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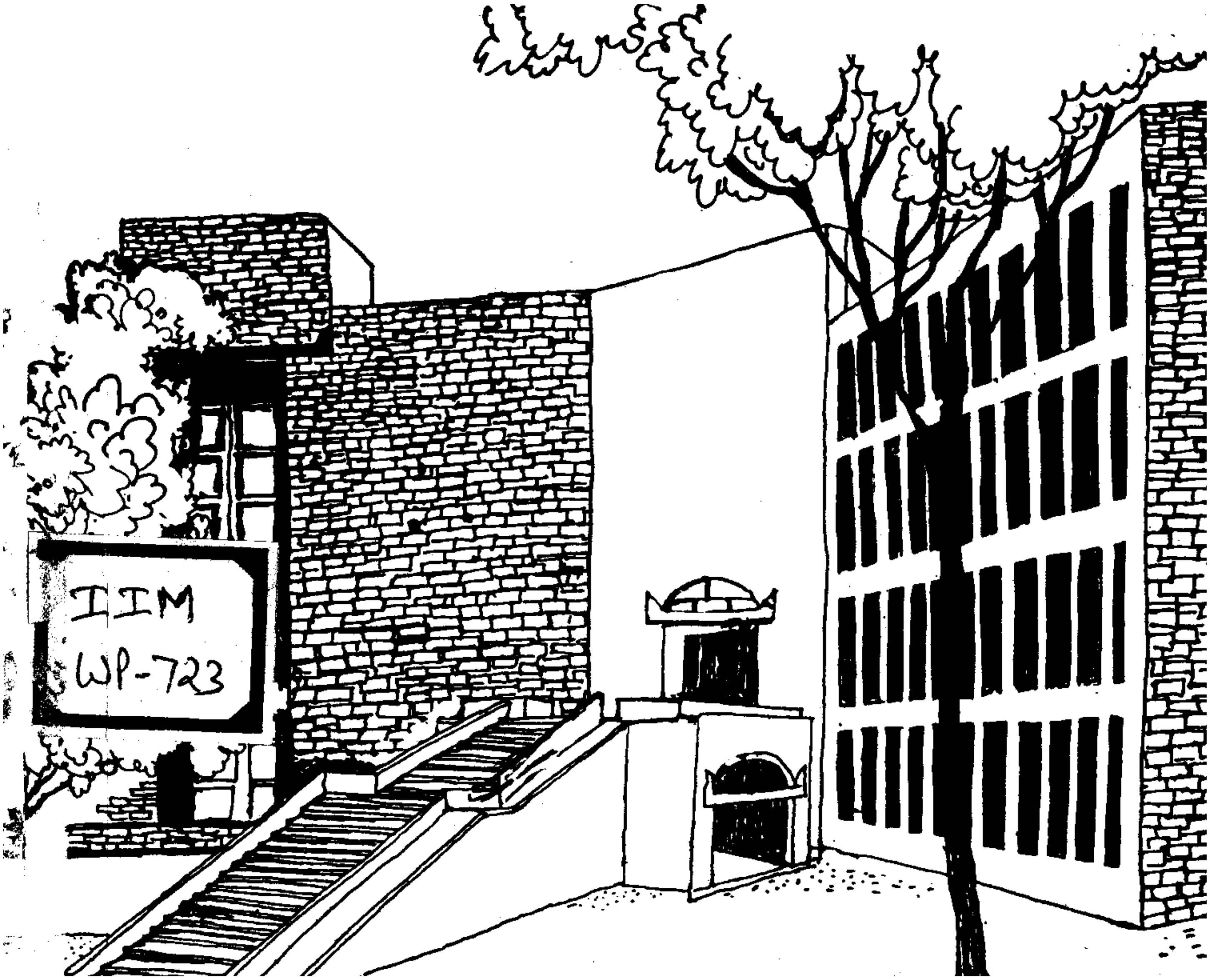

# BIOGAS TECHNOLOGY
# A CASE OF MAHIJDA VILLAGE

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## 1. Significance of Biogas Technology

The household energy consumption accounts for nearly 50 per cent of total energy consumption in the developing countries (3). It is primarily obtained from non-commercial sources such as firewood, animal waste, crop residues, etc. For instance these three sources constitute nearly 90 per cent of the cooking fuel in India(5). The cattle dung production in the country is estimated at 324 million tonnes of dry dung which about 73 million tonnes is estimated to be burnt as cooking fuel (5). It amounts to a net loss of 1.2 million tonnes of nitrogen, in addition to around 70 million tonnes of organic matter(dry weight). In regard to supply of fuel the Fuelwood Committee (1982) observed that the availability of 50 million tonnes of fuelwood was not adequate to meet even half the energy requirements of the household sector(5). Our forest resources of 75 million hectares constitutes 23 per cent of geographical area which is already far less than the desired 33 per cent recommended by the National Commission on Agriculture(6) and it is being fast depleted to meet the ever increasing demand for firewood. It is thus feared that the time is not very far when the availability of fuelwood would become a greater constraint than the availability of food itself(6). This will be more so because of ever increasing cost of commercial energy in the form of oil, natural gas, coal and electricity.

Realising the gravity of the situation Government of India diverted its attention to the exploitation of new and renewable sources of energy. The allocation of Rs.519.55 crores in the Seventh Plan for energy sector is an evidence of the government's concern inthis regard. Biogas was recognised as the major source of energy to tap for household use. Nearly 50 per cent of the central share of 412.35 crores in the plan allocations for the energy sector was earmarked for the development and use of biogas technology. Technically about 100 lakh family sized plants could be feasible in the country with the holding pattern of animal population (16). About 3.55 lakh plants were already installed in the Sixth Plan. The target for the Seventh Plan is fixed at 7.5 lakh plants (5).

## 2. Biogas Technology

Biogas technology is based on anaerobic fermentation of cellulosic material which yields gases. Between 60 to 70 percent (by volume) of the gases produced is methane. In India cattle dung called "gobar" is used and hence the name gobar gas. The digested dung(slurry) is rich in humus than the fresh dung. Thus the technology serves twin purposes of efficient fuel for household energy and rich manure for enhanced production, thereby reducing the dependency on the already fragile forest resources and saving valuable foreign exchange on fertilizer imports.

The benefits of gobar gas technology to individuals are the smokeless efficient fuel for domestic use and nutrient enriched slurry (2) as organic manure. The raw material used is dung and water. Therefore the necessary conditions for its acceptance are i) a minimum number of cattle to produce adequate dung, ii) ownership of land to make use of the slurry and iii) adequate supply of water for mixing dung. Ownership of land is also important for regular supply of fodder to the animals. Investment cost of the plant and equipment may also act as a constraint in the adoption of biogas technology. On the other hand the adopters get indirect benefits in the form of dung, firewood and crop residues saved. These fuels would be available to others in the society - a social benefit. Similarly when the adopters switch over from grazing to stall feeding of their cattle, they manage additional fodder for stall feeding their cattle. On the other hand the landless and the weaker sections who solely are dependent on grazing their cattle will benefit from the pastures vacated by the biogas adopters. At the same time the landless would be deprived of dung they use to collect. As a consequence they have to buy dung or firewood for their fuel needs. So the technology may increase the burden on the poor and weaker sections and benefit the rural rich.

A family size biogas plant needed an initial investment of about Rs. 4000 to Rs. 6000 (fixed dome model, 3 to 6 cubic metre capacity). Only a very few in the rural area notably the owners of large and medium sized land holdings could afford this investment. It may be emphasised that these categories of rural people generally have enough resources in the form of dung, firewood and crop residues for fuel and hence may not opt for this technology purely for its non-pecuniary benefits. Therefore, incentives in the form of cash subsidy on investment cost is being provided to make them adopt this technology. This defeats the objective of equity by favouring the already wealthy. How to maximise the social gains from the technology without upsetting the existing economic balance between the rich and the poor in the rural area is relevant but a complex issue.

## 3. Mahijda Village

Mahijda village of Daskroi taluka of Ahmedabad district in Gujarat state is unique in the sense that it had 117 family size biogas plants in 1987. To understand the phenomenon of this wider acceptance of biogas technology, it was considered pertinent to know the basic features of the village and the perceptions of the villagers about this technology.

### 3.1 Basic Features of Mahijda Village

Table 1 gives some basic data about Mahijda village. It is a small village with a population of 2235 (1981 census) It is about 36 kiometers away from Ahmedabad located at Ahmedabad - Baroda national highway about six kilometers in the interior. It had a total geographical area of 1393 hectare of which 802 hectare was cultivated and another 113 hectare was fallow. Another 347 hectare was grazing land. Nearly 56 per cent of the cultivated area was irrigated by a public canal and private tubewells and pumpsets. Of the 286 holdings 171 were small (upto 2 acres). Only 41 were over 11 acres. Farming was the primary occupation of a large majority in the village while agricultural labour was the other important occupation.

The village had protected water supply. The village got electricity in 1959 . Presently 180 houses got electric connections. The village had cattle population was 1470 in addition to 167 camel, sheep, goat etc. The cropping pattern included paddy, wheat, jowar, bajra, moong, castor and vegetables. Only castor, a minor crop, yields some fuel material. The by product from other crops was fodder. It was reported that the village did not have any forestry activity. However babul was grown on boundaries of some fields as well as it had wildly grown on community lands.

Dung was the primary source of household energy. It was supplemented by firewood and in some cases by kerosene also. While cattle owners had their own dung non-owners gathered it from the open places. Similarly, those having their own trees could prune them occasionaly for firewood while others were illegally foraging the trees on community lands. Even those who had their own trees joined them in this practice. Firewood was also purchased from the nearby places by some households.

Table 1 : Some Basic Data on Mahijda Village

| | | |
|---|---|---|
| 1. Total Population | : | 2235 |
| Male | : | 1129 |
| Female | : | 1106 |
| 2. Livestock Population | : | 1709 |
| Bullocks | : | 365 |
| Buffaloes | : | 1090 |
| Cows | : | 25 |
| Camels | : | 7 |
| Goats | : | 24 |
| Sheep | : | 136 |
| 3. Total land area of the village (ha.) | : | 1393 |
| Cultivated area | : | 803 |
| Area irrigated | : | 460 |
| Grazing land | : | 347 |
| Fallow | : | 113 |
| 4. Size of operational holding (Number) | : | 286 |
| Less than 1 acre | : | 101 |
| 1 to 2 ,, | : | 70 |
| 2 to 4 ,, | : | 74 |
| 4 to 8 ,, | : | 36 |
| 8 acres and more | : | 5 |
| 5. Number of tubewells | : | 14 |
| Government | : | 1 |
| Private | : | 13 |
| 6 Number of pumpset | : | 86 |
| Electric motors | : | 40 |
| Diesel engines | : | 45 |
| 7. Number of tractors | : | 14 |
| 8. Number of carts | : | 32 |
| 9. Year of electrification of the village | : | 1959 |
| 10. Number of houses electrified | : | 180 |
| 11. Number of flour mills | : | 3 |
| 12. Number of rice mills | : | 1 |

(Table 1 : Continued)

13. Cropping pattern (ha.)

| | | 1984-85 | 1985-86 | 1986-87 |
|---|---|---|---|---|
| Kharif : | Paddy | 670.01 | 559.56 | 579.82 |
| | Jowar | 5.31 | 6.25 | 5.59 |
| Rabi : | Wheat | 217.64 | 210.10 | --- |
| | Bajra | 14.71 | 10.33 | 4.57 |
| | Vegetables | 0.51 | 1.89 | 2.45 |
| | Castor | 3.36 | --- | 0.68 |
| | Moong | 1.13 | --- | --- |

The village had a commercial bank branch and a primary agricultural cooperative society for the supply of credit. A Farmers Cooperative Society was established in 1954 for the upliftment of weaker sections. Only scheduled caste households were eligible for membership. Presently there are 42 members. All the 42 member households were located at one place in a cluster. The society was allotted 109 acres of aerable land to be cultivated on behalf of its members. A seven member committee looks after the operations of the society. The committee is elected every year. The society had been functioning well since its inception. It had installed two tubewells and owned a tractor. Almost all the member households own some heads of cattle. However, individually none of them could have a viable biogas unit to meet his household energy needs primarily because of inadequate dung production.

## 3.2 Adoption of Biogas Technology

As mentioned earlier the village had 117 biogas plants. Though four plants (KVIC) were installed more than a decade ago the technology did not catch the imagination of the people even at 50 percent subsidy on the initial investment. The major constraint was the space for the KVIC model. However, the chinese fixed dome model found easy acceptance en masse. Gujarat Agro - Industries Corporation (GAIC) played a vital role in the spread of the technology as it provided inputs like cement, trained masons, etc. The prospective owner had to procure bricks and put in labour for excavation of the pit. The GAIC constructed the plants almost on turn key basis. It also helped its clients in getting institutional finance from commercial and cooperative banks.

## 4. Sample Households

Different households installed different sized biogas plants. A representative sample of 50 per cent of the 103 plants in operation in 1986 was selected as shown in Table 2. Another sample of 60 non-owners households comprising of 30 cultivators and 30 labourers was also selected. In selecting the biogas plant owners due weightage was given to the year of installation. The four KVIC model plants were included in the sample. In the selection of non-owner cultivators and labourers simple random sampling design was used.

Table 2: Size-wise Distribution of Biogas Owners in Mahijda Village, 1986

| Size of the plant(c.m.) | No. of owners | No.selected |
|---|---|---|
| 3 | 22 | 11 |
| 4 | 72 | 36 |
| 6 | 8 | 4 |
| 8 | 1 | 1 |
| Total | 103 | 52 |

Table 3 gives the important features of sample households. It shows that the average size of family for biogas owners was bigger than the non-owners and non-owner cultivators had bigger families than labourers. The literacy of the head of household was also relatively higher for the owners. Similarly level of education was better for the owner households than the non-owners. Among the non-owners, labour households had higher literacy than the cultivators.

While a large proportion of biogas owners owned more than five animals, there was only one household among the labour in this category. Surprisingly, one of the biogas owners had no animals at the time of survey whereas exactly one third of the labour households did not own any animal. The non-owner cultivators positioned in between the owners and non- owner labour households in this respect. Surprisingly five of the 52 owner households

Table 3 : Some **Features** of Selected Sample Households

(Numoer of households)

| Particulars | Biogas owners | Non-owner cultivators | Non-owner labourers |
|---|---|---|---|
| 1. Sample size | 52 | 30 | 30 |
| 2. Average size of family | 6-7 | 5-6 | 4-5 |
| 3. Education of head of household | | | |
| a) Illiterate | 24 | 19 | 16 |
| b) Upto primary | 9 | 8 | 11 |
| c) Upto secondary | 9 | 1 | 3 |
| d) High school | 6 | 2 | -- |
| e) College | 4 | - | -- |
| 4. Livestsock holdings | | | |
| a) No animals | 1 | 5 | 10 |
| b) Upto 2 animals | 4 | 5 | 14 |
| c) 2 to 5 ,, | 9 | 11 | 5 |
| d) More than 5 ,, | 38 | 9 | 1 |
| 5. Size of land holdings | | | |
| a) No land | 5 | 2 | -- |
| b) Upto 1 ha. | 6 | 6 | -- |
| c) 1 to 2.5 ,, | 7 | 9 | -- |
| d) 2.5 to 5 ,, | 16 | 7 | -- |
| e) 5 to 10 ,, | 13 | 5 | -- |
| f) More than 10 ,, | 5 | 1 | -- |
| 6. Sources for cooking energy | | | |
| a) Only dung | 2 | 2 | -- |
| b) Only firewood | 5 | 1 | 1 |
| c) Dung and firewood | 45 | 27 | 29 |

had no land whereas this number was 2 among the 30 non-owner cultivators. They however, had leased in some land for cultivation. Relatively a large proportion of the owners had larger holdings than the non-owners. While nearly two thirds of the owners had holdings over 2.5 hectare, it was only 43 per cent of the non-owner cultivators in this size group. The table also shows that a large majority of sample households in the three groups used both dung and firewoodfor cooking.

5. Reasons for Non-adoption of Biogas

While labour households generally could not afford to keep adequate number of cattle to feed the plant regularly, many of them did not have space for its installtion. Finance was another constraint for some of them. Similarly, non-owner cultivator households though had land and animals did not opt for the technology. As many as 12 out of 30 reported non-availability of space in and around their house to instal biogas plants. Six more reported smaller number of animals to produce adequate dung for charging the plant. While seven others reported finance as constraints five more did not like gas as cooking fuel.

6. Fuels Used for Household Energy Needs

The data on fuels used by the owners of biogas belonged to a year before adoption of this technology while for others it was 1986. Table 4 shows the use of different fuels for cooking and heating water by the three groups of sample farmers. It shows that as a group the owners and non-owner cultivators consumed identical quantities of different fuels whereas labour households consumed very little of kerosene and less of dung and fuelwood. Between the owners and non-owners the latter consumed less of household energy precisely because of labour households with relatively smaller size of family. Among the owner groups based

Table 4 : Per Day Quantity of Different Fuels Used by the Three Groups of Sample Households in Mahijda Village

(Quantity per household)

| Particulars | Dung(Kg) | Fuelwood(Kg) | Kerosene (litre) | Total (K.cal)* |
|---|---|---|---|---|
| 1. Owners of biogas | | | | |
| a) 3 c.m. | 4.5 | 9.1 | -- | 8442 |
| b) 4 c.m. | 7.0 | 10.0 | 0.20 | 9751 |
| c) 6 c.m. | 8.6 | 8.8 | 0.19 | 9106 |
| Overall | 6.7 | 9.3 | 0.13 | 9100 |
| 2. Non-owners | | | | |
| a) Cultivators | 7.1 | 9.3 | 0.13 | 9203 |
| b) Labourers | 3.3 | 6.0 | -- | 5714 |
| Ovearall | 5.2 | 7.7 | 0.07 | 7459 |

* Computed at standard thermal efficiency given in Appendix I.

on size of plant, the consumption of firewood was less for owners of 6 c.m. plant. Also a small quantity of kerosene was consumed by 4 c.m. and 6 c.m. plant owners.

Table 5 gives the proportion of household energy from different sources for different categories of sample households. As pointed out earlier the owner and non-owner cultivator households had identical proportion of total energy from dung and firewood. However, these ratios were marginally higher for non-owners. Kerosene contributed more to the energy use by owners than non-owner cultivators. For the labour households the major source of energy was firewood. Kerosene was used only by non-cattle owners in small quantity. In case of non-owner cultivators kerosene use was reported by small land owners, that is upto 5 animal heads. On the other hand owners with more then three animals reported

Table 5 : Sources of Household Energy For Different Groups

(Percentages)

| Category of households | Dung | Wood | Kerosene | Total |
|---|---|---|---|---|
| 1. Owners ( before biogas) | | | | |
| a) Upto 3 cattle | 12.86 | 87.14 | --- | 100 |
| b) 4 to 5 | 12.44 | 74.63 | 12.93 | 100 |
| c) 6 to 9 | 16.41 | 68.05 | 15.54 | 100 |
| d) Over 9 | 19.65 | 69.53 | 10.82 | 100 |
| All households | 15.73 | 71.62 | 12.64 | 100 |
| 2. Non-owner cultivators | | | | |
| a) Upto 3 | 13.00 | 75.91 | 11.09 | 100 |
| b) 4 to 5 | 12.36 | 80.38 | 7.26 | 100 |
| c) 6 to 9 | 28.55 | 71.45 | -- | 100 |
| d) Over 9 | 28.44 | 71.56 | -- | 100 |
| All households | 17.88 | 75.49 | 6.63 | 100 |
| 3. Non-owner labourers | | | | |
| a) No cattle | 10.28 | 84.87 | 4.85 | 100 |
| b) Upto 3 | 13.17 | 86.83 | -- | 100 |
| c) 4 to 5 | 14.50 | 85.50 | -- | 100 |
| d) 6 to 9 | 14.50 | 85.50 | -- | 100 |
| All households | 12.63 | 86.12 | 1.25 | 100 |

use of kerosene. It was also observed that the proportion of energy from dung tended to increase with the number of animals owned for all the groups. The reverse was true for firewood.

Table 6 gives the distribution of sample households by source of different fuels and their combinations used by sample households. It shows that the use of dung and firewood in general was not different among the groups. However, the source of supply varied significantly. For example a large proportion of labour households gathered dung whereas this practice was non-existing among the owners and only 20 per cent of the non-owner cultivators resorted to this practice to partly get their fuel requirements. Similarly while one of the labour household had its own firewood, all of them purchased a part of their needs and 60 per cent also resorted to collection of this fuel. On the other hand about 50 per cent of the owners had their own firewood supply and another 48 per cent purchased it. One among them reported collection of fuelwood. In case of non-owner

Table 6 : Fuels and Their Sources for the Three Groups of Sample Households

(Per cent of households*)

| Fuel and its source | Owners of biogas plants | Non-owners of Biogas | |
|---|---|---|---|
| | | Cultivators | Labourers |
| Dung: a) Own | 90 | 80 | 93 |
| b) Gathered | -- | 20 | 87 |
| c) Overall | 90 | 97 | 93 |
| Firewwod: a) Own | 50 | 60 | 3 |
| b) Purchased | 48 | 63 | 100 |
| c) Gathered | 2 | 33 | 60 |
| d) Overall | 96 | 93 | 100 |
| Combinations | | | |
| a) Own dung & firewood | 56 | 17 | 3 |
| b) Own dung & firewood purchased | 46 | 50 | 93 |
| c) Own dung & firewood gathered | 2 | 20 | 60 |
| d) Gathered dung & Own firewood | 2 | 10 | -- |
| e) Gathered dung and purchased firewood | 2 | 13 | 87 |
| f) Gathered dung and firewood | -- | 10 | 53 |

*Because of overlap among the sources the proportions do not add to 100 per cent for different fuel sources.

cultivators this proportion was one third . About 63 per cent of them purchased some firewood to meet their needs. Further while more than 50 per cent of the owners depended solely on their own dung or firewood 17 per cent among the non-owner cultivators and only one among the labour households reported self-sufficiency in fuel supply from their own. Another major proportion of owners had supplemented dung with purchased firewwod. This proportion was higher for non-owners and especially for labour it was 93 per cent. Similarly, a large proportion of labour households resorted to collection of firewood. This proportion was only 20 per cent in case of non-owner cultivators and only one owner household reported collection of wood for fuel to supplement its own fuel supply. This household also gathered dung for fuel. It was found that the labour households supplemented their own fuel resources not only by purchase/gathering of firewood but also by gathering dung from the open places. A small proportion of non-owner cultivators also resorted to this practice.

## 7. Impact on Labour Households

The installation of biogas plants by a large number of households in the village might affect adversely the availability of dung for the labourers from the open places. However, in Mahijda the situation had not changed much. A majority of the labour households (87 per cent ) reported that adoption of biogas by others had not affected the availability of dung to them. The remaining 13 per cent however indicated the difficulty in gathering adequate dung in the recent past. These were the households which did not own any animal. As a consequence they had to supplement their fuel availability with firewood. On the other hand the biogas owners reported no change in grazing practices. Eleven of the 50 owner households reported collection of dung while their animals go out for grazing.

8. Some Obeservations

The women folk plays a vital role in operating the plant. They collect dung, prepare slurry, charge the plant and carry digested slurry from the outlet pit to compost pit at the periphery of the village. In return they are relieved from the unhygeinic smoky environment and could save time in cooking for other household chores/productive activities. Some respondents, however, reported that the time saved in cooking is spent in charging the plant and emptying the slurry pit.

The owners households do the entire cooking on gas. However, they keep some dung cakes and firewood for emergencies. Except for three respondents who used gas for lighting also, it was only used for cooking and heating water.

Some of the plant owners fed vegetable waste, wheat flour and other vegetative waste to increase gas production. Otherwise dung was reported available in sufficient quantity.

There is no perceptible change in the practice of feeding animals. Nor there has been any increase in cattle population with the adopters due to biogas plants. As such their cropping patterns did not show any change towards fodders. By-products from paddy, wheat, bajra, etc. are the major source of dry fodder. Since crops grown do not produce any good fuel material, biogas did not result in its saving.

Fuel shortage was the major reason for the acceptance of biogas technology. Subsidy of 50 to 75 per cent on investment cost was a strong incentive, though majority of owners could afford this investment on their own. This has been amply clear from their fully amorting the loans even before maturity.

## 9. Benefits and Costs and Their Valuation

Biogas technology involves two types of costs, namely i) investment cost in plant and other equipments including the burner or stove and ii) operating costs of dung and labour for making slurry charging the plant and carrying the digested slurry to compost pit. The benefits are in terms of gas and slurry in addition to hygeinic and smokeless cooking environment, cleaner utensils and more efficient use of fuel (gas). Since digested slurry and slurry prepared from fresh dung are equally rich in plant nutrients and no major plant nutrient gets lost in the process, the benefits in the form of slurry and cost in the form of dung get cancelled. Assuming no change in the net consumption of energy the two technologies essentially provided equal quantity of energy for cooking, etc. Therefore, the net gain in terms of energy are nil and hence can be ignored. On the other hand dung used for making slurry is not consumed and can be used as organic manure. As such, dung, firewood and other fuels consumed in the chullah technology are saved and may be considered as net benefits. However, burning of dung and firewood would produce phosphorus and potash rich ash which will not be available from biogas. It may be considered as a net loss due to biogas. Hence net added tangible benefits from biogas technology are savings in fuel less ash lost. In addition it provides intagible benefits in terms of hygeinic cooking conditions, cleaner utencils,etc. On the cost side, the labour input in the biogas technology may be taken as equal to labour used in chullah technology in collecting dung, making cakes, cutting wood to pieces etc. Thus net additional costs due to biogas technology are only the investment in plant and equipment.

While investment costs in plant and equipment are given , we have to value the fuels saved and ash lost in the switch over to biogas technology. For the purpose current prices of dung, firewood and kerosene prevailed in the village are considered. The quantities of different fuels consumed by the owner households prior to biogas are considered as saved each year. The ash is taken at 10 per cent of the dry dung. Since ash was mixed with the FYM, it is priced as ordinary manure. It may be mentioned that central and state goverments provides subsidy on investment in plant at 75 per cent to ST/SC and small and marginal farmers and 50 per cent to others. The cost of stove of course is not subsidised. Thus the actual costs incurred by individuals were not substantial.

As subsidy was not paid in cash rather equipment was supplied at subsidised rate, many a time the individuals were not aware of the total investment cost or the subsidy component. Therefore, they could not provide us precise estimates of investment cost in the plant. Even the estimates of their own share in investment cost was not accurate as they did not include their own labour. Hence variations in investment cost were large even for the same size of plants installed almost at the same time. We, therefore, had no choice but to use the standard costs given by GAIC (8).

## 10. Financial Viability of Biogas Technology

Table 7 gives the investment costs and benefits realised by the owners of different sized biogas plants. It shows that net cost of switch over to biogas technology are investment cost in plant and loss of phosphorus and potash rich ash whereas the net benefits are savings in traditional fuels : dung, fuelwood etc. It reveals that the investment would pay for itself in less than three years. This period is reduced to less than a year for ST/SC and small and marginal farmers and less than two years for others. In other words, financially biogas technology is much superior to the traditional open chullah.

## 9. Economic Feasibility of the Technology

Since the fuelwood saved is a source of scarce energy and dung a source of scarce plant nutrients, their shadow pricing faqtors

Table 7 : Costs and Benefits from Replacement of Traditional Technology by Biogas Technology for Household Energy Needs, 1986

| Particulars | Plant sise(c.m.) | | |
|---|---|---|---|
| | 3 | 4 | 6 |
| 1. Investment cost | 5390 | 6580 | 8000 |
| 2. Subsidy | | | |
| a) ST/SC & small/marginal farmers | 4060 | 4800 | 4910 |
| b) All others | 2700 | 3190 | 3270 |
| 3. Investment by owners | | | |
| a) ST/SC & small/marginal farmers | 1330 | 1780 | 3090 |
| b) All others | 2690 | 3390 | 4730 |
| 4. Benefits | | | |
| a) Dung saved | 328 | 512 | 630 |
| b) Fuelwood saved | 1660 | 1825 | 1597 |
| c) Kerosene saved | - | 164 | 153 |
| Total saving | 1988 | 2501 | 2380 |
| 5. Costs (ash lost) | 33 | 51 | 63 |
| 6. Net benefits (4-5) | 1953 | 2450 | 2317 |
| 7. Pay Back Period(yrs) | | | |
| a) ST/SC & small/marginal farmers | 1 | 1 | 1 |
| b) All others | 2 | 2 | 2 |
| c) Without subsidy | 3 | 3 | 3 |

Source; Mannual of Implementation of National Project on Bio Gas Development in Gujarat, Agro Service Division, GAIC, 1988

are greater than one (Appendix 2) and hence the social benefits are higher than the financial gains from this technology (Table 8). On the other hand, installation of biogas plant involves surplus labour as an item of cost for which shadow pricing factor is less than one (Appendix 2). However, because of high rate of subsidy on investment the social costs are higher than the

Table 8 : Incremental Economic Costs and Benefits from Three Models of Biogas Plants in Mahijda Village

| Particulars | Size of plant (c.m.) 3 | | 4 | | 6 | |
|---|---|---|---|---|---|---|
| | Financial | Economic | Financial | Economic | Financial | Economic |
| 1. Investment costs | | | | | | |
| a) Bricks | 900 | 810 | 1520 | 1368 | 1720 | 1548 |
| b) Cement | 1560 | 1716 | 1800 | 1980 | 2340 | 2574 |
| c) Sand | 225 | 189 | 300 | 252 | 450 | 378 |
| d) Rubble, etc. | 170 | 143 | 210 | 176 | 300 | 252 |
| e) Mason charges | 650 | 650 | 750 | 750 | 850 | 850 |
| f) Labour charges | 460 | 368 | 550 | 440 | 640 | 512 |
| g) Hot plate, pipes, fittings, etc. | 1200 | 1020 | 1200 | 1020 | 1400 | 1190 |
| Total | 5390 | 4896 | 6580 | 5986 | 8000 | 7304 |
| 2. Benefits lost | | | | | | |
| Ash | 33 | 412 | 51 | 641 | 63 | 789 |
| 3. Costs saved | | | | | | |
| a) Dung | 323 | 936 | 512 | 1457 | 630 | 1794 |
| b) Firewood | 1660 | 2575 | 1825 | 2829 | 1597 | 2475 |
| c) Kerosene | | | 164 | 205 | 153 | 191 |
| Total | 1988 | 3511 | 2501 | 4491 | 2380 | 4460 |
| 4. Net addition to benefits (3-2) | 1955 | 3099 | 2450 | 3850 | 2317 | 3671 |
| 5. Pay back period (years) | 2 | 2 | 2 | 2 | 3 | 2 |

Source : Computed from Table 7 and Appendix Table 2.1.

financial costs to the individuals. But if subsidy is ignored the economic value of investment is lower than its financial value. In other words the investment is very desirable from society point of .view. On the other hand the technology should be acceptable even without any subsidy because of high financial gains. However subsidy is provided at high but variable rates to different groups of households and it has its own implications as discussed in the following pages.

## 11. Conclusions

The study reveals that biogas technology is both financially as well as socially viable as it yields valuable energy material (gas) without affecting the nutrient value of the dung used in charging the plant. It may be adopted by land owners as well as landless who could keep at least four cattle heads. The landless however have to sell the slurry to the land owners for which ready market is available. Because thermal efficiency of gas is much higher than the traditional fuels of dung and fuelwood less quantity of dung would be required to produce gas to supply same quantity of energy for a household. As such fuelwood consumed as supplementary fuel by those households producing less dung is saved for others.

On the basis of viability and efficiency of this alternative of household energy, there should be no hesitation in its adoption by the rural households. However, there seems to be other than financial reasons for its non-acceptance elsewhere and even in Mahijda village by many well to do households who otherwise are technically eligible. It was so even at 50 per cent subsidy on investment in plant installation. One main reason could be lack of education about its benefits and socially unacceptable practice in the disposal of slurry.

While the well to do households with 4 or more animals and owners of land got the advantage of this technology and also from high rate of subsidy on investment, the weaker sections having no or fewer animals could not avail of such benefits. Such households who partly depend on collected dung for cooking energy would be devoid of it in case of increased stall feeding by the owners of biogas (not applicable in Mahijda case). Therefore, there is a need to rationalise subsidy on this investment and its adoption should be popularised purely on the basis of its financial gains.

On the other hand the existing organisations such as the Farmers Cooperative Society in Mahijda may be exploited for popularising large community sized plants for the use of the member households located in clusters. Elsewhere, similar organisations could be established for the diffusion of biogas technology on community basis. The subsidy of even 100 per cent would be justified in these situations.

The study revealed that the main reason for the wider acceptance of biogas in Mahijda village was the shortage of traditonal fuels coupled with increased prices of commercial fuel e.g. kerosene. Since this situation is likely to deteriorate further with the ever increasing population, depleting scarce forest resources, emphasis on alternative uses of crop residues, policy on more productive use of marginal and waste lands, etc. Therefore potential for adoption and spread of this technology is large and would increase in future. What is needed therefore is an aggressive extention programme for its promotion among the masses. The involvement of weaker sections may be encouraged through organisational innovations for community size plants run collectively. The policy on subsidy may be rationalised so that it is not exploited by the affluent. It may be linked with income and community effort.

## Appendix 1

Availability of Energy for Cooking from Different Fuels under Specified Conditions of Efficiency in Its Utilisation

| Fuels | Energy per unit in calories | Assumptions on Efficiency (per cent) | Conditions | Quantity of fuel required | Total costs (Rs.) |
|---|---|---|---|---|---|
| Gobar gas | 4713 | 60 | Std. stove | 1.00 c.m. | - |
| Butane | 10880 | 60 | ,, ,, | 0.43 c.m. | 1.94 |
| Coal gas | 4004 | 60 | ,, ,, | 1.18 c.m. | - |
| Kerosene oil | 9122 | 50 | Pressure stove | 0.62 lit. | 1.40 |
| Furnace oil | 9041 | 75 | Watertube boiler | 0.42 ,, | |
| Charcoal | 6930 | 28 | Chullah | 1.46 kg | |
| Soft coke | 6292 | 28 | ,, | 1.61 ,, | |
| Dry firewood | 4700 | 17 | ,, | 3.47 ,, | 1.73 |
| Dry dung | 2092 | 11 | ,, | 12.30 ,, | 2.56 |
| Electricity | 860 | 70 | Hot plate | 4.70 Kwt. | 2.54 |

Source : i) National Project on Biogas Development, Gujarat Agro - Industries Corporation, Ahmedabad, April 1982,

ii) Survey information on prices.

## Appendix 2
### Shadow Pricing Factors for Different Items

It has been recognised that costs on and benefits from investments that accrue to individual enterpreneurs are different than that accrue to the society. The two however are related through some coefficients. These coefficients are called the shadow pricing factors (SPF) and are used to convert financial costs and benefits to economic costs and benefits. Their values may be equal to or greater than or less than 1 depending on the nature and extent of distortions in the normal prices of items under consideration due to imperfections in the markets. Such imperfections result from the scarcity or abundance of the items under reference. Normally a more scarce item will have a higher SPF. Sufficient knowledge of demand and supply of various items of costs and benefits, therefore, is necessary to arrive at reliable estimates of these factors. In the absence of detailed information on the above variables some simpler method are used at the cost of some bias. Accordingly we have computed SPF for items of costs and benefits related to biogas technology as given in Table 2.1. The table also contains some details of their computations. The logic behind these values is discussed as follows.

Labour being surplus is priced at less than one. Assuming unemployment rate of 20 per cent its SPF is taken at 0.80. Fuel is also a scarce commodity providing energy on which we spend scarce foreign exchange. It is therefore priced upward at 1.25 for scarcity value of the latter. Firewood is priced on the basis of its energy content and than shadow priced further upward for

Table 2.1 : Shadow Pricing Various Items

| Items of cost and benefits | Composition of costs & benefits | | SPF Ingre-dients | SPF Overall factor | Unit of meas. | Actual price (Rs.) | Shadow price (Rs.) |
|---|---|---|---|---|---|---|---|
| Bricks | Lab. | .70 | 0.80 | (.7*.8)+(.15 | 100 | 40 | 36 |
| | Fuel | .15 | 1.25 | *1.25)+(.15* | | | |
| | Transp. | .15 | 1.00 | 1)=0.90 | | | |
| Cement | | | | 1.10 | bag | 60 | 66 |
| Sand | Lab. | .80 | 0.80 | (.8*.8)+(.2 | c.ft. | 1.50 | 1.26 |
| | Trans. | .20 | 1.00 | *1)=0.84 | | | |
| Rubble, etc | Lab. | .80 | 0.80 | (.8*.8)+(.2 | ,, | 5.00 | 4.20 |
| | Trans. | .20 | 1.00 | *1)=0.84 | | | |
| Stove, pipes, fittings, etc | Matl. | .85 | 1.00 | (.85*1)+(.15 | set | 1200 | 1020 |
| | Taxes | .15 | 0 | *0)=0.85 | | 1400 | 1190 |
| Skilled lab. | | | | 1.00 | m.day | 50 | 50 |
| Unskill. lab. | | | | 0.80 | ,, | 15 | 12 |
| Kerosene | | | | 1.25 | Lit. | 2.25 | 2.81 |
| Firewood | Keros. equiv. | 1.24 | 1.25 | (1.24*1.25) =1.55 | qtl. | 50 | 77.50 |
| Dung# | Nitro. | .017 | 5.84 | (.017*5.84) =0.0993 | ,, | 20 | 56.99 |
| | Phosp. | .016 | 6.64 | (.016*6.64) =0.1062 | | | |
| | Potash | .010 | 2.50 | (.01*2.5) =0.025 | | | |
| | Humus | .957 | 0.24 | (.957*.24) =0.2297 | | | |

# Current prices of nitrogen, phosphorus, potash and humus(organic manure) respectively are Rs. 4.67, Rs. 5.31, Rs.2.00 and Rs. 0.20 per kg.

foreign exchange saved. Similarly dung was valued for the plant nutrients and further priced upward for foreign exchange saved on fertiliser imports. SPF for cement was 1.1 because of its scarce supply. Sand and rubble involve surplus labour as a major input in their supply and hence are shadow priced accordingly. The price of stove and other accessaries and fittings was adjusted for tax component.

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