

SESSION THREE

BIOGAS PROGRAMME

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Biogas Programmes

3.1 Introduction

Having discussed various ways through which biogas can contribute towards resolving many of the developmental issues, this session deals with the essential elements of biogas programmes that are being implemented in Nepal. In doing so, a brief review is made of biogas programmes of China and India as they have been of vital importance for the growth of biogas sector in Nepal. By the end of the session, the participants will be able to:

- explain the basic elements of biogas programmes that are being implemented in Nepal, India and China;
- enumerate different institutions involved in the biogas sector in Nepal and the role of BSP in the development of this sector, and
- explain the scope and limitations for further research and development activities in the biogas sector in Nepal.

3.2 Biogas Programme in China

The first digester for household use was put forth in China in the early 1920s by Luo Guorui. A campaign to popularize biogas plants was initiated in 1958 to address to the problem of fuelwood shortage in rural China. Many types of digesters were popularized then, without much attention to research, training and quality of plants being constructed. As a consequence, many digesters became defunct after a short operation period. Although the total number of digesters had reached 7 million by 1978, only 3 million of them were actually in operation (World Energy Conference, 1989).

During 1975 to 1979, the national slogan of China - "Biogas for Every Household" - led to the construction of about 1.6 million biodigesters every year. But from 1979 onwards, the government policy was changed to emphasize plant quality rather than quantity. This change caused reduction in the number of plants constructed each year but the life and utility of plants were increased.

The total potential for biogas plants in China is estimated at about 200 million. The annual construction target in 1996 included 400,000 to 500,000 of small household size digesters and about 25,000 medium and large scale plants for farms, municipalities, distilleries and other industries. The current rate of biogas plant construction is 500,000 per year. Biogas plants have been concentrated in 16 of 28 provinces of China- By 1994, China had a total of about 5.43 million family size fixed dome plants of 6, 8 and 10 m³ capacity.

China is one of the leading countries in biogas technology with a strong technological base and programme implementation experience. Many personnel involved in the biogas development in Nepal have visited China for training and study tours.

3.2.1 Use of Gas and Slurry

The gas is used by about 25 million people for cooking and lighting for 8-10 months of a year, mainly in the rural areas of China. There are 400 biogas power stations with a total capacity of 7.800 kW which provides electricity to 17.000 households. Biogas technology is also used in industries for crop drying, tea baking, hatcheries, refrigerators and air conditioners. Big cities are using the technology for sanitation, rural areas for organic manure and energy scarce areas for the gas. Efficient use of slurry has been given

high priority in agriculture, aquaculture and for raising earthworms and growing edible fungi. Applications as manure have resulted into higher crop yields compared to the use of chemical fertilizer alone. Similarly, when fed with the digested slurry, fish yields were significantly higher than when they were fed directly with pig manure.

3.2.2 Training

China has a strong training base both for the national and international levels. UNDP has set up a Biogas Research and Training Centre (BRTC) at Chengdu under the Ministry of Agriculture. BRTC is the leading institute that has been conducting international training since 1981 (The Biogas Technology in China, 1989). The Chinese Academy of Science is also involved in R&D of biogas technology. The

on-going research programmes include:

- fermentation technique;
- comprehensive utilization of biogas and slurry;
- use of new materials for feeding and construction;
- basic theories on biogas technology; and
- development of biogas appliances.

3.2.3 Organization

A strong government commitment has been the key factor for rapid development of biogas in China. The overall co-ordination responsibility lies with the State Science and Technology Commission (SSTC) and the Ministry of Agriculture, Animal Husbandry and Fisheries. The Department of Environment Protection and Rural Energy (DEPRE) under the Ministry is responsible for the execution of biogas programmes. There are 9,870 organizational units working in biogas sector at the center, province, district and villages levels. Presently, there are 2,810 biogas companies engaged in construction of biogas plants and 1,914 companies specialized in the production of biogas appliances. About 100,000 people are employed in different biogas programmes.

3.3 Biogas Programme in India

The history of biogas development in India goes back to 1920 when the Indian Institute of Science, Bangalore, investigated the feasibility of generating methane through the anaerobic fermentation of banana skin and waste paper (Updated Guidebook on Biogas Development, 1984).

The Ministry of Non-Conventional Energy Sources (MNES) of India is responsible for implementation of National Project for Biogas Development (NPBD). At the state level, the organization is called "Biogas Cell" and is attached to MNES. Biogas programmes are implemented through state governments, their nodal agencies or corporations, KVIC and NGOs like AFPRO. The three main characteristics of biogas programmes in India are: (a) multi-design; (b) multi-institutions; and (c) multilevel subsidies.

State and district level biogas offices have been established to provide technical and training support. AFPRO coordinates a network of NGOs at grassroots level. Over 80 NGOs have been engaged in organizing practical training courses, besides building biogas digesters with two years' free maintenance guarantee (World Energy Conference, 1989). India has a potential of 16 to 22 million household size biogas plants. By 1995, India had a total of 2 million family size biogas plants. Biogas plants are also being constructed for community and industrial use. MNES provides financial assistance such as subsidies, service charge to the state government and the KVIC, turnkey construction fee, incentives to promoters, organization of training programmes and repair of plants with structural problems. In addition to the

financial assistance from the central government, the state and other local governments also provide funds to support biogas programmes in their areas of priority, Biogas is commonly used for cooking and lighting, in some cases, it is used to operate agricultural equipment and stationary engines as well. The effluent is usually dried in the sun, either separately or in combination with agriculture wastes for partial composting and applied in the fields.

3.4 Biogas in Nepal

3.4.1 Brief History of Biogas Development in Nepal

The first biogas plant in Nepal was put forth in 1955 by the late Father B R Saubolle at St, Xavier's School, Godavari For his personal interest in the technology, he used two 200 litre metal oil drums, one as a digester and the other as a gas holder.

For the first time in 1968, a working model of KV1C design was put for demonstration in a public exhibition in Kathmandu. By 1974, Nepal had a total of four biogas plants, that too in the households of elites in Kathmandu.

The Fiscal Year 1974/75 was observed as "Agriculture Year" by the government. Special programmes were launched to augment national agricultural production It was in this year that biogas was first included in a government programme mainly as the technology for high quality organic manure production and with potential to reduce firewood consumption. In this year, for the first time, out of a total target to put forth 250 biogas plants, 199 family size plants were constructed in different parts of the country. Interest free loan was provided through Agricultural Development Bank of Nepal (ADB/N) as an incentive to the users.

Since the biogas programme was thus initiated by the Ministry of Agriculture (MOA), Division of Soil Science and Agricultural Chemistry (DSSAC) of the Department of Agriculture (DOA) got involved in the promotional activities such as providing technical services for construction, organizing demonstration and study tours, training, field investigations and research. The agriculture extension network of DOA and the rural credit extension network of ADB/N were mobilized to popularize the technology. Support of Development Consulting Services (DCS) of the United Mission to Nepal (UMN) was used to strengthen the technical capability in terms of plant designs, fabrication of gas holders and training of masons.

Following the World energy crisis of 1973, Nepal too formed Energy Research and Development Group (ERDG) in 1975 under the Tribhuvan University (TU) to strengthen research and promotional activities in the field of alternative energy. Under this group, a Biogas Development Committee was also formed to accelerate the process of biogas development in Nepal.

By 1976, the country already had about 400 operating biogas plants. More and more development oriented agencies started getting involved in this technology as a cumulative effect of (a) the World energy crisis of 1973, (b) encouraging performance of biogas programme of the "Agriculture Year" - 1974/75, (c) extension activities of DOA and ADB/N, (d) mason training and appliances (drums and stoves) production programmes of DCS, (e) demonstration and technical services (for construction) of DSSAC, and (f) satisfactory performance of plants installed. The Butwal Technical Institute of UMN, Balaju Yantra Shala (BYS), and Agriculture Tools Factory (ATF) also started including biogas related activities in their annual programmes.

The snow-ball effect of all such initiatives and interest led to the creation of a private company called GGC in 1977 as a joint venture of ADB/N, Fuel Corporation (now Nepal Timber Corporation) and UMN. For 17

years since its establishment, GGC remained the only organization, though in the private sector, fully responsible for the overall growth of biogas technology in Nepal (Karki and Dixit. 1984).

3.4.2 Programmes of GGC and Its Linkages

GGC started its programme in close cooperation with the concerned government agencies. ADB/N and donor agencies with the following objectives (GGC, 1993).

- To increase the rate of installation of biogas plants.
- To fabricate biogas appliances such as biogas stove, gas pipe, main gas valve, gas tap, dung mixture and agricultural tools.
- To carry out research on effective and efficient utilization of biogas technology.
- To train the local unemployed youth for installation, operation and maintenance of biogas plants.
- To advise and assist the government on matters related to biogas technology.

Planning: GGC advised the government bodies such as National Planning Commission (NPC) and Ministry of Finance (MOF) on setting national targets for plant construction and policy for subsidy on biogas plants. Because of such efforts of GGC, a national target of constructing 4,000 biogas plants was first included in the Seventh Five Year Plan (1985-1990). The target was nearly achieved. The on-going Eighth Five Year Plan (1992-1997) has a target of installing 30,000 plants which is most likely to be achieved before the end of the planned period, i.e., July 1997.

In 1984/85. GGC modified the Chinese design to come up with a fixed dome type GGC model. The construction of KVTC design plants were stopped since 1986 owing to various comparative advantages of fixed dome GGC design. Since then and till 1994, Nepal adopted a single model (GGC model) and single institution (GGC) approach to biogas development.

Mobilization of Funds: GGC worked in close coordination with ADB/N in mobilizing national and donor resources in the biogas sector. The functional relationship between ADB/N and GGC has been effective as popularization of biogas created additional lending portfolio for ADB/N. In turn, GGC benefited from the large extension network of ADB/N which was used to create awareness and demand for biogas plants. Because of this mutual benefit, these two organizations have a strong institutional linkage.

ADB/N was established in 1968. It provides rural credit services through its over 700 field offices strategically located to reach even the remote areas of the country. From 1974 to 1995, it has been the only agency to administer loan and government subsidy for biogas construction. Though a financial institution, it has also been involved in promotional activities such as awareness campaigns and training in the biogas sector.

The repayment rate is one of the highest on biogas loans of ADB/N. With increasing demand for biogas plants, the market for rural credit is also expanding. To make use of such opportunity, other commercial banks, i.e., Rastriya Banijya Bank (RBB) and Nepal Bank Limited (NBL), have also started administering loan and subsidy for plant construction since last year. However, institutional credit facilities of all these banks are limited to financing individual plants only.

GGC in collaboration with ADB/N mobilized resources from various donor agencies for building awareness and technical capability in the country. Such programmes included short training and study tours in and out of the country, seminars and workshops for development workers at different levels of planning and implementation, mobilization of subsidy and grant funds mostly on a pilot basis.

The Agricultural Link: The experience and technical capability developed in MOA in general and DSSAC in particular before the establishment of GGC played a pivotal role in strengthening the technical capability of GGC Field workers of DOA, motivated to carry out extension activities for the popularization of biogas plants, continued their efforts even after the establishment of GGC. However, as the biogas programmes of GGC became institutionally much closer to that of ADB/N for the aforesaid reasons, the involvement of DOA and its DSSAC in biogas related activities went on declining. The long affiliation of biogas technology with agriculture development programme revived again in 1982/83 with the inclusion of additional subsidy of Rs. 5,500 for each biogas plant constructed in four districts covered by the Special Rice Production Programme launched by DOA (Sunsari, Dhanusha, Rupandehi and Banke).

The Energy Link: In late 1980s, the Water and Energy Commission Secretariat (WECS) of the Ministry of Water Resources (MOWR) took interest in biogas as a technology with potential to have substantial impact on the overall energy scenario of the country. However, its involvement remained limited to support studies, training and occasionally conduct performance monitoring and evaluation of the technology.

The Forest Link: With the growing acceptance of biogas technology in different parts of the country, it also started being included in multitudes of development programmes. Following the trend and pressed by the need to curb the demand for firewood, a forest development project of the Ministry of Forest and Soil Conservation (MOFSC) included a component to provide subsidies for 5,000 plants out of the 30,000 targeted plants of the Eighth Five Year Plan.

Other Linkages: In addition to the above, various agencies involved in different development activities also started including biogas as a part of their programme, but mostly on a pilot basis. Agencies associated with such projects include the Netherlands Development Organization (SNV), United Nations Children Fund (UNICEF), United Nations Capital Development Fund (UNCDF), Save the Children-USA, Plan International, SAP/N, and Nepal Red Cross Society (Karki, Gautam and Joshi, 1993).

Increasing Demand: With the concerted efforts of various national and international agencies on extension of biogas technology, the demand for and the installation rate of biogas plants increased as shown in Chart 2.3 of Session Two. The two main factors that contributed to the rapid increase in number of biogas plant installations are: (a) growing awareness about the technology; and (b) increasing scarcity of household energy in most part of the country. In 1992, BSP was started with the subsidy provision of Rs 10,000 and 7,000 per plant in the hills and plains, respectively. This level of subsidy further pushed the demand up as the subsidy amount was sufficient to meet almost 50 percent of the investment cost. While so many natural and artificial factors were working to accelerate the demand, including the on-going extension activities of GGC, very little inputs were being put to increase the technical capability of GGC to satisfy the growing demand.

Capacity Building: By 1993, GGC had constructed nearly 16,000 biogas plants in 57 districts through its 15 contact offices and 19 full-fledged establishments including one workshop, one research unit, and regional and branch offices, with head office located in Kathmandu. The workshop at Butwal started production of some biogas appliances including gas tapes, gas pipes, stoves, water drain and dung mixer. However, the production level remained below the national demand and the gap was met through imports from India.

Basic research activities related to the use of slurry, increasing efficiency and strength of biogas appliances, alternative feeding materials and cold-weather biogas production were undertaken. The overall outcome of these research remained less significant owing mainly to the low level of inputs in terms of funds and quality human resource that the GGC could afford (Karki, et al., 1993).

Training remained an important part of GGC activities mainly for building its own technical capability. By 1992, GGC had trained about 600 masons with annual plant construction capability from below 200 till 1981 to above 5,000 in 1994.

In an effort to meet the ever growing demand for biogas plants and services, GGC also worked with NGOs and Community Based Organizations (CBOs) at the village level. However, the outcome of investment made by GGC in expanding its organizational and technical capability (research and training) could not match with the rate of increase in demand facilitated by so many development agencies including GGC itself. The demand increased at so fast a rate that by late 1980s it had already crossed the supplying capacity (technical services and appliances) of GGC as was evident from field problems such as unavailability of technicians at the time of need, less supervision services for the constructed plants and growing demand for users' training (Karki and Gautam, 1993). In summary, GGC, in its 17 years of operation as the single organization fully responsible for biogas development in Nepal, (a) created more demand than it could satisfy even with its extended organizational network and increased technical human resource, and (b) established the need for a comprehensive national biogas programme (Karki, et al., 1993).

3.4.3 Support for the Development of a National Biogas Programme (FAO/TCP/NEP/4451-T)

To address to the above mentioned situation in 1995, FAO formulated a programme titled "Support for the Development of a National Biogas Programme". This programme focuses on formulation of a comprehensive National Biogas Programme; training of masons, master-masons, extension workers, users and study tours for concerned personnel to India and China; and production of curricula and training materials. It is providing technical inputs of one international expert in designing training programmes, production of training materials and formulation of national biogas programme based on The performance review of the biogas sector. This programme is being implemented in collaboration with the MOFSC and is scheduled to be completed by the end of 1996 (FAO, 1996).

3.4.4 Biogas Support Programme

First Phase: In order to expedite the progress rate towards achieving the biogas potential of Nepal, BSP was launched in 1992 in collaboration with ADB/N and GGC with the grant support from the SNV. In two years of its first phase, BSP (a) provided subsidy of Rs 10,000 and 7,000 for each plant constructed in hills and plains respectively for a total of 7,000 plants, (b) increased the demand for biogas plants with the subsidy, and (c) formulated recommendations to allow companies, other than GGC, to provide technical services for construction, and O&M of biogas plants. Since then, BSP has remained the major programme for the promotion of technology in Nepal (BSP, 1992).

A mid-term evaluation of the first phase revealed the following (de Castro, et al., 1994).

- GGC alone will not be able to meet the growing demand and more parties need to be involved in providing technical services for construction, operation and maintenance of biogas plants.
- Along with ADB/N, there is a need to encourage other banks to provide loan for biogas installation.
- Participation fee should be collected from construction companies and such fund should be used for promotional activities such as research and training.
- Construction of over-sized plants (size larger than required in terms of gas use or dung availability) is a problem and the average size of plants constructed each year has to be brought down.
- A mechanism needs to be developed to ensure that construction companies provide adequate after-sale services to users and comply with the six-year guarantee services for the digester and one-year guarantee services for appliances used,
- Training should be provided to users.
- Efforts should be made to ensure proper use of slurry by the plant user.
- A national level government body should be formed to oversee biogas sectoral activities.
- BSP should be extended to its second phase covering the period 1994 to 1997.

Second Phase : The second phase started with objectives to (a) install 13,000 biogas plants with the involvement of GGC and other companies, (b) support the establishment of a national level government body, and (c) take initiatives in implementing programmes guided by the findings of the mid-term review of BSP (de Castro, et al., 1994).

At the present rate of annual plant construction, the target of constructing 13,000 biogas plants in the second phase is likely to be achieved before the end of July 1997. All technical preparation for the establishment of the proposed national level organization as "Alternative Energy Promotion Center" (AEPC) is being actively considered by the government. Awaiting the government decision on establishment of AEPC, a "Biogas Development Steering Committee" has been formed under the MOFSC to facilitate continuation of on-going second phase activities in collaboration with ADB/N. The steering committee has representatives from NPC, MOF, MOA, ADB/N, WECS, GGC, private construction companies and BSP/SNV/N. The mid-term review of the second phase has recommended its extension to the third phase.

Third Phase: The third phase is to be implemented over a period of six years (1997-2002) to attain the overall objective of further developing and disseminating biogas as an indigenous sustainable energy source in rural areas of Nepal. The specific objectives that would contribute in attaining the overall objective are as follows (BSP, 1996).

- To develop commercially viable and market-oriented biogas industry.
- To increase the number of quality smaller-sized biogas plants by 100,000 (see Chart 3.1). To ensure the continued operation of all biogas plants installed under BSP.
- To conduct applied R&D, in particular the development and local production of quality gas valves, taps and lamps.
- To maximize the benefits from the operated biogas plants, in particular the optimum use of biogas slurry.
- To strengthen and facilitate establishment of institutions for the continued and sustained development of the biogas sector.

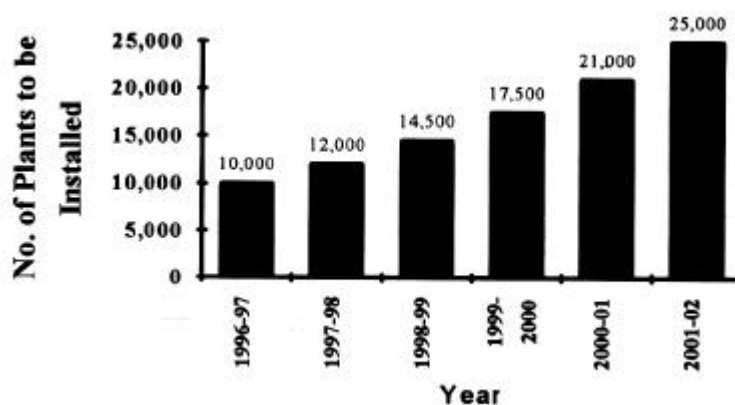


Chart 3.1 Year-wise Breakdown of Biogas Plants in BSP Phase III

The third phase envisages providing financial incentive to private biogas companies in terms of soft loans, tax exemptions on import of biogas appliances and construction materials, technical and managerial support services, research, training and institutional strengthening.

The research would focus on (a) minimization of installation cost and increasing gas production during winter, and (b) standardization of biogas plants, appliances and accessories to safeguard the interest of

users and companies involved in construction.

Institutionally, the programme would focus on (a) strengthening the technical and managerial capability of the construction companies, (b) enabling the local government bodies at district and village levels to assume the responsibility for planning and implementation of biogas programme in their respective areas, (c) integrating biogas development activities with other sectors of the economy such as agriculture, cottage industries, education, income generating activities, women in development, and (d) establishing and strengthening of a government body solely responsible for promotion of biogas technology from the national perspective.

Along with the Netherlands Government, the Kreditanstalt für Weideraufbau (KfW), a development bank of Germany, will be co-funding the third phase. Considering the size of BSP in terms of financing and institutional strength as a project, it stands for almost all activities of biogas sector in Nepal. In the absence of any specialized government agency to oversee the biogas development activities in Nepal, BSP is assuming this responsibility in collaboration with ADB/N, RBB, NBL and the recognized biogas companies.

3.4.5 Basic Features of BSP Third Phase

Output Targets: The overall target of BSP third phase is to develop the biogas industry as rapidly as possible. The aim is to increase the capacity of the sector to construct upto 25,000 plants per year as well as to ensure proper functioning of upto 120,000 plants installed under BSP, giving biogas a permanent place in the provision of rural energy. An assessment of demand and supply of biogas plants and the influencing factors show that the demand as well as supply will be adequate to meet these targets.

The breakdown of construction targets by size of plant and fiscal year is presented in Annex 3.1.

Credit and Subsidy Requirements: It is expected that in the third phase, 25 percent of all plants will be paid in cash while 75 percent will be financed through bank loans. The total gross loan requirement excluding physical and price contingencies is Rs 1,097 million (US\$ 19.6 million). Besides, an amount of Rs 365 million will be generated by customers to install biogas plants on cash basis. Commercial banks have indicated that they would consider providing working capital loans to recognized biogas companies.

The total amount of subsidy required for the duration of the project is Rs 837 million (US\$ 15 million). The average subsidy per plant is expected to decline from Rs 9,000 in 1996/97-1998/99 to Rs 8,000 for the period 1999/2000-2001/02.

Training; In the third phase, BSP has scheduled various training programmes as summarized below.

Biogas Companies

- (a) *60 days' mason training:* By the end of the third phase, 3,300 new masons will have been trained.
- (b) *4 days' refresher training for trained masons:* By the end of the third phase, 2,100 trained masons will have refresher course.
- (c) *4 days training to supervisors:* By the end of the third phase, 410 new supervisors will have been trained and 350 supervisors will have had refresher course
- (d) *2 days' training to field office staff and 6 days' training to staff/managers:* By the end of the third phase, 720 managers and 755 staff will have been trained.
- (e) Each new companies entering into the biogas sector will receive a 2 days' orientation training

Banks, (I) NGOs and Line Agencies

- (a) 3 days' training to the staff from these organizations on the basics of biogas.
- (b) Loan officers and assistant loan officers will be trained on loan appraisal.

Users

- (a) 1 day O&M training to the users.
- (b) 7 days' training for trainers on how to enable users to operate and maintain their plants.

Institutional Targets: The third phase will consist of two programme stages of three years each. In the second stage, the focus will be on institutionalization of the programme, having transferred tasks and functions from the BSP project office to Nepalese organizations.

At the end of the third phase, the biogas sector will be a market oriented, autonomous, and adequately structured sector with maximum participation by the private sector. Dependence on subsidy will have been reduced. Quality control and regulation will have been handed over to Nepali organizations.

Promotion and Marketing: During the first two phases, BSP had paid less attention to the marketing aspect since the subsidy was sufficient to let the demand rise to approximately 5,000-10,000 plants per year. In the third phase, marketing strategies will be important to meet the target of installing 25,000 plants per year. As the number of private biogas companies increase, there will be competition for market which will require identifying a specific market segment and approaching that segment with an appropriate strategy.

A well functioning plant is the best possible promotion and a satisfied user is the best promoter for biogas. Therefore, the third phase has emphasized quality control regarding plant size, construction, after-sale-services and user training on O&M.

Quality Control: Biogas companies willing to benefit from the subsidy scheme to their clients will be required to seek recognition and approval from the national level government body and/or BSP. The recognition criteria as laid down in the second phase will also be applicable in the third phase.

In the second stage of the third phase, this task can be performed by the association of biogas companies in cooperation with the Nepal Bureau of Standards.

New plant designs and/or improvements on the existing designs will be thoroughly tested and standardized before they are permitted for large-scale dissemination. Although product changes will be limited, innovative Entrepreneurship will be encouraged.

The present quality system, consisting of standards and penalties, has proved to be very effective and will therefore be continued in the third phase as well. A study will also be undertaken to investigate whether the amount received from penalties can be used to give awards to high quality companies or to use it in other effective ways.

After-Sale-Services: Biogas companies are required to give a guarantee of six years and visit every installed biogas plant once a year. At present, Rs 1,000 is charged as a guarantee fee as well as for the visits conducted by the company. This amount is deposited into a special account, jointly administered by the BSP and the concerned company. This system is planned to be continued in the third phase.

The present system requires company and user to sign the maintenance contract. Formally, the user has to write a complaint to the company which would then send a mason to investigate and solve the problem. This is a long and complex process which negatively influences the quality of the after-sale-service. Attempts will be made in the third phase to improve the after-sale-services of the companies and to shorten

and simplify the present process.

Operation and Maintenance: Biogas users will be trained on O&M including some minor repairs. Since this is also a task for the masons, supervisors and extension workers, it will be included in their training programmes. BSP has developed user instruction manuals which will be distributed to users by the respective companies.

Research and Development: The following specific applied research activities are planned to be carried out under the third phase.

- Development and testing of new biogas designs and appliances
- Reduction of the cost of biogas installations
- Improvement in plant performance efficiency
- Solution to technical problems related to construction, operation, maintenance and repair of plants including the appliances
- Standardization of biogas plant designs and appliances
- Research to support extension on the use of composted slurry
- Studies to assess the impact of the introduction of large scale biogas plants

Extension: The third phase will provide some financial support for development of extension materials and users' group training. Since the use of biogas slurry as fertilizer is still far from optimal, there is a plan to develop and distribute extension materials for this purpose. Extension activity is also planned to promote connection of toilets to biogas plants. Some NGOs will be financially supported to study other development activities which have resulted in households as a result of the installation of biogas plants. This type of integrated approach will link biogas with other socio-economic development of the rural areas.

Monitoring and Evaluation: BSP will subcontract M&E activities to research institutions, biogas companies and consulting firms on the basis of project proposals and TOR that will be elaborated by the national level government body and BSP.

Management and Technical Assistance: At present, two Development Associates, one Programme Manager and one Engineer are provided by SNV/N as technical assistance to the project. For the first stage of the third phase, this staff arrangement is planned to be continued and for the second stage, only the services of a Programme Manager will be retained.

It is estimated that eight staff will be required for management, coordination, reporting and financial administration even after transferring the tasks to other institutions at the end of the third phase.

Financial Procedures: At present, the application for taking a loan from ADB/N for biogas plant installation concentrates on the collateral of the farmer. Farmers cash income is not taken into consideration. Under the third phase, such cash income will also be accounted for in the application form.

A standard contract between the biogas construction company and the farmer will be introduced for biogas plants financed on cash basis.

SNV/N in consultation with HMG/N and in cooperation with ADB/N and/or organizations designated by the national level government body will retain the overall responsibility for the financial administration of the funds. The National Biogas Coordination Committee with representatives from MOF and the individual banks will review and approve the annual subsidy disbursement schedule.

Gender and Environment: It is estimated that the implementation of the third phase will result in the reduction of the workload of women in 90,000 families. In the Nepalese context, reduction of workload can be considered as a pre-condition to avail opportunities for women to work for their own betterment.

At the end of the third phase, an additional 90,000 biogas plants will be in operation (assuming 10 percent failure) producing about 54 million m³ of biogas and 3 million tons of digested dung (7 percent dry matter) annually. The following environmental benefits are expected from the programme:

(a) Saving on Traditional Energy Sources

Assuming that 85 percent of gas will be used for cooking and replacement will be as per the shares of traditional energy sources in 1992/93, the following substitutions are expected annually.

- 170,000 ton of fuelwood by 34 million m³ of biogas
- 72,000 ton of agricultural waste by 8 million m³ of biogas
- 40,000 ton of dung cakes by 4 million m³ of biogas

(b) Saving on Commercial Energy Sources

When biogas is used for lighting, it will save kerosene consumption. It is assumed that 15 percent of annual gas production (8 million m³) will be used for this purpose saving 4.5 million litres of kerosene per year.

(c) Improving Soil Fertility

By installing a biogas plant, dung management on the farm will be improved. Besides possible savings on nutrients (NKP), biogas slurry contributes to sustain the amount of organic matters of soil. The organic matters and plant nutrients of agricultural waste and dung cakes, which are otherwise burnt, are available to sustain the fertility of soil.

(d) Reduction of Carbon Dioxide(CO₂)Emission

The replacement of firewood by biogas will reduce the emission of CO₂ by 238,000 ton per year assuming an emission coefficient of 1.4 ton of CO₂ per ton of firewood.

The replacement of kerosene (lighting) by biogas will reduce the emission of CO₂ by 12,600 ton per year assuming an emission coefficient of 2.8 kg of CO₂ per liter of kerosene.

Poverty, Health and Employment: The flat rate subsidy policy adopted in 1992 favours smaller plant sizes than the larger ones and this subsidy policy is to be continued in the third phase. However, biogas will never directly benefit those without cattle and these are generally among the poorest strata of the society.

The programme is expected to have significant health effects. The main positive effect is on the level of indoor air pollution. Several studies have shown that indoor pollution and smoke exposure in rural areas of Nepal, expressed in respirable suspended particulates (RSP), carbon monoxide (CO) and formaldehyde (HCHO), are to be amongst the worst in the world.

The programme is expected to generate a fair amount of employment for both skilled and unskilled labour in The rural areas. At the end of the third phase, the total number of staff of biogas companies will be about 4,000. There will also be a need for 2,500 person-years to produce the appliances and building materials, while another 4,000 person-years of unskilled labour will be needed for the construction of biogas plants.

Risks: Elections and rapid changes in governments in the recent years caused delays in government and bank procedures and influenced the decision of farmers to install biogas plants. This is an unavoidable risk for which no measures can be taken. Although some degree of government ownership is essential for the sustainability of biogas sector, excessive regulation and interference is not considered desirable for the development of a healthy industry.

If other sources of domestic energy such as kerosene and LPG are heavily subsidized by the government, they may affect the promotion of biogas. This is not likely since the Perspective Energy Plan states that all price distortion for commercial fuel should be removed.

Availability of construction materials can also influence the rate of implementation of the programme. Shortage of cement and brass (required to manufacture gas taps and drains) can significantly increase the construction cost.

Another major risk is the possibility of insufficient funding which is a major external risk that will effect the sustainability of this sector.

3.4.6 Biogas Companies

As a result of the government policy to encourage the participation of private sectors, many private companies have been established since 1992 in order to meet the ever increasing demand for the installation of biogas plants. Until now, 20 companies and three NGOs have been registered with the government and are recognized by BSP as qualified organizations to provide technical services for construction and O&M of biogas plants. Using technical services of these companies, above 5,000 plants were constructed in 1995 which is estimated to be less than 50 percent of the potential in terms of their cumulative technical capability.

3.4.7 Need for Research and Development

Research has remained one of the low priority areas in terms of human resource and allocation of funds. So far, the major programme emphasis has been on increasing the number of biogas plants. Some areas of R&D that need immediate attention are discussed below (Karki, Gautam and Karki, 1994; Gautam, 1996).

Designs of Biogas Plants: A concrete dome model biogas design that was developed about 17 years ago is continuously being promoted by GGC and BSP, mainly for its proven high rate of success (above 90 percent) Many other models have been developed in India and China in the last few years. Deenbandhu model, which replaces concrete dome with brick masonry, is one of such designs developed in India and is reported to be cheaper than other fixed dome plants. Though BSP has approved this design for its eligibility for subsidy, not much efforts are being made in evolving cheaper and durable models.

Cold Weather Biogas Plant: Biogas production decreases in cold weather or at higher altitude, ironically, in a time and place when the household energy requirement substantially increases. Various attempts were made by researchers and scientists to maintain or increase gas production in the cold season through physical, chemical and biological methods. For instance, some methods used in Nepal consisted of using warm water for daily feeding of the biodigester and covering the digester with straw or plastic. However, practical and effective methods have yet to be developed.

Slurry Utilization: Field observations and reports indicate that biogas plant owners pay more attention towards gas production and neglect the slurry utilization aspect. Little scientific or agronomic data have been generated in this subject in the Nepalese context. Realizing this, BSP has implemented a programme particularly to augment the use of slurry as fertilizer. It has recruited "Slurry Extension Workers" and assigned them to work with biogas companies in promoting the proper storage and use of slurry.

Health and Sanitation: Unlike in the past, about 40 to 50 percent of plants installed every year are now connected with latrines. This has made it important to find out whether the slurry coming out from night-soil attached plants still contain a significant amount of pathogens. If so, it has to be further treated to avoid health hazards. Further research in this area would be to determine the optimum retention time at which the amount of pathogenic germs become negligible. Also, it is worth mentioning that in Tanahun district of Nepal, mosquito proliferation has been reported as a result of establishment of latrine attached biogas plants. Appropriate research needs to be carried out in this subject.

Alternative Feedstocks: To date, animal dung, especially cattle dung (dung from cows and buffalo), has been used as raw material to feed the biogas plants. Use of other organic materials including municipal solid waste and agro-industrial wastes for methane generation have not been extensively examined in the context of Nepal.

Manufacture of Biogas Appliances: Biogas burners are manufactured by GGC in its workshop at Butwal but the quantity produced is not sufficient to meet the ever increasing demand due to the increasing rate of plant construction. Biogas lamps and other accessories are usually imported from India. High quality main gas valves are imported from the Netherlands. In the long run, for the smooth implementation of the programme, all biogas appliances need to be manufactured in the country.

3.5 Session Plan

Activity No	Topic and Area of Discussion	Time (min.)	Methods of Training	Teaching Aids
1.	Introduction and highlight of the objectives of the session	2	Lecture	O/H projector
2.	Biogas programme in China	5	Lecture	O/H projector
3.	Biogas programme in India	4	Lecture	O/H projector
4.	Brief history of biogas development in Nepal	4	Lecture cum discussion	O/H projector
5.	Programmes of GGC and its linkages	6	Lecture cum Discussion	O/H Projector, flip chart
6.	FAO programme	3	Lecture	O/H projector
7.	First and second phase of BSP activities	6	Lecture	O/H projector
8.	Third Phase of BSP activities	8	Lecture	O/H projector
9.	Biogas companies	2	Lecture	O/H projector
10.	Need for research and development	5	Lecture	O/H projector, flip chart
11	General discussion	15	Discussion	O/H projector, flip chart
Total Time		60		

3.6 Review Questions

- How did the biogas programme pick up momentum in Nepal?
- Explain the role of BSP in the promotion of biogas programme in Nepal.
- What lesson in biogas technology could one learn from China?
- What is meant by AEPC?
- Enumerate R&D needed to promote biogas programme in Nepal.

- Comment on "biogas programmes can not be successful without a strong government organization to oversee all biogas related activities".

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Break-Down of Construction Targets by Size of Plant and Nepalese Fiscal Year

Size of Plant (m³)	1996/97	97/98	98/99	1999/2000	2000/01	01/02	Total
4	100	200	300	400	500	600	2,100
6	2,000	2,900	4,100	5,300	7,000	9,000	30,300
8	3,500	4,300	5,300	6,800	8,300	10,000	38,200
10	4,100	4,300	4,500	4,700	4,900	5,100	27,600
15	250	250	250	250	250	250	1,500
20	50	50	50	50	50	50	300
Total	10,000	12,000	14,500	17,500	21,000	25,000	100,000
Average Size	8.6	8.4	8.1	8.0	7.8	7.7	8.0