In fact, Janata plant design seems to be still in the process of evolution and subject to various corrections.

(iii) In comparison, the floating dome KVIC design, over a long period of trial and error and implementation, has almost become a standardized product. Also, the level of masonary skills required to construct KVIC modal plant are relatively simple and easily available in local village situation.

The second aspect of the findings is in relation to external problems. Here again, it seemed that the long experience and standardized procedure/processes seemed to help the experienced implementing agencies to avoid as compared to janata plants, certain mistakes related to non-plant related factors, which were implemented by various implementing agencies with extra-enthusiasm to prove the design and meet the targets

....53....

in its initial years of popularization programmes without any past experience and standardized operational parameters.

8. It was reported that the existing fixed dome Janata designs tended to develop serious plant related problems as it grew older, say, after 2-3 years of operation. The floating dome KVIC design was not found to have such problem. This means that the trouble free operating plant life of KVIC design is distinctly higher than that of Janata plants.

9. One of the major problems of Janata plant was found to be leakage of gas. Almost all the janata plants investigated were found to have varying degrees of leakage problems. Apart from leakage, the volume of gas storage chamber of Janata plants seemed to get reduced over the years as the slurry got accumulated below the digestor. Over the years, this tend to create serious problems of digestion and gas production. In fact, it has been observed that the chances of incomplete digestion of feedstock was more in Janata plants as compared to KVIC design.

10. There seemed to be a general tendency to opt for over-sized plants than what was required or possible, given the resource position of the plant owners. As a result, a very high percentage of biogas plants seemed to suffer under-a irregular - feeding, often causing serious problems

...54....

(e.g.incomplete digestion) particularly, in janata plants. Just as, in most cases, the choice of plant model was basically determined by the concerned implementing agencies, the size of the plant was also largely determined by the implementing agencies.

11. Two important performance parameters of biogas plants are gas flow and gas pressure, which, in turn, is largely dppendent on amount of feeding and gas use. While the measurement of these two parameters could not be done in our investigation under strict controlled conditions, both pressure and flow of gas in Janata plants was found to be conspicuously higher than in the case of KVIC plants. In fact, because of the high gas presence, the gas leakage in Janata plant it was generally not felt or cared by the users.

12. Irrespective of biogas models, the most important and in fact almost the only feedstock used in the plants was found to be cowdung. Only 8% of the plants were found to be connected with latrines. Similarly, barring a few exception in Bihar, most of the plant owners were found to use biogas for cooking and heating water. Wherever biogas was tried to be used for lighting or pumping etc. as in Bihar, the variable characteristics of gas pressure of Janata plant was

felt to be more inconvenient as against the constant pressure characteristics of KVIC plant. In other words, relatively more of KVIC plants was used for other than cooking purposes than Janata plants.

13. Janata plant has two distinct advantages over KVIC plant: less cost and relatively less space requirement or underground nature of the construction. In fact, in remote areas without accessible road facilities and without any infra-structural facilities for local fabrication and transport of gas holder for KVIC plant, the fixed dome Janata plant seem to be most convanient.

14. A close supervision during construction of plants and a regular follow-up services by the implementing agencies are clearly the most important requirements for success of biogas programme. Because of higher masonary skill requirements and problems associated with age of the plant, these requirements of supervision and follow-up services are more crucial for Janata plants. In fact, the failure rates in areas where the implementing agencies were following these two essential services with care and regularity was found to be significantly less.

15. The results of the survey clearly brings out several conclusions which can provide definite guidelines for future

.....56...

courses of action. Many of those conclusions are often a mere confirmation of some current notions and experiences. The major conclusions of the study are:

1. Under the existing operating field conditions and given the present level of biogas technologies that are being promoted, the performance of floating dome KVIC design is far more assuring than that of fixed dome Janata design. The rate of failures with major design or construction related problems tended to be much greater among Janata plants than among KVIC plants.

2. The major disadvantages of KVIC model is its relatively high cost, larger space requirements, and fabrication/ transportation difficulties for gas holder to infra-structurally remote areas. On the other hand, its advantage is its standardized design and relatively simpler skill requirements for its construction along with relatively higher reliability of its operational performance.

3. The advantages of Janata plant are exactly the opposite of the disadvantages of the KVIC model i.e. less cost, less space requirement and appropriate for remote areas. Its disadvantages are: fairly high degree of trained masonary skill requirement, proneness to gas leakage,

....57...

tendency for developing major problems as it grows older i.e. relatively less trouble-free operating life.

4. It is clear, therefore, that given a choices KVIC design would have a preference over Janata design. However, considering India's field condition and resource base, a serious R & D efforts should be made to evolve a KVIC design which can replace steel holder with some cheaper material which can reduce its cost at least by 40%. also it should be possible to fabricate such holder locally and/ or should be transported easily without breakage. The recent experiment with ferro-cement or fibreglass is an attempt in this direction.

5. Janata plant being essentially slightly chinese design, the experience of China should be taken as a lesson. China had discarded almost half (4 million) of its biogas plants after 8-10 years because of serious leakage and other design related problems which made these plants non-operative. Given this experience, the immediate policy could be to decide finally about Janata plant on the basis of serious evaluation of the existing plants after at least 5-6 years.

6. The above mentioned policy of waiting for evaluation results for 5-6 years might not be practically feasible or desirable.

....50....

In that case, certain definite policy and action parameters are absolutely necessary in order to promote Janata plants:

a. A vigorous and continuing training programme for the masons to create an army of skilled masons;

b. No Janata plant construction should be allowed without properly trained masons and under strict supervision of the implementing agencies.

c. The implementing agencies should have a regular follow up service facilities.

d. The implementing agencies should give options to the people to choose between the models rather than predetermining the model themselves.