# Chapter 7
# A Case Study of the Biogas Programme in Nepal

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## 7.1 Introduction

Biogas is produced by the anaerobic digestion of organic wastes and water, for which an airtight digester is a prerequisite. The digestion process ferments the organic materials in the presence of a natural mixed bacteria culture and produces gaseous products and a liquid effluent. The gas consists of a mixture of methane (50-60%), carbon dioxide (30-40%), and other gases, including hydrogen, nitrogen, and hydrogen sulphide. Hydrogen sulphide gives biogas a slightly pungent smell. Biogas is colourless and non-toxic. Its yield rate is temperature-dependent, the optimum temperature being 33°C. Biogas is mainly used for cooking and lighting and sometimes as a fuel for internal combustion engines. The mixing ratio of diesel to biogas is theoretically 20:80, but a 40:60 ratio is frequently reported by users. The effluent is used as a wet or sun-dried fertilizer, and is superior to green manure in nutrient content. The digestion process reduces the level of pathogens within the dung and therefore may generate public health benefits (Rijal 1993, PEP 1995). The two main types of biogas plants are the floating steel drum (Indian design) and fixed-dome (Chinese design) models, as shown in Figure 7.1 (CRT and ICIMOD 1998).

The drum type consists of underground two-compartment chamber digester pits with a floating steel drum gas holder. Slurry is fed into the base of one chamber from a cemented inlet pipe. The gas rises and is collected inside the drum, while the effluent overflows into the second chamber. Then the slurry is expelled through an outlet pipe, which is situated at a lower level than the inlet pipe. The few modifications to a biogas plant designed by the Khadi and Village Industries' Commission (KVIC) to suit Nepalese conditions are as follow: the pit tapers down into the ground; gas is removed through a central guide pipe; and the two-compartment chamber has been designed. The floating drum holds 60 per cent of the daily rated gas output. The gas pressure, which is supplied by the weight of the drum, is 10cm of water head (WECS 1987, Rijal 1993). The gas drum has to be prefabricated in a workshop and carried to the plant site.

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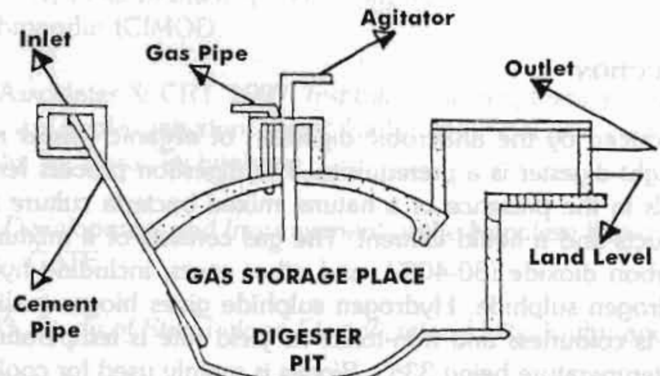
**Dome Design Gobar Gas Plant (Chinese type)**




**Floating cover digester (Indian type)**

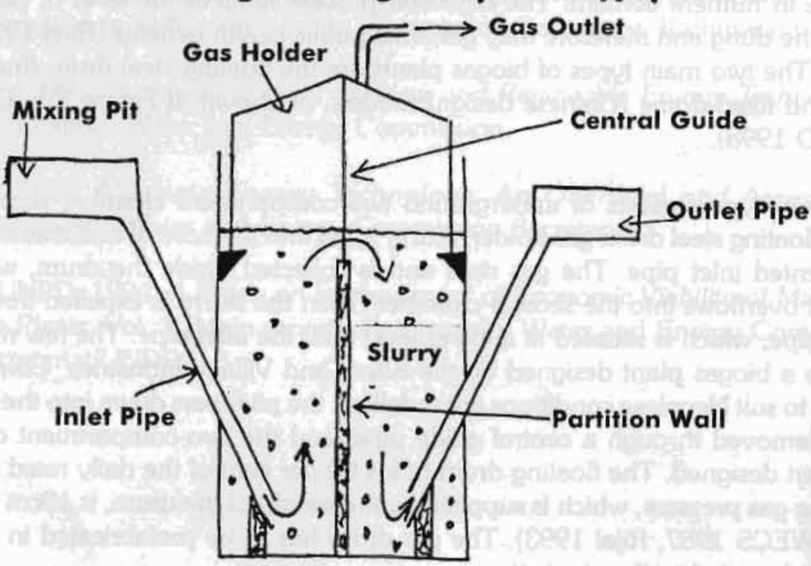



**Figure 7.1: Different Types of Biogas Plants**

As the steel drums are expensive and difficult to transport, the fixed-roof gas plant, called the dome type, eliminates this component. As the gas forms, instead of pushing the drum up, it pushes the slurry down, forcing it into the input and outflow chamber. When the gas is used, the pressure diminishes, and the slurry flows back into the main pit. The plants have been modified slightly for use in Nepal. The major modification is a fixed stirrer which breaks the crest on the surface of the slurry in the plant and thereby maximises gas production (Rijal 1993). It can be constructed at the site with locally available materials (except cement and GI pipes), so currently 80 per cent of the biogas plants in the country are of the dome type (van Nes and Lam 1997).

After the installation of a biogas plant, the owner has to feed the digester with the required quantity of dung and water. The dung, collected from the livestock stall, is poured into a dung-mixing pit, and an equal amount of water is added. The components are mixed by hand or foot until no lumps are left, since the pressure of lumps may reduce biogas production. All plants manufactured in Nepal are of the continuous feed type, so the digester must be loaded daily with the required amount of dung and water for a particular capacity.

Dung from cattle is the main potential source of biogas in Nepal. The possible contribution of human waste is not big, but such waste is available on every farm, and important in relation to sanitation. Besides the supply of dung, other limiting factors for biogas plant installation are water and altitude (temperature). It is estimated that 1.5 million households can install biogas plants that are technically feasible (BSP 1994-95). This figure is almost three times more than the number of households that have access to electricity (i.e., 14% of the total population). The rate of installation of family-sized biogas plants has shown unprecedented growth in the past. This trend is expected to continue in the next ten years. More and more people are becoming involved in biogas as users, technicians, extension workers, researchers, trainers, supervisors, and investors.

The history of biogas development in Nepal began with the fabrication and installation of a prototype unit at Godavari in 1955. It was made using an old 200-litre oil drum and a gasholder made of mild steel sheet. No real interest in biogas was forthcoming until the fiscal year 1975/76, which was designated as 'Agriculture Year' to boost farm production. A special plan for biogas promotion was developed, and 199 plants were built by various contractors with interest-free loans made available by ADB/N (WECS 1987).

In 1977, the *Gobar* Gas *Tatha Krishi Yantra Vikas* Ltd. (Biogas and Agricultural Equipment Development Company), popularly known as the Gobar Gas Company (GGC), was established for the promotion of biogas technology, as a joint venture investment of the ADB/N, the Development and Consulting Services (DCS) of the United Mission to Nepal, and the Fuel Corporation of Nepal (now called Timber

Corporation of Nepal). The Biogas Company was backed by a Research and Fabrication Unit in Butwal and sales and service centres at strategic locations in the *Terai* and Inner *Terai* regions (WECS 1987). Due to the success of biogas development programmes and the availability of a government subsidy, as well as the interest and involvement of a number of INGOs and donor agencies, private biogas companies started coming up after 1990 following the government privatisation policy (Khandelwal 1996).

The floating drum design encountered a number of technical problems and has now been replaced by a concrete fixed-dome type design based on the Chinese model. There are already 32,119 biogas plants in place (Fig. 7.2 and Table 7.1), and more than 90 per cent of them are functional (New Era 1995); the target having been to build 30,000 family-size biogas plants (NPC 1992) during the Eighth Five Year Plan period (1992-97).

**Table 7.1: The Number of Biogas Plants Installed in Nepal (FY 1996/97)**

| Development Region | Physiographic Zone Mountain | Hill | Terai | Total |
|---|---|---|---|---|
| **No. of Biogas Plants (FY 1996-97)** | | | | |
| Eastern | 37 | 1,010 | 5,097 | 6,144 |
| Central | 277 | 3,506 | 4,891 | 8,674 |
| Western | 0 | 10,633 | 2,855 | 13,488 |
| Mid-western | 0 | 836 | 1,831 | 2,667 |
| Far-western | 4 | 43 | 1,099 | 1,146 |
| Total | 318 | 16,028 | 15,773 | 32,119 |
| **Potential HHs for Biogas Plants** | | | | |
| Eastern | 2,695 | 111,858 | 271,640 | 386,193 |
| Central | 3,741 | 132,603 | 299,892 | 436,236 |
| Western | 131 | 187,180 | 149,880 | 337,191 |
| Mid-western | 2,951 | 121,693 | 94,072 | 218,716 |
| Far-western | 2,118 | 40,497 | 76,441 | 119,056 |
| Total: | 11,636 | 593,831 | 891,925 | 1,497,392 |

Source: BSP 1994-95

The Biogas Support Programme (BSP) was set up in 1992 as a joint venture between ADB/N, recognised biogas companies, and the Netherlands' Development Organization (SNV-Nepal) to support the biogas programme through subsidies, quality control, training, etc (BSP 1994/95). A third phase of the programme has been proposed for the time period 1996/97-1999/2000, with the target of installing 100,000 biogas plants. It has been estimated that a subsidy of NRs 750 million and a loan investment of NRs 1,080 million will be required to achieve this target.

The cost of biogas plants has shot up by12-16 per cent within the span of a year and now amounts to NRs 24,056 for $10m^3$ unit. The increase in the cost of material (mainly cement) and in biogas companies' overheads are the main causes of this price hike. However, given an inflation averaging 10 per cent annually, the real price of biogas plants has fallen considerably (i.e., about 20% in the past five years).

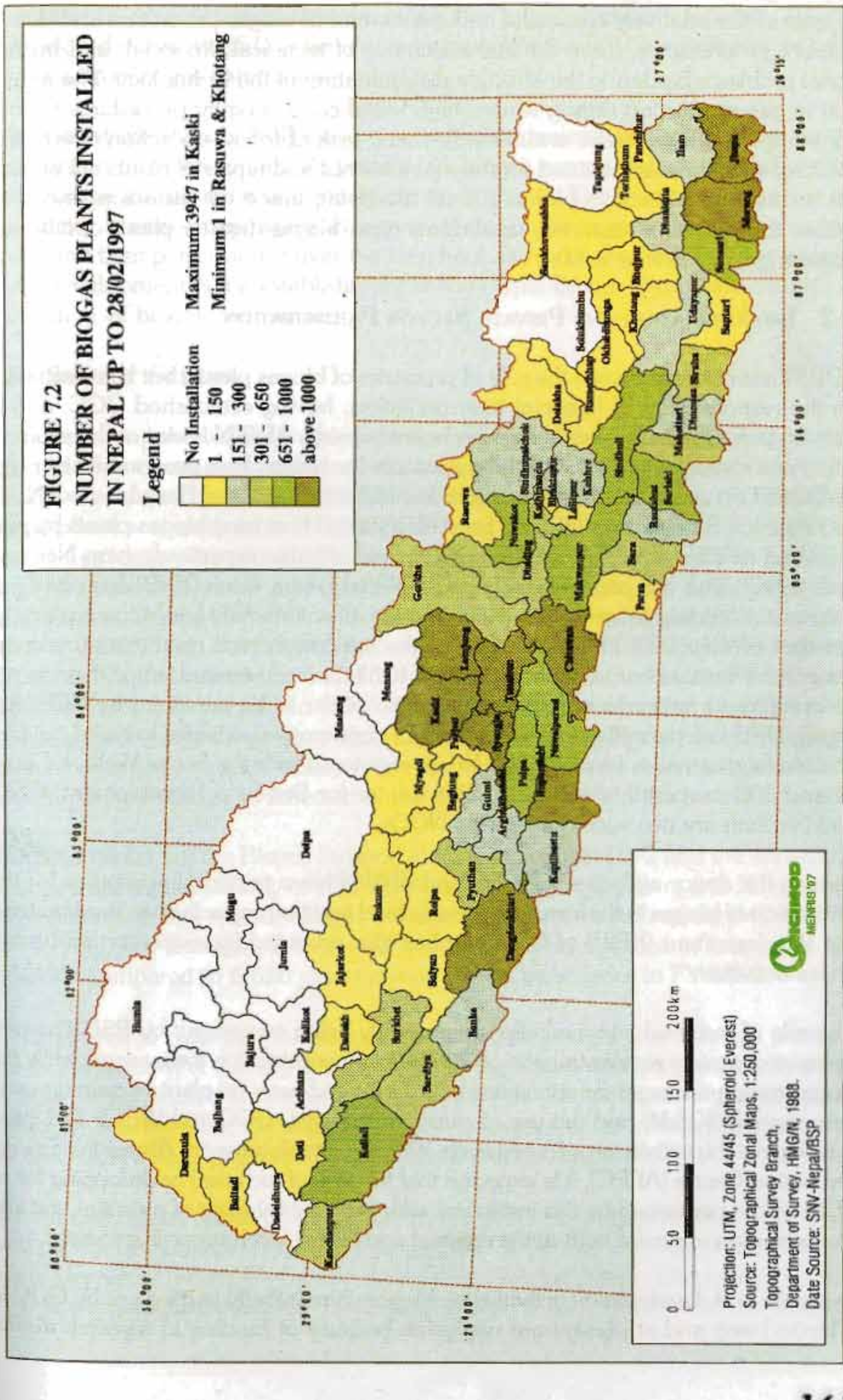


FIGURE 7.2
NUMBER OF BIOGAS PLANTS INSTALLED IN NEPAL UP TO 28/02/1997
Legend
No Installation
1 - 150
151 - 300
301 - 650
651 - 1000
above 1000
Maximum 3947 in Kaski
Minimum 1 in Rasuwa & Khotang
0 50 100 150 200km
Projection: UTM, Zone 44/45 (Spheroid Everest)
Source: Topographical Zonal Maps, 1:250,000
Topographical Survey Branch,
Department of Survey, HMG/N, 1988.
Date Source: SNV-Nepal/BSP
MENRIS'97

In spite of the relatively successful implementation of biogas promotion and development programmes, there are still a number of technical, financial, and institutional problems hindering the effective dissemination of the technology. The reduction in gas production during winter, high initial costs, lengthy procedures for obtaining information, loans, and subsidies, and lack of follow-up action due to the shortage of technicians trained for the maintenance and repair of plants are among the technology-related problems. Efforts are being made by various agencies to reduce the cost of the currently used dome type, biogas digester plants of different sizes ranging from four to $50m^3$.

## 7.2 Intermediation and Private Sector Participation

ADB/N has not only played the role of promoter of biogas plants, but has also taken on the responsibility of financial intermediation, having established GGC, and is now engaged in channelling the government subsidy. ADB/N is one of the promoters of and shareholders in GGC. It implements the biogas loan programme through its 422 SFDP network. Other commercial banks, including Nepal Bank Limited (NBL) and Rastriya Banijya Bank (RBB), have also started financing biogas plants by participating in BSP through their 39 and 29 field offices, respectively (van Nes and Lam 1997). This has come about because Nepal Rastra Bank (NRB) launched priority sector-lending programmes which require all commercial banks to earmark 12 per cent of their total loan portfolios for the agriculture and rural energy sectors. Other joint-venture banks generally do not fulfill this requirement, since they do not have sufficient networks in rural areas and so prefer to be penalised by NRB. Recently, NRB has permitted 24 NGOs and 19 cooperative societies to carry out limited banking activities (out of 3,500 NGOs registered with the Social Welfare Council and 300 cooperative societies). The Centre for Self-help Development (CSD) and Nirdhan are two such noteworthy NGOs.

Among the donor agencies, UNCDF and SNV/N have provided assistance for the promotion of biogas in the form of a subsidy fund and training activities. Kreditantstatt Für Wiederaufbau (KFW) of Germany has also provided financing for BSP third-phase activities.

The role of technical intermediation is currently being carried out by BSP. The programme organizes regular training on biogas plant construction for masons, while the biogas companies organize orientation courses for end users on plant organization and management (O&M) and the use of slurry. In the past, GGC and WECS had been carrying out this activity on a limited scale. With the establishment of Alternative Energy Promotion Centre (AEPC), it is expected that the task of technical backstopping for all RETs will be performed by this institution, with the establishment of a central unit and the expansion of similar units at the regional and district levels according to need.

Research and development activities on biogas were initially carried out by GGC in a limited way and at present are negligible because of funding to research institutions like RECAST, RONAST, and the Nepal Agricultural Research Council (NARC). GGC closed down its R&D activities on biogas after the BSP's recognition of other private sector biogas companies.

After the introduction of BSP, various private companies have been set up for the construction of biogas plants. At present, 41 biogas companies are officially recognised for the construction and maintenance of plants. The involvement of the private sector is very encouraging. However, many of the organizations are inexperienced and their performance over the long haul has to be awaited. Another encouraging development is the establishment of the Nepal Biogas Promotion Group, an association of biogas companies.

## 7.3 Subsidy Scheme

In the beginning the biogas programme was primarily based on external assistance. This included community biogas plants built under SFDP programmes of ADB/N which were funded by UNDP, UNICEF, USAID, and UMN. A subsidy for household biogas plants was received from UNCDF. During the Agricultural Year (FY 1995/96) interest-free loans were provided to set up biogas plants. A subsidy of NRs 5,500 per plant was provided under a special Rice Crops Programme (FY 1983/84) in four *Terai* districts. During FY 1985 and 1986, a fifty per cent interest subsidy was provided on bank loans, but this was discontinued in FY 1987 (WECS 1987). Again, a 25 per cent capital subsidy for 6 and 10$m^3$ plants was available during FY 1988 and 1989, but it too was withdrawn in FY 1990 during the interim government after the advent of multi-party democracy (deLucia and CRT 1997). It was observed that the frequent change in subsidy policy made farmers hesitant to commit themselves to installing biogas plants, as reflected in the fluctuating trend in the installation rate.

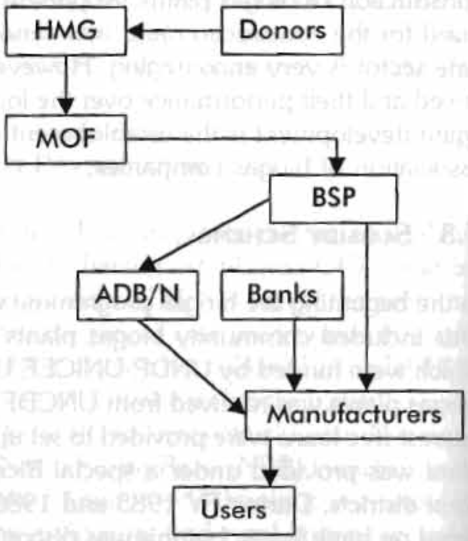
With the initiation of the Biogas Support Programme in FY 1992 and the announcement of a flat capital subsidy of NRs 7,000 and 10,000 in the *Terai* and Hills respectively, the installation rate for all sizes of biogas plants increased rapidly (MOF 1996a and 1996b). For example, a total of 24,410 plants was installed in four years (FY 1992-95) compared to 6,620 plants during the 18 years prior to FY 1992.

It is important to note that the success of the biogas programme was not primarily due to the amount of subsidy provided but to the way it was integrated with a host of other issues related to the promotion of biogas plants. These included quality control, encouragement to the private sector to engage in fair competition, monitoring and supervision, promotion, and institutional development.

The flat-rate capital subsidy brought down the cost of energy produced from small-sized plants (from NRs 11.14 to 4.77 in the Hills for 4$m^3$) to almost the same level as that of big plants (from NRs 5.35 to 4.07 in the Hills for 20$m^3$). This type of subsidy scheme encouraged farmers to install small biogas plants, which were less susceptible to underfeeding as well as being affordable to middle-income farmers. The higher rate of subsidy resulted in a higher rate of installation in the Hills (i.e., 55% of the total installations).

Since the subsidy is now administered through BSP instead of ADB/N (Fig. 7.3), it has been possible to reduce the transaction costs to farmers willing to finance the plants themselves, since they need not go through the loan procedures required by ADB/N. BSP pays the subsidy directly to construction companies upon completion of the plant.

**Figure 7.3: Flow of Biogas Subsidy**




## 7.4 Issues and Options

A summary of the issues identified from the individual case study is presented in Table 7.2, and detailed discussions on various issues and options are presented below.

**Table 7.2: Issues Pertaining to the Biogas Programme**

| Case Study | Policy/Strategy | Institutional | Financial/ Economical | Technological | Social |
|---|---|---|---|---|---|
| Biogas dissemination in Dhaitar, Mahadevsthan | Need for policy- and strategy-level emphases on linking biogas dissemination with livestock development | An agricultural extension network is needed for the proper use of slurry | Dissemination of plants among upper economic classes of villagers. Need for action research on dissemination of plants among lower economic classes. | Need for action research on reducing the cost of the biogas plant's effective use of slurry. Toilet-fed biogas sets to be encouraged. | Need for awareness campaign on the proper use of slurry and toilet-fed biogas plants |
| Deen Bandhu biogas plant in Chitwan | Need for policy- and strategy-level encouragement of action research on participatory/innovative biogas dissemination programmes | | Deen Bandhu plant is found to be 25 per cent cheaper than GGC model | Need for trained (skilled) masons | Need for awareness campaign on the proper use of slurry and toilet-fed biogas plants |

### 7.4.1 Dissemination of Biogas Plants to Lower Economic Classes

The biogas owners interviewed all belonging to the middle or upper economic classes, among whom there is an increasing demand for biogas. The study team came to the conclusion that the technology cannot penetrate through to the lower economic classes due to the high investment cost, lack of collateral for credit, and small numbers of livestock. Biogas plants need to be distributed to low-income villagers.

### 7.4.2 The Effect of Demonstrations

Almost all plant owners interviewed said that they installed biogas only after they were convinced that it worked well in their neighbourhood. They do not believe the advantages of biogas on hearsay alone. A biogas promoter or developer should carefully identify progressive farmers willing to install a biogas plant and let other village residents come to see the benefits of biogas for themselves, the target-driven approach not having worked in the past. Some resilience is necessary.

### 7.4.3 Linking the Livestock Development Programme with Biogas

In Dhaitar, most farmers rear buffaloes for milk. The livestock extension workers working in the village were not familiar with biogas technology. BSP should be integrated with the Livestock Development Programme.

### 7.4.4 Toilet-fed Biogas Plants

Most of the biogas plants in Dhaitar area are attached to toilets. Though users realise the advantages to health and sanitation with gas production from a toilet attachment, they cannot find labourers willing to apply the slurry to their fields. Awareness needs to be increased and appropriate tools/equipment (such as trolleys) for handling slurry need to be developed.

### 7.4.5 Use of Slurry

Almost none of the biogas owners are informed about the efficient use of slurry. Generally they allow the slurry to dry in the pit before applying it to their fields. An awareness campaign needs to be launched to impart proper composting techniques and technologies for the efficient use of slurry. The agricultural extension workers of the Department of Agriculture should also be involved in this campaign.

### 7.4.6 Structure and Level of Subsidies

The positive results of a flat-rate subsidy were observed to a remarkable extent in Dhaitar. In the early eighties, oversized biogas plants were constructed and most of them were later abandoned due to lack of dung. At present, most of the plants are $8m^3$ in size, matching the livestock and gas requirements. This has also encouraged the construction of small biogas plants by farmers who own fewer cattle.

### 7.4.7 Research and Development

From the case study, the following R&D-related issues were identified: a) poor performance of the biogas lamp; b) sub-optimal use of biogas slurry; and c) reducing the cost of installing a plant. There is a need to develop and promote a low-cost biogas plant suitable for low-income farmers. In this context, the dissemination strategy and performance of the "*Deen Bandhu*" biogas model (Box 7.1) have brought about encouraging results in Chitwan. Similar action research programmes to promote low-cost biogas plants should be launched, with all due care.

**Box 7.1: *Deen Bandhu* Biogas Plant at Chitwan**

The Integrated Rural Community Development Centre (IRCDC), an NGO, has been involved in constructing several self-help biogas plants, based on the *Deen Bandhu* model as an action research programme, outside the Royal Chitwan National Park since 1993. The project is located in Kumroj VDC in Chitwan District. The main ethnic groups in the villages are the *Tharu*(s), *Brahmin*(s), and *Chettri*(s). The objectives are to introduce low-cost plants by using local materials as an alternative source of energy in order to support and to protect the Royal Chitwan National Park as a model programme, and also to prepare a community-based biogas programme as a means of conserving biodiversity. So far, five biogas plants have been constructed in five wards with a NRs 10,000 subsidy per plant, and there are plans to construct 45 additional plants in the future. Households are identified by a ward-level Biogas Committee as suitable for plant installation. The plant owner provides sand, stones, and unskilled labour, while cement, rods, stovepipes, and skilled labour are provided by the NGO. After the plant's installation, the owner plants five saplings on his own land and 75 saplings in the community forest area that is monitored by the Committee. With the installation of a biogas plant, the consumption of a *bhari* (a local basket full) of fuelwood and use of one to two litres per month of kerosene are saved. The biogas lamp has helped children to study for more hours per day, and women get relief from smoke, heat, and drudgery by cooking over biogas stoves. The nutrient content of biogas slurry is superior to that of traditional compost, but an orientation course is required for its efficient use by farmers. The *Deen Bandhu* model biogas plant is 25 per cent cheaper than the Chinese model. Moreover, the participation of the members by contributing labour and local materials has helped make the programme sustainable.

Source: BZB 1997

### 7.4.8 Standardisation and Quality Control

The strict enforcement of quality and standardisation by BSP has helped to reduce the operational failure of biogas plants. Still, manufacturers are claiming that it has halted cost-cutting innovations since only one type of design is approved for construction by the BSP.

### 7.4.9 Gender Issues

Results of various studies (ADB/N et al. 1994, EAST Consult 1994, WECS 1995, WECS 1997, Keizer 1993 and 1994, Britt 1994) have indicated that biogas has a time-saving effect on women's work loads in most instances. The average amount of time saved as a result of biogas use ranges from two to four and a half hours per day (see Table 7.3). The studies mention that cooking, collecting water and fuelwood, and cleaning utensils are the activities most dramatically affected by the introduction of biogas. The time thus freed can ultimately be used for income-generating activities, which can be seen as another indirect contribution to the expansion of technology within the economy. This generally positive assessment, however, needs to be qualified. The water requirement of biogas plants is a commonly neglected aspect . Another work-related problem for women that biogas installations entail arises from the resulting shift from cattle grazing to stall feeding and the accompanying increased collection of fodder. These are good examples of how gender perception creates a distorted optimal solution, the men ignoring the water and fodder requirements under the implicit assumption that women will somehow manage.

**Table 7.3: Women's Daily Allocation of Time before and after The Installation of a Biogas Plant**

| Time | Before | Time | After | Remarks |
|---|---|---|---|---|
| 4:00-6:00 | Get up, make fire, fetch water, milk cow and boil milk, prepare for *puja*, cook animal food, and do cleaning | 4:00- 6:00 | Get up, make fire, fetch water, milk cow and boil milk, prepare for *puja*, cook animal food, and do cleaning | |
| 7:00-9:00 | Prepare lunch and eat | 7:00-900 | Prepare lunch and eat | |
| 9:00-10:00 | Send children to school | 9:00-10:00 | Send children to school | |
| 10:00-12:00 | Clean utensils | 10:00-12:00 | Feed animals, clean animal shed, and (within half an hour) clean utensils | Before it took two hours to clean utensils |
| 13:00-14:00 | Feed animals, clean animal shed | 12:00-15:00 | Sleep and sometimes chat with friends in friend's tea shop | |
| 14:00-16:00 | Prepare *khaja* (snack) eat, and clean up | 15:00-16:00 | Prepare *khaja*, eat, and clean up | |
| 16:00-18:00 | Fuelwood collection | 17:00-19:00 | Prepare food for animals and feed them | |
| 18:00-1900 | Prepare food for animals and feed and clean them | 19:00-21:00 | Dinner preparation, eating, and cleaning utensils | Collect fuelwood once a week |
| 19:00-21:00 | Prepare dinner, eat, and clean utensils | 21:00-22:00 | Chat with family Members | |
| 21:00-23:00 | Prepare essential things and go to bed | 22:00 | Go to bed | |

Source: Field study (Kabhre, Mahadevsthan), source persons: Mrs Indira Khadka and Mrs Krishna Kumari Shrestha

It is doubtful whether the overall work load on women is in reality reduced because women having access to biogas were found working longer hours than before its introduction, having simply substituted one labour activity for another. However, it has definitely provided an opportunity for them to perform their activities in a more relaxed manner, whether these involve tending their babies or spending time in income-generating activities.

Further, as women in general do not have access to and control over productive resources, they do not, or cannot, own biogas plants. In addition, they do not seem to be actively involved in the implementation and management of the biogas programme.

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