FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS

SUPPORT FOR DEVELOPMENT OF NATIONAL BIOGAS PROGRAMME (FAO/TCP/NEP/4451-T)

BIOGAS TECHNOLOGY:
A TRAINING MANUAL FOR EXTENSION

NEPAL **September 1996**

Consolidated Management Services Nepal (P) Ltd.
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PREFACE

Biogas has proved to be a viable technology in the physical and socio-economic conditions of Nepal. The hydropower generating potential of Nepal is calculated as one of the highest in the world but only about 12 percent of the population is connected to the national electricity grid. The percapita energy consumption is one of the lowest in the world and more than 90 percent of the energy use is in the domestic sector, mainly for cooking. Nepal's agrarian economy is fully dependent on imports for all of its chemical fertilizer, petroleum and coal requirements. The growing population and small scale industries are pushing the use of traditional sources of energy (forest and agricultural waste) beyond the sustainable generation capacity of the existing forest and farm lands. The occurrence of natural calamities such as draughts and floods has become more frequent in the recent past owing to the removal of vegetative cover on the fragile geology of the young mountains. This situation, coupled with the low rate of literacy and low investment capacity, is bringing more and more people into the ever tightening grip of poverty. Amidst all this, the biogas technology has gained popularity in Nepal for its multitudes of benefits. Nepal stands highest in the world in terms of the ratio of biogas plants over the population.

Biogas development in Nepal has remained largely a private sector operation. The role of the government has been limited to provide policy framework and subsidy funds. The Biogas Support Programme (BSP), initiated in 1992 under the Netherlands Development Organization (SNV/N), is the first comprehensive programme implemented in the country which is planned to continue till 2002 in its third phase. BSP started with an attractive subsidy scheme that pushed the annual rate of plant installation beyond the servicing capacity[1] of existing institutions. The "single-agency, single-design" approach of the past has now been modified to "multi-agency, multi-design" approach to benefit more from the potential of private sector and the new designs developed in die neighboring countries. To maintain the high rate of success in the "multi-agency, multi-design" environment, a strong quality control programme is now in place. FAO support is being used to develop a comprehensive national programme under the FAO/TCP/NEP/4451-T project.

The biogas sector of Nepal is characterized by its focus on family size plants in rural households with catties. The emphasis on research and training has been limited in the past. A strong training programme is required to maintain the high success rate of the past. Equally important is to further increase the annual rate of plant installations to make use of the existing potential estimated at 1.3 million biogas plants. This manual is expected to contribute towards attaining both of these objectives.

This manual is an outcome of (FAO/TCP/NEP/4451 -T) project being implemented with the Ministry of Forest and Soil Conservation as the liaison institution. CMS developed this manual through six stages. To start with, a team of four CMS professionals prepared a draft of this manual which was improved upon based on the comments and suggestions from the national experts and practitioners. At this stage, professional inputs from FAO was also used. This first draft was put to test in the first training programme participated by the 30 district and central level officers from the departments of Forest, Soil Conservation. Agriculture. Livestock, and other agencies active in the promotion of biogas technology in the country including rural credit institutions and NGOs. The team of professionals who prepared the manual also presented it in the training programme and made subsequent improvements based on the experience gained and comments received from the participants. Thus, an improved second draft was prepared and put to test in the second training programme also participated by 30 participants from the same institutions This process was repeated for each of the five training programmes organized at 15 days interval during June to August 1996. The draft manual prepared after the third training also incorporated the comments and suggestions from FAO experts. Altogether 151 senior officials were trained in the process of bringing this manual to its present shape.

Preparation of this manual has been greatly benefited by the long experience of Dr Amrit B Karki, who has provided his expert services on the subject in more than twenty countries of Asia, Africa and Latin America Just before taking this assignment as the Team Leader, Dr Karki was decorated with the title of "Father of Biogas in Nepal". His long service to this sector and wide international experience is well reflected in the manual making it relevant not only to the conditions of Nepal but also for other countries interested in making optimum use of their bio-energy potential.

Mr. Krishna M Gautam deserves special thanks for his contributions as the Training Specialist and Rural Energy Expert. This manual would not have seen this light of the day without his untiring efforts in enriching the manual with the wide rage of information and their succinct presentation.

The contribution from Mr. Govind P. Kandel (Chief of the Programme Monitoring and Evaluation Section of the Ministry of Forest and Soil Conservation) both as the National Coordinator of FAO/ TCP/NEP/4451-T project and member of the expert team is well appreciated.

Thanks are also due to Dr Krishna B. Karki,. a Soil Scientist and Agriculture Extension Worker, who provided his valuable time in presentation of the material in the training programmes.

CMS, along with all of the above four members of the expert team, express their sincere thanks to Dr. Gustavo Best from FAO Headquarters. Rome, for this continuous support and encouragement to the team.

In addition 10 the core group of four professionals, CMS also used the services of two professional engineers. Mr Ajoy Karki. an experienced engineer and member of Editorial Board of Biogas and Natural Resources Management newsletter, assisted the team in technically improving and editing the manual. Mr. Ajaya L Shrestha. Director of CMS. did the final editing of the manual. The contribution made by these two engineers has been of utmost importance in improving the structure of manual and its content.

Dr K C Khandelwal. an expatriate consultant expert from FAO participated in the two of the five training conducted. His professional inputs helped to define the contents of the manual as well to improve the presentations We are greatly indebted to his support not only in bringing out this manual but also in other ventures of CMS in the biogas sector. Ms Regula Meierhofer from FAO office in Kathmandu deserves special mentioning for her facilitating role during the assignment period.

I take this opportunity to thank all 151 participants of five training programmes for their valuable contributions in making of this manual. I also appreciate the painstaking efforts made by Messrs Hari Upreti, Surendra Shrestha, Murali Dahal, Tirtha Maharjan and Ms Bandana Swar in being effective in their respective role of support staff for the timely completion of this CMS assignment.

Last but not the least, I would like to express my sincere appreciation for SNV/N supported BSP in general and its Programme Manager, Mr Wim J van Nes in particular, for all the information that was made available to the team without which the manual would not have been completed, It would not be an exaggeration to state that BSP has been an important source of information as it has been pivotal to the over all development of biogas sector in Nepal.

While thanking ail those involved in making this manual possible, I look forward to receiving comments and suggestion so that it becomes a living document whose utility transcends beyond any national boundary.

Upendra Gautam
President

TABLE OF CONTENTS

CONTENTS (Con'd ………)

CONTENTS (Con'd ………)

CONTENTS (Con'd …….)

CONTENTS (Con'd ………)

APPENDICES

LIST OF TABLES

LIST OF FIGURES

LIST OF CHARTS

LIST OF ANNEXES

ACRONYMS AND ABBREVIATIONS

ADB/N	Agriculture Development Bank of Nepal
AEPC	Alternate Energy Promotion Centre
AFPRO	Action for Food Production
AIC	Agricultural Inputs Corporation
AsDB	Asian Development Bank
ATF	Agriculture Tool Factory
BCR	Benefit Cost Ratio
BNRM	Biogas and Natural Resources Management
BORDA	Bremen Overseas Research and Development Association
BRTC	Biogas Research and Training Centre
BSP	Biogas Support Programme
BYS	Balaju Yantra Shala
ON	Carbon Nitrogen Ratio
CBO	Community Based Organization
CDO	Chief District Officer
CMS	Consolidated Management Services Nepal (P) Ltd.
DCS	Development Consulting Services
DDC	District Development Committee
DGIS	Directorate General for International Co-operation
DM	Deutsch Mark
DOA	Department of Agriculture
DSSAC	Division of Soil Science and Agricultural Chemistry
ERDG	Energy Research and Development Group
FAO	Food and Agriculture Organization of the United Nations
FYM	Farm Yard Manure
GGC	Gobar Gas and Agricultural Equipment Development Company
GI	Galvanized Iron
GTZ	German Technical Co-operation
HMG/N	His Majesty's Government of Nepal
INGO	International Non-Governmental Organization
KfW	Kreditanstalt fur Wiederaufbau
KVIC	Khadi and Village Industries Commission
LPG	Liquified Petroleum Gas
M&E	Monitoring and Evaluation
MNES	Ministry of Non-Conventional Energy Sources
MOA	Ministry of Agriculture
MOF	Ministry of Finance
MOFSC	Ministry of Forest and Soil Conservation
MSW	Municipal Solid Waste
NBC	Nepal Biogas Centre
NBL	Nepal Bank Limited
NBPG	Nepal Biogas Promotion Group
NGO	Non-Governmental Organizations

NPV	Net Present Value
NPW	Net Present Worth
NTV	Nepal Television
O/H	Over Head
PVC	Polyvinyl Chloride
R&D	Research and Development
RBB	Rastriya Banijya Bank
RMP	Red Mud Plastic
SAP/N	South Asian Partnership/Nepal
SCF/US	Save the Children Fund/USA
SFDP	Small Farmers Development Programme
SNV/N	Netherlands Development "Organizations/Nepal
TOR	Terms of Reference
TU	Tribhuwan University
UASB	Upflow Anaerobic Sludge Blanket
UMN	United Mission to Nepal
UNCDF	United Nations Capital Development Fund
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme
UNICEF	United Nations Children Fund
USAID	United States Agency for International Development
VDC	Village Development Committee
WECS	Water and Energy Commission Secretariat

RELEVANT UNITS AND CONVERSION FACTORS

Area of rectangle	=	Length x breadth		
Area of Circle	=	ð (radius)2		
Volume of a rectangular tank	=	Length x breadth x height		
Volume of a cylindrical tank	=	ð x (radius)2 x height		
1 metre	=	39.37 in	=	3.28 ft
1 foot	=	0.305 metre	=	30.5 cm
I inch		2.54 cm		
lm2	=	10.764 sq ft		
lft2	=	0.0929 m2		
lft3	=	0.0283 m3		
lm3	=	1,000 litres		
lm3	=	35.315 cu ft		
1 litre	=	103 cm3	=	0.0353 cu ft
1 1b	=	0.454 kg		
1kg	=	2.25 lb		
1 ton	=	1,000 kg		
1 quintal	=	100 kg		
1 hectare	=	10,000 m2		
lkm2	=	100 ha	=	106m2
1 acre		0.40468 ha	=	4046.8 m2
lsq.ft	=	929,03 cm2		
1 sq. in	=	6.452 cm2		
1MJ	=	238.8 kcal (1 MJ/m3)	=	947. 9 BTU (26.75 BTU/ft3)
1 Cal (Calorie)	=	4.1868 J (Joule)		
1BTTJ	=	1.055 Id	=	0.252 kcal
1 BTU/ft3	=	37.2 kj/m3	=	8.894 kcal/m3
1 United States gallon	=	3.785 litres		
1 British (Imperial) gallon	=	4.55 litres		
1 degree Fahrenheit 0°F)	=	5/9 (°F-32)°C		

UNIT EQUIVALENT

1 Watt is equal to:
1 Joule/Sec
0.00134 Horse power
0.001 Kilowatt
3.43 heat unit/hour
0.74 ft. lbs/sec

1 Kilowatt is equal to:
1000 watts
1.341 Horse power
26,56,400 ft. lb./hour
36,00,000 Joules
3,411 heat units

1 Horse power is equal to:
746watt
0.746 Kilowatt
33,000 ft.lb/min
2,545 heat units/min

1 heat unit is equal to:
778 ft.lb
0.24 Calorie
1048 Watt seconds
0.00293 Kilowatt hour
108 Kilogramme meters
0.0000666 1b. coal oxidised
0.00039 Horse power hour

1 joule is equal to:
1 Watt second
278 x 10-8 Kilowatt hour
0.00094 heat units
0.7376 ft. 1b

INTRODUCTION TO THE MANUAL

The rate of installation of family size biogas plants in Nepal has shown unprecedented growth in the past. This trend is expected to continue in the next ten years. More and more people are getting involved in biogas as users, technicians, extension workers, researchers, trainers, supervisors and investors. As a result, the need for suitable training programmes along with the development of high quality training manual has become a matter of immense importance for the sustainable growth of the biogas sector in Nepal. Realizing this, one of the main components of FAO funded *Support for the Development of National Biogas Programme Project (TCP/NEP/4451 -T)* has been the development of appropriate training curriculum and materials with the objectives: (i) to create awareness on the biogas programme; and (ii) to provide background for the promotion and facilitation of biogas extension activities.

A national level meeting for the development of a national biogas policy framework was organized by FAO on 7 February 1996 in Kathmandu. Experts from FAO headquarters and expatriate consultants also participated in the meeting. Guided by a review of the performance of biogas sector and the opinions and ideas expressed in the meeting, a programme for district officers' training was designed as provisioned in the aforesaid FAO funded project.

The training programme aimed to train about 130 district level officers from the Departments of Forest, Soil Conservation, National Parks and Wildlife, Agriculture and Livestock Services. It also aimed to include 20 participants from NGOs, banks and other organizations that are active in the biogas sector. After going through this training, participating government officers and NGO personnel were expected to become more effective in facilitating promotional activities for biogas in their respective areas.

In accordance with the TOR of the Consultant, five training programmes were conducted. These training covered a total of 151 participants. A detailed report was separately prepared for each of these programmes. The final training report includes details on participants, their recommendations, venue and other details of all the training programmes.

Nine topics for training were originally planned. Based on the experience gained in different training, the sequence of presentation of the topics was modified. Also, one topic initially named as Biogas Technology in Agriculture was renamed as Utilization of Slurry as Feed and Fertilizer to suit the content presented in the manual. Thus, modified names and sequence of topics as presented in the fifth training programme are as follows:

Session One	:	System Approach to Biogas Technology
Session Two	:	Relevance of Biogas Technology to Nepal
Session Three	:	Biogas Programmes
Session Four	:	Utilization of Slurry as Feed and Fertilizer
Session Five	:	Installation Cost and Financial Viability
Session Six	:	Subsidy and Institutional Financing
Session Seven	:	Field Visit for Observation of Biogas Plants
Session Eight	:	Extension Support Services for Biogas
Session Nine	:	Quality Standards
Session Ten	:	Monitoring and Evaluation

This manual contains a complete set of training materials on above topics presented in five training programmes of three days each. The first four topics were covered on the first day as against the six topics as originally planned. Two topics were covered on the second day before proceeding to field visit of at least two biogas plants representing both the success and failure cases. The remaining three topics were dealt with on the third day along with open floor discussion on all aspects of and experience with the technology. Evaluation of the training programme by the participants was the last activity of the third day preceded by sessions of slide show and a video film on biogas.

The five training programmes were conducted on the following dates and venues.

S. N.	Training Programme	Dates of Training	Training Venue
1.	First Training	2, 3 & 4 June 1996	Kathmandu *
2.	Second Training	16, 17 & 18 June 1996	Chitwan **
3.	Third Training	1.2&3 July 1996	Kathmandu *
4.	Fourth Training	16, 17 & 18 July 1996	Kathmandu *
5.	Fifth Training	31 July, I &2 August 1996	Kathmandu *

* Venue in Kathmandu : Nepal Administrative Staff College, Jawalakhel. Lalitpur

** Venue in Chitawan: Uncles' Lodge, Narayanghat, Gaindakot, Chitwan

Out of five training programmes, four were conducted in Kathmandu and one outside Kathmandu, i.e., in Chitawan district. Each training programme was of three days duration with two and one-half days of applied theory and a half day of field visit. Consolidated Management Services Nepal (P) Ltd (CMS) assumed the training responsibility by forming a team of experts/trainers comprising of national professionals with long experience related to the topics mentioned above. The team led by Dr Amrit B Karki consisted of the following experts:

- Mr Krishna M Gautam, Resource Economist/Training Specialist
- Dr Krishna B Karki, Soil Scientist
- Mr Govinda P Kandel, Monitoring and Evaluation/Environment Expert

These experts/trainers were assigned for manual preparation and its presentation in all the training programmes. The basic rational for this arrangement was to ensure that the experience gained by each trainer in presenting his subject matter in the training could be readily used to improve the manual after each training programme.

The published and unpublished literature on each of the above topics were reviewed by the concerned experts to ensure that training materials on each topic presented up-to-date information on the state-of-the-art of the technology.

The team of experts prepared a write up on each topic. Efforts were made to ensure that the presentation was simple and gave a complete coverage of the subject that could be presented in the allocated time during the training programme. Provisions were made to use various illustrative training aids such as charts, graphs, photographs, diagrams and sketches.

The first draft of the training manual was prepared in May 1996 after incorporating the valuable comments and suggestions received from FAO and other experts. This first draft was put to test in the first training programme organized in Kathmandu from 2 to 4 June 1996 in cooperation with the National Project Coordinator and the FAO expert. Similarly, based on the reaction of this training as well as valuable comments and suggestions received from FAO, the second draft was prepared for presentation in the second training held outside Kathmandu, i.e., in Chitwan district, from 16 to 18 June 1996.
After completion of the second training programme in Chitwan, a meeting was held at FAO Office in Kathmandu on 24 June 1996 in the presence of all four experts/trainers of the team, FAO Programme Officer and the FAO Consultant. The meeting made a mid-term review of the manual and the two training programmes conducted. The meeting came up with a strategy to further improve the manual as well as the quality of presentation in the remaining three training programmes. Thus, improved third draft was presented in the third training programme conducted from 1 to 3 July 1996 in Kathmandu. Similarly, comprehensively revised and improved fourth draft was put to test in the fourth training that took place

during 16, 17 and 18 July 1996 in Kathmandu. This draft was also submitted to FAO for comments and suggestions. Meanwhile, the revised fifth draft was used in the fifth and final training programme from 31 July to 2 August 1996 in Kathmandu.

The team of experts/trainers continued to improve the manual guided by the experience gained in their presentation and the inputs received from national and international experts and the trainee participants. The manual was thus continuously revised and improved after the completion of each training programme, hi course of the fifth training programme, the manual that was revised and tested four times was presented to the trainee participants. The fifth draft incorporated experience gained in previous four training programmes. Therefore, this manual in its present shape contains comprehensive and well tailored training materials that could be utilized not only to conduct a country specific training programme but also to be used as a source book by rural development workers interested to promote biogas technology in their countries.

SESSION ONE

SYSTEM APPROACH TO BIOGAS TECHNOLOGY

SESSION ONE

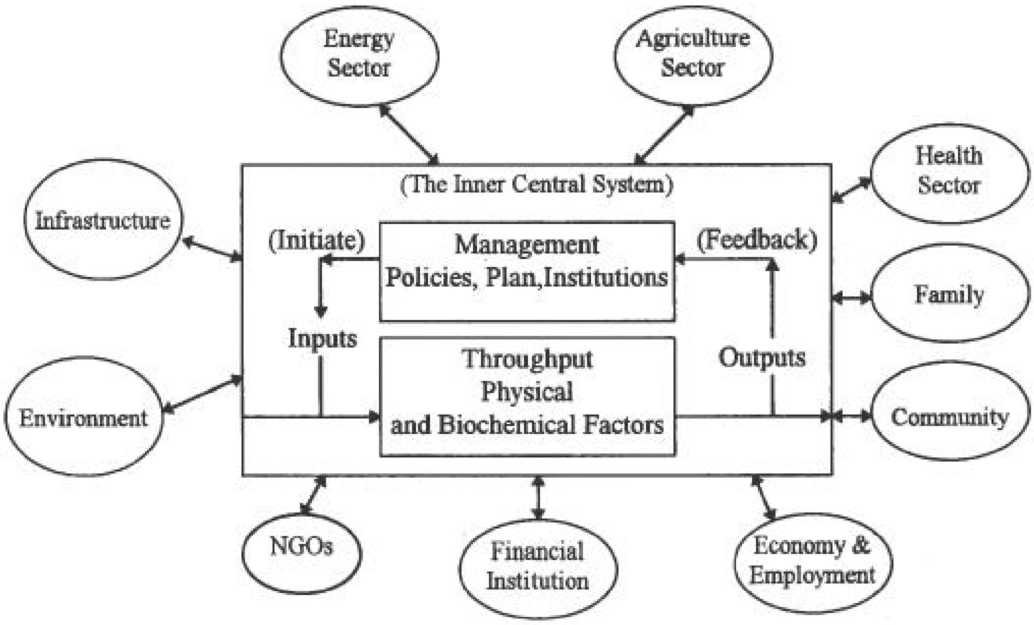
System Approach To Biogas Technology

1.1 Introduction

A system is a conglomerate of interrelated parts, each of which in turn can be viewed as a subsystem {Flippo, 1981). This training takes a system approach to understand various aspects of biogas technology and its relevance to other sectors at different levels of operation. Chart 1.1 shows inner and extended systems of the biogas technology. It depicts various subsystems through which biogas could be affected and influence the socio-economic well-being of a society. Such an understanding is necessary for being able to manipulate different elements of the biogas system to make optimum use of the technology in different situations.

This is the first session of the training programme and by the end of this session, the participants will be able to:

- explain different components of biogas technology;
- explain relevance of multi-disciplinary approach for promotion of the technology; explain inter-relationships between biogas and other subsystems that surround it; and
- enumerate critical factors to consider in making optimum use of the technology in a given situation or context.



The Outer Extended System

Chart 1.1 A System Approach to Biogas Technology

1.2 Components of a Biogas System

Biogas technology is a complete system in itself with its set objectives (cost effective production of energy and soil nutrients), factors such as microbes, plant design, construction materials, climate, chemical and microbial characteristics of inputs, and the inter-relationships among these factors. Brief discussions on each of these factors or subsystems are presented in this section.

1.2.1 Biogas

This is the mixture of gas produced by methanogenic bacteria while acting upon biodegradable materials in an anaerobic condition. Biogas is mainly composed of 50 to 70 percent methane, 30 to 40 percent carbon dioxide (CO2) and low amount of other gases as shown in Table 1.1.

Table 1.1
Composition of Biogas

Substances	Symbol	Percentage
Mclhane	CH,	50 - 70
Carbon Dioxide	CO_2	30-40
Hydrogen	H,	5- 10
Nitrogen	N_2	1-2
Water vapour	H_2O	0.3
Hydrogen Sulphide	H_2S	Traces

Sources: Yadav and Hesse 1981

Biogas is about 20 percent lighter than air and has an ignition temperature in the range of 650° to 750° C It is an odourless and colourless gas that burns with clear blue flame similar to that of LPG gas (Sathianathan, 1975). Its calorific value is 20 Mega Joules (MJ) per m^3 and burns with 60 percent efficiency in a conventional biogas stove.

1.2.2 Methanogenic Bacteria or Methanogens

These are the bacteria that act upon organic materials and produce methane and other gases in the process of completing their life-cycle in an anaerobic condition. As living organisms, they tend to prefer certain conditions and are sensitive to micro-climate within the digester. There are many species of methanogens and their characteristics vary.

The different methane forming bacteria have many physiological properties in common, but they are heterogeneous in cellular morphology. Some are rods, some cocci, while others occur in clusters of cocci known as sarcine. The family of methanogens (Methanobacteriacea) is divided into following four genera on the basis of cytological differences (Alexander, 1961).

A. Rod-shaped Bacteria

(a) Non-sporulating, Methanobacterium
(b) Sporulating. Methanobacillus

B. Spherical

(a) Sarcinae, Methanosarcina
(b) Not in sarcinal groups, Methanococcus

A considerable level of scientific knowledge and skill is required to isolate methanogenic bacteria in pure culture and maintain them in a laboratory. Methanogenic bacteria develop slowly and are sensitive to a sudden change in physical and chemical conditions. For example, a sudden fall in the slurry temperature by even T C may significantly affect their growth and gas production rate (Lagrange, 1979).

1.2.3 Biodigester

The biodigester is a physical structure, commonly known as the biogas plant. Since various chemical and microbiological reactions take place in the biodigester, it is also known as bio-reactor or anaerobic reactor. The main function of this structure is to provide anaerobic condition within it. As a chamber, it should be air and water tight. It can be made of various construction materials and in different shape and size. Construction of this structure forms a major part of the investment cost. Some of the commonly used designs are discussed below.

Floating Drum Digester

Experiment on biogas technology in India began in 1937. In 1956. Jashu Bhai J Patel developed a design of floating drum biogas plant popularly known as *Gobar Gas plant.* In 1962, Patcl's design was approved by the Khadi and Village Industries Commission (KVIC) of India and this design soon became popular in India and the world. The design of KVIC plant is shown in Figure 1.1.

In this design, the digester chamber is made of brick masonry in cement mortar. A mild steel drum is placed on top of the digester to collect the biogas produced from the digester. Thus, there are two separate structures for gas production and collection. With the introduction of fixed dome Chinese model plant, the floating drum plants became obsolete because of comparatively high investment and maintenance cost along with other design weaknesses. In Nepal. KVIC design plants have not been constructed since 1986.

Fixed Dome Digester

Fixed dome Chinese model biogas plant (also called drumless digester) was built in China as early as 1936. It consists of an underground brick masonry compartment (fermentation chamber) with a dome on the top for gas storage. In this design, the fermentation chamber and gas holder are combined as one unit. This design eliminates the use of costlier mild steel gas holder which is susceptible to corrosion. The life of fixed dome type plant is longer (from 20 to 50 years) compared to KVIC plant. Based on the principles of fixed dome model from China, Gobar Gas and Agricultural Equipment Development Company (GGC) of Nepal has developed a design and has been popularizing it since the last 17 years. The concrete dome is the main characteristic of GGC design. Its sketch is given in Figure 1.2.

Deenbandhu Model

In an effort to further bring down the investment cost, Deenbandhu model was put forth in 1984 by the Action for Food Production (AFPRO), New Delhi. In India, this model proved 30 percent cheaper than Janata Model (also developed in India) which is the first fixed dome plant based on Chinese technology. It also proved to be about 45 percent cheaper than a KVIC plant of comparable size. Deenbandhu plants are made entirely of brick masonry work with a spherical shaped gas holder at the top and a concave bottom. A typical design of Deenbandhu plant is shown in Figure 1.3 (Singh. Myles and Dhussa, 1987).

The Soudi Asian Partnership/Nepal (SAP/N), an INGO working in Nepal, has introduced Deenbandhu model plants in Bardiya district of Nepal. About 100 plants were constructed by SAP/N in the villages of Bardiya district in 1994. Preliminary studies carried out by BSP did not find any significant difference in the investment costs of GGC and the Deenbandhu design plants.

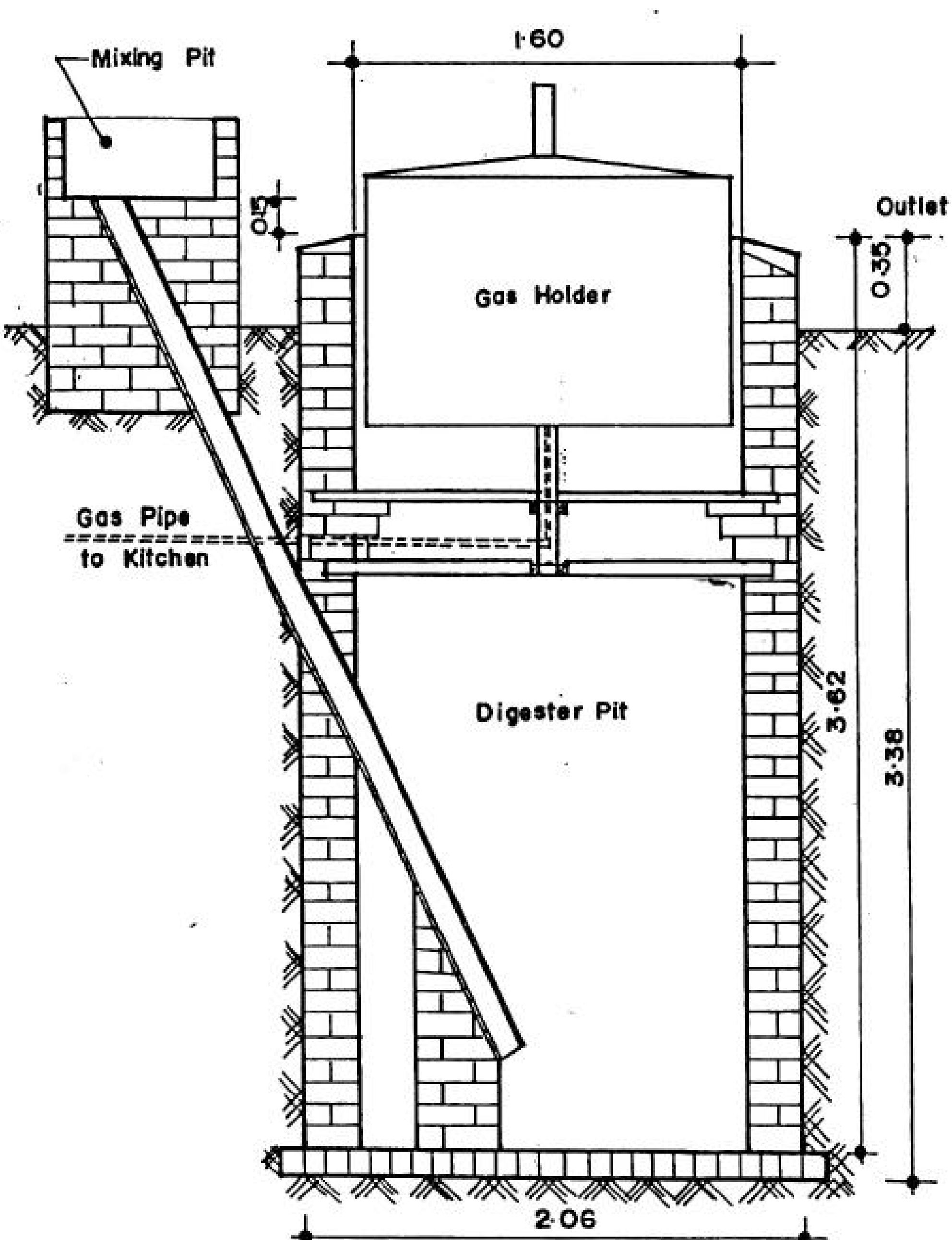
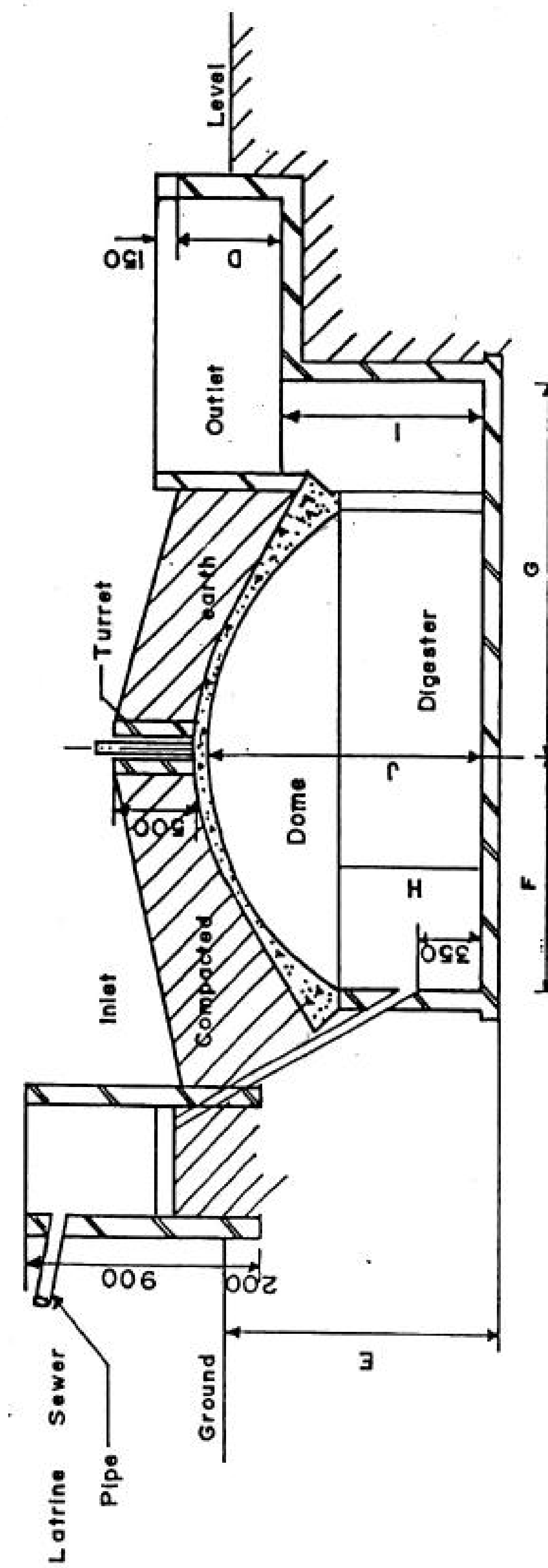
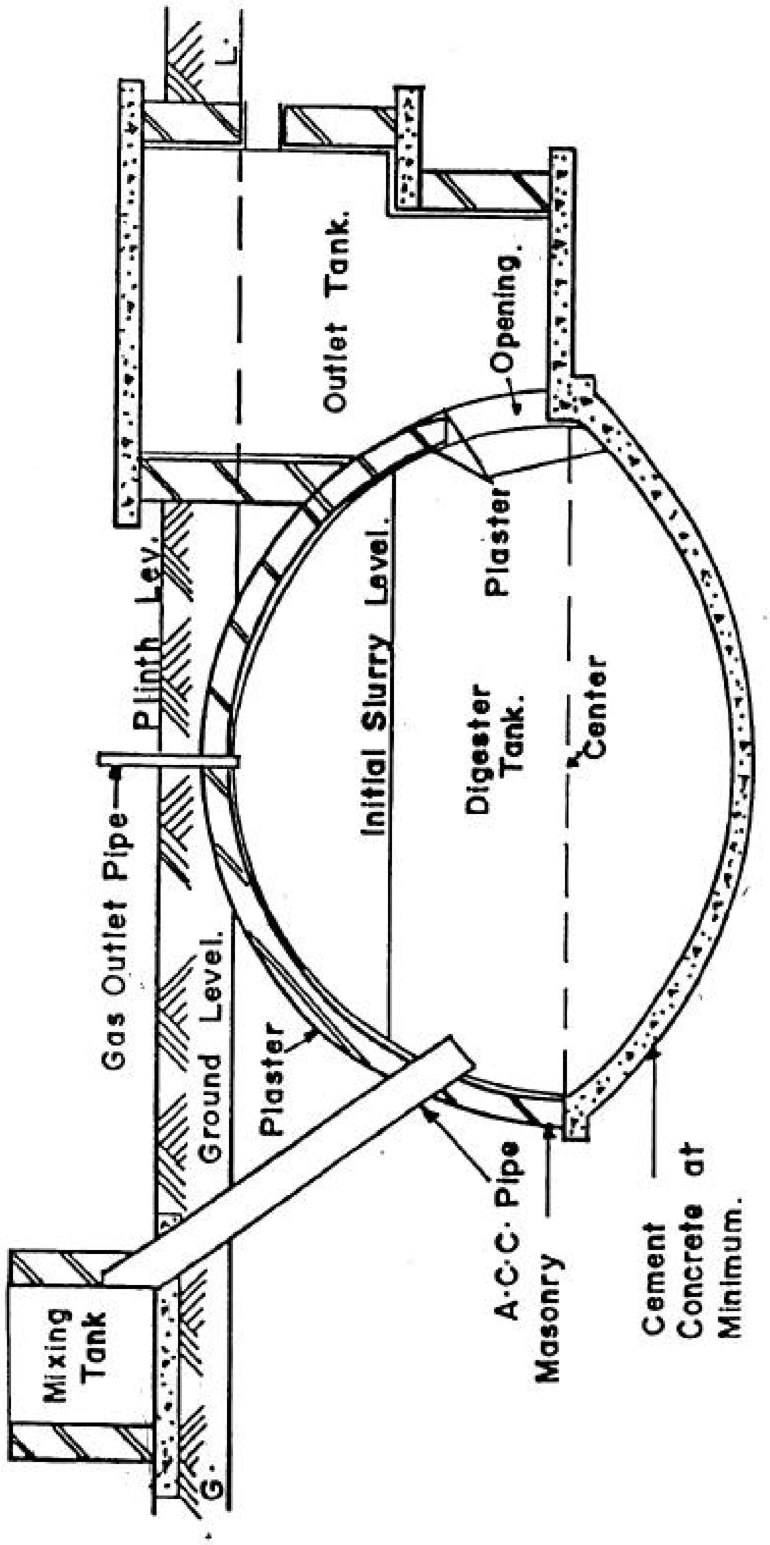


FIGURE 1·1 KVIC FLOATING GAS HOLDER SYSTEM



SECTION

FIGURE-1·2 GGC CONCRETE MODEL BIOGAS PLANT



FIGURE–1.3 DEENBANDHU BIOGAS PLANT (3m^3 gas production per day)

Recently, Environmental Protection and Social Development Association (EPA), a NGO, has constructed modified Deenbandhu design plants in Bardiya district which is also approved by Biogas Support Programme (BSP)

In addition to above designs developed particularly for household use in developing countries, there are other designs suitable for adoption in other specific conditions. Though they are not of much relevance to present conditions in Nepal, they could prove useful in the future. These designs are briefly described below for reference.

Bag Digester

This design was developed in 1960s in Taiwan. It consists of a long cylinder made of PVC or red mud plastic (Figure 1.4). The bag digester was developed to solve the problems experienced with brick and metal digesters. A PVC bag digester was also tested in Nepal by GGC at Butwal from April to June 1986. The study concluded that the plastic bag biodigester could be successful only if PVC bag is easily available, pressure inside the digester is increased and welding facilities are easily available (Biogas Newsletter, No. 23, 1986). Such conditions are difficult to meet in most of the rural areas in developing countries.

Plus Flow Digester

The plug flow digester is similar to the bag digester. It consists of a trench (trench length has to be considerably greater than the width and depth) lined with, concrete or an impermeable membrane. The reactor is covered with either a flexible cover gas holder anchored to the ground, concrete or galvanized iron (GI) top. The first documented use of this type of design was in South Africa in 1957. Figure 1.5 shows a sketch of such a reactor (Gunnerson and Stuckey, 1986). This design has not been constructed at the field level in Nepal.

Anaerobic Filter

This type of digester was developed in the 1950's to use relatively dilute and soluble waste water with low level of suspended solids. It is one of the earliest and simplest type of design developed to reduce the reactor volume. It consists of a column filled with a packing medium. I A great variety of non-biodegradable materials have been used as packing media for anaerobic filter reactors such as stones, plastic, coral, mussel shells, reeds, and bamboo rings. The methane forming bacteria form a film on the large surface of the packing medium and are not earned out of the digester with the effluent. For this reason, these reactors are also known as "fixed film" or "retained film" digesters (Bioenergy Systems Report. 1984). Figure 1.6 presents a sketch of the anaerobic filter (Gunnerson and Stuckey. 1986). This design is best suited for treating industrial, chemical and brewery wastes.

Upflow Anaerobic Sludge Blanket

This UASB design was developed in 1980 in the Netherlands. It is similar to the anaerobic filter in that it involves a high concentration of immobilized bacteria in the reactor. However, the UASB reactors contain no packing medium, instead, the methane forming bacteria are concentrated in the dense granules of sludge blanket which covers the lower part of the reactor. The feed liquid enters from the bottom of the reactor and biogas is produced while liquid flows up through the sludge blanket (Figure 1.7). Many full-scale UASB plants are in operation in Europe using waste water from sugar beet processing and other dilute wastes that contain mainly soluble carbohydrates (Bioenergy Systems Report, 1984). Such reactor has not been experimented in Nepal.

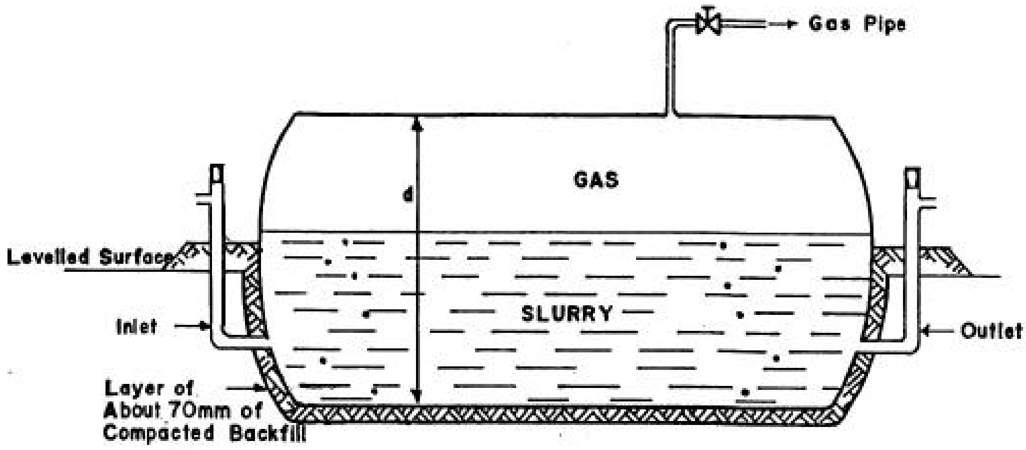


FIGURE-1.4 BAG DIGESTER.

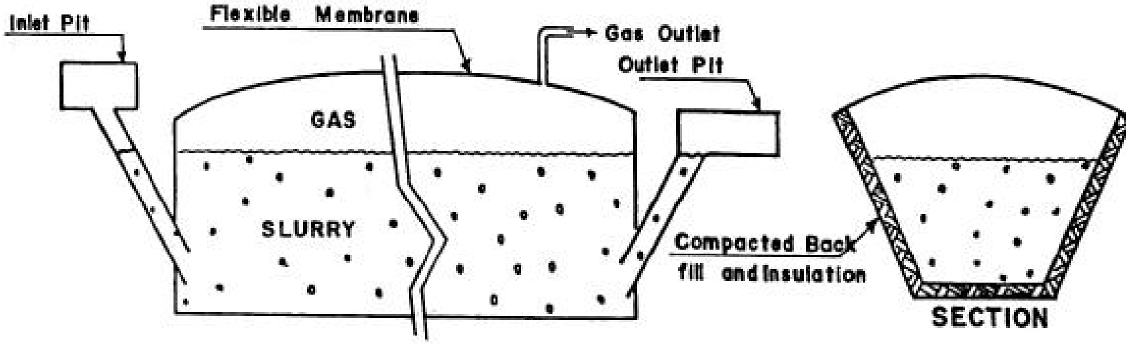


FIGURE-1.5 PLUG FLOW DIGESTER

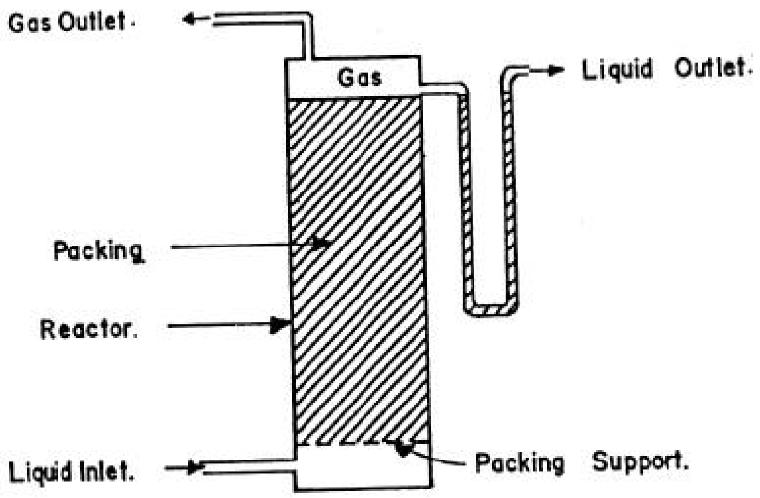


FIGURE.-1·6 ANAEROBIC FILTER.

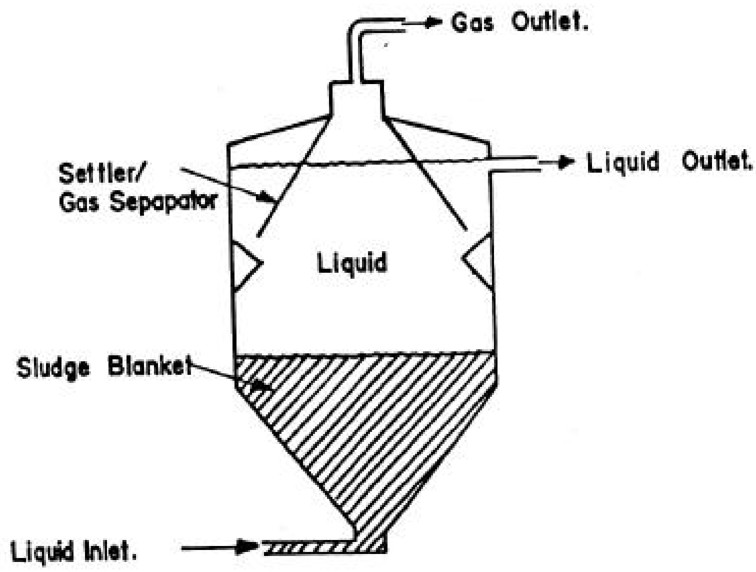


FIGURE.-1:7 UPFLOW ANAEROBIC SLUDGE BLANKET(UASB)

There are also other designs of anaerobic reactors which are of less interest in the context of Nepal due to their limited utility. Reduction in investment cost using alternative construction materials has been one of the main driving forces in he development of new designs. In a effort to achieve this objective, use of bamboo, plastics and other such cheap construction materials have also been tried with varying degree of success (Cortsen, Lassen and Neilsen, 1995; beteta, 1995). However, all such reported success stories are yet to take the form if implementation programmes in a mass scale.

The main factors that influence the selection of a particular design or model of a biogas plant are as follows:

Economic: An ideal plant should be as low-cost as possible (in terms of the production cost per unit volume of biogas0 both to the user as well as to the society. At present, with subsidy, the cost of a plant to the society is higher than to an individual user.

Utilization of Local Materials: Use of easily available local materials should be emphasized in the construction of a biogas plant. This is an important consideration, particularly in the context of Nepal where transportation system is not yet adequately developed.

Durability: Construction of a biogas plant requires certain degree of specialized skill which may not be easily available. A plant of short life could also be cost effective but such a plant may nto reonstructed once its useful life ends. Especially in situation where people are yet to be motivated for the adoption of this technology and the necessary skill and materials are not readily available, it is necessary to construct plants that are more durable although this may require a higher initial investment.

Suitable for the Type of Inputs: The design should be compatible with the type of inputs that would be used. If plant materials such as rice straw, maize straw or similar agricultural wastes are to be used then the batch feeding design or discontinuous system should be used instead of a design for continuous or semi-continuous feeding.

Frequency of Using inputs and Outputs: Selection of a particular design and size of its various components also depend on how frequently the user can feed the system and utilize the gas.

1.2.4 Inputs and Their Characteristics

Any biodegradabel organic material can be used as inputs for processing inside the biodigester. However, for economic and technical reasons, some materials are more preferred as inputs than others. If the inputs are costly or have to be purchased, then the economic benefits of outputs such as gas and slurry will become low. Also, if easily available biodegradable wastes are used as inputs, then that benefits could be of two folds: (a) economic value of biogas and its slurry; and (b) environmental cost avoided in dealing with the biodegradable waste in some other ways such as disposal in landfill

One of the main attractions of biogas technology is its ability to generate biogas out of organic wastes that are abundant and freely available. In case of Nepal, it is the cattle dung that is most commonly used as an input mainly because of its viability. The potential gas production form some animal dung is given in Table 1.2

Table 1.2
Gas Production Potential of Various Types of Dung

Types of Dung	Gas Production Per Kg Dung (m^J)
Cattle (cows and buffaloes)	0.023 - 0.040
Pig	0.040 - 0.059
Poultry (Ciuckens)	0.065-0.116
Human	0.020- 0.028

Source: Updated Guidebook on Biogas Development, 1984

In addition to the animal and human wastes, plant materials can also be used to produce biogas and bio-manure. For example, one kg of pre-treated crop waste and water hyacinth have the potential of producing 0.037 and 0.045 m^3 of biogas, respectively.

Since different organic materials have different bio-chemical characteristics, their potential for gas production also varies. Two or more of such materials can be used together provided that some basic requirements for gas production or for normal growth of methanogens are met. Some characteristics of these inputs which have significant impact on the level of gas production are described below.

C/N Ratio : The relationship between the amount of carbon and nitrogen present in organic materials is expressed in terms of the Carbon/Nitrogen (C/N) ratio. A C/N ratio ranging from 20 to 30 is considered optimum for anaerobic digestion. If the C/N ratio is very high, the nitrogen will be consumed rapidly by methanogens for meeting their protein requirements and will no longer react on the left over carbon content of the material. As a result, gas production will be low. On the other hand, if the C/N ratio is very low, nitrogen will be liberated and accumulated in the form of ammonia (NH4), NH_4 will increase the pH value of the content in the digester. A pH higher than 8.5 will start showing toxic effect on methanogen population.

Animal waste, particularly cattle dung, has an average C/N ratio of about 24. The plant materials such as straw and sawdust contain a higher percentage of carbon. The human excreta has a C/N ratio as low as 8. C/N ratio of some of the commonly used materials are presented in Table 1.3 (Karki and Dixit, 1984).

Table 1.3
C/N Ratio of Some Organic Materials

S.N.	Raw Materials	C/N Ratio
1.	Duck dung	8
2.	Human excreta	8
3.	Chicken dung	10
4.	Goat dung	12
5.	Pig dung	18
6.	Sheep dung	19
7.	Cow dung/ Buffalo dung	24
8.	Water hyacinth	25
9.	Elephant dung	43
10.	Straw (maize)	60
11.	Straw (rice)	70
12.	Straw (wheat)	90
13.	Saw dust	above 200

Materials with high C/N ratio could be mixed with those of low C/N ratio to bring the average ratio of the composite input to a desirable level. In China, as a means to balance C/N ratio, it is customary' to load nee straw at the bottom of the digester upon which latrine waste is discharged. Similarly, at Machan Wildlife Resort located in Chitawan district of Nepal, feeding the digester with elephant dung in conjunction with human waste enabled to balance C/N ratio for smooth production of biogas (Karki, Gautam and Karki, 1994).

Dilution and Consistency of Inputs: Before feeding the digester, the excreta, especially fresh cattle dung, has to be mixed with water at the ratio of 1:1 on a unit volume basis (i.e. same volume of water for a given volume of dung) However, if the dung is in dry form, the quantity of water has to be increased accordingly to arrive at the desired consistency of the inputs (e.g. ratio could vary from 1:1.25 to even 1:2). The dilution should be made to maintain the total solids from 7 to 10 percent. If the dung is too diluted, the solid particles will settle down into the digester and if it is too thick, the particles impede the flow of gas formed at the lower part of digester. In both cases, gas production will be less than optimum. A survey made by BSP reveals that the farmers often over dilute the slum'.

For thorough mixing of the cow dung and water (slurry), GGC has devised a Slurry Mixture Machine that can be fitted in the inlet of a digester. The specifications of the Slurry Mixture Machine which presently costs Rs 625 is given in Figure 1.8. It is also necessary to remove inert materials such as stones from the inlet before feeding the slurry into the digester Otherwise, the effective volume of the digester will decrease.

Volatile Solids : The weight of organic solids burned off when heated to about 538" C is defined as volatile solids. The biogas production potential of different organic materials, given in Table 1.2, can also be calculated on the basis of their volatile solid content. The higher the volatile solid content in a unit volume of fresh dung, the higher the gas production For example, a kg of volatile solids in cow dung would yield about 0.25 m^3 biogas (Sathianathan. 1975).

1.2.5 Digestion

Digestion refers to various reactions and interactions that take place among the methanogens. non-methanogens and substrates fed into the digester as inputs. This is a complex physio-chemical and biological process involving different factors and stages of change. This process of digestion (methanization) is summarized below in its simple form.

The breaking down of inputs that are complex organic materials is achieved through three stages as described below:

Stage 1 Hydrolysis: The waste materials of plant and animal origins consist mainly of carbohydrates, lipids, proteins and inorganic materials. Large molecular complex substances are solubilized into simpler ones with the help of extracellular enzyme released by the bacteria. This stage is also known as polymer breakdown stage. For example, the cellulose consisting of polymerized glucose is broken down to dimeric, and then to monomeric sugar molecules (glucose) by cellulolytic bacteria.

Stage 2 Acidification: The monomer such as glucose which is produced in Stage 1 is fermented under anaerobic condition into various acids with the help of enzymes produced by the acid forming bacteria. At this stage, the acid-forming bacteria break down molecules of six atoms of carbon (glucose) into molecules of less atoms of carbon (acids) which are in a more reduced state than glucose. The principal acids produced in this process are acetic acid, propionic acid, butyric acid and ethanol.

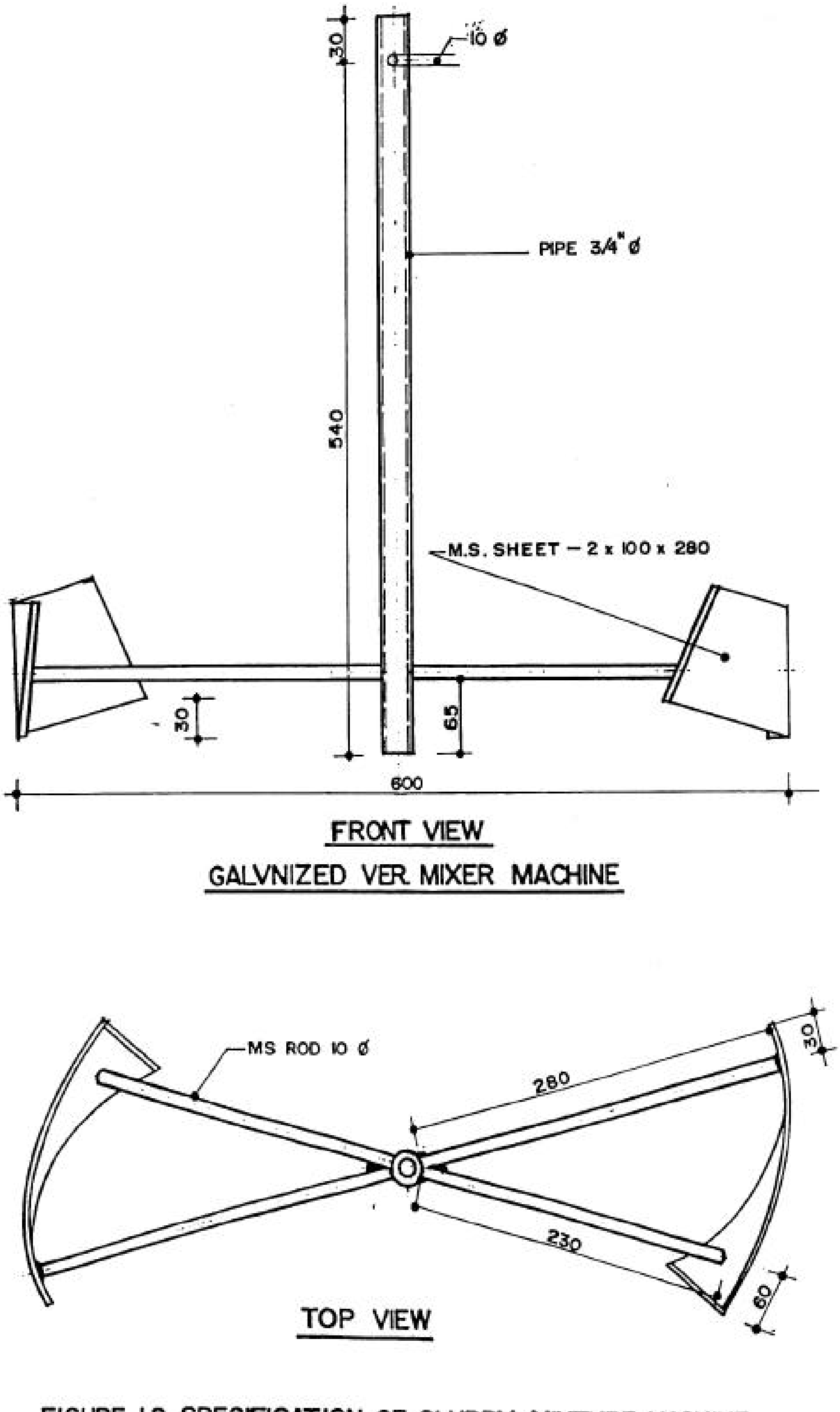


FIGURE 1·8 SPECIFICATION OF SLURRY MIXTURE MACHINE

ALL DIMENSIONS ARE IN MM

Stage 3 *Methanization:* The principle acids produced in Stage 2 are processed by methanogenic bacteria to produce methane. The reactions that takes place in the process of methane production is called Methanization and is expressed by the following equations (Karki and Dixit. 1984).

CH_3COOH	$\rightarrow$	CH_4	+	CO_2		
Acetic acid		Methane		Carbon dioxide		
$2CH_3CH_2OH$	+	CO_2	$\rightarrow$	CH_4	+	$2CH_3COOH$
Ethanol		Carbon dioxide		Methane		Acetic acid
CO_2	+	$4H_2$	$\rightarrow$	CH_4	+	$2H_2O$
Carbon dioxide		Hydrogen		Methane		Water

The above equations show that many products, by-products and intermediate products are produced in the process of digestion of inputs in an anaerobic condition before the final product (methane) is produced. Obviously, there are many facilitating and inhibiting factors that play their role in the process. Some of these factors are discussed below.

pH value : The optimum biogas production is achieved when the pH value of input mixture in the digester is between 6 and 7. The pH in a biogas digester is also a function of the retention time. In the initial period of fermentation, as large amounts of organic acids are produced by acid forming bacteria, the pH inside the digester can decrease to below 5. This inhibits or even stops the digestion or fermentation process. Methanogenic bacteria are very sensitive to pH and do not thrive below a value of 6.5. Later, as the digestion process continues, concentration of NH4 increases due to digestion of nitrogen which can increase the pH value to above 8. When the methane production level is stabilized, the pH range remains buffered between 7.2 to 8.2.

Temperature: The methanogens are inactive in extreme high and low temperatures. The optimum temperature is 35° C. When the ambient temperature goes down to 10" C, gas production virtually stops. Satisfactory gas production takes place in the mesophilic range, between 25º to 30° C. Proper insulation of digester helps to increase gas production in the cold season. When the ambient temperature is 30° C or less, the average temperature within the dome remains about 4º C above the ambient temperature (Lund, Andersen and Tony-Smith, 1996).

Loading Rate: Loading rate is the amount of raw materials fed per unit volume of digester capacity per day. In Nepalese conditions, about 6 kg of dung per m^3 volume of digester is recommended incase of a cow dung plant (BSP, 1992). If the plant is overfed, acids will accumulate and methane production will be inhibited. Similarly, if the plant is underfed, the gas production will also be low.

Retention Time: Retention time (also known as detention time) is the average period that a given quantity of input remains in the digester to be acted upon by the methanogens. hi a cow dung plant, the retention time is calculated by dividing the total volume of the digester by the volume of inputs added daily. Considering the climatic conditions of Nepal, a retention time of 50 to 60 days seems desirable. Thus, a digester should have a volume of 50 to 60 times the slurry added daily. But for a night soil biogas digester, a longer retention time (70-80 days) is needed so that the pathogens present in human faeces are destroyed. The retention time is also dependent on the temperature and upto 35° C, the higher the temperature, the lower the retention time (Lagrange, 1979).

Toxicity: Mineral ions, heavy metals and the detergents are some of the toxic materials that inhibit the normal growth of pathogens in the digester. Small quantity of mineral ions (e.g. sodium, potassium, calcium, magnesium, ammonium and sulphur) also stimulates the growth of bacteria, while very heavy concentration of these ions will have toxic effect. For example, presence of NH4 from 50 to 200 mg/1 stimulates the growth of microbes, whereas its concentration above 1,500 mg/1 produces toxicity.

Similarly, heavy metals such as copper, nickel, chromium, zinc, lead, etc. in small quantities are essential for the growth of bacteria but their higher concentration has toxic effects. Likewise, detergents including soap, antibiotics, organic solvents, etc. inhibit the activities of methane producing bacteria and addition of these substances in the digester should be avoided. Although there is a long list of the substances that produce toxicity on bacterial growth, the inhibiting levels of some of the major ones are given in Table 1.4.

Table 1.4
Toxic Level of Various Inhibitors

S. N.	Inhibitors	Inhibiting Concentration
1.	Sulphate (SO_4^{--})	5.000 ppm
2.	Sodium Chloride or Common sail (NaCl)	40,000 ppm
3.	Nitrate (Calculated as N)	0.05 nig/ml
4.	Copper (Cu^{++})	100 mg/1
5.	Chromium (Cr^{+++})	200 mg/1
6.	Nickel {Ni^{+++})	200 - 500 mg/1
7.	Sodium (Na^{+})	3,500 - 5,500 **mg/1**
8.	Potassium (K^{+})	2,500 - 4,500 **mg/1**
9.	Calcium (Ca^{++})	2,500 - 4.500 mg/1
10.	Magnesium (Mg^{++})	1,000 - 1,500 mg/1
11.	Manganese (Mn^{++})	Above 1,500 mg/1

Source: The Biogas Technology in China, BRTC, China (1989)

1.2.6 Slurry

This is the residue of inputs that comes out from the outlet after the substrate is acted upon by the methonogenic bacteria in an anaerobic condition inside the digester. After extraction of biogas (energy), the slurry (also known as effluent) comes out of digester as by-product of the anaerobic digestion system. It is an almost pathogen-free stabilized manure that can be used to maintain soil fertility and enhance crop production. Slurry is found in different forms inside the digester as mentioned below:

- a light rather solid fraction, mainly fibrous material, which float on the top forming the scum;
- a very liquid and watery fraction remaining in the middle layer of the digester;
- a viscous fraction below which is the real slurry or sludge; and
- heavy solids, mainly sand and soils that deposit at the bottom.

There is less separation in the slurry if the feed materials are homogenous. Appropriate ratio of urine, water and excrement and intensive mixing before feeding the digester leads to homogeneous slurry.

1.2.7 Use of Biogas

Of the outputs of biogas, the gas is valued for its use as a source of energy and the slurry for its fertilizing properties (soil nutrients). Energy content of biogas can also be transformed into various other forms such as mechanical energy (for running machines) and heat energy (for cooking and lighting) depending on the need and availability of the technology. Some of the common uses of biogas are; (a) cooking, (b) lighting, (c) refrigeration, and (d) running internal combustion engine.

1.3 Implications of Biogas System

Biogas technology is best suited to convert the organic waste from agriculture, livestock, industries, municipalities and other human activities into energy and manure. The use of energy and manure can lead to better environment, health, and other socio-economic gains is shown in Chart 1.2.

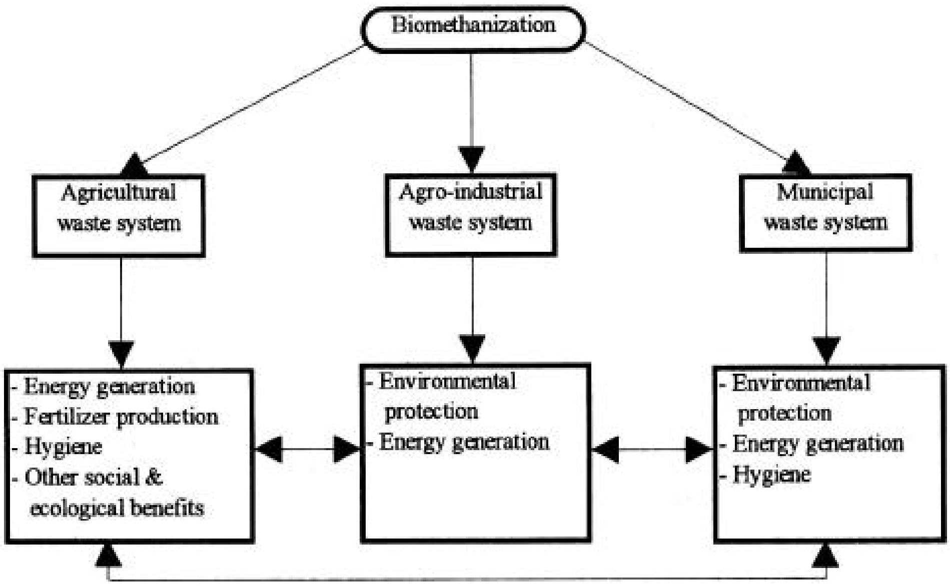


Chart 1.2 Biomethanization Implementation and its Effects

1.4 Session Plan

Activity No.	Topic and Area of Discussion	Time (minutes)	Methods of Training	leaching-Aids
1.	Introduction and highlight of the objectives of the session	3	Lecture	Overhead (O/H) projector, screen and flip chart
2.	Component of a biogas system	20	Lecture	O/H projector, screen and flip chart
3.	Broader implications of biogas system	7	Lecture cum discussion	O/H projector, screen and flip chart
4.	General discussion	20	Discussion	Questions and answers
	Total Time	**50**		

1.5 Review Questions

- Prepare a list of different components of a system for biogas generation.
- What are the main functions of a biodigester?
- Can biogas be produced in an open pit?
- What factors need to be considered in selecting a particular design of a biogas plant?
- How could biogas technology be useful for urban population?

- Why is biogas technology viewed more as a technology for rural people?
- What role can biogas technology play in the overall development of Nepal?
- Prepare a list of minimum qualifications that a potential biogas user should have.

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1.7 Further Reading Materials

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SESSION TWO

RELEVANCE OF BIOGAS TECHNOLOGY TO NEPAL

SESSION TWO

Relevance of Biogas Technology to Nepal

2.1 Introduction

The basic components of biogas technology as a complete system were discussed in the previous session. This session highlights the relevance of the technology in terms of its potential to ameliorate some of the development problems and the potential that exist for the promotion of this technology in Nepal. By the end of this session, the participants will be able to:

- enumerate problems generally' faced by developing countries that can be resolved through the
- adoption of biogas technology:
- explain the potential of biogas technology in Nepal; and
- explain how biogas technology can help improve the socio-economic condition of women in Nepal.

The attainment of the national objective of providing better life for its citizens depends upon various factors such as agriculture, industry, health, infrastructure and education to name a few. Energy consumption is so much a common factor in all these sectors that the per capita energy consumption is taken as one of the indicators to assess the quality of life in a country. All economic policy planning initiatives have a direct and/or indirect impact on the demand for and supply of commercial and non commercial energy. Furthermore, various policies of energy consumption and energy investment influence the performance of the non-energy sectors of an economy.

> *"Plans and Master Plans have been completed for the development of forestry, agriculture, tourism etc. Hut these plans will prove to be ineffective in the long run in achieving broader national development objective if they arc not linked to the overall energy implications."* (WECS-1994)

2.2 Energy Situation in Nepal

The energy situation in Nepal is characterized by a very low annual energy consumption per capita of 14.06 GJ (WECS. 1994). The sources of energy are conventionally grouped into three categories as discussed below.

2.2.1 Traditional Sources of Energy

This group of energy sources includes fuelwood. agricultural residue and animal waste. Sustainable fuelwood supply from existing forest and other sources was estimated at 7.5 million tons for the year 1993. Agricultural residue and animal waste production for that year was estimated at 11.0 million tons each ("WECS, 1994). These sources meet about 91 percent of total national energy consumption as shown in Chart 2.1.

Nepal has an estimated area of 9.2 million ha of potentially productive forest, shrub and grassland, of which 3.4 million ha are considered to be accessible for fuelwood collection. Sustainable yield from this accessible area was estimated to be about 7.5 million tons, while total fuelwood consumption was estimated to be about 11 million tons. The deficit was met mainly by felling of trees and burning more of agriculture and animal waste.

In the face of dwindling forest area in fragile geology and its consequences, the possibility of fuelwood substitution by kerosene is limited to urban areas alone due to the limited transport network and low affordability of a majority of the population.

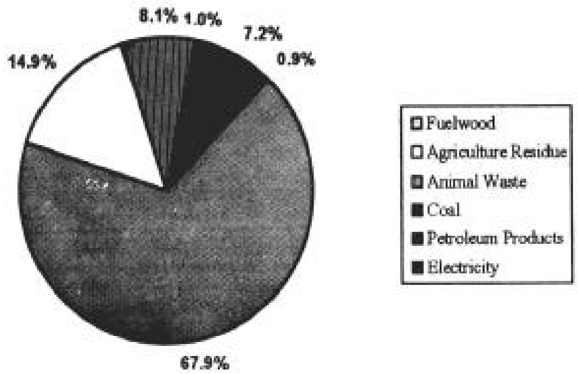


Chart 2.1 Domestic Sector Energy Consumption (WECS, 1994)

2.2.2 Commercial Sources of Energy

Nepal fully relies on the import for all commercial fuels except electricity. In 1992, Nepal spent about 32 percent of its merchandise export earning for the import of fossil fuel. With increasing cost and unreliable supply of some of the commercial fuels such as coal, use of firewood in the commercial sector is also increasing (WECS, 1994).

Electricity : Nepal has an estimated theoretical hydropower potential of 83,000 MW, out of which 42,000 MW seems to be economically feasible. However, the present installed capacity of Integrated Nepal Power System (INPS) is about 268 MW of which 232 MW is hydropower and the remaining 36 MW is generated from diesel and multifuel plants. About 12 percent of the population are connected to electricity distribution system, 3 percent of which comprises of rural population.

Petroleum and Natural Gas : Nepal has started conducting various surveys and measurements to explore the possibility of fossil fuel and gas in the country. However, any finding of practical implication is still awaited except the deposition of about 300 million m^3 of natural gas in the Kathmandu valley.

Coal : Except for small deposition of lignite in different locations, no coal deposition has yet been identified that could be economically mined.

2.2.3 Sources of Alternative Energy

This category includes solar, wind, micro-hydropower generating less than 100 kW and biogas.

The potential for wind energy in the country is yet to be determined. The solar energy potential is estimated at about 26.6 MW. Use of these sources of energy in a mass scale is limited by the high level of technology involved and the mis-match with the end-use pattern in the Nepali context. For example, people would not prefer to cook outside of the house using solar energy.

Of all types of alternative energy' sources known, it is only the biogas technology that has established itself as a viable and feasible technology in a wide range of socio-physical conditions of Nepal which is characterized by:

- low level of per capita energy consumption;

- a large share of energy consumed in the domestic sector, in scattered dwellings, mainly for cooking and lighting;
- low rate of literacy and skilled human resource;
- low investment capacity; and
- farming combined with a few cattle heads practised by majority of the population.

As pointed out earlier, the gap between the sustainable production of firewood from existing forest area and the level of firewood consumption is about 3.5 millions tons (WECS, 1994). A large part of this gap can be bridged with the use of existing biogas potential as is revealed from the following calculation.

- 1 m^3 biogas is equivalent to 3.5 kg of firewood
- A family size biogas plant of 8 to 10 m^3 produces about 2 m^3 gas per day
- A family size biogas plant saves an average of 7.0 kg firewood per day or 2.55 tons per year
- 1.3 million plants (potential) will save an equivalent of 3,320,000 tons firewood per year

Realizing this situation, the following policy provision has been made in the current Five year Plan (1992-97).

- Replace the fossil fuel energy needs of the individual, commercial and transport sector by indigenous energy production whenever possible, and
- Encourage the development of renewable and alternative energy technologies in order to reduce the heavy dependence on traditional and imported fuels.

2.3 Biogas in Other Countries

The implementation of biomethanation in the developing world has a history as long as in the developed world. Biogas technology is being widely used both in the developed and developing economies in agricultural or rural, industrial, and municipal waste systems. The incentives of these projects and programmes may differ, but the main ones are energy generation and/or environmental protection.

During the World War II, many farmers in England, France and Germany built family scale digesters to produce methane from their household and farm waste. Use of these plants declined as other forms of energy became cheaper with supply assurance. The World energy crisis of 1973 stimulated the promotion of this technology, specially in the developing countries.

In developing countries, biogas is valued more as a source of energy for household cooking than the slurry is for its fertilizing value. Since 1973, the technology has spread at a faster rate in developing countries compared to the developed countries. Nearly 6 million digesters were installed in 53 countries of the Third World by 1987 compared to only 669 digesters in Europe. Most of these 6 million plants were of small scaled household plants while those installed in developed countries were of larger scale.

The stages of biogas development in different countries vary. In some countries, development of biogas programmes has lacked urgency because of the ensured supply of cheap energy sources other than biogas In China, India and Nepal, accelerating diffusion is taking place due to increasing scarcity of other sources of energy. In other countries such as Latin America, shift in the sectors of application and changes in implementation strategies can be observed.

China and India are among the leading countries both in terms of the technological development and the rate of adoption. Thailand, Republic of Korea, the Philippines and Nepal have also achieved significant progress on the development of this sector. In terms of ratio between number of plants and the size of population. Nepal ranks highest in the world.

Among the Latin American and the Caribbean countries, Brazil has made some significant development in the biogas sector. Other countries that are at different stages of promoting the technology with varying degree of success include Argentina. Barbados. Bolivia. Colombia. Costa Rica. Chile. Dominican Republic, Ecuador, El Salvador. Grenada, Guatemala. Guyana, Haiti, Honduras, Jamaica, Mexico. Nicaragua, Panama, Peru, Tobago, Uruguay and Venezuela.

Africa lags behind in the biogas development sector. Some efforts were undertaken on biogas in Kenya. Rwanda, Burundi, Lesotho and Benin but the programmes failed to pick national momentum in these countries.

2.4 Biogas Potential in Nepal

The potential for biogas production in Nepal is based on the number of cattle/buffalo in the country, or specifically on the quantity of dung that could be available for biogas. and the micro-climatic pockets in different parts of the country. The potential for biogas generation based on the number of cattle and buffalo in 1991/92 is presented in Table 2.1.

Table 2.1
Biogas Potential

Animal	Number (million)	Dung Available/ Animal/Day (kg)	Total Dung Available/Day (ton)	Biogas Yield per Kg of Dung (m^3)	Gas Volume (m^3)
Cattle	7.4	10	74.000	0.036	2,664.000
Buffalo	3.1	15	46,500	0.036	1,674,000
Total	**10.5**		**120,500**		**4,338,000**

The daily dung production from cattle and buffalo alone is about 120,500 tons which has theoretically a potential to produce 4,338,000 m^3 of biogas. Practically, only 75 percent of the potential, i.e., 3.253.500 m^3. would be available since the number of animals also include households with only one cattle or buffalo and hence do not have enough dung volume to feed the smallest size biogas plant (4 m^3) which requires 24 kg of dung per day. These calculations do not take account of the dung available from poultry and other domestic animals such as pigs and goats (van Nes, 1991). While such a huge energy potential remains unused which otherwise could have enhanced the rate of employment and the level of rural income, the rural communities continue to face energy starvation.

The potential number of biogas plants in the plains, hills and mountain has been estimated to be 800,000 (61 percent). 500,000 (38 percent) and 10,000 (1 percent), respectively. By June 1991, only about 0.5 percent of the potential of 1.3 million was realized (van Nes, 1992). But as a result of increasing number of private biogas companies (23 companies by February 1996), this number has increased to 1.92 percent (25,000 plants). This is graphically depicted in Chart 2.2. Compared to 1991, although the progress seems remarkable, there is still a long way to go so far as substantial achievement of the potential is concerned. It is estimated that about 25 to 50 percent of the technically potential plants are economically feasible. The number of households with animals, potential biogas households by district as per July 1995 are given in Annex 2,1 (BSP, 1996).

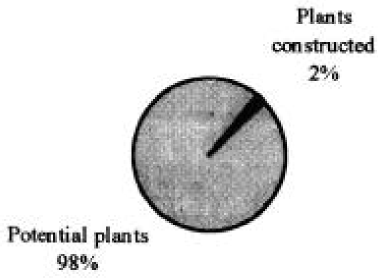


Chart 2.2 Biogas Potential

Chart 2.3 shows the rate of growth in the number of biogas plants installations.

2.5 Uses of Biogas

Like any other fuel, biogas can be used for household and industrial purposes, the main prerequisite being the availability of especially designed biogas burners or modified consumer appliances. Possible use of biogas as energy source is shown in Chart 2.4 (Ni Ji-Qin and Nynl, 1993).

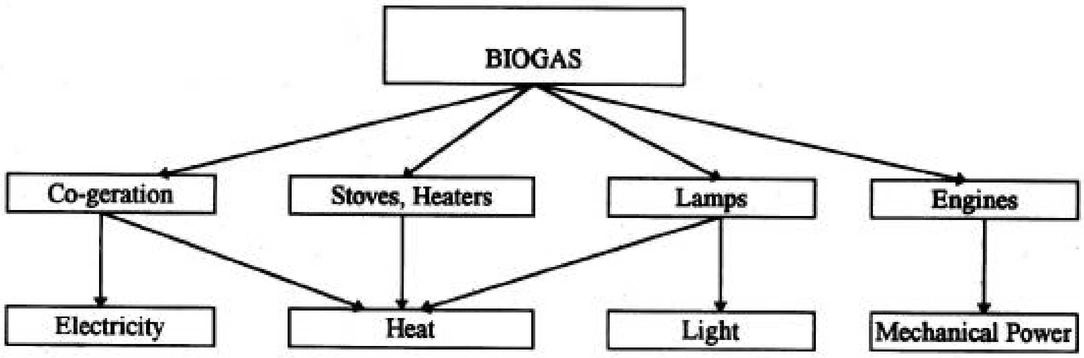


Chart 2.4 Utilization of Biogas as Energy Resource

2.5.1 Cooking

Cooking is by far the most important use of biogas in the developing world. Biogas burners or stoves for domestic cooking work satisfactorily under a water pressure of 75 to 85 mm. The stoves may be single (Figure 2.1) or double (Figure 2.2) varying in capacity from 0.22 to 1.10 m^3 gas of gas consumption per hour. Generally, stoves of 0.22 and 0.44 m^3 (8 and 16 cu ft) capacity are more popular A 1.10 m (40 cu ft) burner is recommended for a bigger family with larger plant size.

Gas requirement for cooking purposes has been estimated to be 0.33 m^3 per person per day under Indian or Nepalese conditions. If a family of 6 members owns a plant producing 2 m^3 of gas per day, usually two stoves (one with 0.22 m^3 and the other with 0.44 m^3 per hour capacity) can be used for one and half hours each in the morning and the evening to meet all cooking requirements of the family (Karki and Dixit, 1984).

Biogas stoves are also produced in Nepal but not in sufficient quantities to meet the demand and therefore, additional stoves have to imported from India.

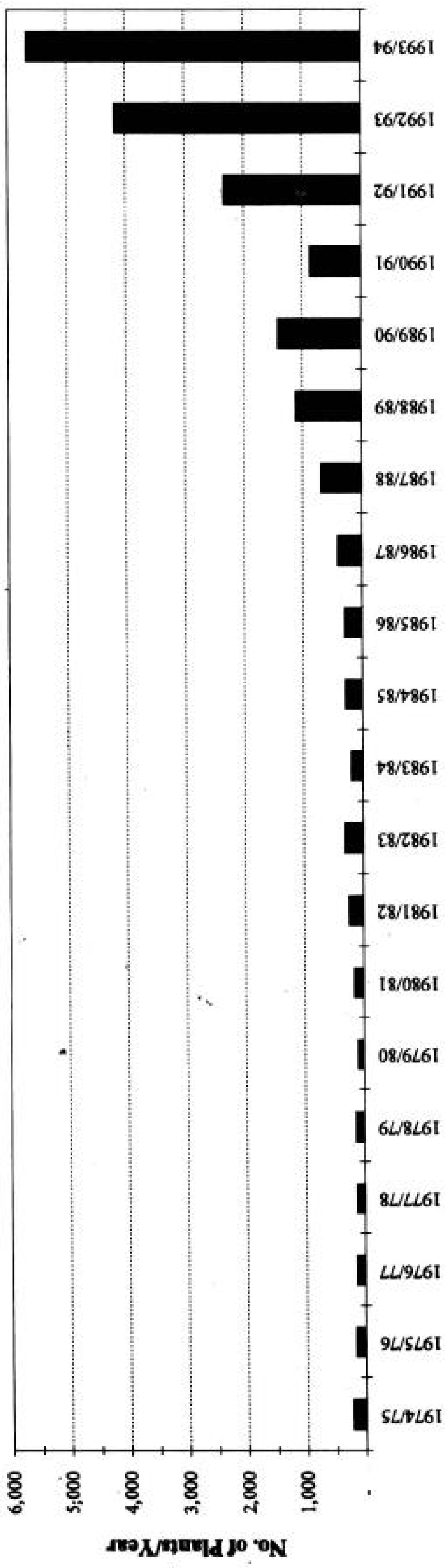


Chart 2.3 Number of Biogas Plants Built in Nepal From 1974/75 to 1993/94

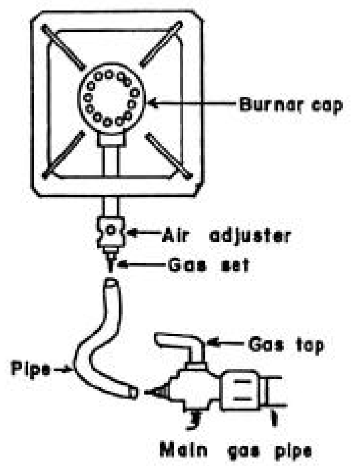


Figure-2.1 Biogas Burner Manufactured By GGG Workshop At Butwal, Nepal

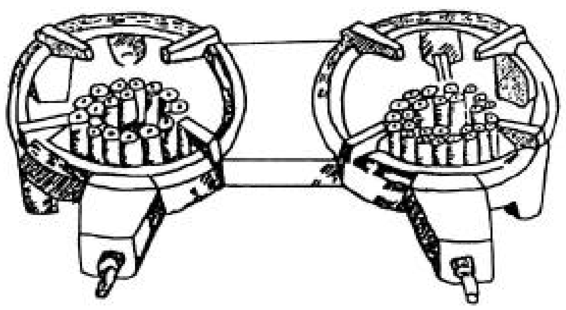


Figure-2.2 Biogas Burner With Two Mouths Manufactured In India

2.5.2 Lighting

Biogas can be used for lighting in non-electrified rural areas. Special types of gauze mantle lamps consuming 0.07 to 0.14 m^3 of gas per hour are used for household lighting. Several companies in India manufacture a great variety of lamps which have single or double mantles. Generally, 1-mantle lamp is used for indoor purposes and 2-mantle lamps for outdoors Such lamps emit clear and bright light equivalent to 40 to 100 candle powers. These are generally strong, well built, bright, efficient and easy to adjust Compared to stoves, lamps are more difficult to operate and maintain. The lamps work satisfactorily under a water pressure of 70 to 84 mm (Karki and Dixit, 1984). Until now, biogas lamps are not manufactured in Nepal and are imported from several companies in India. A sketch of the typical biogas lamp manufactured in India is given in Figure 2.3.

Different types of lamps are in use in China. They are simple in operation and easy to manufacture and are low priced. In remote places, clay lamps that do not need much skill to manufacture are still being used by Chinese farmers.

Biogas requirements for various appliances are indicated in Table 2.2.

Table 2.2
Biogas Requirements for Various Appliances

S.N.	Description	Size	Rate of Gas Consumption (m^3/hour)
1.	Stove	2" diameter	0.33
2.	Stove	4" diameter	0.44
3.	Stove	6" diameter	0.57
4.	Lamp	1 mantle	0.07 - 0.08
5.	Lamp	2 mantle	0.14
6.	Refrigerator	18"xl8"x 18"	0.07
7.	Incubator	18" x 18" x 18"	0.06
8.	Table Fan	12" diameter	0.17
9.	Room Heater	12" diameter	0.15
10	Running Engine	per HP/hour	0.40
11.	Electricity Generation	per unit	0.56

Apart from household cooking and lighting, some other uses of biogas are discussed below.

2.5.3 Refrigeration

Biogas can be used for absorption type refrigerating machines operating on ammonia and water and equipped with automatic thermo-siphon. Since biogas is only the refrigerator's external source of heat, just the burner itself has to be modified Refrigerators that are run with kerosene flame could be adapted to run on biogas. A design of such a burner successfully tested in Nepalgunj is given in Figure 2.4. With a gas pressure of 80 mm and gas consumption of 100 litres/hour, this burner operates a 12 cu ft refrigerator.

In a country like Nepal where only about 12 percent population has access to the electricity supply, biogas run refrigerator could be of high importance for safe keeping of temperature sensitive materials such as medicines and vaccines in the remote areas. Gas requirement for refrigerators can be estimated on the basis of 0.6-1.2 m^3 per hour per m^3 refrigerator capacity (Updated Guidebook on Biogas Development, 1984).

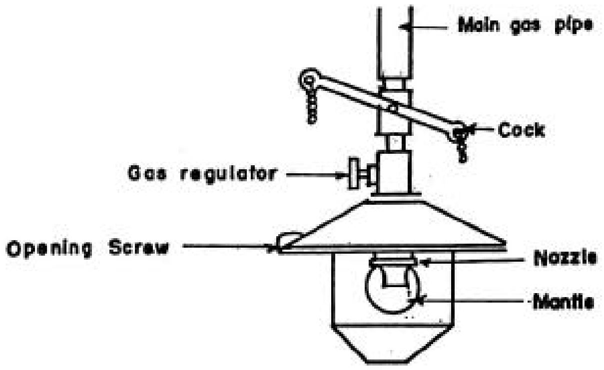
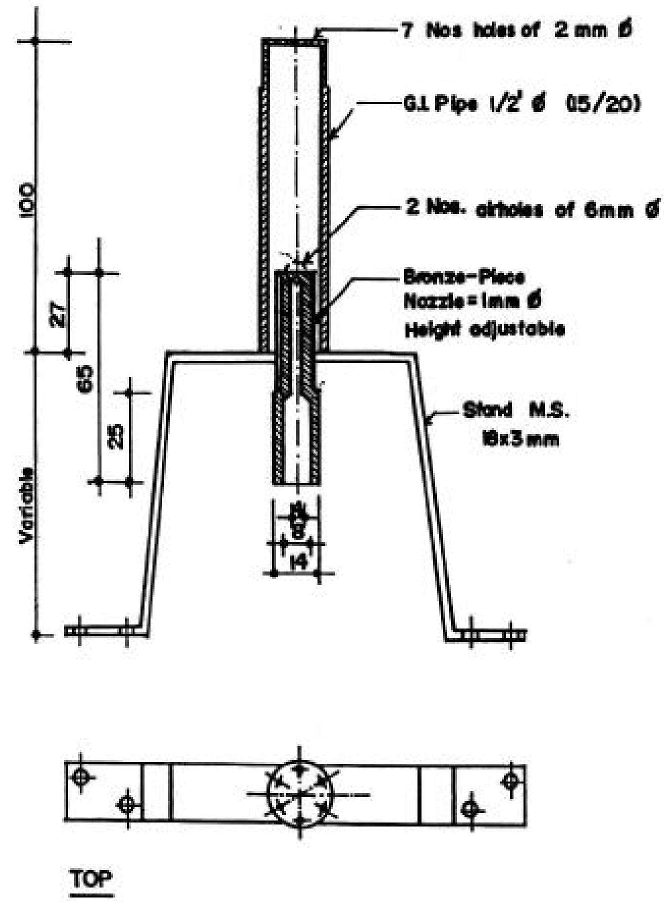


FIGURE-2·3 SKETCH TYPICAL BIOGAS LAMP MANUFACTURED IN INDIA



FGURE- 2·4 DESIGN OF A BIOGAS BURNER ADAPTED TO RUN KEROSENE REFRIGERATOR

Measurements in mm

2.5.4 Biogas-fueled Engines

Biogas can be used to operate four stroke diesel and spark ignition engines. Biogas engines are generally suitable for powering vehicles like tractors and light duty trucks as has been successfully experimented in China. When biogas is used to fuel such engines, it may be necessary to reduce the hydrogen sulphide content if it is more than 2 percent. Using biogas to fuel vehicles is not so much of an attractive proposition as it would require carrying huge gas tanks on the vehicle.

Diesel engine can be converted to dual fuel engine in which as much as 80 percent of the diesel used can be replaced by biogas. In these engines, biogas is used as the main fuel while diesel is used for ignition. When gas runs out, the duel fuel engine can be switched back to run fully on diesel. Pre-converted dual fuel engines are available in the market. Such engines could be used for pumping water both for drinking and irrigation purposes. This utility is of high importance in hilly areas where rivers flow nearby, while the adjacent field dries up due to lack of irrigation.

2.5.5 Electricity Generation

Generating electricity is a much more efficient use of biogas than using it for gas light. From energy utilization point of view, it is more economical to use biogas to generate electricity for lighting. In this process, the gas consumption is about 0.75 m^3 per kW hour with which 25 40-watt lamps can be lighted for one hour, whereas the same volume of biogas can serve only seven lamps for one hour (BRTC. 1983).

Small internal combustion engines with generator can be used to produce electricity in the rural areas with clustered dwellings Biodigesters can be used to treat municipal waste and generate electricity. The anaerobic digestion process provides energy in the form of biogas per ton of organic municipal solid waste (MSW) digested. One of the options to utilize biogas is to produce electricity using a gas engine or gas turbine (ETSU. 1994).

2.6 Biogas and Agriculture fin

In Nepal, biogas was included for the first time in the government programme in 1976 which was observed as "Agriculture Year". The emphasis was then laid to promote the technology mainly for its utility in returning more of the nutrients to soil in the form of organic manure. With the passage of time. the technology is now valued more for its energy rather than manure

In many parts of the country, the productivity of soil is declining mainly because of continuous cropping without the use of quality manure and fertilizer in required quantities. Nepal does not produce any chemical fertilizer and has to fully rely on imports. Because of the declining net profit from agricultural enterprises and increasing prices of imported fertilizer, many farmers can not afford to use chemical fertilizer to replenish the soil nutrients. Also, the availability of chemical fertilizer at the time of need in the required quantity and the desired form can not be ensured. In this context, the importance of biogas technology for Nepal's agriculture has become more prominent as a means to produce easily available localized organic manure at low cost.

Biogas technology fits well in an agricultural system, especially in subsistence farming where cattle and poultry raising becomes an integral part of it. Animal dung is the primary input for biogas and it therefore encourages farmers to rear cattle and other animals. With biogas plant, farmers are also more likely to stall feed their cattle to optimize dung collection. This practice could increase cropping intensity in the areas where some farmers are forced to leave their land fallow because of the problem of free grazing, especially during winter crop season. Stall feeding not only enhances the rate of regeneration of pasture and forest land, but also makes more organic fertilizer available for improving texture and structure of soil along with its fertility. Biogas can also motivate farmers to incorporate integrated farming system because of the feed value of the slurry for fish and piggery. Integration of biogas with agriculture put forth by N. A. de Silva in 1993 for use in the Latin America is shown in Chart 2 5 (Ni Ji-Qin and Nyns, 1993).

China has a long tradition of utilizing human waste as an input material for the production of fuel and fertilizer. In most cases, the sources of carbon such as leaves, grass and straw are loaded in the digester in batches, while the sources of nitrogen are slowly added every day. For example, pigsty and latrine attached to the household digester serve as the sources of nitrogen for daily feeding. Similar practice can be introduced in Nepal to augment the total production of organic manure in the villages.

Biogas technology supports agricultural system through various uses of slurry as listed below.

- Slurry as a basal manure
- Diluted slurry for foliar application or spray as manure
- Application of slurry as manure with irrigation
- Slurry as insecticide and pesticide
- Slurry treatment of seeds for higher rate of germination, disease resistance, better yield and improved colouration of fruits
- Slurry as a means to increase die protein content of low quality fodder
  Slurry as a part of concentrate ration for cattle, pig and fish
- Slurry as a means to increase the quality and quantity of organic manure production at the farm level

2.7 Biogas and Forests

Comprehensive data are not available to quantify the overall impact of biogas adoption on the nearby forest. However, as result of a case study conducted in 1994 at two Village Development Committees (VDC) in Chitwan district, Mr. Binod P Devkota, Forest Officer, has come up with the following findings.

- The number of animal heads kept by a farming family decreased after installation of a biogas plant, compared to non-adopters.
- Biogas technology led to the adoption of stall feeding practices which reduced the pressure on nearby forest and pasture land by animals grazing there.
- Biogas replaces 80 to 85 percent of firewood consumption of a family.

These preliminary findings exhibit die positive impact of biogas installation on the regenerative capacity of existing forest and pasture lands along with the qualitative improvement in animal husbandry.

2.8 Biogas and Women

The heavy reliance on fuelwood has caused not only irreparable damage to the sustainability of agriculture and ecosystems in Nepal but has also increased the workload of 78 percent of rural women and a large number of children, mostly girls, who have to allocate 20 percent of their work time for fuelwood collection (WECS, 1995).

Comprehensive studies on women's workload in different parts of Nepal conclude that a day's work consists of nine to 11 hours. A study by BSP conducted in 1992 estimates that almost 75 percent of households spent more time collecting firewood in 1988 than in 1983. Two-third of them spent about six hours a day (Britt, 1994). van Vliet and van Nes (1993) studied the effect of biogas on the workload

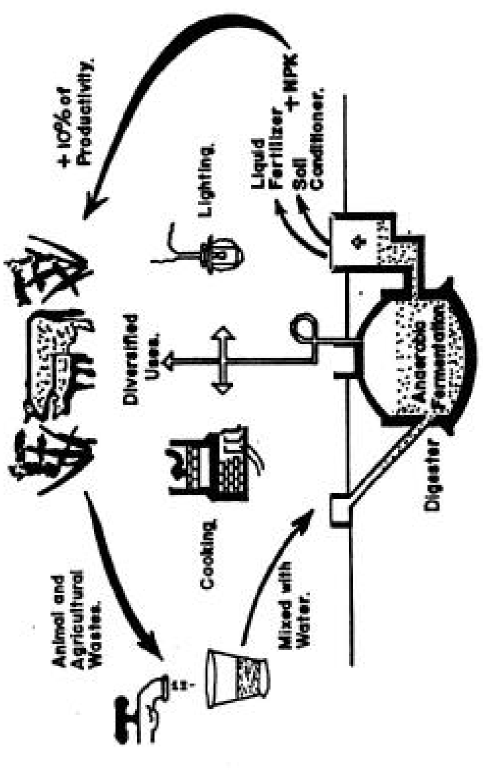


Chart-2-5 INTERGRATION OF BIOGAS WITH AGRICULTURE of women in Rupendehi district in Nepal. They concluded that the reduction in workload of women as a result of installing biogas plants amounts to a minimum of two hours and maximum of seven hours per family per day. When pressed with the labour shortage for such works in a family, it is the female children who have to forego their schooling.

Cooking with traditional fuels such as firewood and waste from agriculture and livestock produces obnoxious odorous and smoke that pollute the kitchen. Long hours of exposure in such smoke polluted environment is known to cause various coronary and respiratory diseases (Hurst and Bamett, 1990). Use of biogas helps relieve women from such diseases. Studies have shown that women cough less and have fewer eye problems once they switch to biogas from firewood. Cases have been reported about older women who could no longer cook on open fire, being able to cook with biogas. Many studies have reported the substantial improvement in in-house pollution and the sanitary condition of homestead after installation of biogas plants.

As biogas helps to do away with the need to collect fuelwood, it indirectly helps women in so many different ways such as opportunity for income generation, education, and improvement in health by providing some leisure time. Results of studies on saving of time for women's work in user households are summarized in Table 2.3.

Table2.3
Average Saving in Women's Work in Selected Districts and Villages

	Rupandehi District	Nuwakot District	Madan Pokhara Village	Pithuwa Village	Hathilet Village
Average Plant Size	10 m^3	10 m^3	6 m^3	10 m^3	15 to 20 m^3
Average Saving of Women's Work Time	4:30 hrs	2:35 hrs	1:55 hrs	3:14 hrs	-0:15 hrs (increase)
Sample Size (Households)	100	100	4	4	4
Limiting Factor	Fuelwood	Water	Water	Fuelwood	Water

Source: Charla Britt, 1994.

The table illustrates that the introduction of biogas in regions where fuelwood is readily available and where water is in short supply or the source is located at a great distance from die plant site, biogas may actually increase the workload of women.

A study of 100 biogas households in 16 districts of Nepal has shown a net saving on workload of 3 hours 6 minutes (3:06 hrs or 3.10 hrs) as a result of installing a biogas plant (East Consult, 1994). Time saving on account of biogas related activities is shown in Table 2.4.

Table 2.4
Average Effects of a Biogas Plant on the Workload of a Household

S. N.	Activity	Saving **in Time (Hour/day)**
1.	Collection of water	(-)0:24
2.	Mixing of water and dung	(-)0:15
3.	Collection of firewood	(+) 1:24
4.	Cooking	(+) 1:42
5.	Cleaning of cooking utensils	(+) 0:39
	Total	(+) **3:06**

Source: East Consult, 1994

It is worth mentioning that the first design of biogas plant developed by Jashu Bhai 3 Patel of India around 1956 was named *"Greeha Laxmi"* (housewife) to indicate its relevance to the well-being of housewives. In view of the traditional role that a female member plays in a family, following are some of the prominent aspects of biogas that help women in particular.

- Reduction of in-house pollution in general and that of kitchen in particular.
- Biogas flame does not leave black soot on the pots. Cleaning is easy, cleaning time is lessened and life of the utensils is prolonged.
- It reduces the time required for cooking. The time saved can be used for other useful purposes.
- Healthy environment - free from flies and mosquitoes is produced. Most of the pathogens are destroyed in the process of anaerobic digestion.
- hi remote villages, where there is no possibility for electrification, children can devote their time in study and the family can perform some income generating activities with the help of biogas lamp.

Generally, it is the housewife who is more involved in operating and maintaining a biogas plant. This has forced all development workers in the biogas sector to focus their activities to the female members of a family. In other words, use of biogas technology has been instrumental in enhancing the role of women not only in matters of family decisions but also in planning and implementation of other development activities.

2.9 Health and Sanitation

As pointed out earlier, smoke is the main cause for lung and eyes diseases in the rural community. As a result of biogas installation, improvement in the health and hygiene has been reported by the housewives.

Infestation of various water-borne diseases occurs due to faecal contamination such as worms (hook worms, round worms), bacterial infections (typhoid fever, paratyphoid, dysentery, cholera) and viral infections (gastro-enteritis resulting in diarrhea and vomiting, hepatitis). The anaerobic digestion process has proved effective in reducing the number of pathogens present in the faecal matters to a considerable extent. Studies carried out in China on the survival of pathogens showed that about 90 to 95 percent of parasitic eggs are destroyed at the mesophilic temperature while at times ascaris are reduced by 30 to 40 percent (UNEP, 1981).

Chinese experience shows that if the faeces are fed into the digester at one feeding (without daily addition of fresh faeces) and kept fermenting for a reasonable retention time, satisfactory results of faeces treatment are achieved. On the other hand, if faeces are added to the digester every day, the effluent has to be used only after it has been treated by ovicide and bactericide. Treatments with Calcium Cyanide, Calcium Hydroxide and Caustic Soda have been found to be effective. However, manure treated with Caustic Soda is not recommended for use as fertilizer (UNEP, 1981).

In the Nepalese context, there are only a few ethnic groups (e.g. *Pode)* who are accustomed to handling night soil, whereas a larger section of the population still faces social or cultural resistance towards such an activity and cooking food with biogas produced from human faeces. These days, because of increasing cost of the conventional fuel, the biogas users are forced to connect their biogas plant with latrines. About 40 to 50 percent of the biogas plants presently installed are found to be connected to latrines and this tendency is likely to increase in the future (van Nes, 1996).

If human faeces are used as an input material for methane generation, one has to be cautious due to high concentration of pathogens present in it. Depending on the hydraulic retention time, it is likely that some digested sludge may still contain a few pathogens. Based upon the lessons learned from China, there is every need to ensure that the digested slurry is completely free from pathogens. Appropriate R&D has to be carried out in this direction.

2.10 Municipal Waste

Biogas technology or biomethanization can be used to treat all types of organic wastes and crops not only to produce gas and manure, but also to reduce pollution.

Haphazard disposal and accumulation of the city refuges have resulted in environmental degradation in the Kathmandu valley. Other cities and towns of the country are also facing similar problems of increasing waste and pollution in dense settlements. Refuges from the household, small scale industries and construction activities constitute the major sources of the wastes generally encountered in the cities. Quantities of waste generated in the three cities of Kathmandu valley are given in Table 2.5 (Karki, Gautam and Gautam, 1995). With the use of biogas technology, such municipal wastes can be profitably utilized as resources for the production of biogas and stabilized manure.

Table 2.5
Waste Generation Per Day in Kathmandu Valley

S.N.	Waste	Kathmandu	Lalitpur	Bhaktapur
1.	Generated per day (m^3)	350	106	40
2.	Actually collected per day (m^3) (50% of 1)	175	54	NA^+

$^+$NA denotes Not Available

There are different technologies available to treat municipal solid waste as shown in Chart 2.6. However, it is the anaerobic process that has proved to be the most economical option in terms value of energy and manure production. The chart illustrates that treating municipal waste through anaerobic digestion process has more benefits than other methods such as incineration or landfill (Ni Ji-Qin and Nyns. 1993). This process has also been used in other countries to treat sewage for two distinct benefits: (a) for production of useful energy; and (b) for reduction of the cost of sewage treatment with some other technologies.

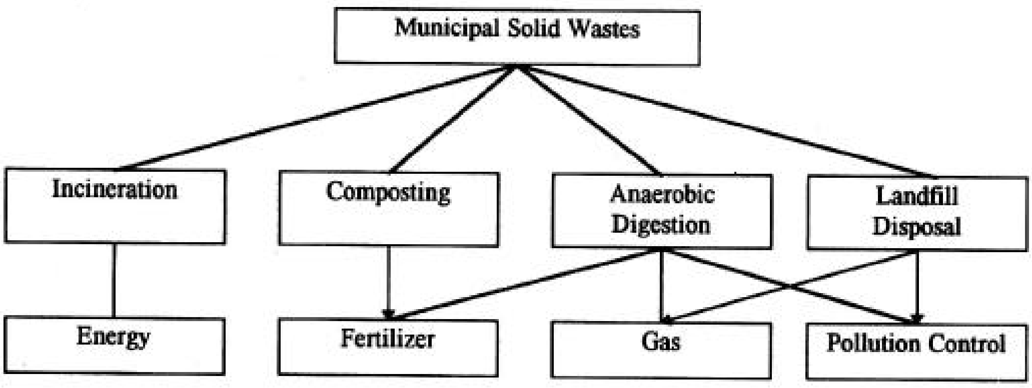


Chart 2.6 Treating Municipal Waste Through Anaerobic Digestion Process

Collection of biogas generated from the landfill sites is yet another way of deriving energy from municipal waste. The proper management of landfill sites for gas production has been found to be a cost effective way of treating municipal solid waste in terms of the investment cost.

Nepal has limited experience in the use of biogas technology for processing of the municipality waste.

Municipalities that have started to connect municipal toilets with biodigesters are Biratnagar and Hetauda. These plants have proved useful in improving the sanitary condition of the area. The experience with plants in schools, jails, military barracks, hotels and other such group livings has also shown encouraging results. With this experience, it is likely that more municipalities will follow the suit in the coming years.

2.11 Economy and Employment

Presently, there are 23 companies that are involved in the construction of biogas plants. In addition, there are many NGOs that are also involved in promoting the biogas technology. As the demand for biogas is ever increasing, so will the workload of these companies and NGOs. In other words, the potential of the biogas development to create employment opportunities in the rural areas has already been demonstrated. Because of this labour intensive nature of the technology, it helps ameliorate some of growing socio-economic problems such as rural out-migration and social woes of unemployed rural youth. Presently, there are about 900 people employed in the biogas sector in Nepal.

Once installed, the biogas plant becomes an additional resource base of the user. This resource base could lead to other economic activities such as fish culture, piggery, and small cottage industries. Experiments carried out in other developing countries have shown that the slurry could be used to replace a part of the feed for fish and pig resulting in higher production (see Session Four).

Except for a few stoves, almost all appliances related to a biogas plant are imported, even though the technology for their production within the country is available and the investment cost is not high either. With the existing level of demand for such appliances in the country, it will not be economically viable proposition to establish production units. However, as the number of biogas installation will go on increasing, the demand for its appliances will rise and the in-country production of such appliances could become an economically viable industry.

Millions of tons of agricultural and livestock wastes are burnt every year in the country in the process of meeting household energy requirements. In other words, millions of tons of soil nutrients are burnt every year causing (a) increase in the cost of importing the chemical fertilizers which is paid in convertible currency that the country is always in short of, and (b) decrease in agricultural production. This two fold economic loss could be avoided to a certain extent with the use of biogas technology. Similar relation can also be viewed in terms of decreasing number of tourists due to increasing pollution and the possibility of generating commercial energy with the refuge of the growing urban population.

2.12 Session Plan

Activity No.	Topic and Area of Discussion	Time (min.)	Methods of Training	Teaching Aids
1.	Introduction and highlight the objectives of session	3	Lecture	O/H projector, screen, sheets or flip chart
2.	Energy situation in Nepal	5	Lecture cum discussion	O/H projector, screen and flip chart
3.	Biogas in other countries	5	Lecture	O/H projector, screen
4.	Biogas potential in Nepal	5	Lecture cum discussion	O/H projector, screen
5.	Various users of biogas	5	Lecture cum discussion	O/H projector, screen
6.	Agriculture	4	Lecture cum discussion	O/H projector, screen, flip chart
7.	Biogas and forest	2	Lecture cum discussion	O/H projector, screen
8.	Women and biogas	**4**	Lecture cum discussion	O/H projector, screen, flip chart
9.	Health and sanitation aspects	4	Lecture cum discussion	O/H projector, screen
10.	Municipal waste	4	Lecture cum discussion	O/H projector, screen
11.	Economy and the employment	4	Lecture cum discussion	O/H projector, screen
12.	General discussion	15	Discussion	
Total Time		**60**		

2.13 Review Questions

- How can biogas influence the overall development pattern of Nepal?
- In the context of Nepal, how does biogas compare with other alternative sources of energy?
- Comment on: "The single most important reason for relevance of biogas technology to Nepal is the fact that more than 90 percent of the total energy is consumed in the domestic sector".
- Explain how biogas can help improve the balance of payment of developing countries.
- How significant is the role of biogas in increasing the employment opportunities in Nepal?
- Comment: "Biogas technology is not neutral to gender issues of developing countries."

2.14 References

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Number of Households with Animals, Potential Households with Biogas by Districts
(As of July 1995)

District	Households with Animals (No)	Potential Biogas Households (No)	Households with Biogas	
			(No)	(%)
Mountain Region :	**192.609**	**9.630**	**253**	**2.63**
Taplejung	16,110	805	0	0
Sankhuwasabha	18,662	933	29	3.11
Solukhumbu	9,789	489	0	0
Dorakna	2,854	1.493	10	0.67
Sindhupalchoke	31,562	1,578	210	13.31
Rasuwa	2,920	146	0	0
Manang	421	21	0	0
Mustang	1,230	61	0	0
Dolpa	2,117	106	0	0
Jumla	8,531	427	0	0
Kalikot	13,987	699	0	0
Mugu	5,516	276	0	0
Humla	5,345	267	0	0
Bajura	15,793	790	0	0
Bajhang	18,110	906	0	0
Darchula	13,180	659	4	0.61
Hill Resion:	**967.638**	**483.819**	**11,188**	**2.31**
Panchlhar	24,957	12,478	28	0.22
Ham	28,983	14,492	289	1.99
Dhankuta	14,724	7.362	167	2.27
Terhathum	14.531	7,266	63	0.87
Bhojpur	31,399	15,699	35	0.22
Okhaldunga	23,264	11,632	0	0
Khotang	35,468	17,734	0	0
Udayapur	14,481	7,240	104	1.44
Sindhuli	36,172	18.086	571	3.16
Ramechhap	23,130	11,565	0	0
Kavrepalanchok	33,932	16,966	131	0.77
Lalitpur	10,216	5.108	54	1.06
Bhaktatpur	11.795	5,897	22	0.37
Kathmandu	18.281	9.140	301	3.29
Nuwakot	10.471	5,236	530	10.12
Dhading	35,055	17,528	238	1.36
Makwanpur	26,695	13.,348	439	3.29
Gorkha	3,340	1,670	376	22.52

Lamjung	14,980	7,490	1.042	13.91
Tanahu	26,479	13,239	1.194	9.02
Syangja	55,789	27.895	815	2.92
Kaski	21,744	10,872	3,057	28.12
Myagdi	15,172	7.586	21	0.28
Parbat	16,239	8.119	43	0.53
Baglung	32,675	16.337	93	0.57
Gulmi	39,316	19.658	202	1.03
Palpa	28,400	14,200	579	4.08
Arghakhanchi	29,447	14,723	225	1.53
Pyuthan	24,280	12,140	203	1.67
Rolpa	23,472	11,736	4	0.03
Rukum	25,212	12.606	32	0.25
Salyan	27,731	13,867	6	0.04
Surkel	31,830	15,915	248	1.56
Dailekh	26.668	13,334	44	0.33
Jajarkot	12,629	6,314	2	0.03
Achhain	28,973	14,486	0	0
Doti	23,359	11,679	11	0.09
Dadeldhura	7,971	3,986	0	0
Baitadi	24,176	12.088	19	0.16
Terai Reeion :	**821,290**	**821,290**	**12,421**	**1.51**
Jhapa	27,753	27.753	1.546	5.57
Mo rang	54,533	54,533	1,555	2.85
Sunsari	31.773	31,773	605	1.90
Saplari	49.988	49.988	97	0.19
Siraha	62,658	62.658	356	0.57
Dhanusa	55.466	55.466	199	0.36
Mahottari	31,833	31.833	248	0.78
Sarhi hi	53,704	53,704	666	1.24
Raulahat	45,596	45.596	153	0.34
Bara	36,885	36.885	447	1.21
Parsa	37.310	37.3 H	126	0.34
Chilwan	41,767	41,767	2.187	5.24
Nawaiparasi	41.141	41,141	469	1.14
Rupandchi	63,367	63.367	1,414	2.23
Kapilbastu	39.728	39,728	217	0.55
Dang	37.133	37.133	741	2.00
Banke	32,018	32.018	167	0.52
Bardiya	7,870	7,870	405	5.15
Kailali	35,975	35,975	521	1.45
Kanchanpur	32,006	32,006	302	0.94
Nepal	**1,988,695**	**1,314,739**	**23,862**	**1.81**

SESSION THREE

BIOGAS PROGRAMME

SESSION THREE

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 m^3 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 die 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 K.V1C, turnkey construction fee, incentives to promoters, organization of training programmes and repair of plants with structural problems. In addition to the financial assistance from >|he 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, hi 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 (UNTCEF), 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 die 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 die low level of inputs in terms of funds and quality human resource that the GGC could afford {Karki, etal., 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 (si2e 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.

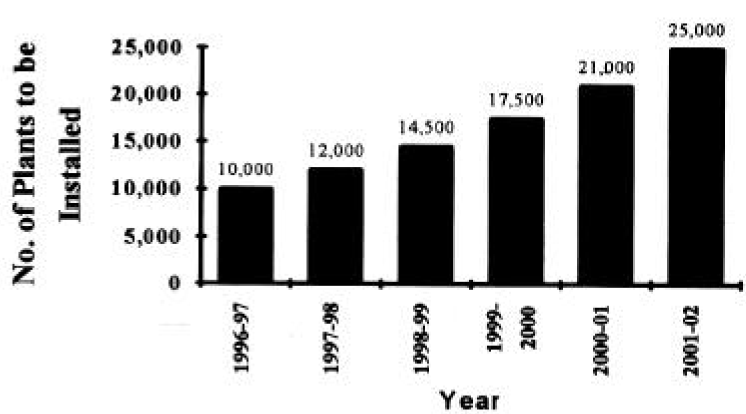

Chart 3.1 Year-wise Breakdown of Biogas Plants in BSP Phase III

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 fur 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 (USS 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.

<u>Biogas Companies</u>

(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 form 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 men send a mason to investigate and solve the problem. This is a long and complex process which negatively influences the quality of Die 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 me 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 m^3 of biogas and 3 million tons of digested dung (7 percent dry matter) annually. The following environmental benefits arc 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 m^3 of biogas
- 72,000 ton of agricultural waste by 8 million m^3 of biogas
- 40,000 ton of dung cakes by 4 million m^3 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 m^3) 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($C0_2$)Emission

The replacement of firewood by biogas will reduce the emission of CO_2 by 238,000 ton per year assuming an emission coefficient of 1.4 ton of CO_2 per ton of firewood.

The replacement of kerosene (lighting) by biogas will reduce the emission of CO_2 by 12,600 ton per year assuming an emission coefficient of 2.8 kg of CO_2 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.

Shirty 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 coining 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 biodigesters. 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 picked 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 (m^3)	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**

SESSION FOUR

UTILIZAITON OF SLURRY AS FEED AND FERTILIZER

SESSION FOUR

Utilization of Slurry as Feed and Fertilizer

4.1 Introduction

Discussions in previous sessions might have created an impression that the inflammable gas (methane) is the main product of a biogas system and the digested slurry is the by-product of it. It should be understood that such is a case in an energy scarce area. The slurry is equally important, if not more, for its high nutrient content and multiple use as manure, soil conditioner and feed for cattle, pig and fish.

By the end of this session, the participants will be able to:

- explain nutritive value of anaerobically digested slurry for maintenance of soil fertility and increased crop production;
- enumerate different methods of utilization of slurry for crop production; and
- explain the role of slurry as a partial supplement in the rations of animals, poultry and fish.

4.2 Inter-relationship of Biogas Technology and Agriculture

More than 90 percent of the population in Nepal are engaged in agriculture. Therefore, any technology that can influence agriculture or gets influenced by the agricultural practices becomes a subject of concern not only to the biogas user but also to the nation as a whole.

By-products of agriculture, mainly animal wastes and crop residues, are the primary inputs for biogas plants. The digested slurry as one of the outputs of a biogas plant can be returned to the agricultural system. Proper application of the slurry as organic fertilizer increases agricultural production because of its high content of soil nutrients, growth hormones and enzymes. Dried slurry can also safely replace a part of animal and fish feed concentrates. Furthermore, slurry treatment also increases the feed value of fodder with low protein content When the digested slurry is placed into the food chain of crops and animals, it leads to a sustainable increase in farm income.

This close relation between biogas and agriculture can be taken as an indicator of "environmental friendly" nature of the technology as shown in Chart 4.1.

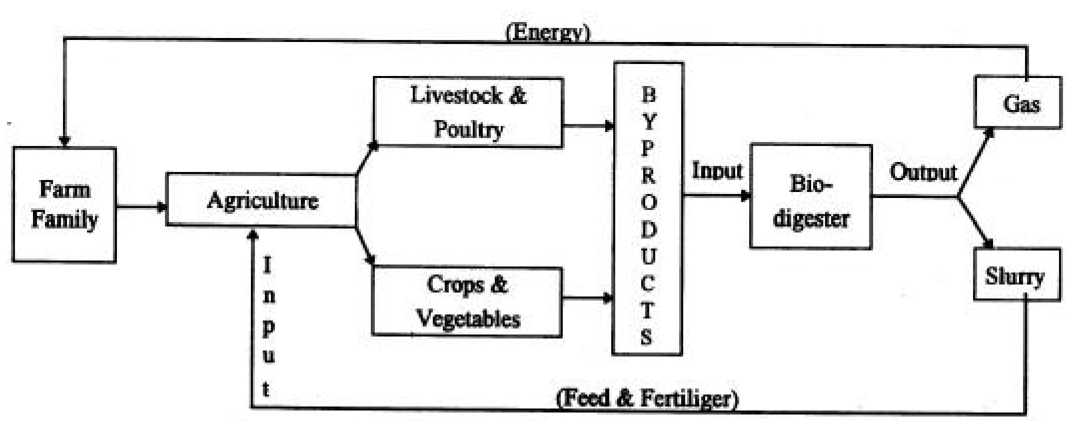


Chart 4.1 Relationship Between Biogas and Agriculture in a Farming Family

4.3 Limitations of Chemical Fertilizer Use

Table 4.1 shows the quantity of soil nutrients removed in kg/ha by the cropping rotation of maize-paddy-wheat as is commonly practised in Nepal (Sthapit. 1987). At current yield levels, rice, wheat and maize alone are estimated to be removing 700,000 tons of soil nutrients annually. With expanding area under improved varieties and high yielding crops, this extraction of soil nutrients is expected to continue at the higher rate in the future.

The present rate of commercial fertilizer use in the country replenishes only about 10 percent of the soil nutrients removed every year With the declining trend observed in the rate of application of Farm Yard Manure (FYM), soils are not replenished for more than 70 percent of the nutrients mined every year in terms of agricultural production. Thus, the productivity of soils is declining due to this continuous over mining (APROSC/JMA, 1995).

Table 4.1

Soil Nutrient Loss (Maize-Rice-Wheat System)

Crop	Quantity Removed (kg/ha)		
	Nitrogen	Phosphorus	Potash
Maize	**53**	**22**	12
Rice	**54**	**7**	74
Wheat	**30**	**23**	32

Source: Sthapit (1987)

In the early 1960s, yields of major crops such as paddy, wheat and potato were higher in Nepal than in all other South Asian countries. In early 1990s, the national average yields of these crops have become considerably lower owing to over-mining of soil nutrients in Nepal and the higher rate of agricultural growth in other countries. The availability of food grain per capita has decreased by 0.02 percent over a decade of 1981 to 1991. Out of 75 districts, 41 are now food deficit areas. This is one of the main root causes of growing poverty in Nepal (APROSC/JMA, 1995).

Pressed between the need to feed the growing population and the declining productivity of agricultural land, new areas have been brought under cultivation. Observations and data of 1992 indicate that the possibility to expand agriculture into new land, except at the expense of the remaining forest area, has been exhausted. Therefore, fertilizer has become the leading means to increase agriculture production. The present level of nutrient application of less than 25 kg per ha of cultivated land is about a quarter of Bangladesh and 10 percent of China. The much higher application rates used in neighbouring countries show profitability of fertilizer use.

In 1994, the government allocated Rs 300 million and 50 million as price and transport subsidies for chemical fertilizer, respectively. The removal of transport subsidy will make fertilizer use unprofitable in the lulls. In the remote hills, the amount of fertilizer transported depends on the level of transport subsidy. The economic implication of increasing the present level of fertilizer consumption from the present rate of less than 25 kg/ha to 152 kg/ha, as speculated by Agricultural Perspective Plan, is obvious for Nepal which has large trade deficit and all chemical fertilizer has to be imported.

The most common fertilizers consumed in Nepal are Urea (46:0:0) and Diammonium Phosphate (DAP. 18:46:0). In 1992/93, the price of DAP increased by about 66 percent, potash by 293 percent and urea by 9 percent. Negligible amount of subsidy is provided in chemical fertilizers other than urea. With the on-going 12 percent annual increase in fertilizer consumption, the ability of the government to provide subsidy is ever decreasing.

More and more farmers are finding it difficult to continue the use of chemical fertilizers even at the present low level of less than 25 kg/ha due to (a) increase in prices at a rate higher than the rate of increase in farm income, (b) non-availability of chemical fertilizers at the required time in a desired form and quantity.

Not a single fertilizer factory exists yet in Nepal. A study has revealed that a factory with the production capacity of less than 270 thousand metric tons per year is not economically viable. Another limiting factor is the current deficit in the supply of electricity. Frequent load shedding will limit the factory's production output. Furthermore, the present rate of electricity tariff is too high for a such factory to be financially viable.

The Agriculture Inputs Corporation (AIC) with its distribution network scattered all over the country, is mainly responsible for procurement and distribution of the chemical fertilizers. However, despite its widespread network of more than 70 distributional offices, it has been unable to supply chemical fertilizer on time and at sites where it is required. In some cases, import of low quality fertilizers has also been reported (AIC, 1996).

The on-going degradation of forest cover has a direct impact on the cattle population and hence the production of FYM is also affected causing reduction in the availability of organic fertilizer. In this context, biogas has proved to be one of the feasible means to conserve forest as well as to reduce the burning of animal dung which otherwise could be used as fertilizer Research data indicate that under optimum condition, one m[1] of biogas is equivalent to 5 kg of firewood or 9 kg of agricultural waste or 10 kg of dung cakes.

A continuous use of chemical fertilizer alone, without the addition of organic manure, has been found to have detrimental effect on soil quality in the long run mainly because of constant loss of humus and micro-nutrients.

The above discussion leads to the conclusion that reliance on chemical fertilizer alone would not ensure sustainable development of agriculture in Nepal.

4.4 Organic Fertilizer

Average farms in Nepal are characterized by their small land holding of about 0.2 ha and integration of agriculture with a few heads of animal and birds, as shown in Table 4.2.

Table 4.2

Percentage of Households Keeping Animals and Birds by Region, 1991/92

Region	Cattle	Chauri	Buffalo	Goat	Sheep	Pigs	Horses/ Mules	Poultry	Ducks
Mountains	82.8	2.9	44.8	55.5	6.5	10.3	1.3	56.4	6.0
Hills	77.3	0.1	60.0	54.2	4.2	12.2	0.4	67.6	9.2
Terai	74.4	0.0	35.8	46.8	1.8	7.1	0.4	32.4	15.7
Nepal	76.6	0.3	48.5	51.3	3.4	9.9	0.5	51.9	11.6

Three-quarters of all households in Nepal raise cattle, and one-half raise buffalo, goats and poultry. About two-thirds of livestock owners cultivate less than 1.0 ha of land (National Sample Census of Agriculture for Nepal, 1991/92). This situation favours the production of organic manure at the household level for augmenting agricultural production through increased use of organic manure. Biogas supports such **a** strategy by preventing the burning of agricultural and animal waste for meeting household energy needs and providing slurry rich in nutrients for soils and animals.

4.5 Importance of Slurry for Crop Production

Organic matter plays an important role because of its beneficial effects in supplying plant nutrients, enhancing the cation exchange capacity, improving soil aggregation, increasing water holding capacity of soils, stabilizing its humic content and increasing its water holding capacity. Organic soil amendments support biological activities and also control root pathogens. Biogas slurry has proved to be a high quality organic manure Compared to FYM, digested slurry will have more nutrients, because in FYM, the nutrients are lost by volatilization (especially nitrogen) due to exposure to sun (heat) as well as by leaching.

The farmer needs to use chemical fertilizer to increase his crop production. However, if only mineral fertilizers are continuously applied to the soil without adding organic manure, productivity of land will decline. On the other hand, if only organic manure is added to the soil, desired increase in crop yield can not be achieved. Fertility trials carried out in Nepal and elsewhere have revealed that optimum results can be achieved through the combined application of both chemical and organic fertilizers.

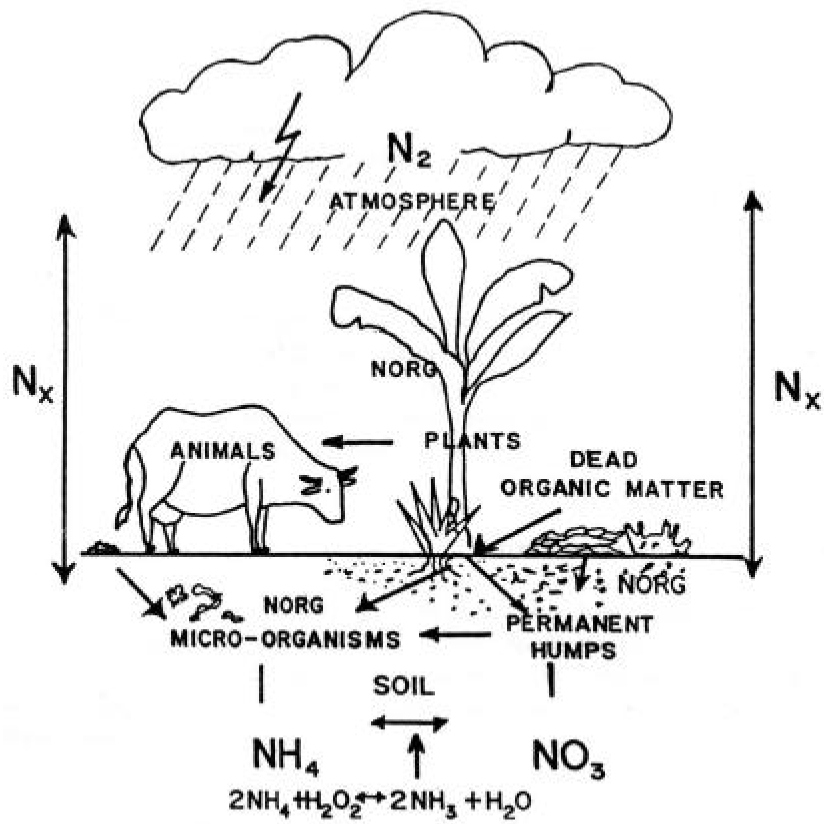
In countries where biogas technology is well developed, for instance in China, there are evidences which support the fact that productivity of agricultural land can be increased to a remarkable extent with the use of slurry produced from biogas plant. In Nepal too, if properly managed, the biogas slurry could play a major role in supplementing the use of imported and expensive chemical fertilizers However, in the present context of Nepal, the focus has been only to increase the number of biodigesters for its gas use and little attention has been paid on the proper utilization of digested slurry as organic fertilizer.

4.6 Characteristics of Digested Slurry

Only approximately 10 percent of the total nitrogen content in fresh dung is readily available for plant growth A major portion of it has first to be biologically transformed in the soil and is only then gradually released for plant use. When fresh cow dung dries, approximately 30 to 50 percent of the nitrogen escapes within 10 days. While nitrogen escaping from digested slurry within the same period amounts to only 10 to 15 percent Therefore, the value of slurry as fertilizer, if used directly in the field as it comes out of the plant, is higher than when it is used after being stored and dried (Moulik, 1990).

The short term fertilizer value of dung is doubled after being anaerobically digested while the long term fertilizing effects are cut by half. Under tropical conditions (i.e. where biogas plants are most effective) the short term value is of greater importance because rapid biological activities degrade even the slow degrading manure fraction in relatively short time.

Cattle dung contains about one percent total nitrogen. Nitrogen is considered particularly important because of its vital role in plant nutrition and growth. The nitrogen cycle in nature is depicted in Chart 4 2 (Sasse, 1991). During anaerobic digestion, 25 to 30 percent organic matter is decomposed and hence the nitrogen percentage is raised to 1.3. Although no new nitrogen is formed during anaerobic digestion, 15 to 18 percent nitrogen is converted into ammonia (NH4) whereas nitrogen in aerobically digested organic wastes (activated sludge, compost) is mostly in oxidized form (nitrate and nitrite). Increasing evidence suggests that for many land and water plants, ammonium is more valuable as a nitrogen source than oxidized nitrogen in the soil. Ammonium is less likely to leach away and hence more apt to become fixed to exchange particles like clay and humus (Satliianathan, 1975). Experiments in China have shown that compared to fresh dung, the ammonical nitrogen in the digested slurry increases by 260 percent whereas it decreases by 17.5 percent in the FYM. The slurry thus has more free ammonia than available in composted manure.



Chart—4·2 The Nitrogen—Cycle in Nature

As a result of anaerobic fermentation, about 30 to 40 percent of organic carbon present in the dung is decomposed as carbon dioxide and methane. The rest is retained as such and contains plant nutrients. When fully digested, the slurry from a biogas plant is odourless and does not attract insects or flies. The organic fraction of slurry may contain upto 30-40 percent of lignin. undigested cellulose and lipid material, on a dry weight basis. The remainder consists of substances (mineral, salts, etc.) originally present in the raw materials but not subject to bacterial decomposition. The amount of bacterial cell mass is low (less than 20 percent of the substrate is converted to cells). Therefore, there is less risk of creating odour and insect breading problems.

Some of the major key features of biogas slurry can be summarized as follows:

- Biogas manure is ready in shortest possible time.
- There is minimum loss of nitrogen in biogas slurry due to anaerobic conditions in the plant.
- If night soil and cattle urine are added, availability of nitrogen and phosphorus in the biogas manure is increased.

4.7 Utilization of Digested Slurry

It has been observed that the use of digested slurry as manure improves soil fertility and increases crop yield. Data from field experiments suggest that the slurry should be applied at the rate of 10 tons/ha in irrigated areas and 5 tons/ha in dry farming. The manure can be used in conjunction with normal dose of chemical fertilizers. Such practice will help achieve better returns from fertilizers, minimize the loss of fertilizers from the soil and provide balanced nutrition to crops. Different methods of slurry applications are described this section.

4.7.1 Application of Slurry in Liquid Form

The digested slurry can be directly applied in the field using a bucket or a pale. An alternative to this is to discharge the slurry into an irrigation canal. However, these methods of direct application have some limitations. Firstly, not all farmers have irrigation facility throughout the year. Secondly, in the cascade system of irrigation in which water is supplied from one field to another, slurry is not uniformly distributed in the fields. Finally, since the digested slurry is in a liquid form, it is difficult to transport it to farms located far from the biogas plants.

The sludge and slurry could be applied to the crop or to the soil both as basal and top dressings. Whenever it is sprayed or applied to standing crop, it should be diluted with water at least at the ratio of 1:1. If it is not diluted, the high concentration of available ammonia and the soluble phosphorus contained in the slurry will produce toxic effect on plant growth. However, such method of application is not yet practised in Nepal.

4.7.2 Application of Slurry in Dried Form

The high water content of the slurry causes difficulties in transporting it to the farms. Even if it is applied wet in the field, tilling is difficult. Due to such difficulties, the farmers usually dry the slurry before transporting it into the fields. When fresh slurry is dried, the available nitrogen, particularly ammonium, is lost by volatilization. Therefore, the time factor has to be considered while applying the slurry and in this regard, immediate use can be a way of optimizing the results.

4.7.3 Utilization of Slurry for Compost Making

The above mentioned difficulties can be overcome by composting the slurry. If the slurry is composted by mixing it with various dry organic materials such as dry leaves, straw, etc., the following advantages can be realised:

- The dry waste materials around the farm and homestead can be utilized.
- One part of the slurry will be sufficient to compost about four parts of the plant materials. Thus, increased amount of compost will be available in the farm.
- Water contained in the slurry will be absorbed by dry materials. Thus, the manure will be moist and pulverized. The pulverized manure can be easily transported to the fields.

A schematic diagram for use of slurry in making compost is shown in Chart 4.3. The ideal arrangement would be to dig three similar pits which may be filled in turn. The size of these pits should be such that by the time the third one is filled, the first one is dry enough to transport the compost to the field.

The availability of nutrients in composted manure, FYM and the digested slurry are presented in Table 4.3 (Gupta, 1991).

Table 4.3

Nutrients Available in Composted Manure, FVM and Digested Slurry

Nutrients	Composted Manure		FVM		Digested Slurry	
	Range	Average	Range	Average	Range	Average
Nitrogen (N)	0.5 to 1.5	1.0	0.5 to 1,0	0.8	1.4 to 1.8	1.60
P205	0.4 to 0.8	0.6	0.5 to 0,8	0.7	1.1 to 2.0	1.55
K20	O.5tol.9	1.2	0.5 to 0.8	0.7	0.8 to 1.2	1.00

Furthermore, the complete digestion of cattle dung in a biogas plant destroys weed seeds and organisms that can cause plant diseases.

4.8 Size of Compost Pit

It is advisable to construct at least two compost pits beside the biogas plant so that each of them can be emptied alternatively. The pit volume should be equal to die volume of the biogas digester. The recommended pit sizes corresponding to different sizes of biogas plants are given in Table 4.4.

Table 4.4
Recommended Size of Compost Pits Corresponding to the Sizes of Biogas Plants

Capacity of Biogas Plant	Depth (m)	Width	Length (m)
4	1.2	1.3	3.2
6	1.3	1.3	3.9
8	1.3	1.3	5.2
10	1.3	1.5	5-2
15	1.3	1.5	7.7

Sometimes, there is a limitation of space for compost making. In such case, the length of pit can be shortened by increasing the width but the depth should remain around 1.2 to 1.3 m.

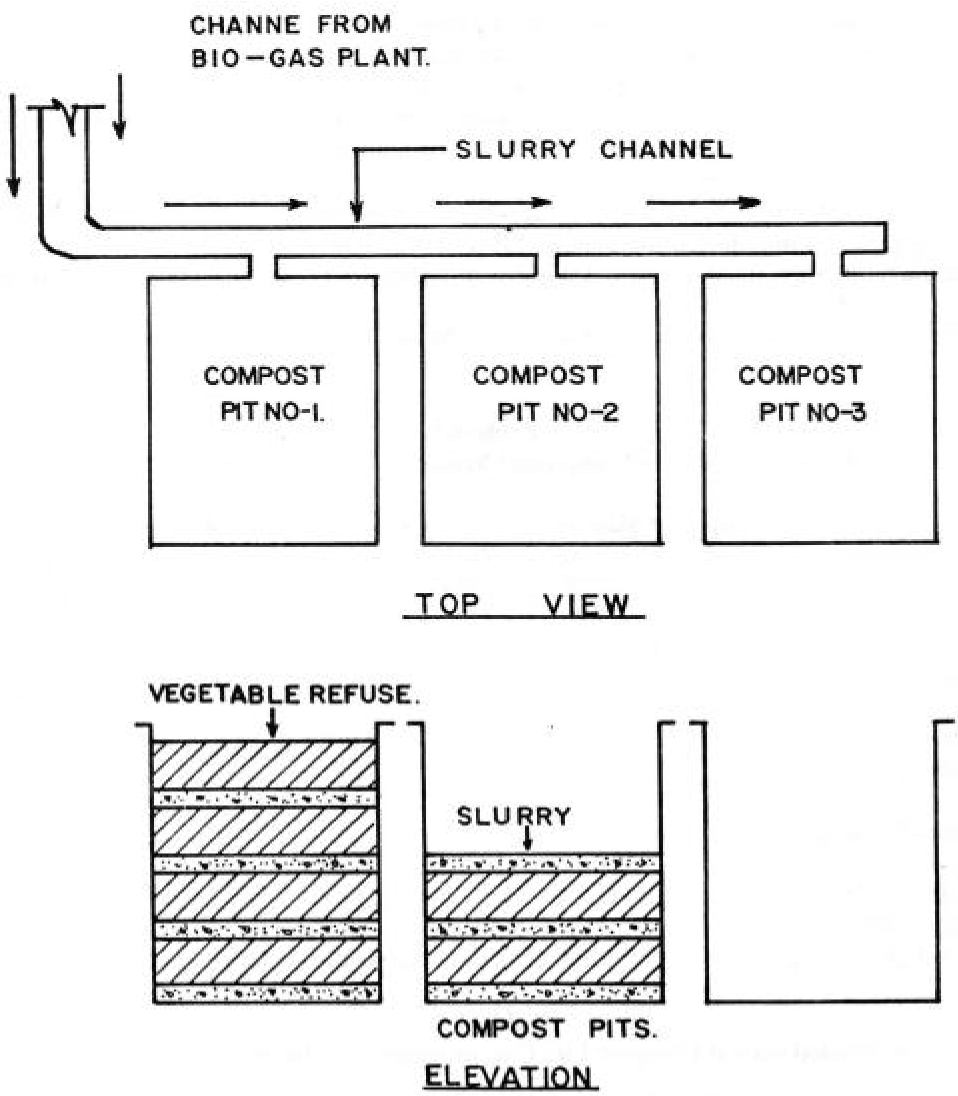


CHART-43 USE OF SLURRY IN MAKING COMPOST

4..9 Quality Assessment of Compost and Digested Slurry

To derive maximum benefit from organic manure application, the compost should be well decomposed and be of good quality. Use of undecomposed organic manure should be avoided as it will do more harm than good. Undecomposed materials when applied to the soil attract insects and take a longer time (i.e. more time than the life cycle of the crop) before the plant nutrients present in them are converted in the form that can be assimilated by the plants.

It is essential to know whether the compost has attained the stage of maturity before applying it in the field. In practice, mature compost can be identified from its physical appearance. Matured compost has a dark brown colour whereas undigested slurry is light brown or greenish. When pressed between two fingers, matured compost is friable in consistency and can be easily distributed in the field. Similarly, if bubbles are still rising in the slurry pit, it indicates that the slurry could still produce some gas and hence, has not completed the required retention time

4.10 Influence of Slurry on the Yield of Crops and Vegetables

Little attention has been given by the promoters and the scientists in generating sufficient scientific data in the Nepalese context regarding the influence of slurry on the growth and yield of crops and vegetables. The preliminary experiment carried out so far in Nepal indicated that the yield of crops and vegetables could be increased from 10 to 30 percent through slurry application. There is a need to design a suitable field experiment (that can be carried out by agricultural scientists) to generate information in this area. Following guidelines could be useful for this purpose.

4.11 Field Experiment

In the present context, a fertility trial including following treatments, if necessary with some modifications, is worth conducting in different agro-climatic conditions of Nepal.

- Control
- FYM (traditionally prepared) @ 5 and 10 tons/ha
- Wet slurry @ 5 and 10 tons/ha
- Composted slurry @ 5 and 10 tons/ha
- Recommended dose of chemical fertilizers
- Recommended dose of chemical fertilizer and wet slurry @ 5 and 10 tons/ha
- Recommended dose of chemical fertilizers and composted slurry @ 5 and 10 tons/ha

These treatments should be replicated four times for conducting statistical analysis.

Similar experiments carried out in China have produced the following results (see Biogas Technology in China, 1983):

- Compared to the control, application of digested slurry increased the late rice, barley and early rice yields by 44.3 percent, 79.8 percent and 31 percent, respectively.

- Compared to FYM, application of digested slurry increased the rice, maize and wheat yields by 6.5 percent, 8.9 percent and 15.2 percent, respectively.

- Compared to FYM, application of digested slurry along with ammonium bicarbonate (chemical fertilizer) increased the rice and maize yields by 12.1 percent and 37.6 percent, respectively.

The Chinese results indicate that biogas slurry is of superior quality than FYM. Crop productivity can be significantly increased if the slurry is used in conjunction with appropriate nature and dose of chemical fertilizer.

4.12 Effluent as a Supplement in Ration of Animal and Fish

Digested slurry has been used to supplement feed for cattle, hogs, poultry and fish in experimental basis. The encouraging results obtained from experiments arc yet to be commonly practiced by the users. The following subsections describe various experiments carried out in this area.

4.12.1 Digested Slurry as a Feed to Animals

Results from the Maya Farms in the Philippines showed that in addition to the plant nutrients, considerable quantity of Vitamin Bi_2 (over 3,000 mg of Bi: per kg of dry sludge) are synthesiscd in the process of anaerobic digestion. The experiment has revealed that the digested slurry from biogas plant provides 10 to 15 percent of the total feed requirement of swine and cattle, and 50 percent for ducks (Gunnerson and Stuckey, 1986). Dried sludge could be substituted In cattle feed with satisfactory weight gains and savings of 50 percent in the feed concentrate used (Alviar. et al.. 19X0). The growth and development of Salmonella chloreasuis and Coli bacillus were inhibited under anaerobic fermentation.

This is also relevant in Nepal, since about one-third of the livestock are generally underfed (Pariyar. 1993). The low availability of good quality forage is the result of low productivity of rangeland as well as limited access to it. Only 37 percent of rangelands arc accessible for forage collection (HMG/AsDB/ FINN1DA. 1988). Therefore, addition of dried sludge in cattle feed would improve the nutrient value of the available poor forgae.

An experiment was carried out at BRTC, Chengdu. China in 1990 to study the effects of anaerobic ally digested slurry on pigs when used as food supplement. Effluent (digested slurry) was added at the rate of 0.37 to 1.12 litres of kg of feed in the normal mixed feed rations. The pigs were fed with this ration until their body weight reached 90 kg. The piglets in this experiment grew faster and showed better food conversion than the control group. Negative effects on the flavour or hygienic quality of the meat were not noticed (Tong, 1995). Subject to further trials, digested slurry might be safe as animal feed.

4.12.2 Digested Slurry as a Feed to Fish

A comparative study on fish culture fed only with digested chicken slurry was carried out by National Bureau of Environmental Protection (NBEP). Nanjing. China in 1989. The results showed that the net fish yields of the ponds fed only with digested slurry and chicken manure were 12,120 kg/ha and 3,412.5 kg/ha, respectively. The net profit of the former has increased by 3.5 times compared to that of the latter. This is an effective way to raise the utilization rate of waste resources and to promote further development of biogas as an integrated system in the rural areas (Jiayu, Zhengfang and Qiuha, 1989).

An experiment was carried out in Fisheries Research Complex of the Punjab Agricultural University, Ludhiana, India to study the effects of biogas slurry on survival and growth of common carp. The study concluded that growth rates offish in terms of weight were 3.54 times higher in biogas slurry treated tanks than in the control. Biogas slurry proved to be a better input for fish pond than raw cow dung since the growth rate of common carp in raw cow dung treated tanks were only 1.18 to 1.24 times higher than in the control. There was 100 percent survival of fish in ponds fed with digested biogas slurry as compared to only 93 percent survival rate in ponds fed with raw cow dung.

A model for integrating fish farming system has been illustrated in Chart 4.4. In an integrated Magur fish (Clavias batrachus) farming system, wastes from poultry' and duck house, cattle dung and slurry are

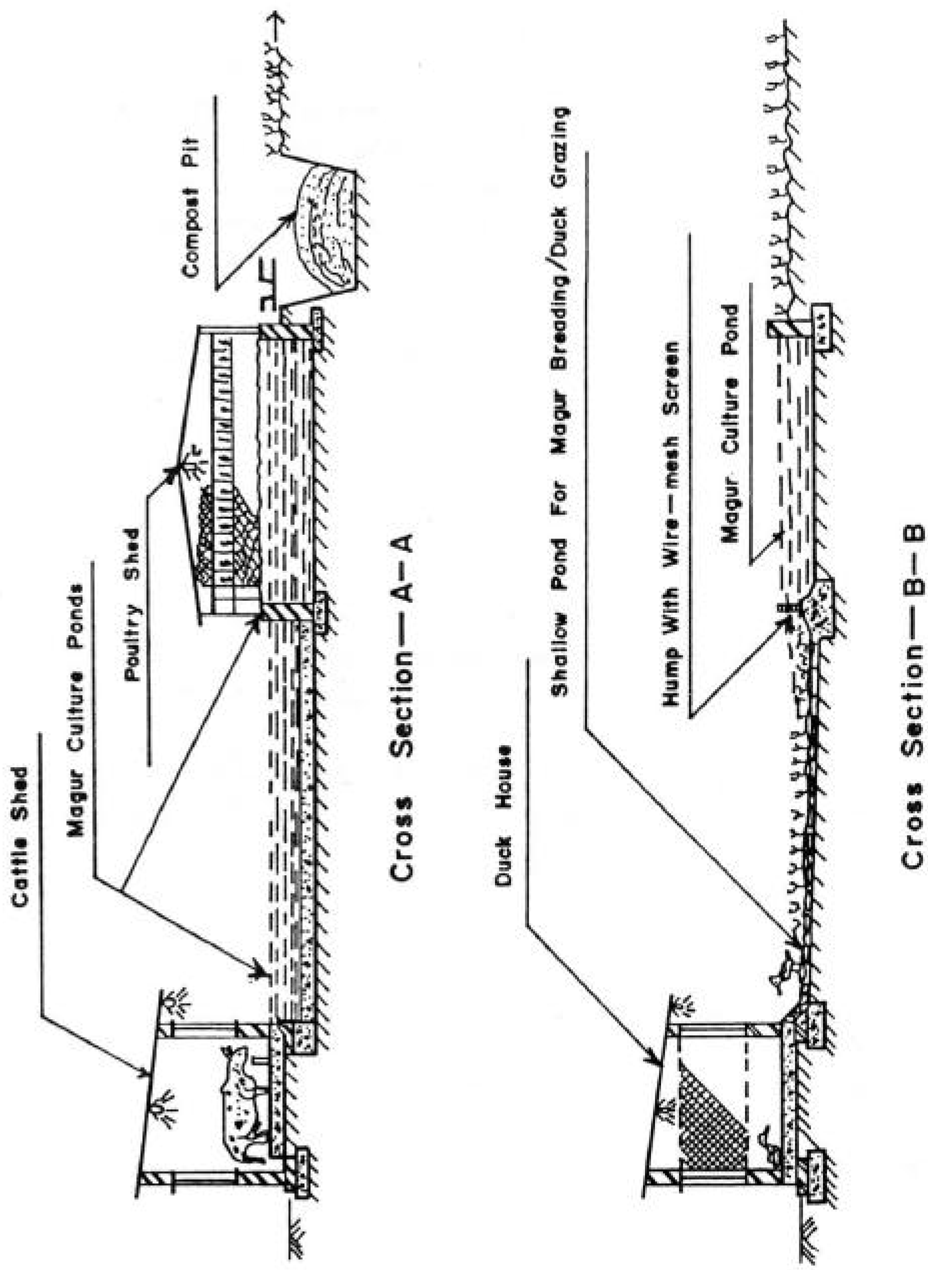


Chart-4.4. A Model For Intergrating Fish Farming.

used as manure. It may be directly consumed by fish or may be recycled through a biological food-web of trash fish, molluscs or earthworms introduced in the system and consumed by the fish. The poultry shed is constructed above the culture pond and the duck house is placed adjoining the breeding pond. The leftover feed of ducks and poultry are utilized by the fish directly. Care has to be taken to ensure that the excess slurry from the biogas plant is not discharged into the system. Otherwise, there would be a depletion of dissolved oxygen which has an adverse effect (Singh, 1992).

4.12.3 Improving the Quality of Feed

Straw was treated with biogas slurry liquid (BSL) and the treated samples were ensiled for 0. 3. 6, 9, 12 and 15 days. The findings showed that due to high nitrogen content of BSL, it could be considered as a rich source of nitrogen in upgrading the feeding quality of crop residues and ensiling of poor quality grasses. During the growth period, the microbes utilize the available nitrogen and convert it into quality proteins and nucleic acid. Thus, the protein content of fodder or grass increases, crude fibre content significantly decreases, and the overall digestibility of fodder increases. Such results suggest that substantial improvement in feeding value of straw could be achieved with BSL treatment (Perera. et al,. 1940).

All the foregoing information indicate that although the aspect of utilization of digested slurry for animal feed is well developed in some countries, no effort has been made so far by the biogas promoters in Nepal to carry out appropriate R&D for the utilization of slurry as a feed and fertilizer for which immense potential exists.

4.13 Other Uses

Many extensive experiments performed in China have proved that the digested slurry, when used as fertilizer, has strong effects on plant tolerance to diseases such as potato wilt (Pseudomonas salanacearum. late blight, cauliflower mosaic, etc. and thus can be used as bio-chemical pesticide.

A series of experiments and analyses conducted in China in a period of three years show that the cold-resistant property of early season rice seedling are effectively enhanced by soaking seeds with digested slurry. The survival rate increased by 8 to 13 percent and the quality of seedlings raised by soaking seeds with digested slurry is much higher than that of the control group during the recovering period after low temperature stress. The seedlings germinated faster, grew well and resisted diseases (Biogas Technology In China, 1989).

Foliar application of diluted slurry increases rate of wheat plant growth, resists to lodging and increases size of grains and length of the ear Foliar application in grapes have been found to increase yield, length of fruit-year, sugar content, fruit size, colour, and resistance to mildew diseases. In cucumbers, it has been observed to increase resistance to wilt diseases. In peach, it develops better fruit colour and early maturation.

Digested slurry can effectively control the spreading and occurrence of cotton's weathered disease. It decreases the rate of the disease with an efficiency rate of 50 percent for one year. 70 percent for more than two years along with increase in production.

Wheat aphids are effectively cured when digested slurry mixed with a 30 to 40 percent of Rogor is sprayed saving the cost of Rogor chemical which also has an adverse environmental impact.

Biogas can be used to inhibit the process of post-maturation of fruits and vegetables and thus increase their safe storage time. When biogas is filled for the first time in the storage tank, box or bin, the valve on the exhaust tube should be opened in order to exhaust air or gas in the jar as completely as possible. When ail other gas are pushed out by the biogas in the bin, the valve should be closed. In this way, all the pests can be destroyed (Biogas Technology In China, 1989).

4.14 Session Plan

Activity No	Topic and Area of Discussion	Time (ntin.)	Methods of Training	Teaching Aids
1.	Highlight the objective of session	2	Discussion	O/H projector, screen
2.	Interrelation of biogas technology and agriculture	2	Discussion	O/H projector, screen
3.	Limitation of chemical fertilizer use	3	Discussion	O/H projector, screen
4.	Organic Fertilizer	*3*	Lecture cum discussion	O/H projector, screen, flip chart
5.	Importance of slurry for crop production	4	Lecture cum discussion	O/H projector, screen, flip chart
6.	Characteristics of Digested slurry	4	Lecture cum discussion	O/H projector, screen, flip chart
7.	Utilization of digested slurry	4	Lecture cum discussion	O/H projector, screen, flip chart
8.	Size of compost pit	3	Lecture cum discussion	O/H projector, screen, flip chart
9.	Method of assessment of quality of compost	.1	Lecture cum discussion	O/H projector, screen. flip chart
10.	Influence of slurry on the yield of crops and vegetables	3	Lecture cum discussion	O/H projector, screen, flip chart
II.	Field experiment		Lecture cum discussions	O/H projector, screen, flip chart
12.	Effluent as a supplement in ratio of animal and fish	.1	Lecture cum discussion	O/H projector, screen, flip chart
13.	Other uses of slurry	3	Lecture cum discussion	O/H projector, screen, (lip chart
14.	Questions and answers	10	Discussion	
Total Time		50		

4.15 Review Questions

– Why is organic matter important for the maintenance of soil fertility?

– Is application of only mineral fertilizer beneficial for soil and crop production?

– Explain the role of digested slurry in decreasing the rate of deforestation and enhancing crop production.

– Enumerate different methods of slurry applications.

– What is the significance of the use of digested slurry as a feed to animal and fish?

– What appropriate R&D is needed in Nepal in view of proper utilisation of effluent?

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SESSION FIVE

INSTALLATION COST AND INANCIAL VIABILITY

SESSION FIVE

Installation Cost And Financial Viability

5.1 Introduction

In the context of Nepal, biogas is known more as a technology for meeting household energy requirements than its other utilities. Even this limited view of the technology is significant since a large number of population could be benefited by it. Having discussed various utilities of the technology in previous sessions, this session is devoted to the economics of the technology mainly as units for the production of biogas and slurry at the household level. By the end of this session, the participants will be able to:

– explain the concept, terminology and "norms" used to assess financial viability of family size biogas plants:
– explain different factors that affect the financial viability of a biogas plant; and
– assess the financial viability of a family size biogas plant.

5.2 Financial Analysis

Financial analysis is the most commonly used tool that helps to decide whether a user benefits by installing a biogas plant and, if so, by how much. The basic underlying assumption for financial analysis is that people will adopt a new technology only if they expect it to have a positive impact in their financial situation.

In financial analysis, all costs and benefits arc valued from die point of view of the user for whom this is being done. Since this analysis is undertaken before making a decision to install the plant, it is important to ensure that all costs and benefits are estimated as they are most likely to be realized by the user after the plant installation.

Benefits and costs of a biogas plant will vary depending upon the use of inputs and outputs by the particular user. For example, if additional cost is incurred in the use of inputs, such as the need to buy cattle dung or use additional labour for feeding the plant, such cost should also be included in the financial analysis.

The financial analysis should show when the cost and benefit accrue or how they are distributed over the project period. To make the analysis more comprehensive, costs and benefits should be reflected for each year of the project life. It should include all those costs and benefits that arc changed or influenced by the use of the technology. Any change in costs and benefits that are not related to the use of biogas should not be included in assessing the financial viability of a biogas plant.

The major parameters that need to be considered for the financial viability, of biogas plants are discussed below.

5.2.1 Project Life

A fixed dome type plant could last for more than 40 years depending on the quality of construction and the materials used. However, the economic life of a plant is taken as 20 years mainly because any cost or benefit accrued after 20 years will have insignificant value when discounted to the present worth. Hence, in the calculations in Tables 5.1 and 5.2 (for 10 m^3 plant), it is assumed that the plant will become non-functional by the end of 20^{th} years from its first day of commissioning. Similar calculations for a 8 m^3 plant are shown in Tables 5.3 and 5.4.

5.2.2 Benefits and Costs

Benefits or Inflow

Unpriced benefits : All benefits of a biogas plant can not be readily priced or even compared with the price of similar products or services in the market. For example, it is difficult to put a money value for the benefit of cleaner homestead or decrease in the population of harmful pathogens in the slurry.

There are economic tools which can be used to assign money value for such benefits. But they are not only sophisticated to use but are also not free from controversies. To make the financial analysis as simple and comprehensive as possible, all benefits arc generally not included. However, it is worth noting that such benefits do accrue to individual users and should have been accounted for, had there been any simple method. This indicates that even if the financial analysis shows zero net benefit of installing a biogas plant, it should be interpreted as having positive net benefits owing to the unpriced factors.

One of the ways to account for all unpriced benefits is to prepare an exhaustive list of such benefits, assign weightage (some numerical figure) to each category of benefits depending upon their importance as preferred by the family (for financial analysis) and by society (for economic analysis). Such numbers are then processed to arrive at a single number that could be used as an objective basis for the decision making.

Biogas technology also provides additional resource base which opens new opportunity for financial gains in the future. For, example, with the availability of slurry, a farmer may decide to profit from raising pig or fish as the slurry could supplement as high as 30 percent of their feed leading to a substantial decrease in the cost of production. But such "possible benefits" should not be included in the financial analysis until there is a strong reason to believe that such opportunity will actually be realized by the user in a definite time frame in the future.

Indirect Valuation : There arc some forms of benefits of a biogas plant that can be priced by using indirect methods. For example, saving in the use of kerosene and/or firewood due to the use of a biogas plant could be quantified and their prices can be obtained from the local market. In such case, benefit of a biogas plant is realized by the family in terms of the cost avoided in purchasing fuelwood and/or kerosene. Use of biogas in a family may lead to saving in both kerosene and firewood. In such cases, it would be erroneous to price all energy values of a biogas plant with only one of the substitutes.

The indirect valuation for financial analysis should give due considerations to what actually happens to the family for which the analysis is done. For example, if it does not cost anything for a particular farmer to collect firewood, then it would be erroneous to use the price of firewood in the market as benefit or the cost avoided in doing the financial analysis for that particular farmer. In such case, it would be more relevant to calculate only the value of labour saved which otherwise would have been spent in collecting firewood. An analysis on this basis may show that investment in a biogas plant is not a profitable proposition for people who do not buy firewood or get it at a very low price.

Valuation of Lighting Benefits : Biogas is also used for lighting along with its use for cooking. The benefit of lighting could be quantified in terms of cost saved by reducing the use of kerosene or paraffin candles or electricity depending on what was used before the installation of the biogas plant.

Table 5.1
Financial Analysis of a 10 m^3 Biogas Plant (With Loan and Subsidy)

(in Rs.)

Year	1	2	3	4	5	6	7	8 to 20
Benefits								
To Non-Users								
- Forest Conservation								
Unpriced								
- Sanitation/Environment								
- Health								
- Tourism (New Opportunities)								
Indirectly Priced								
- Saving Firewood	5.519	5,519	5.519	5.519	5,519	5,519	5,519	5.519
- Saving Kerosene/Candle								
- Saving In Time/Labour	6,200	6,200	6,200	6.200	6,200	6,200	6,200	6,200
- Saving Feed								
Salvage Value								
Increased Crop Yield								
Loan	17,056							
SUB TOTAL	**28,775**	**11,719**	**11,719**	**11,719**	**11,719**	**11,719**	**11,719**	**11,719**
Costs								
- Investment	17.056							
- Operation								
- Maintenance	700	700	700	700	700	700	700	700
- Loan Repayment		4,629	4,629	4.629	4.629	4,629	4,629	
- Others								
SUBTOTAL	**17,756**	**5,329**	**5,329**	**5,329**	**5,329**	**5,329**	**5,339**	**700**
NET BENEFIT	**11,019**	**6,390**	**6,390**	**6,390**	**6,390**	**6,390**	**6,390**	**11,019**

IRR = Above 50 percent NPV = 51,337 BCR = More than *2*

Table 5.2
Financial Analysis of a 10 m^3 Biogas Plant (Without Loan and Subsidy)

(in Rs.)

Year	1	2	3	4	5	6	7	8 to 20
Benefits								
To Non-Users								
- Forest Conservation								
Unpriced								
- Sanitation/Environment								
- Health								
- Tourism (New Opportunities)								
Indirectly Priced								
- Saving Firewood	5,519	5,519	5,519	5,519	5,519	5,519	5,519	5,519
- Saving Kerosene/Candle								
- Saving In Time/Labour	6,200	6,200	6,200	6,200	6,200	6,200	6.200	6.200
- Saving Feed								
Salvage Value								
Increased Crop Yield								
Loan								
SUBTOTAL	**11,719**	**11,719**	**11,719**	**11,719**	**11,719**	**11,719**	**11,719**	**11,719**
Costs								
- Investment	24,056							
- Operation								
- Maintenance	700	700	700	700	700	700	700	700
- Loan Repayment								
- Others								
SUBTOTAL	**24,756**	**700**	**700**	**700**	**700**	**700**	**700**	**700**
NET BENEFIT	**(13,037)**	**11,019**	**11,019**	**11,019**	**11,019**	**11,019**	**11,019**	**11,019**

IRR = Above 50 percent NPV = 45,303 BCR = More than 2 US$ 1 00 = NRs. 56.00

Table 5.3
Financial Analysis of a 8 m^3 Biogas Plant (With Loan and Subsidy)

(in (Rs.)

Year	1	2	3	4	5	6	7	Rio 20
Benefits								
To Non- Users								
- Forest Conservation								
Unpriced								
- Sanitation/Environment								
- Health								
- Tourism(New Opportunities)								
Indirectly Priced								
- Saving Firewood	4,415	4,415	4,415	4.415	4,415	4,415	4,415	4,415
- Saving Kerosene/Candle								
- Saving In Time/Labour	6,200	6,200	6,200	6,200	6,200	6,200	6,200	6,200
- Saving Feed								
Salvage Value								
Increased Crop Yield								
Loan	**14,281**							
SUBTOTAL	**24,896**	**10,615**	**10,615**	**10,615**	**10,615**	**10,615**	**10,615**	**10,615**
Costs								
- Investment	14,281							
- Operation								
- Maintenance	700	700	700	700	700	700	700	70U
- Loan Repayment		3,876	3,876	.1,876	3,876	-1.876	3,876	
- Others								
SUB TOTAL	**14,981**	**4,576**	**4,576**	**4,576**	**4.576**	**4,576**	**4,576**	**700**
NET BENEFIT	**9,915**	**6,039**	**6,039**	**6,039**	**6,039**	**6,039**	**6,039**	**9,915**

IRR - Above 5(J percent NPV = 47,1 S3 BCR - 2.64

Table 5.4
Financial Analysis of a 8 m^3 Biogas Plant (Without Loan and Subsidy)

(in Rs.)

Year	1	2	3	4	5	6	7	8 to 20
Benefits								
To Non-Users								
- Forest Conservation								
Unpriced								
- Sanitation/ Environment								
- Health								
- Tourism (New Opportunities)								
Indirectly Priced								
- Saving Firewood	4.415	4,415	4.415	4,415	4,415	4,415	4.415	4,415
- Saving Kerosene/Candle								
- Saving In Time/Labour	6,200	6,200	6,200	6,200	6.200	6,200	6,200	6,200
- Saving Feed								
Salvage Value								
Increased Crop Yield								
Loan								
SUBTOTAL	**10,615**	**10,615**	**10,615**	**10,615**	**10,615**	**10,615**	**10,615**	**10,615**
Costs								
- Investment	21.281							
- Operation								
- Maintenance	700	700	700	700	700	700	700	70!)
- Loan Repayment								
- Others								
SUBTOTAL	**21,981**	**700**	**700**	**700**	**700**	**700**	**700**	**700**
NET BENEFIT	**(11,366)**	**9,915**	**9,915**	**9,915**	**9,915**	**9,9 IS**	**9,915**	**9,915**

IRR = Above 50 percent NPV = 411,50 BCR = 2.83 US$ 1.00 = NRs 56.00

Biogas lamps provide more reliable lighting than the electricity (in areas suffering from frequent load shedding) and better light than kerosene. However, the value of "such convenience can not be readily priced. As lighting forms very small part of the benefit stream, its value is not included in the analyses.

Salvage Value : The salvage value of biogas plant is not included in the benefit stream of financial analysis because after 20 years of operation, the plant or its parts will not be re-salable.

Value of Cooking Fuel Saved : In the general form of financial analysis, only those items that can be quantified and priced are included in the stream of benefits that accrue over a project or plant operation period. One of the most important uses of biogas for a family is its gas for cooking. Most of the rural households use firewood for cooking. With this assumption, it is the quantity and value of the firewood saved that becomes the benefits of the biogas plant. For a family that used to cook in kerosene stoves prior to the installation of the biogas plant, it is the price of kerosene saved that makes the benefit stream, hi this session, die price of firewood saved is taken as one of the benefit components.

Problems associated with the collection, storage and use of fuelwood are avoided by the availability of gas. These are the most appreciated benefits of the plant also in terms of reducing the drudgery of women who arc responsible for most of these activities. In this session, all firewood saved is valued at Rs 2.00/kg, based on the market price of the Timber Corporation of Nepal (TCN) for the year 1996.

The examples in Tables 5.1 to 5.4 reflect the situation of a user who used to buy firewood from the TCN before the installation of the plant and docs not have to buy any firewood afterwards. Relevance of such assumption should be checked and appropriate value should be used to best reflect the real life situation in a given context.

The relationships between the quantity of gas produced, the amount of firewood saved and the value of such savings for different plant sizes are presented in Table 5.5 based on the following assumptions:

- 6 kg of dung is required per m^3 size of biogas plant
- 0.036 m^3 of gas is produced per kg of fresh cattle dung
- 1 m^3 of gas is equivalent to 3.5 kg of firewood
- The cost of firewood is Rs 2.00/kg

In such calculations, care should be taken to value the quantity of firewood saved and not the value of the total gas produced as equivalent to the cost of firewood. These two values may differ in cases when either all the gas produced is not consumed or occasional use of firewood become necessary due to low production of gas such as in the winter. Preliminary case studies have shown that biogas replaces about 80 percent of the firewood consumption as users generally continue to use firewood for heating animal feed, cooking food in winter when gas production is low (Devkota, 1994). In this session, it is assumed that all gas produced is fully consumed and there is no need to use firewood even in the winter (Tables 5.1 to 5.4).

Valuation of Time Saved : As discussed in Session Two, on an average, biogas household women either spent an additional 15 minutes or gained up to 4.5 hours per day depending on access to forest and water. Another study with 100 biogas households in 16 districts has reported an average net labour saving of 3 10 hours. In all these studies, the availability of firewood and water were the critical factors to determine the extent of labour saved (East Consult, 1994).

Thus the labour time saved can be used for leisure or for other economic activities. Putting money value on leisure requires dealing with sophisticated economic principles. An acceptable alternative way is to assume that the labour saved could be used in other economic activities or could be directly sold in the local labour market. Assumptions that need to be made in doing such valuation should be based on

Table 5.5
Cost Estimation of Firewood in Terms of Gas and Simple Pay Back Period of Family Size Biogas Plants

Plant Size (m^3)	Required Qty of Dung (kg/day)	Gas Produced (m^3/day)	Gas Produced (m^3/yr)	Firewood Equivalent of Gas (kg/yr)	Annual Cost of Gas in terms of Firewood (Rs)	Total Cost of a Plant in the Plains (Rs)	Simple Payback (yr)
4	24	0.864	315.36	1,103.76	2,208	15,610	7.1
6	36	1.296	473.04	1,655.64	3,311	18,049	5.5
10	48	1.728	630.72	2,207.52	4,415	21,281	4.8
15	60	2.160	788.40	2,759.40	5,519	24,056	4.4
20	90	3.240	1,182.60	4,139.10	8,278	30,253	3.7
	120	4.320	1,576.80	5,518.80	11,038	36,286	3.3

existing rate of employment and market wage rate for the unskilled labour, as in shown below assuming 3:06 hours are saved from the installation of a biogas plant:

$$Y = \frac{3.10\,hr \times 365\,days}{7} \times P \quad \text{...} \quad (5.1)$$

Where,

Y	=	value of saving in time
3.10 hr	=	gross saving in time for fuelwood collection, cooking and cleaning of utensils (3 hours 6 minutes) expressed in decimals (see Table 2.4).
7	=	working hour per day of female labour {as such works are generally done by the females and the labour wage rates are different for men and women)
P	=	current market wage rate for women (Rs 70/day)

The money value of above calculation comes to be Rs 11,315. If the average employment in agricultural activities for women is about 200 days a year, then the value for 200 days, which is Rs 6,200, should be used for financial analysis.

Valuation of Slurry : Slurry from a biogas plant is known to have better influence on soil and its productivity compared to the use of fresh or composted dung. During the process of anaerobic digestion, some enzymes and vitamins arc produced. Also, bio-chemical composition of some of the nutrients such as nitrogen is changed and becomes more readily available for plants. Because of the cumulative effect of these elements in biogas slurry, its value as feed and manure is enhanced.

The money value of such benefits depends on whether the slurry is actually used and the benefits realized by the particular user for whom the financial analysis is done. For example, if the slurry is not used for feeding pigs, then it is not relevant to include the potential benefit of such use in the financial analysis. Similarly, the manure value of slurry can not be included in the financial analysis if the potential increase in crop yield is not actually realized by the use of slurry. However, it should be noted that slurry has a potential to increase the income or saving of a farmer and needs to be considered whenever it is very likely that the actions will be taken to realize such benefits.

A review of literature shows different ways of putting money value to slurry (APROSC, 1988). One of the commonly used methods is to put money value to the increased amount of N, P and K in the slurry compared to the content in the dung. The market prices of N. P and K in chemical fertilizers arc taken as the basis for such calculation. Based on the same principle, the increased quantity of protein in the slurry could be valued if the slurry is to be used as a part of cattle feed and not as manure. In this approach, there is more degree of uncertainty in realizing the expected benefits (Rubab and Kandpal. 1996).

A more direct approach would be to put the value of incremental benefit from a system in which the slurry is used. For example, if the authentic research data show that the yield of corn is increased by, say. 30 percent with the application of biogas slurry, then this increase could be shown as a part of benefit stream after considering the cropped area and the present yield. This approach is more reliable as it takes account of the process through which the ingredients of slurry are transformed into products that have market price.

Costs or Outflow

Investment Cost : The cost of a digester differs with time, space and so many other factors as shown in Chart 5.1. However, about 40 percent of the cost of a biogas digester remains independent of the digester size in the range of 6 to 20 m^3

Of the total investment cost, the construction cost alone amounts to 71 and 81 percent for plants of 20 and 4 m^3, respectively The most expensive item is cement followed by gas pipes. The general distribution of total investment cost to individual items for a typical 10 m^3 size biogas plant is shown in Chart 5.2.

In the beginning of each fiscal year, all biogas companies publish their quotations for constructing different sizes of plants. These quoted costs vary among companies reflecting their differences in overhead costs. The distribution of overhead cost of GGC in the fiscal year 1991/1992 is shown in Chart 5.3. This cost structure of GGC shows a higher proportion of cost for personnel. This is because, actual construction activities can not be carried out throughout the year due to weather conditions, particularly the monsoon. Some of the staff have still to be retained throughout the year to ensure their availability at the time of need (Gutterer and Sasse, 1992).

The quotations of companies also vary within a year to reflect the change in market prices of construction materials. Therefore, the results of the financial analysis for a particular size of plant will also vary within the year of construction and the company that constructed it. However, Nepal Biogas Promotion Group (NBPG) is considering the possibility of starting a single price quotation (for a given plant size) which is applicable to all companies.

All biogas companies are in the private sector and do not receive any institutional subsidy. All of their institutional cost have to be reflected in the plant cost that<they charge to the users. With the increasing competition among the companies, each company is now pressed to reduce its overhead costs by using part-time staff and curtailing involvement in research, education and extension.

In this session, the installation (investment) costs for different size biogas plants are taken from the quotations of GGC for the year 1996. Generally, the installation costs are different foi plants in the hills and plains (Terai), as the plains is more accessible. The use of biogas is found to be relatively higher in the plains than in the hills. Because of this, prices for the plains are taken in the examples of this session. The cost breakdown of different sizes of biogas plants is presented in Table 5.6.

The investment cost includes :

- cost of unskilled labour to be provided by farmers;
- all overhead costs borne by a biogas company,
- provision for penalty on construction defaults;
- 1 year guarantee on pipes and appliances;
- 6 years guarantee on inlet, digester, dome and outlet;
- 6 years after-sales-services (including yearly visit); and
- participation fee (Rs 500 per plant).

However, transport cost of building materials, pipes and appliances are excluded.

O&M Cost : The O&M cost includes the labour time needed to collect water and mixing of dung which is estimated at 0:39 hrs per day per labour. This cost is already accounted for in the financial analysis when the net saving in time is considered (Activity Nos. 1 and 2, Table 2.4).

In addition to the time spent on O&M, additional cost may accrue in changing gas valves, mantle and glass of lamps, and procuring technical support services from biogas companies. In this session, it is grossly estimated that about Rs 700 is spent to meet other expenses such as changing of mantel and traveling cost to nearby biogas company for technical help. BSP assumes this cost to be negligible.

Table 5.6

Material Requirement and Breakdown of Cost of 4 m\ 6 m^3 8 m^3, 10 m^3, IS ra^3 and 20 m^3 Biogas Plants

Description	Unit	Unit Rate	4 m		6 m^3		8 m^3		10 m^3		15 m^3		20 m^3	
			Qty	Price	Qty	Price	Qty	Price	Q«y	Price	Qty	Price	Qty	Price
A. Construction Materials														
- Cement														
Plains	Bag	280.00	11	3,080	13	3,640	16	4,480	19	5.320	27	7,560	34	9,520
Hills	Bag	280.00	12	3,360	14	3.920	18	5,040	21	5.880	30	8,400	37	10,360
- Bricks or Stones	Piece	2.00	1200	2,400	1400	2,800	1700	3,400	2000	4,000	2400	4.800	2800	5.600
- Sand	Bag	15.00	60	900	70	1.050	80	1,200 .	90	1,350	110	1.650	120	1.800
- Gravel/Aggregates	Bas	12.00	30	360	35	420	40	480	50	600	60	720	70	840
B. Biogas Appliances				2,460		2,805		3,360		3,625		4,215		4.825
C. Pipe and Pipe Fittings				990		1,014		1,071		1.071		1,448		1.821
D. Reinforcement Steel	Kg	30.00	9	270	9	270	13	390	13	390	17	510	41	1,230
E, Labour (unskilled)	MD	60.00	20	1,200	25	1,500	30	1,800	35	2.100	45	2,700	55	3,300
F. Construction and One Year				2,450		3.0J0		3,600		4,100		5,150		5,850
G. 5 Year Guarantee Charge for the Plant				1,000		1,000		1,000		1,000		1,000		1,000
H. Participation Fee				500		500		500		500		300		500
TOTAL Plains:				**15,610**		**18,049**		**21,281**		**24,056**		**30,253**		**36,286**
Hills:				**15,890**		**18,329**		**21,841**		**24,616**		**31,093**		**37,126**

Source : GGC, 1996 US$ 1.00 = NRs 56.00

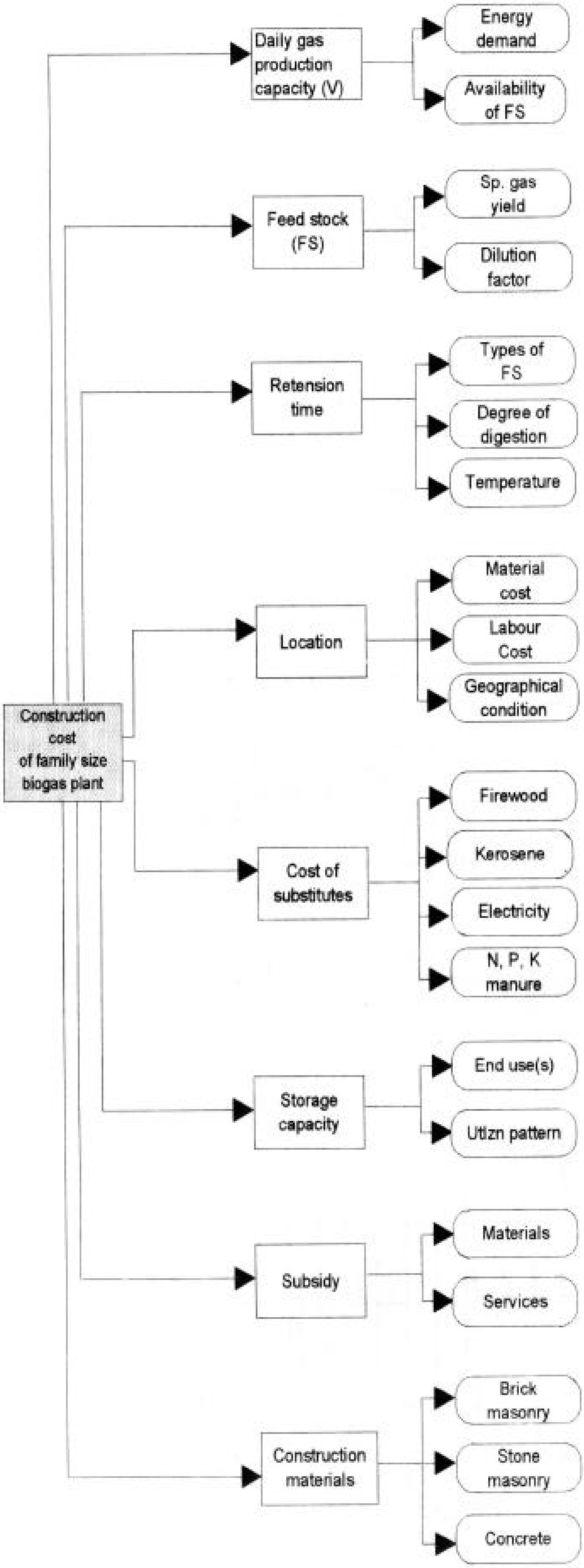

Chart 5.1 Factors Influencing the Financial Viability of a Biogas Plant

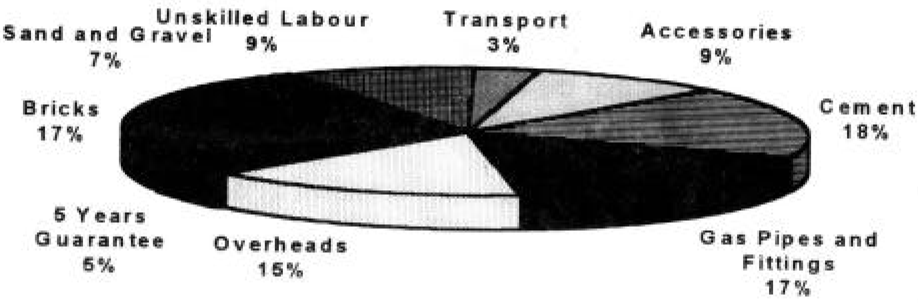

Chart 5.2 Cost Distribution of a Biogas Plant

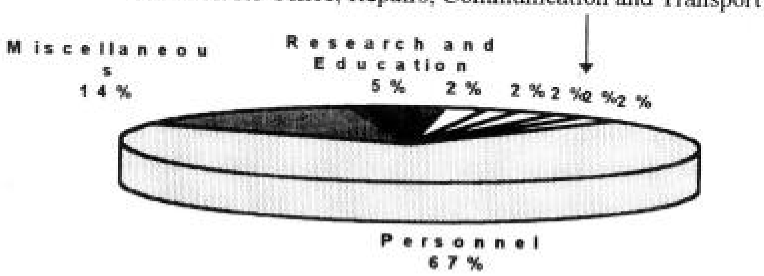

Chart 5.3 GGC Overheads in 1990/1991

5.2.3 Cash Flow Analysis

The basic procedure of a cash flow analysis is to enter all the year-by-year income to be received over the estimated life of the project as *Inflows* Similarly, yearly expenditures are entered in the analysis as *Outflow*. Finally, for each year, expenditure is deducted from the income. The result thus arrived at is the net cash flow or net benefit. Generally, in the initial year(s) of the project, the net cash flow or net benefit tends to be negative, because of the expenditures incurred to meet the establishment costs (Gittinger. 1982).

5.2.4 Time Value of Money and Discount Rate (Factor)

The real value of money changes over time. The reasons for such changes are:

– money of today can be invested to earn a return in the future; and
– people have time preference, i.e. they prefer now to the future.

For example, if Rs 100 is invested today at an interest rate of 20 percent per annum, this will be worth Rs 120 in a year's time, Rs 144 after two years, etc.

5.2.5 Net Present Value

As the costs and benefits *of* a project are spread over the useful years of project life, they need to be expressed in terms of one common denominator to make the comparison possible. Once the annual cash flow of a project is derived, it needs to be discounted so that all values could be compared to the value of a single year. This discounted net cash flow will provide a widely used criterion for measuring the profitability of a project. For this purpose, all future values are discounted to make them equivalent to the present value and is expressed as Net Present Worth (NPW) or Net Present Value (NPV).

The NPV technique measures the worthiness of a project by converting the annual cash flow to a single present value. A positive NPV indicates that the benefits are higher than the costs that accrue over the project life.

The process of relating future amount to the present value is known as discounting and is expressed by the following equation.

$$P = \frac{F}{(1+r)^n} \qquad \text{(5.2)}$$

Where,

P = present sum of money
F = future sum of money
r = rate of interest
n = number of years

Choice of Discount Elate : The commonly used discount rate is the rate of interest that a bank charges on loans and the opportunity cost of capital in situations where private capital is being committed. The on-going interest on biogas loan is 16 percent. Therefore, the NPV and Benefit-Cost Ratio (BCR) are calculated in Tables 5.1 and 5.2 at the discount rate of 16 percent.

5.2.6 Internal Rate of Return (1RR)

IRR, a most widely used measure of project profitability, is defined as the discount rate which makes the NPV of a project zero. In other words, IRR is that discount rate which makes the discounted benefits of a project equal to its discounted costs IRR can also be viewed as the interest rate that the investment pays to the user. Calculation of IRR requires trial and error methods. The NPV needs to be calculated assuming several discount rates until the value is zero. The following equation (based on interpolation) can be used to derive an approximate value of IRR.

$$IRR = \frac{r_1 . NPV_2 + r_2 . NPV_1}{(NPV_1 + NPV_2)} \qquad \text{(5.3)}$$

Where,

r_1 = discount rate of positive value of NPV

r_2 = discount rate of negative value of NPV

NPV_1 = value of positive NPV

NPV_2 = value of negative NPV

The IRR for biogas plants as calculated in Tables 5.1 to 5.4 is above 50 percent in both cases, i.e., with and without subsidy. This indicates that the return on investment made for the installation of a biogas plant is far above the opportunity cost in the capital market which is about 16 percent for loan.

5.2.7 Benefit-Cost Ratio

The benefit-cost ratio (BCR) is another tool for assessing the profitability of a project. If the ratio is greater than unity (i.e. B/C > 1.0), the rule of thumb is to accept the project. In this example, the BCR is above 1.0 in both with and without subsidy cases.

5.3 Discussion on Result of Financial Analysis

The net cash flow of a 10 m^3 biogas plant with subsidy situation is positive in the first year whereas it is negative without the subsidy {Tables 5.1 and 5.2). This indicates that without subsidy, a user has to invest about Rs 13,000 to get a positive return on investment. This is beyond the investment capacity for a general farmer- This further strengthens the argument for the need of subsidy. Furthermore, the present level of subsidy is very near to make the cash flow positive from the first year onwards.

Another factor to notice in the example is the higher benefit of biogas plant use in terms of the labour saved than the saving in firewood. This suggests that the biogas plant may not be viewed as profitable if the labour saved is not used for generating income for the family or in cases where the family attaches no value to all other benefits of the biogas plant such as leisure, clean homestead, and better health. The results in Table 5.1 also reveal that if about 70 percent of the time saved due to the biogas plant is used for income generating activities at the on-going market wage rate, the user will be able to pay the loan component.

The present bank policy requires a user to pay back the loan within seven years in six installments starting from the second year of plant installation. The annual payment of loan is less than the cost saved in firewood. In other words, even if the cost of firewood is reduced by 20 percent, the farmer would still be able to pay back the loan. Furthermore, the profitability of investment in biogas will increase with the increase in the price of firewood in the future.

Considering the generally low le vel of income of farmers and the nature of benefits from biogas which is 'indirect', doubts are expressed whether a majority of biogas loan users can actually repay the loan. The ADB/N's experience in this regard has been very positive as the biogas sector lending has minimum defaulters compared to lending in other sectors. The average percentage of overdue on outstanding loans for the period 1988/89 to I993AH was about 12 percent for biogas loans compared to 35 to 40 percent for all loans of ADB/N (BSP, 1996).

5.4 Financial Viability Assessment as Practiced by ADB/N

It is the staff of nearby ADB/N office who assesses financial viability of an user application for biogas loan. The standard format used for all types of enter prizes seeking loan is also used for assessing the viability of loan for biogas. In practice, the field staff do not undertake an in-depth analysis as discussed in this session.

ADB/N takes the quotation from the concerned biogas company (which the user wants to use for plant construction) as a basis to fix the investment cost required by the user. This cost is taken as one time investment loan.

To assess the benefit, the user is asked about the quantity of firewood and/or kerosene consumed. These quantities arc then multiplied by on-going prices in the local market. Thus calculated annual cost is taken as equivalent to annual benefit assuming that the biogas will replace all of the present consumption of firewood and/or kerosene. This benefit is then multiplied by six or seven years to arrive at total benefit that will accrue within the guarantee period of six years.

Then, the user is asked about other sources of income which will be used to repay the loan. The loan has to be fully repaid with interest within seven years at the most. An annual or bi-annual repayment schedule is fixed in agreement with the user.

5.5 Indicators of Financial Viability of Biogas Plants

ADB/N is the main rural credit agency that provides most of the credit requirement of the biogas sector, In its lending portfolio, biogas ranks the topmost sector for good lending or minimum number of defaulters. In other words, compared to other types of clients, biogas users are able to repay the loan with interest in time.

Before 1993, the subsidy was tied up with the bank loan. People who are willing and able to use their own saving for investment had to go through bank loan in order to receive government subsidy. However, such a mandatory requirement has now been removed. Since 1993, the number of plants constructed by users with their own saving has been increasing every year.

5.6 Economic Analysis

Some of benefits and costs of biogas plants arc not limited to the users. For example, if a large number of biogas plants are installed in a community, the non-users will also be benefited due to a cleaner community and conservation of forest in the area. Such benefits and costs that accrue even outside of the user household is a subject matter of economic analysis and not of financial analysis. A single biogas plant docs not significantly affect the economy as a whole. Therefore, economic analysis may not be relevant for a single plant but is of an immense importance at the community programme level where the impact of the programme on the economy is assessed. Economic analysis measures the effect of biogas programme on the fundamental objectives of the whole economy (van der Tak. 1975).

Many countries are at the initial stage of realizing their potential for biogas installation. Because of this, very little literature is available on the case study of economic analysis compared to case studies on financial analysis.

The accounting system or procedures developed for financial analysis could also be used for economic analysis except that the time of costs and benefits has to be valued in terms of the marginal productivity of resources used by a biogas plant.

Difficulties involved in identifying all items of costs and benefits and adjusting their market prices to reflect social preferences have been the major limitation of the economic analysis. This situation requires some level of generalization, simplification and even some restrictive assumptions.

It should be noted that even if the technology proves to be economically viable, the decision to adopt the technology by a single household may not be guided by national considerations. Also, the implementation of programmes for municipal waste treatment need not necessarily be economically viable because of the greater need of the society to deal with the existing pollution problems.

5.6.1 Economic Valuation of Firewood

Use of firewood for cooking by a family has negative effect on the density of forest area in the locality, which in turn affects the micro-climate of the area and thus the society. Therefore, economic price of firewood has to be higher for the society than to an individual resulting into higher economic rate of return on the investment.

NPC has yet to declare a single value for firewood that would reflect the social cost or benefit of it. The AsDB Report No NEP AP-24 (1980) has treated firewood as non-traded goods and valued it at lower than the financial price, whereas an APROSC study (1986) has valued it at 9 percent higher than the financial price. Another case study conducted by Krishna M Gautam in 1988 for APROSC has taken economic price of firewood as 20 percent higher than the financial price.

5.6.2 Economic Valuation of Kerosene

It is easier to arrive at the economic value of kerosene as it is readily marketed and the money value of subsidy in it can be calculated. Kerosene is imported from India and payment is made in Indian Currency (IC). Assuming that the official exchange rate between Nepalese Rupees (Rs) and IC would fully reflect the true economic value of goods traded with these currencies, the border price paid by Nepal is taken as the economic price of kerosene. About 10 percent is added to this price to reflect the economic cost involved in transportation and handling of kerosene within the country (Gautam, 1988).

5.6.3 Economic Valuation of Labour

The use of biogas results in the saving of unskilled labour time. A wage rate for unskilled labour has to be reduced by a factor that would reflect the cost of subsistence. Gautam used a factor of 0.65 to arrive at the economic wage rate of an unskilled labour.

5.6.4 Value of Slurry

Slurry is valued for its content of soil nutrients, particularly N, P and K As all chemical fertilizers in Nepal are imported, the economic values of N, P and K are calculated at the international market prices of N. P and K fertilizers.

5.6.5 Investment Cost

The guarantee fee and service charge taken by biogas company should be deducted from the total investment as they are only transfer of payments. The subsidy should be included as part of the investment cost. The total expenditure actually incurred for construction activities should be reduced by a factor to reflect the true economic cost of materials and labour used in construction. The weighted average Construction Conversion Factor of 0.76 was used by Gautam in the case study referred above.

It is seen from above discussion that the economic cost of goods and services used for biogas plant installation become lower than the costs used for financial analysis. Also, the benefits of biogas use are valued at higher rate for economic analysis than for financial analysis Therefore, any plant that proves to be financially viable to an individual user will still be viable at higher rate of return form the economic or social point of view.

5.7 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	3	Lecture cum discussion	O/H projector, flip chart
2.	Financial analysis	20	Lecture cum discussion	O/H projector. screen, flip chart
3.	Discussions on the result of financial analysis	5	Lecture cum discussion	Flip chart
4.	Indicators of financial viability of biogas plants	4	Lecture cum discussion	Flip chart
5.	Economic analysis	8	Lecture cum discussion	O/H projector
6.	General discussion	20	Discussion	O/H projector, flip chart
Total Time		**60**		

5.8 Review Questions

- Prepare a list of benefits and costs from biogas use that accrue even to non-users in the area.
- Should one install a biogas plant when the financial analysis shows that the NPV of future benefits is zero?
- How will the profitability of a biogas plant be affected with the rate of change in the prices of its inputs and outputs?
- How important is it to carry out detailed economic analysis for making a decision on whether a family should or should not install a biogas plant, and why?
- What are the new opportunities that a biogas plant provides to a user for additional financial gains in the future?

5.9 References

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SESSION SIX

SUBSIDY AND INSTITUTIONAL FINANCING

SESSION SIX

Subsidy And Institutional Financing

6.1 Introduction

It was seen in the previous session that some benefits of a biogas plant accrue not only to the user but also to the society as a whole. An example of this is the benefits to the society from the conservation of forest due to the adoption of biogas technology by a large number of families in a given area. It is not justifiable to make an individual user to bear the entire cost of the technology under the principle of users' pay all while the benefits are shared by the non-users as well.

This session discusses the need and justification for subsidy in the biogas sector in Nepal. In doing so, some of the past performance of subsidy programmes have been reviewed. The involvement of different institutions in administering subsidy and credit are also discussed. By the end of this session, the participants will be able to:

- explain why subsidy is needed in the biogas sector; explain the subsidy history in the biogas sector;
- enumerate credit institutions involved in biogas and explain procedures for using their services; and
- explain the role of institutional financing in the biogas sector.

6.2 Definition of Subsidy

Individuals work to maximize their personal gains or satisfaction, while organizations work to maximize gains for all of their members. There are situations when the organizational objectives are positively or negatively affected when some members try to maximize their personal gains. Penalty and subsidy are some of the tools that organizations use to discourage or encourage certain behavior of individuals. At the national level, it is the government as an organization that pays subsidies to the industry or directly to the users either for the adoption of the goods and services or to reduce cost to the users with an aim of maximizing the broader national objectives.

Subsidy could be provided at different levels. The local government could add to the subsidy provided by the central government. For example, a District Development Committee (DDC) could provide some financial support to a user household on top of what the user receives from the central government. Similarly, a VDC could also bear some part of the users' cost to add to the subsidy provided by the central and district government. Such multi-level subsidy schemes have been in practice in India. In Nepal too, the multi-level subsidy has been successfully practiced by specific projects for their target group population. Some NGOs have also been providing additional incentive to users in their particular area of work. However, such practices are yet to become common in Nepal.

6.3 Rationale of Subsidy for Biogas Plant Installation

Discussions in previous sessions have established that the adoption of biogas technology by an individual user has some positive impacts on broader and long term social objectives such as improved forest cover, improved productivity of soils, improved health of women, to name a few. The government has been making investments through other projects and programmes to attain these social objectives. Therefore, subsidy on biogas plants could be interpreted in two parallel ways: (a) the government payment to a biogas user for all the benefits that the society derives from the investment made by the user, (b) government incentive for individuals to invest for the attainment of the broader social objectives.

Each of these interpretations of subsidy has different implications in arriving at the right amount of subsidy. Principally, the amount of subsidy to a family size plant should be equal to the value of all net benefits of the plant minus the benefits that are exclusively enjoyed by the individual user or the investor. But, many of the benefits of biogas plants are not marketable and are difficult to express them in terms of money value. Because of such difficulties in fully accounting all costs and benefits of a biogas plant, for practical purposes, the amount of subsidy to be provided is generally guided by the questions : (a) what can the government afford as subsidy, and (b) what level of subsidy is sufficient to increase the demand above the existing construction capacity?

It is generally argued that subsidy creates market and price distortions and should be avoided to the extent possible. The validity of such an argument is questionable in case of biogas where some of the benefits from individual investment directly leads to reduction in social cost which otherwise would have to be borne by the government. For example, adoption of biogas technology by a large group of people in a particular area would decrease die government cost of aforestation project for that area. Similar argument can be made in terms of public spending on treating respiratory diseases in women caused by in-house pollution. However, like an individual, the government should also try to maximize social benefits at minimum cost or subsidy.

It was discussed in the previous session that the financial returns to users of a biogas plant are quite attractive in terms of NPV, BCR and IRR. However, to be able to realize these benefits from the plants to be constructed, an individual has to invest first. The level of investment required for a family size biogas plant is almost equal to the investment required for construction of a rural household. BSP estimates the average size of loan required at about Rs. 14,000 with annual interest of about Rs.3,122 for seven years. The number of households that are not already indebted and have sufficient annual gross saving to meet these requirements are about 110,960 and most of them are medium (land holding of 2 to 4 ha) and large scale formers (land holding of above 4 ha). But, it is the small and marginal farmers that are exerting greater pressure on sustainable use of common resources such as the forest and soils. This situation calls for subsidy for biogas installation in the absence of which the full technical potential can not be realized. The Perspective Energy Plan has recommended to continue the present level of subsidy for a decade to come (1994 to 2004).

6.4 Subsidy and External Financing

The subsidy on interest free loan provided to users in the "Agriculture Year" was fully met from the government's own resources. The government could not bear this cost for long and again farmers were required to pay interest in the subsequent years. Therefore, the government has to continue to look for external assistance in this sector.

The first external assistance for the biogas programme was obtained for die community biogas plants built under the Small Farmers Development Project (SFDP) and funded by the UNDP. UNICEF, USAID and UMN. UNCDF was the first organization that provided assistance for household level biogas plants in Nepal. It provided 25 percent subsidy on investment cost for 4 m^ to 10 m^3 plants.

Another significant subsidy scheme was provided by AsDB under the Forestry Sector Programme Loan. A total of 2,500 biogas plants were installed during 1991/92 to 1993/94 with the subsidy provided under this loan. AsDB is also involved in providing loan to ADB/N which in turn provides loan to the farmers for agriculture development programmes including that for biogas installation.

A large scale external assistance was obtained in 1992/93 when the Directorate General for International Cooperation (DG1S) of the Ministry of Foreign Affairs of the Netherlands Government (via SNV/N in cooperation with HMG/N) provided Dutch Guilders 8,085,000 equivalent to Rs 202.12 million for a period of five years. Out of this, Rs 164 million was allocated for subsidy on the investment costs. The remaining budget was allocated for privatization study, institutional strengthening, programme management and evaluation. The implementation was carried out by a joint venture of GGC. ADB/N and SNV/N. The target of 20,000 biogas plant construction for the project period (i.e. 1992/93 to 1996/97) was met a year earlier. The implementation took place in two phases, i.e., 1992/93 to 1993/94 (Phase 1) and 1994/95 to 1996/97 (Phase II).

In the first phase, construction was carried out by GGC with financial support from ADB/N. In the second phase, besides GGC and ADB/N, 20 private biogas construction companies, 3 NGOs, RBB and NBL have also been involved in the promotion of biogas technology.

The encouraging progress in biogas not only made the Netherlands Government commit to assist Nepal in the future, but also drew the attention of other donors like the German Government to assist in the development of this sector. The third phase of the BSP is under consideration and a proposal for it has been prepared and approved by HMG/N. This phase will be of six years {1996/97 to 2001/2002) and will be assisted by the Netherlands and German governments. A total of Rs 3,500 million has been proposed for the implementation of this phase.

6.5 Review of Subsidy on Biogas Programmes in Nepal

The subsidy on biogas has been supply driven, i.e., guided by the capacity or willingness of the government to bear a part of the investment cost. Table 6.1 chronologically presents the different rates and forms of direct subsidy provided by the government for installation of family size biogas plants. It shows the continuation of government support even in the absence of a consistence policy. Frequent changes in the subsidy policy before 1992 is taken as one of the factors that inhibited the rate of adoption in the past.

Chart 2.3 of Session Two illustrates that the rate of installation of biogas plants has been very responsive to the flat rate subsidy of Rs 7,000. Also, the additional transportation subsidy of Rs. 3.000 has been instrumental in increasing the rate of installation of plants in hills compared to that in the plains. In 1991/92, the subsidy amount was sufficient to meet more than 40 percent of the total investment cost depending on the ease of access to construction materials. The flat rate subsidy has been preferred for its following advantages over the subsidy based on fixed percentage of investment cost.

- It is simple to understand.
- It encourages the installation of smaller sized biogas plant which is an important consideration as substantial number of plants are now over-sized in terms of the gas requirement and plant feeding capacity of the user family.
- It makes administration simple and transparent
- It almost equalizes the cost of biogas plants (per m^3 of gas production) irrespective of their sizes between 6 to 20 m^3. The subsidy reduces the cost for a 4 m^3 plant from Rs 9.90 to 5.40 per m^3 gas; for a 20 m^3 plant from Rs 4.70 to 3.80 as shown in Table 6.2.

Table 6.1
Subsidy Provided by HMG/N for Biogas Installation (1975/76 to 1991/92)

Fiscal Year	Subsidy	Remarks
1975/76	Interest free bank loan	Only for "Agriculture Year"
1976/77	Subsidized or preferential interest rate of 6 percent	Normal interest rate was 11 percent
1981/82	11 percent interest	Subsidy on interest removed
1982/83	Rs 5,500 for each plant constructed in Dhanusha. Sunsari, Rupandehi and Banke districts under Special Rice Production Programme,	Other districts continued with the increased interest rate of 11 percent
1985/86 and 1986/87	50 percent subsidy on bank interest for biogas loan	
1988/89 and 989/90	25 percent subsidy on investment and 50 percent subsidy on bank interest	Normal bank interest rate was 15 percent
1990/91	25 percent subsidy on investment for 6 in[1] and 10 m[?] plants only	This provision was removed after the new government took a policy to do away with all forms of subsidies, in late 1991.
1991/92 till present	A flat rate investment subsidy of Rs. 7,000 for all size plants in the country with additional subsidy of Rs. 3,000 for hilly districts.	Has been continued since then with SNV/N support

Table 6.2
Cost of Biogas per m^3 Gas Produced
With and Without Flat Rate Subsidy of Rs 7,000 (1995/96)

Plant Size	**Yearly Gas Production**	**Investment Cost (Rs)**		**Yearly Cost (Rs)**		**Cost of Biogas (Rs/m^3)**	
	(m^3)	Without	With	Without	With	Without	With
4	350	15,500	8,500	3,457	1.896	9.90	5.40
6	525	18.000	11,000	4.014	2,453	7.60	4.70
8	700	21.000	14.000	4,683	3.122	6.70	4.50
10	875	24,000	17,000	5.352	3.791	6.20	4.30
15	1,315	30,000	23,000	6,690	5,129	5.10	3,90
20	1,750	36,500	29,500	8.140	6,579	4.70	3.80

Source: BSP, 1996

BSP aims to continue with the on-going rate of subsidy in its third phase of programme implementation. On an average, it will amount to a flat rate subsidy of Rs 9,000 for the first three years of the programme which will be reduced to Rs 8.000 for the final three years period. The subsidy amount will remain fixed and will not be adjusted for inflation. Assuming a 7 percent annual rate of inflation over this period of six years, the share of subsidy in the average construction cost for a 10 m biogas plant will decline from 29 percent in 1995/96 to 16 percent in 2001/02 (BSP. 1996). This approach establishes a basis for gradual reduction of subsidy on the total investment cost.

A recent study on biogas subsidy has come up with a suggestion to provide Rs 12.000 for each plant constructed in remote areas defined as districts not linked with national road network. This suggestions is being favorably considered but has not become effective yet (Silwal and Pokharel, 1995).

In addition to the subsidy on family size plant installations, the government has also made regulatory provision to exempt taxes on biogas appliances and accessories. However, making use of this provision by biogas companies has been complicated due to lack of well defined institutional arrangement and clear administrative procedures.

Followings are the three important features of the existing subsidy policy :

– Subsidy is made available only for the installation of family size plants. Subsidy is not provided for community size biogas plants.

– Designs other than approved by BSP are not subsidised. So far, GGC and Deenbandhu are the only designs approved by BSP. However, BSP has an open policy to approve other designs after a careful performance test in the Nepalese conditions.

– Subsidy is not provided to plants fed with materials other than the cattle dung.

6.6 Institutional Financing

Almost all plants in Nepal are constructed with institutional loan mainly from ADB/N for the following reasons.

– ADB/N has an extended network of 244 branches and sub-branches and 420 SFDP offices in the rural areas. No other bank has such a strategically located and scattered network. It has a good knowledge base of local conditions and credit worthiness of its customers which joint venture banks and private banks lack.

– ADB/N is a development bank. Unlike other commercial banks, ADB/N is prepared and willing to accept high overhead costs for small loan administration.

– ADB/N has about 85 percent of the shares in GGC, the largest producer of biogas plants, and the major creditor of GGC.

Till 1995. ADB/N was the only bank to administer credit and subsidy for biogas plants. After 1995, RBB and NBL too took interest in administering loan and subsidy for biogas installation. Biogas is a priority sector for government investment. Any bank willing to administer loan in biogas sector has to first notify the MOF

RBB is a state owned commercial bank with 206 branch offices. Out of these, 164 offices are involved in lending for priority sector areas and 71 percent are located in the rural areas. These offices are located in areas not well covered by the offices of ADB/N. therefore the two banks do not heavily compete in the same geographical area but complement each other.

RBB has a Priority Sector Credit Department that actively seeks to expand credits in the priority sectors of the government. One programme of the RBB is "Banking with the Poor" which has a facility to extend group loans up to Rs. 10,000 without collateral. Interest rate charged for loans in the rural sector is 2 to 3 percent lower than that charged by ADB/N.

In the recent past, RBB received several requests from its clients for loans for biogas plants. The RBB had to refuse these loan applications as the government subsidy was channeled through ADB/N only. As biogas is a priority sector, the government was inconsistent in its policy to impose a 12 percent target for priority sector loans on one hand and to effectively prohibit the RBB to provide loans for biogas plants on the other hand. This issue has now been resolved and RBB has become one of the partners in the implementation of BSP.

NBL, the other state owned commercial bank, has about 250 branch offices, of which 71 percent are located in the rural areas. This bank too has now started administering loan and subsidy for biogas plants,

A recent development has been the creation of rural development banks in the eastern, central and far-western development regions of the country. These banks, inspired by the success of the Grameen Bank in Bangladesh, have adopted a similar strategy and extend group loans up to Rs 5,000 without collateral. These banks are not yet involved in financing biogas plants but certainly have a great potential for doing so in the future.

Other private sector banks arc mostly located within or near urban areas. Their core business is short to finance trade and short term investments. Long term investments in biogas plants are probably too risky and too costly for these banks.

On the basis of present trend, BSP has estimated that 25 percent of all plants that will be constructed during BSP Phase III will be paid in cash, while 75 percent will be financed through bank loans. The amount of loan required for this phase is calculated on the basis of the following assumptions :

- of the 75.000 loans, the shares of the ADB/N and of the two commercial banks will be 86.67 percent (65,000 plants) and 13,33 percent (10.000 plants), respectively: and
- the average loan size after deduction of subsidy is Rs 14.620. Higher investment cost; of biogas plants in the hills (accessible and inaccessible) will be compensated by higher subsidy rates for these areas.

Table 6 3 presents the estimated loan requirement for the BSP Phase **III.** Total gross loan requirement excluding physical and price contingencies is Rs. 1,097 million (US$ 19.6 million). Besides this, an amount of Rs. 365 million (US$ 6.5 million) is expected to be generated by customers willing to install biogas plants on a cash basis.

Working capital requirements for the biogas construction companies are not included in the above loan calculations although the companies indicate a significant need for such capitals. Commercial banks have indicated that they will consider providing working capital loans to recognized biogas companies.

Table 6.3
Estimated Loan Requirement for BSP Phase III by Nepalese Fiscal Year
(Excluding Physical and Price Contingencies)

	1996/97	97/98	98/99	99/00	2000/01	01/02	Total
Target (No.)	10,000	12,000	14,500	17,500	21,000	25,000	100,000
Cash (No,)	2,500	3,000	3,625	4,375	5,250	6,250	25,000
Loan (No.)	7,500	9.000	10,875	13,125	15,750	18.750	75,000
-by ADB/N	7,200	8,400	9,675	11,025	13,250	14,850	65,000
- by NBL	150	300	600	750	1,250	1,950	5,000
- by RBB	150	.100	600	750	1,250	1,950	5,000
Loan Requirement (Rs in million).							
	112	131	154	1%	232	272	1,097

6.7 Flow of Funds

It is estimated that about 15 percent of plants will be constructed with institutional loans during the BSP Phase III. Since the well established banks have just started to finance biogas plants, the two commercial banks, NBL and RBB, are expected not to have problems of fund shortage for the loans. ADB/N, however, due to liquidity constraints, may not be in a position to provide the full amount for the credit component. Taking into account the actual collection of the already financed biogas plants under BSP

Phase I and Phase II, the fund shortfall of the ADB/N has been estimated to be Rs. 261 million for the first stage of BSP Phase III. In this regard, KfW, a German development bank, has agreed to provide a financial contribution of DM 6.9 million for the credit interest rate reflecting the savings rate in Nepal which is an average of 8 percent per annum. This amount is to be transferred to a special Biogas Support Fund. For the remaining portion of the credit requirement, ADB/N is committed to fund through its own sources.

The number of plants constructed without bank loans (self financed) has been increasing in the recent years. In 1992, 6 percent of the plants were constructed on a cash basis (without loans) and this has increased to 23 percent by 1995. This trend is marked by the introduction of provision for subsidy even to plants that are not financed through the banks. This is a reflection of (a) the existing cumbersome procedures of obtaining bank loans and (b) people with the ability to afford biogas plants are willing to install them. In view of the present trend, it is estimated that about 25 percent of biogas plants in the future will be constructed on a cash basis.

Financing of BSP Phase III comes from two donors, i.e., KfW and the DGIS, Besides these, HMG/N. biogas companies, banks and farmers are also proposed to contribute, as shown in Table 6.4.

Table 6.4
Proposal for the Financing of the Three Components of BSP Phase III by Different Parties (Rs in million)

Component	Subsidy	Credit	Technical Assistance	Total	(%)
Users	-	575.9	-	575.9	16
Biogas Companies	-	-	52.5	52.5	2
NBL, RBB	-	244.0	-	244.0	7
ADB/N	-	1,222.8	-	1,222.8	35
HMG/N	139.5	-	-	139.5	4
DGIS	109.2	-	266.4	375.6	11
KfW	629.6	261.0)	-	890.6	25
Total	**878.3**	**2,303.6**	**318.9**	**3,500.8**	**100**

Source : BSP Phase III, pp 49

Procedures for Flow of Funds

For the FY 199V96. the procedures for disbursement of subsidy, participation fee and guarantee charge are outlined below.

Flow of Subsidy: The grant aid received from the Netherlands Government and KfW is the only source of subsidy. The subsidy is administered by the Nepal office of SNV. Disbursement of subsidy fund by SNV/N is done on the basis of biogas plant completion reports submitted by recognized biogas companies and compiled by BSP as monthly progress reports. Following steps are involved in the process of transferring subsidy from SNV/N to ADB/N and other banks and users.

Step 1: SNV/N forwards a cheque to the Financial Controller General's Office (FCG) of Nepal with a covering letter in which die budgel release is explained.

Step 2: SNV/N sends copies of the covering letter to the MOF (Foreign Aid Coordination Division), and ADB/N (Financial Management Division and Loan Division).

Step 3: FCG transfers the fund to the ADB/N within a period of three weeks.

Step 4: ADB/N's Financial Management Division transfers the subsidy money to ADB/N field offices according to its own regular plans and procedures.

Step 5: After the construction of a biogas plant is fully completed, which has to be certified by the user to the biogas company, the ADB/N field office deducts subsidy amount from the total loan taken by the user.

In case of plants constructed on cash basis. SNV/N requests ADB/N to pay the concerned company the total subsidy amount for all plants that it constructed on cash basis in the last month. In doing so, Rs. 500 as participation fee and Rs 1,000 as guarantee fee are deducted from the subsidy amount to be paid to the companies for each plant constructed without loan. SNV/N makes such a request on the basis of monthly report that it receives from each company on the number of plants constructed on cash and loan basis. Accordingly, ADB/N transfers such amount to Current Account of the concerned companies.

In case of banks other than ADB/N, request is made by SNV/N to ADB/N to transfer the total subsidy amount to the bank that has provided loan to users. Such request is based on the progress report sent by the companies to BSP which include information on the bank involved.

Transfer of participation fee by ADB/N to SNV/N : Participation fee is the amount paid by a user to the biogas company. Presently, it is Rs 500 per plant. When government subsidy or support for the promotional activities is phased out, the fund thus created is planned to be used for these activities such as training and research. This approach is taken to make the biogas more complete and self sustainable programme of the private sector. Every month, SNV/N requests ADB/N to deposit the total amount of the participation fee based upon the progress report submitted to SNV/N by the companies.

Transfer of guarantee charge by ADB/N to Joint Account of companies and SNV/N: The guarantee charge of Rs. 1,000 is the fee taken by the biogas company from each of its users to create a fund that will be used for free repair of the plant in case some structural defect is developed within six years from the time of plant construction. Every month, SNV/N requests ADB/N to transfer the total amount of the guarantee fee to a savings account jointly operated by SNV/N and the companies.

All progress reports need to be prepared in a monthly basis by the bank and the companies. All financial transactions are to be completed within three weeks of requests made by the concerned parties. In the implementation of BSP Phase III, the procedure on disbursement of subsidy fund, participation fee and guarantee charge is planned to be reviewed while preparing the annual programme for approval by HMG/N,

6.8 Procedure for obtaining Loan and Subsidy with Technical Assistance

It is important for a user or an extension worker to understand the procedures for obtaining loan, subsidy and technical assistance. The sequential process is given below.

a) The potential user (client) either gets self motivated by seeing a biogas plant in the neighbourhood or is motivated by the biogas company staff or by NGO personnel

b) The client is either willing to invest her own savings or decides to take a loan from the bank for installing a biogas plant,

c) If the client wishes to pay cash, the biogas company and the client decide on the plant size. The cost estimate of the plant is made by the company based on the standard norms. The company receives the subsidy from the bank or BSP on behalf of the client after the plant construction is completed. The client pays the remaining amount to the company.

d) If the client decides to take loan from the bank, the staff of the company assist the client in receiving loan from the bank. The client has to mortgage her property (generally house and land) as collateral for the loan.

e) After the loan is sanctioned, the bank provides a portion of the loan directly to the client for the part of the work that she wants to do. e.g. collection of sand, stones, gravel and digging of pits, etc.

f) The bank sends a coupon to the concerned biogas company for the delivery of the biogas appliances and other goods that are to be supplied by the company.

g) The company supplies the appliances and other goods to the client according to the bank's coupon.

h) The company then sends the receipt to the bank requesting for the reimbursement of the amount that was paid by the company to the user.

i) The bank then reimburses the amount to the company.

j) The bank interest is charged to the client effective from the data of amount paid to the client. Similarly, the interest for the amount paid to the company is charged to the client effective from the date the money is provided to the company

k) Since the subsidy is paid by BSP to the banks in advance, the clients are not charged for the interest on the subsidy amount.

l) The loan pay back period for ADB/N is six years, whereas that for the RBB and NBL is three years.

m) For loan taken for the installation of a biogas plant, the interest rate of ADB/N is 16 percent and that of NBL and RBB is 14 percent.

6.9 Session Plan

Activity No.	Topic and Area of Discussion	Time (min.)	Methods of Training	Teaching Aids
I.	Introduction and highlight of the objective of the session	4	Lecture	Transparent sheet or flip chart
2.	Definition of subsidy	4	Lecture cum discussion	O/H projector, screen and flip chart
3.	Rational of subsidy for biogas plant installation	4	Lecture cum discussion	Transparent sheet
4.	Subsidy and external financing	4	Lectures cum discussion	Transparent sheet
5.	Review of subsidy on biogas programmes in Nepal	4	Lecture cum discussion	Transparent sheet
6.	Institution financing	4	Lecture cum discussion	O/H projector
7,	Flow of funds	6	Lecture cum discussion	Transparent sheet
8.	Procedure for Establishing a biogas plant	5	Lecture cum discussion	Flip chart
9.	General discussion	15	Discussion	O/H projector, flip chart
Total Time		**50**		

6.10 Review Questions

- What is subsidy? What are the objectives of subsidy?
- What is the rational for biogas subsidy in Nepal?
- Explain the fact that the subsidy policy of the government on biogas was not stable till 1991. What is the present subsidy policy of the government?
- What are the recommendations of the recently made study on the review of subsidy policy on biogas?
- Explain the fact that the subsidy policy of the government on biogas was not stable till 1991. What is the present subsidy policy of the government?
- What are the recommendations of the recently made study on the review of subsidy policy on biogas?
- What sectors arc involved in financing the biogas development programme?
- How are the internal and external resources mobilized for biogas development programme?
- Besides SNV/N, what other donors are assisting Nepal in biogas development?
- Explain the financing of biogas programme in Phase III of BSP.
- Give the sequential procedures involved in financing a biogas plant.

6.11 References

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SESSION SEVEN

FIELD VISIT PROGRAMME

SESSION SEVEN

Field Visit Programme

7.1 Introduction

The previous sessions have enabled participants to understand various aspects of biogas including the level of technology involved, its relevance to the attainment of national development objectives, programme planning and management, financial and economic implications. To build on such understanding developed through class room discussions, this session aims:

– to visit at least two user families representing the success and failure cases;

– to interact with members of user family to understand the technology from users' perspective: and

– to relate the class room discussions of previous sessions with the users and the physical structure of the plants.

7.2 Methodology

Following are the sequential steps for identification of field observation sites.

(a) Tentatively identify possible areas in a village or town for field visit.

(b) Obtain a list of biogas plants and report on their operational status from BSP and/or biogas companies operating in the area.

(c) Visit some of the user households, discuss with them, assess performance status of the plant visited and rank them in order of priority for selection for field visit.

(d) Select plants in discussion with the related biogas company considering the following,

– Plants that are nearest to the training centre so that minimum time is spent in travelling.

– The user family that is willing and able to share experience with the participants.

– Plants to be visited represent both the success and failure cases.

(e) Prepare a brief note on each of plants selected for observation tour of the participants.

7.3 Themes for Observation

Before departing for the observation tour, the participants need to be briefly oriented on the four major elements of a biogas plant as shown in Chart 7.1.

Detailed observation on each of the four major elements should include at least the following:

- Alignment of inlet, centre of the dome, outlet and slurry pit (whether they are in a straight line).
- Inlet distance from the cattle shed, kitchen and household waste drainage system, source of water, size of outlet and slurry level in the outlet.
- Height of dome top in relation to the ground, adjacent field, drainage and water drain pipe. Size of slurry pit in relation to the digester size (daily slurry output).
- Slurry application.
- Biogas appliances, their use, maintenance and repair.

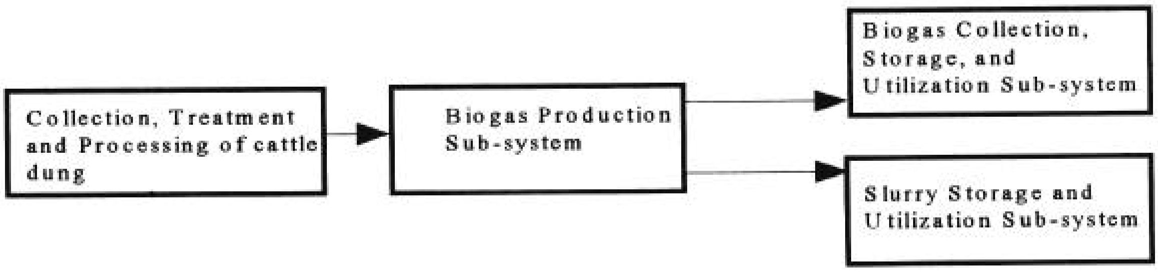

Chart 7.1 Elements of a Family Size Biogas Plant to be Observed During Filed Visit

- Technical support and services for the user.
- Effect on family health.
- Effect on family income.
- General opinion of the user.
- Strengths and weaknesses of the technology as felt by the user.
  - Technical
  - Social
  - Economic
  - Institutional
  - Administrative
  - Others

Trainers intervene in the discussion between the user and the participant only when called upon Participants can be divided into two groups. One group observes the successful case and the other observes the failure case and take turn.

7.4 Information on Plants Visited in Each of the Five Training

Descriptions of biogas plants identified by the experts/trainers for field visit in Kathmandu and Chitwan are presented in Annexes 7.1 and 7.2, respectively. The plants visited in each of the five training programmes are listed below.

- The First Training in Kathmandu : (a) + (c) + (d) as given in Annex 7.1
- The Second Training in Chitwan : All plants (a to e) as given in Annex 7.2
- The Third Training in Kathmandu : (d) + (f) + (h) as given in Annex 7.1
- The Fourth Training in Kathmandu : (b) + (d) + (h) as given in Annex 7.1
- The Fifth Training in Kathmandu : (b) + (d) + (h) gas given in Annex 7.1

The participants of each training programme organized in Kathmandu were taken to three plants whereas those of Chitwan visited five plants.

7.5 General Opinions and Impression about Field Visits

The field visit was an integral part of all the five training programmes. After the field visits, the participants were asked to provide their comments. The response of the participants about the usefulness of the field visit was encouraging.

Over 70 percent of the participants found the field visit to be useful in several ways. It provided them practical knowledge and enabled them to understand the biogas technology and its different elementsincluding the factors responsible for success or failure of a plant. A summary of reaction of the participants on the field visits conducted in the five training programmes is presented in Table 7.1.

Table 7.1
General Opines and Impressions

S. N.	Topics	No. of
1.	Field visit remained very useful in many ways: particularly to understand the current technology of biogas plants, and the underlying reasons for success and failure cases	23
2.	Insufficient duration for field visit	14
3.	The visited sites should have included all types and models of biogas plants including those in the remote pans of the country	10
4.	The biogas plant attached to a public toilet in Bhaktapur was found unsuccessful probably due to wrong site selection	7
5.	Field visits in some sites (Sinamangal, Balkot, Nakhliu) were interesting	*6*
6.	Field visit should be conducted to learn about the site selection procedures	5
7.	More interactions/idea sharing with plant owners would be interesting and useful	5
8.	Field visits should include biogas plants under construction	*5*
9.	Field visit in areas without electricity would be desirable	3
10	Biogas companies should be made more responsible/accountable towards their clients	3
11.	Post installation services/supports for biogas users seem inadequate	2
12.	Biogas plants should also be targeted to small farmers	1
13.	Biogas plants should be promoted as a national campaign	1
	Total	**85**

7.6 Review Questions

- What factors helped the users to adopt the technology?
- What factors discouraged the users to adopt the technology?
- What is the importance of field visit?
- To what extent did the field visit enhanced your practical knowledge?

Annex - 7.1

Description of Biodigesters Identified for Field Visit in Kathmandu

(a) Night Soil Plant at Prabhat English School

- Location of the plant: Prabhat English School, Bhaktapur Besi
- Capacity of the plant: 20 m
- Inputs: Human wastes from Public Toilet and School Latrines are fed to the biogas plant
- Problems as stated by the plant owner: Leakage of water from the foundation of digester
- Present status of the plant: The plant was commissioned about 10 to II months ago. The public toilets are neglected and are not maintained at all. Human excreta are scattered haphazardly around the biogas plants and in the surrounding area of the public latrines. Because of the obnoxious smell produced from human faeces, it is difficult to stand even for five minutes in that area. Latrines are not cleaned In brief, this is an example of failure project simply because of poor management system. If the management is not improved, there is every reason to believe that some epidemic could spread in the future.
- Use of gas: One stove is in use. The gas is burning with very weak pressure and is left burning even when there is no need for the gas. This is a sheer wastage of energy.
- Utilisation of digested slurry: Not practised.

(b) Biogas Plant Installed at Balkot

- Location of the plant: Balkot
- Name of the owner: Moti Bhakta Shrestha
- Capacity of the plant: 15 m^3
- Inputs: Dung from two cows and two calves are used to feed the biogas plant.
- Problems as stated by the plant owner: None
- Present status of the plant: The plant was commissioned four years ago and is functioning excellently The owner is highly satisfied with the performance of his plant
- Use of gas: Two stoves are in use. The gas bums with good flame. The visiting team tasted tea prepared on biogas by the sister of the plant owner.
- Utilisation of digested slurry: The farmer stores the digested slurry in a pit from where it is used to fertilise the vegetable plants. At the time of visit, it was observed that the slurry was applied to chilly seedlings.

(c) Night Soil Biogas Plant Installed at Balkot

- Location of the plant: Balkot.
- Name of the owner: Chakra Lall Shrestha
- Capacity of the plant:
- Inputs: Human waste from three latrines (one at the top floor and two at the ground floor) are used to feed the biogas plant.
- Problems as stated by the plant owner: None
- Present status of the plant: The plant was commissioned four years ago and is functioning well. The owner is highly satisfied with the performance of his plant.
- Use of gas: One stove is in use. The gas is burning well. The owner utilises the gas in preparing tea. They arc satisfied with their plant.
- Utilisation of digested slurry: The digested slurry is led to a pit for storage and subsequent use.

(d) Biogas Plant Installed at Shree Prakash Sanyas Ashram

- Location of the plant: Sinamangal, Kalimati Dolt
- Capacity of the plant: 20 m^3
- Inputs: Dung from 6 cows is used to feed the biogas plant.
- Problems as stated by the plant owner: Less gas in winter
- Present status of the plant: The plant, commissioned about one year ago, is functioning very satisfactorily.
- Use of gas: Three stoves are in use. The gas is burning well. The gas is used for cooking food for 10 to 25 people. There is a significant saving due to biogas installation since three LPG cylinders were used before commissioning of the biogas plant. The net saving is about Rs 1,000 per month.
- Utilisation of digested slurry: The digested slurry is led to a cemented pit for storage and is used to fertilise crop and vegetable plants. At the time of site visit, it was observed that the slurry was applied to the maize crop.

(e) Fibre Dome Biogas Plant Installed at Bhimsen Gola

- Location of the plant Bhimsen Gola, Baneshwar
- Capacity of the plant: 6 m^3 with dome constructed with fibre glass and rest as per GGC design
- Inputs: Dung from a cow and a calf is used to feed the biogas plant.
- Problems as stated by the plant owner: Less gas in winter
- Present status of the plant: The plant is well maintained and is functioning very satisfactorily.
- Use of gas: The gas is used for cooking food for three people.
- Utilisation of digested slurry: The digested slurry is used to fertilise vegetables and lower plants.

(f) Biogas Plant Installed at Anamnagar

- Location of the plant: Anamnagar. Baneshwar
- Name of the owner: Ms Bhadra Ghale
- Capacity of the plant: Two plants are constructed - one plant of 20 m^3 and the other of 50 m^3
- Inputs: The owner possesses 24 to 25 cows and 100 to 125 pigs, only cow dung is fed into the biogas plant.
- Problems as stated by the plant owner: Biogas tamps are not available. Gas production is less.
- Present status of the plant: The plants were commissioned five years ago. The surrounding is very dirty and unhealthy and die plant is poorly managed. The owner possesses 5 to 6 Ropani of land (0.3 ha) and fruit saplings like plum, peaches, pears are also planted. A fish pond has also been constructed. Proper management is required to improve the performances of the system.
- Use of gas: Only one stove seems to be in use and the gas production visualised for cooking food for 20-25 people is insufficient.
- Utilisation of digested slurry: The digested slurry is used to fertilise vegetables and fruit plants.

(g) Night Soil Biogas Plant Installed at Nakhu Jail

- Objective: The first objective is to provide illumination which is especially required during the load shedding periods. Secondly, the biogas project has been initiated to keep the environment clean and healthy.
- Location of the plant: Nakhu, Lalitpur
- Capacity of the plant: 20 m^3

- Inputs; The plant is fed with human faeces of 150 to 200 prisoners.
- Problems as stated by the plant owner: Biogas lamps are not available. Gas production is less.
- Present status of the plant: The construction of the plant has been completed and the wastes from latrines (14 latrines) are connected to the plant. Gas production is expected but it remains to be tested yet.
- Use of gas: The gas will be used to provide illumination, i.e., seven biogas lamps are already installed.
- Utilisation of digested slurry: The digested slurry is used to fertilise vegetables and fruit plants.

(h) Biogas Plant Installed at Sainju Bhainsepati

- Location of the plant: Nakhu. Sainju Bhainsepati VDC. Nayabasti
- Name of the owner: Rom Bahadur Thapa. This is a joint venture in which 3 to 4 families are united to implement the project named as *Bharseli Pasupalan Udyog*.
- Land holding : Total area consists of about 11 Ropani (0.55 ha) owned by 3 to 4 families. Capacity of the plant: A plant of 20 m^3. A latrine is also attached to the plant.
- Inputs: The owner possesses 80 pigs (big and small) and 4,000 to 4,500 poultry birds (broilers). At the present, the plant is run only with poultry excreta. Pig excrement is not used.
- Problems as stated by the plant owner: None
- Present status of the plant: The plant is working excellently and the owner is highly satisfied. Use of gas: Biogas burners with two mouths are burning excellently. The gas is used to cook food for about 5 to 6 people.
- Utilisation of digested slurry: Since there is sufficient land, the digested slurry is used to fertilise vegetables and fruit plants.

Description of Biodigesters Identified for Field Visit in Chitwan

The original plan required to visit at least two biogas plants representing both the success and failure stories. However, in the process of identifying sites for field visits, it was felt desirable to take participants to the following five biogas plants located at Panchkanya VDC of Chitwan district. It was remarkable to note that in this area almost every household has installed a biogas plant.

(a) The first plant was a 20 m^3 biodigester fed with cattle dung (6 cows and 4 calves). It was installed at the house of a farmer, Mr. Kamal P. Sapkota. The plant was constructed by GGC four years ago. The farmer possesses 0.4 ha of land where he grows rice, maize, mustard and vegetables. He applies biogas slurry to fertilize his crops and vegetables. He pumps water into the slurry pit so that the diluted slurry overflows automatically into irrigation channel.

Although the farmer is feeding his plant every alternate day. he has sufficient gas to cook food for his the six members of his family. The plant is functioning well and the family has enough gas even in winter.

(b) The second plant was a 10 m^3 biodigester fed with buffalo dung without any latrine attachment. It was installed three years ago at the house of a farmer Mr. Prem B. Paudel. The dung obtained from six buffaloes is more than sufficient to feed his digester. He has sufficient gas to cook food for his family of five members. He is satisfied with the performance of his digester. He uses biogas slurry to fertilize his crops and vegetables.

(c) The third plant belongs to a farmer named Mr Dhrub P. Sapkota. It is a 10 m^3 biodigester fed with the dung of eight cattle (big and small) without latrine attachment. The biodigester installed two years ago is working excellently and sufficient gas is produced from this plant in order to meet the cooking requirement for eight family members. Biogas slurry is used to fertilize crops and vegetables grown by the farmer.

(d) The fourth plant was a 10 m^3 biodigester fed with cattle dung (1 buffalo and 2 oxen). It was attached with a family latrine at the house of a School Headmaster Mr. Laxmi Kanta. The plant was constructed by GGC six years ago. The plant owner applies biogas slurry to fertilize his crops and vegetables. He also makes compost with the slurry.

He has sufficient gas to cook food for his family of eight members but the gas is not sufficient for cooking during winter.

A few months ago. he had a problem with the plant. After proper diagnosis, it was discovered that the inlet pipe made up of cement was damaged and as such, materials fed though inlet could not enter into the digester. Recently, he solved this problem by replacing the damaged portion of cement pipe with a polythene pipe.

(e) The fifth situ was a 10 m^3 plant attached with a family latrine. It was installed three years ago by Rastriya Gobar Gas Company at the house of a farmer. Mrs. Radha D. Borha. Since the beginning, her plant has been working only for 15 to 30 minutes, although she has been using dung from two buffalo. Because of the mal-functioning of the plant, she is compelled to revert to firewood and kerosene for cooking. In fact, with two buffalo, at least the gas should have burnt for more than two hours. The plant owner is aware that in her neighbourhood, another farmer is meeting his all requirements of cooking with his plant with same number of animals and same size of plant. Complains were lodged several times to the company but her problem remains unsolved as yet.

Once some technician from the company visited her plant. Assuming that the plant was overfed, he advised to empty some portion of slurry from the digester. This did not improve the performance of the plant. The owner was so frustrated with her plant and biogas technology that she now advises people not to install one.

SESSION EIGHT

EXTENSION SUPPORT SERVICES FOR BIOGAS

SESSION EIGHT

Extension Support Services For Biogas

8.1 Introduction

In developing countries, biogas technology is valued mainly for its household use. Therefore, the rate of adoption of the technology in these countries depends on family decisions. These families or the potential users are generally characterized by scattered dwelling, low literacy rate, low investment capacity, low access to infrastructure for communication and transport. Therefore, some special efforts arc necessary to influence these families to adopt the technology. Such efforts are categorically termed as extension activities which is the main subject of this session.

Biogas extension refers to activities and procedures for motivating people to adopt biogas technology. Extension activities aim to take an individual through the mental stages of being aware of the technology, getting interested in it, assessing the relevance of the technology in resolving problems faced or for getting additional benefits, and finally taking decision to adopt the technology hi the context of Nepal, a family is the basic unit for making such decisions. Therefore, the principal aim of the extension activities is to motivate a family to install a biogas plant.

By the end of this session, the participants will be able to:

- explain the importance of extension services in the development of biogas sector;
  select suitable extension method for use in a given situation; and
- enumerate institutions and their areas of expertize relevant to the extension of biogas in Nepal.

8.2 From a Single Plant to National Objectives and Strategy

8.2.1 Building Government Commitment

Biogas is not an indigenous technology of Nepal. The historical plant in Nepal was introduced in 1955 through the effort of a school teacher. Rev Father B R Saubolle, at St. Xaviers' School, Godavari, Kathmandu. The first plant that he installed in the school was mainly for making people aware of the technology through demonstration. Some of them who visited the plant got interested in it but did not take the decision to install one. After some time, a biogas plant, popularly called *Gobar Gas Plant,* of 250 cu ft capacity was demonstrated by Indian Aid Mission in an exhibition held in Kathmandu in 1968 where many of the high government officers saw this technology for the first time. By the end of 1973, there were a total of four biogas plants installed in Nepal, that too in the elite households of Kathmandu. Thus, it was 18 years after the first biogas plant that the first four families decided to adopt this technology.

Nepal responded to the World Energy Crisis of 1973 by forming the ERDG under the TU, Kathmandu. Some ERDG members were aware of the initiatives taken by Father Saubolle in promoting biogas technology. This awareness developed into interest in the technology, mainly due to the pressure on ERDG by the government to formulate a programme on alternate sources of energy. Father Saubolle was called upon to advise ERDG and a Biogas Development Committee was formed under ERDG. Thus, like other countries, the World Energy Crisis of 1973 played pivotal role in Nepal in making national institutions interested in biogas technology.

At that time, the Minister for Agriculture was Mr Hari N Rajauriya, also a progressive farmer, who had seen functioning biogas plants in India. This knowledge base of the Minister, coupled with the

World Energy Crisis and the initiatives of TU, led him to include biogas as a special programme of the MOA for the year 1974/75. Out of a total target set by MOA to construct 250 biogas plants, 199 were successfully installed in the year 1974/1975. The programme was implemented by the DOA through its DSSAC in the leadership of Dr Amrit B Karki, a Soil Scientist and Co-ordinator of Biogas Development Committee under ERDO. Interest free loan were provided as an incentive to users particularly in the auspicious of "Agriculture Year". However, in the subsequent years, the programme thus started could not be continued as MOA lost its interest in the technology because the manure value of slurry could not be effectively used.
By 1976. the country had about 350 biogas plants spread in different parts in Nepal. Each of these plants worked as demonstration unit and more and more people became aware of the technology. The encouraging results of biogas loan repayments and increasing demand for subsidized biogas loan led the involvement of ADB/N in the extension of the technology. Biogas became a permanent feature of rural technology exhibitions regularly organized by the bank. The field workers of ADB/N were directed to increase lending on biogas. ADB/N also introduced biogas in seminars, workshops and training that it organized in collaboration with and involvement of government and donor agencies. Thus, after 1974. ADB/N became the leading agency not only in financing biogas plant construction but also for extension of biogas technology in Nepal.

The demand for technical services also increased with the increasing number of biogas user households. ADB/N. being a credit institution, could not cope with this demand. To fill this gap, in 1977, ADB/N in collaboration with UMN and TCN established GGC as its sister organization in the private sector.

From 1977 to 1994, GGC remained the only specialized organization for the extension of biogas technology in Nepal and worked in close association with ADB/N. Besides providing technical services for the installation of biogas plants, it undertook various activities to make more people aware of the technology. It reached policy makers and planners in the government through seminars, workshops, and study tours in and out of the country. It reached a wider circle of potential users through field level workers of its own and that of ADB/N and the DOA. It used mass media such as radio programme and national news papers. It printed leaflets, calendars, posters and other such materials for distribution, hi addition to such extension methods, each plant that it constructed (for users) worked as a demonstration model to convince more people about the benefit of adopting the technology.

A large scale implementation of biogas programme is difficult without strong political commitment from the government. Realizing this. GGC worked with the MOF and NPC. By 1984, more than 1.600 plants were commissioned by GGC in different parts of the country. As a result of satisfactory performance of these plants and other extension activities of GGC. a massive national target of constructing 4,000 biogas plants was included for the first time in the Seventh Five Year Plan (19X5-1990) of the government. Since then, a national target for biogas plants installation has become a permanent feature of the Five Year Plans.

GGC. though in the private sector, assumed the responsibility for meeting the targets set by the government as there were no government line agency to do so, Thus established linkage gave GGC an informal status for working with the government. With this institutional linkage. GGC was able to work with various donors and government agencies. As a result, some of the development programmes included biogas as a part of their regular programme such as in community forestry and sanitation

8.2.2 Energy Related Objective of Eighth Five Year Plan

The Eighth Five Year Plan (1992-1997) has a target to construct 30.000 biogas plants. Some of the energy related objectives of the Eighth Five Year Plan include the following:

- To maximize the development of indigenous energy resources in a most efficient manner and if technically and economically feasible, to fully meet the energy requirements of the nation on a sustainable basis;

- To promote cost effective and environmentally sensitive energy conservation and demand management practices;

- To address environmental problems associated with energy supply and demand by the relevant ministries/agencies in collaboration with both non-governmental and international organizations and to keep balance between energy development, environmental protection and enhancement; and

- To examine the possibility of transferring ownership of government-owned energy sector utilities to the private sector in accordance with the privatization policy.

8.2.3 Objectives and Strategies of Perspective Energy Plan

To contribute towards attaining the national objectives put forth in die Eighth Five Year Plan, the Perspective Energy Plan of Nepal was formulated in J995 with specific objectives and strategies given below.

Objectives

- Provide lighting and improve the quality of life of rural people.
- Set the process of industrialisation in motion in rural areas.
- Provide employment opportunities to rural people, especially the youth, and prevent/reverse the process of rural to urban migration.
- Reduce drudgery of rural women by decreasing the amount of time spent in collecting fuel wood, washing utensils and in agro-processing activities.
- Improve the health of rural people, especially women and children, through reduced smoke level, improved sanitation and provision for medicine and vaccines.
- Protect natural forests to minimize adverse environmental and ecological impacts.
- Increase indigenous technology manufacturing capability.

Strategies

- New and renewable energy development should be based on proper assessment of resource to meet felt energy needs of rural people.
- Development and promotion of alternate energy resources technologies should be made an integral part of overall rural development activities.
- At least 10 percent of the total government subsidy allocated for this sector should be used for R&D purpose.
- Planning, development, promotion and dissemination of new and renewable energy resources and technologies should be done at DDC and VDC levels with maximum participation *of* local government bodies, local people, public institutions like schools and health posts and INGOs
- The private sector should be encouraged to play a leading role in the development and dissemination of alternate energy.
- In the beginning, new and renewable energy technologies must be supported by providing identified amount of financial subsidy, though the concept of revolving fund should be introduced for the sustainability of the programme.
- An independent and autonomous apex body solely responsible for all aspects of new and renewable energy development programmes should be established.

Thus, it took about 40 years for the biogas technology to become a permanent feature of national development plans in Nepal.

8.3 Institutions For Extension of Biogas Technology

Inclusion of biogas in national development plans and policies is a prerequisite for rapid expansion of the technology on a sustainable basis. Equally important is the institutional development for sustainable growth of the biogas sector. By early 1990s, the demand for installation of biogas plants had become more than the capacity of GGC to supply trained human resource and materials. It is in this respect that more companies arc now being established in the recent years.

8.3.1 Establishment of Biogas Companies and Biogas Related NGOs

The unsatisfied demand coupled with the government policy to encourage participation of private sector, led to the emergence of about 23 companies between 1992 and 1996 mainly as result of the flat rate subsidy of Rs 10,000 and Rs 7,000 in the hills and plains, respectively.

The second biogas company was registered in 1988 by Mr. Prem N Baral in Pokhara. Thereafter, one new biogas company was registered each year during 1989, 1990 and 1991. Four and five companies were registered in 1993 and 1994, respectively. These companies are specialized in providing technical services for installation of family size biogas plants and their technical capabilities widely vary, hi the process of expanding their business, they too started motivating potential users for plant installation. The names and addresses of these companies are given in Annex 8.1.

These private companies came together in 1995 to form a NBPG as an NGO with the mandate to undertake general promotional activities such as training, extension and research for the common good of all private companies.

By early 1990s, Nepal had several hundreds of NGOs involved in various rural development activities in different parts of the country. Many of them also included biogas as a part of their development programme. Their role has been mainly limited to make their target group aware of the biogas technology and assist them to procure technical services from a nearby biogas company, A survey conducted in 1995 by BSP revealed that there are 76 NGOs, five INGOs and 18 other agencies involved in the promotion of biogas technology in Nepal (Development Partners-Nepal, 1995). A brief description of these agencies is given in Annex 8.2

Biogas companies have started a practice of paying some incentives to any organized body including VDCs and NGOs that creates and collects demand for installation of biogas plants. The process requires an organization to submit the demand to a biogas company which then pays certain percentage of fee and profit to the organization. Biogas companies sign an agreement with the organizations willing to be involved in the process. This on-going practice has broadened the scope for involvement of all types of organizations in the process of biogas extension.

8.3.2 Formation of Biogas Steering Committee

The long existing need for the involvement of government agency in the promotion of biogas has also been filled since the formation of a Biogas Steering Committee in 1995 with the coordinating role of the MOFSC. The 11-membcr Steering Committee consists of representatives from the MOFSC, NPC, MOF, MOA, WECS, ADB/N, BSP/SNV/N. NBPG and GGC The main functions of this Committee are:

- to advise the MOFSC regarding the policy on biogas development;
- to discuss and approve the annual work plan and programmes;
- to review the norms used in construction, financing and operation of biogas plants;
- to review the quality standards of biogas plants and its appliances; and
- to assess the physical and financial progress on biogas development.

8.3.3 Proposed Alternate Energy Promotion Centre

In the study of "Future Structure of Biogas Sector in Nepal" conducted by CMS with support from BSP, a recommendation was made to establish a National Biogas Centre (NBC) to oversee the overall development of biogas in Nepal (karki, et al., 1993; de Castro, et at, 1994). The Centre was suggested to be a semi-autonomous body which should be integrated with the proposed AEPC.

For the first time, a comprehensive national programme on biogas is being prepared with the technical assistance from FAO The decision has also been taken in mid-1996 to establish an apex body. AEPC, as a government agency to oversee the development of alternative energy sources in Nepal-including biogas. However, AEPC is yet to be established. The main expected functions of AEPC are given below (BSP. 1996).

- Analysis of policy issues and advice on policy matters (subsidy, price, taxation and R&D policies)
- Co-ordination with other sectors and ministries Planning and co-ordination of biogas related R&D Preparation of sector-wise plans and targets
- Elaboration of regulatory frameworks; setting of sector-wise standards and guidelines, criteria for registration and licensing of companies, etc. Mobilization of funds and liaison with donors
- Review/approval of annual work plans in respect of donor-funded projects Monitoring of developments in the biogas sector as a whole and of the implementation of specific projects Organize and/or participate in programme and project evaluation.

It is visualized that AEPC would have a small number of staff and most of the work will be carried out through contractual arrangements with other agencies in the private and public sectors. AEPC is likely to be affiliated with the newly formed Ministry of Science and Technology (MOST). Also, the function of existing Steering Committee under the MOFSC could be taken over by the biogas eel! of AEPC.

8.4 Factors Affecting Biogas Extension

8.4.1 Government Commitment

As pointed out earlier, the government commitment for biogas promotion was first observed by the establishment of ERDG and its Biogas Committee under TU in the wake of the World Energy Crisis of 1973. This was taken a step further by the inclusion of biogas as a part of the special programme for the "Agriculture Year" celebrated in 1975. Both of these initiatives faded away as the effect of World Energy Crisis subsided and the Minister for Agriculture was changed. However, the government's facilitating role in the establishment of GGC and its activities continued- Government commitment has also been expressed in terms of the inclusion of target for biogas construction in the Seventh and Eighth Five Year Plans.

8.4.2 Subsidy

Subsidy is yet another expression of government commitment for the extension of biogas technology in Nepal. Following the introduction of biogas programme in 1975, the government has been providing subsidy in one form r the other except in the year 1992. The rate of adoption of biogas technology in Nepal has been very responsive to the levels and forms of government subsidy. The provision of subsidy has pushed the demand ahead of the existing national capability for plant construction in terms of the organization and the trained human resource. The provision of the flat rate subsidy has been conducive to boost the rate of installation of smaller sized plants and has increased the annual rate of plant construction in the hills compared to that of the plains. The subsidy is provided only to families possessing cattle. This could be one of the reasons for low application of the technology at the community level.

In Nepal, additional subsidy for attaching family latrines to biogas was provided by some projects with the aim of improving community health and sanitation. Although this concept was found effective, such practices are yet to become common.

8.4.3 Institutional Arrangements

A large number of 1/NGOs, private companies and consulting firms are currently involved in supporting the extension of biogas technology. The establishment of AEPC and formulation of a national biogas programme is expected to facilitate integration of biogas with the development programmes of other agencies in the private and public sectors.

8.4.4 Energy Pricing

The access to common property forest and availability of firewood is getting limited in most part of the country[1]. This scarcity of traditional fuel along with high prices of other energy sources such as electricity and kerosene has led people to adopt biogas technology.

8.4.5 Education and Access to Technology

A high rate of literacy observed among the existing biogas users indicates that literate people are more likely adopt the technology faster than the illiterate people. The adoption rate is found higher in places near biogas company offices and ADB/N branch offices and in areas with easy access to road. Therefore, the rate of adoption is expected to be higher in the future because (a) the number of biogas companies and rural banks are increasing, (b) the literacy rate is on rise and people are becoming more aware of environmental concerns, (c) more areas are becoming accessible with the expansion of road and communication network, (d) the; availability of firewood is on decline in most part of the country, and (e) more agencies in the private sector are getting involved in the extension of biogas technology.

8.4.6 Performance of Existing Plants

A well constructed plant with satisfied user is the only way to ensure proper extension of biogas technology, It has been reported that more than 90 percent of existing plants in Nepal are functional. This is a very high rate of success compare to other countries including China and India. The single model (GGC model) and single institution (GGC) strategy adopted till 1994 may have been the main cause for this high rate of success, From 1994. Nepal too adopted the multi-design (GGC, Deenbandhu and other designs approved by BSP) and multi-institution (more than one institution involved in construction) approach to expedite the rate of installation of biogas plants. To maintain the existing high rate of success, a strong quality control programme has also been enforced in the construction of the plant and quality of appliances.

8.5 Extension Approaches

The main target groups for extension activities arc the potential users and the officials in government and non-government agencies who can influence the attitude of potential users through appropriate policies, programmes and projects. Some extension methods arc more suitable to one target group than others. Door-to-door visits, fairs and exhibitions, audio-visuals and demonstrations arc more suitable for the first category of the target groups. Seminars, workshops, training, study tours, books, technical reports, journals and audio visuals are more suitable for the second category of the target groups.

The selection of appropriate extension method depends not only on the availability of resources but also on the characteristics of the target group. For example, printed information in the form of books and booklets are not relevant when the majority of target groups are illiterate.

In addition to above, an extension worker should have a clear understanding of the information level of the target group before selecting a particular method of extension. For example, the mass media such as radio and newspapers are effective in making a large number of people aware of the technology.

Making people aware does not necessarily lead to the adoption of a technology. They should be provided with more information on the technology to inspire them to adopt it. At the interest building stage, individual contacts, group discussion, study tours, audio-visuals and demonstrations could be more effective than mass media. The information on comparative advantages of biogas and problem solving methods should be highlighted.

After developing interest about a new technology, people tend to evaluate the technology in their own ways. Some of the interested people may take initiative to collect more information while others wait. The demand for information at this stage would be more specific. It is also likely that most of the information demanded by potential users at this stage may not be readily available with the extension worker Therefore, access to library, technical and research papers, discussion with knowledgeable people, and other such activities become important at this stage. One of the important roles of the extension worker at this stage is to refer the potential user to a nearby biogas company or a user

Thus, the role of extension worker goes on changing as demand of information by potential users gets more detailed and specific. With this change, the relevance of a particular extension method differs as shown in Annex 8.3 (Leermakers, 1992).

8.6 Extension Methods

Following arc brief discussions on most commonly used methods for extension of biogas technology in Nepal.

8.6.1 Door-to-Door Visits

GGC in its early days relied on this method of extension. It requires a knowledgeable person to visit potential users to inform them about the technology and its potential benefits. This is an effective method for awareness building. This is not the most efficient way of mobilising the limited human resource that any single organization might have. However, this method can be efficiently practised in collaboration with agencies that already have large extension networks such as that of MOA. MOFSC and ADB/N

Junior Technical Assistant (JTA) and Technical Assistant (JT) of the DOA. Ranger of the Department of Forest and Loan Assistant of the ADB/N are village level job positions that require frequent visits to households as part of their regular duties. These personnel can be mobilized to reach a large number of households in a short period with minimum cost for extension. The effectiveness of information passed through them are higher as they are familiar to the villagers.

One of the p re-requisites for use of this method is to first train these personnel on basic features of biogas technology and its relevance to a rural household.

8.6.2 Use of Local Leaders

Local leaders are the prominent people in the community who can influence the behaviour of local people in terms of adoption of biogas technology. This group includes political leaders, teachers, social workers, elders, progressive farmers, entrepreneurs and high ranking officials. The approach discussed in Section 8.6.1 can be combined with this one for effective mobilization of agency personnel for biogas extension GGC has been organizing one day seminars for local leaders to make them aware of the technology so that they become useful in motivating the local people

In this context, it is worth noting that the third biogas plant in Nepal was installed in the house of Mr. Ranjan R. Khanal, the then Chief Secretary to His Majesty the King. Also, one of the first ten biogas plants was constructed for the then Prime Minister Mr. Kirti N Bista. Such an effort made by pioneering biogas extension workers had positive impact in the rate of plant installation in Kathmandu.

8.6.3 Exhibitions and Demonstration

People believe more on what they see than they hear. Each plant works as a demonstration or exhibition site for non-adopters. From this point of view, there are now about 25,000 demonstration sites spread over 57 districts. Though each plant will automatically have some demonstration effects on non-adopters, the rate of information dissemination can be enhanced by conducting organized tour for potential users to a nearby successful plant

District Agriculture Offices periodically organize study tours for formers and exhibition of improved agricultural products and practices. Such opportunities can be used to inform a large group of potential users about biogas technology. This approach was also used in the past but not on a regular basis.

8.6.4 Use of Mass Media

Radio has been frequently used to disseminate information on biogas as this is the most efficient means for wide coverage in a short time. GGC, ADB/N, DOA, BSP and other development programmes have used this media in the past. Information on biogas has been broadcasted in the form of radio drama, news, information bulletin and other formats of presentation mostly in the Agriculture Programme of Radio Nepal. However, the frequency of such broadcast has remained less than desired. Though this form of information dissemination has its own limitations, it is still the best source of mass media for people to know about the technology. BSP and ADB/N have some of the recorded radio talk programmes on biogas

Many feature articles and news related to biogas have been frequently published in national daily and weekly newspapers. Like radio, this media too has the limitation of being a means for one way communication. Though effective in providing information to educated people in urban areas and office positions, its general impact on awareness level among rural population is low due to low level of literacy.

The regular publication of Biogas Newsletter was started in 1978 by Dr Amrit B Karki on his personal initiative. This publication in English has been the only means to maintain professional link with the outside world. Since 1995, this newsletter, renamed as *Biogas and Natural Resources Management*

(RNRM). is published four times a year by Consolidated Management Services Nepal (P) Ltd with Dr Karki as the Chief Editor It has a large number of subscribing institutions and individuals in and out of Nepal and is much appreciated by the professionals and people interested in higher form of information on biogas. Though priced, it can be available free of cost to interested individuals. So far, this has remained the only regular publication on biogas in Nepal.

BSP too has started regular publication of biogas bulletins in Nepali as one of its programme activities. The publication is not priced and gives information on BSP activities in Nepal. It can be obtained from the BSP office.

GGC, BSP and ADB/N have been publishing posters, calendars and charts highlighting various aspects of biogas technology that are used for extension and training purposes.

8.6.5 Occasional Publications

There are numerous occasional publications on biogas in Nepal *"Gobar Gas: Samaya Ko Mang Ra Hank"* (i.e. Biogas: Demand and Challenges of Time) is the first book in Nepali language on biogas published by Dr Amrit B Karki in 1978. Another important publication came out in 1984 as the book titled "Biogas Fieldbook" written by Dr Karki and Mr Kunda Dixit. Many books, booklets, reports, technical papers, workshop proceedings, manuals and other forms of print have been published since then. This in-country growth of literature on biogas has also been substantially supplemented by publications received from other countries. Following organizations have good collection of literature on biogas technology published from Nepal and abroad.

(a) BSP Head Office at Dhobighat, Lalitpur

(b) GGC Headquarters Office at Kupondole, Lalitpur

(c) CMS Library at Lazimpat, Kathmandu

(d) WECS Library at Singh Durbar, Kathmandu

8.6.6 Audio-Visuals

Video cassettes are effective means of presenting information on biogas to groups of people. The main agencies that have video-cassettes on different aspects of biogas technology are GGC, ADB/N, BSP and CMS. Most of these video-films are about 30 minutes long and their subject or main theme vary. Some highlight the relevance of technology to Nepal while others are specific on the techniques of plant construction, O&M and quality control. These cassettes can be borrowed for public viewing.

8.6.7 Seminars and Workshops

These are the most suitable methods to inform officials on various aspects of biogas technology. Since the early days of biogas development in Nepal, ADB/N and GGC have been the two mam agencies to organize seminars and workshops for educating planners, policy makers, administrators and other concerned personnel. Since 1992, BSP has also been assigning high priority to these activities

A two day national level biogas workshop was organized by BSP in collaboration with ADB/N and GGC in 1993. More than 100 high ranking officials from the government, donor and non-government agencies participated in the workshop. The workshop was inaugurated by the then Prime Minister Mr Girija P Koirala. Following this and with BSP support, CMS organized regional level workshops in all five regions of the country. Participants of these two day workshops included Members of Parliament, DDC Chairmen of biogas potential districts in the region, and regional level officers of related government and non-government agencies (Karki, et al., 1994).

To take the message further down. CMS organized district level biogas workshops in eight districts with high potential for biogas plant installation. These two day workshops were supported by BSP Each workshop was participated by about 100 participants representing people from various walks of life in the district, including the district level officials (Karki, ct al., 1995). Though formal evaluation on the impact of these workshops has not been carried out yet, they were found to be very effective means of disseminating the technology to a wider circle of potential users and the promoters. It is expected that similar workshops will be organized in die future at the district and VDC levels.

The utility of biogas technology contributes to the attainment of social objectives which are the concern of various departments and ministries. These related ministries and departments periodically organize seminars and workshops for their own purposes. Biogas can be included as one of topics for discussion in such workshops and seminars.

8.6.8 Training

Training as a method of extension is more suitable for officials and users. However, it is not a very cost effective method for building awareness.

ADB/N has been organizing biogas training since early 1980s in the areas of construction, repair and maintenance. Training has been one of the important functions of GGC. It has been organizing field based training on various aspects of biogas programme including the following.

(a) *Farmers' Training* : A 1-day training for users and non-users.
(b) *Women's Training/Seminar :* A 1 -day training to motivate women in the locality.
(c) *O&M Training* : A 1-day training for users.
(d) *Local Masons' Training* : This is a 60-day long training with 5 days of theoretical and 55 days of practical work.
(e) *Repair and Maintenance Training* : A 7-day training for local masons.
(f) *Staff Training* : Duration of this training varies from a few days to a week depending on the subject to cover such as supervision techniques, loan processing etc.

The new biogas companies have also started conducting training mainly to expand their technical base (masons and foremen) and to enable users to operate and maintain their plants. With support from BSP, these companies have been conducting Extension Orientation Training for personnel from the banks and 1/NGOs. In all of these training, the participation of women has been highly emphasized. Some of the training on O&M include women users only.

In the process of developing this manual, 150 senior officers from departments of Forest, Soil Conservation, Agriculture, Livestock Services and personnel from the banks and I/NGOs were also trained.

Nepal now has substantial experience and skill base necessary to design and implement training programmes on different aspects of household size biogas plants. The major organizations with this capabilities include the following.

(a) Gobar Gas and Agricultural Equipment Development Pvt. Ltd.
- Specialized in skill level training for construction and O&M

(b) Agriculture Development Bank of Nepal
- Specialized in process and knowledge based training. Has sufficient physical facilities, for training.

(c) Consolidated Management Services Nepal Pvt. Lid.
- Specialised in process and knowledge based training, to be organised in and out of Nepal

(d) Nepal Biogas Promotion Group
- This is a newly established organization and has potential for skill and knowledge based training

There are also various training manuals prepared by CMS and GGC that enable trainers to organize training for biogas technicians, users, masons and extension workers.

8.7 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	**3**	Lecture	Transparent sheets or flip chart
2.	From a single plant to national objectives and strategies	**5**	Lecture	O/H projector. screen, and flip chart
3.	Institutions for extension of biogas technology	**8**	Lecture cum discussion	O/H projector
4.	Factors affecting extension of biogas	**8**	Lee lure cum discussion	O/H projector
5.	Extension approaches	**8**	Lecture cum discussion	O/H projector, flip chart
6.	Extension methods	**8**	Lecture cum discussion	Flip chart
7.	General discussion	**20**	Discussion	
Total Time		**60**		

8.8 Relevant Questions

- Is the Government of Nepal committed for extension of biogas technology in a mass scale? Substantiate your answer with evidences.

- What are the stages that a user goes through before taking a decision to adopt biogas technology.

- Why are all extension methods not equally effective in building awareness on biogas technology? Substantiate your answer with examples.

- What are the major institutions involved in promotion of biogas technology in Nepal? What institutions would you visit to acquire more information on biogas in Nepal?

8.9 References

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List of the Recognised Biogas Companies

S.N.	Name of the Company	Place
1.	Birat Biogas Company (P) Lid.	Tinkune, Kalhmandu
2.	Baral Gobar Gas Scwa Kendra	Rastra Bank Chowk. Pokhara.
3.	Bhairabi Gobar Gas Udyog (P) Lid.	Chaughada Bazar. Nuvvakot
4.	Baikalpic Urja Bikash Company (P) Ltd.	Bharaipur, Chitwan
5.	Chitwan Gobar Gas Nirman Talha Sewa Co. (P) Lid.	Bharatpur, Chilwan
6.	Gobar Gas Tatlia Krishi Yantra Bikash (P) Ltd.	Kupondole, Lalitpur
7.	Gandaki Gobar Gas Sewa Kendra	New Road, Pokhara
8.	Gramin Urja Bikash Company (Pvt.) Ltd.	Shrijana Chowk. Pokhara
9.	Himalayan Gobar Gas Talha Gramin Sewa (P) Ltd.	Bharaipur, Chitwan
10.	Janata Gobar Gas Nirman Talha Baikalpic Urja Bikash Aimshandan Kendra	Besi Sahar, Lamjung
11.	Jana Bhawana Gobar Gas Udvog (P) Ltd.	Bidur, Nuwakot.
12.	Khanal Gobar Sewa Kendra, (P) Ltd.	Damauli, Tanahun
13.	Kishan Gobar Gas Udyog Man	Bidur, Nuwakot
14.	Shanti Gobar Gas Udvog (P) Ltd.	Bidur Nuwakol
15.	Nepal Biogas Company (P) Ltd.	Min Bhawan, Kathmandu
16.	Nepal Gobar Gas Bistar Tatha Bikash Co. (P) Ltd.	Bharaipur, Chitwan
17	Nepal Rastriya Gobar Gas Company (P) Ltd.	Sltyanja Bazar, Shvanja
18.	Nil Kamal Gobar Gas Company (P) Lid.	Bharatpur, Clvitwan
19.	Pokhara Gobar Gas Sewa Kendra (P) Lid.	New Road, Pokhara
20.	Rastriva Gobar Gas Ninnan Tatha Sewa (P) Ltd.	Bharatpur, Chitwan

Inventory of Organizations Involved in Biogas Programme

S.N.	Name & Address	Current/Past Activities	Working Areas	Future Biogas Related Activities
1.	Arjun Khola Project Arjun Khola. Dang	Mobilization of community for plant construction	Dang	
2.	Ashahaya Mahila Kalyan Kendra Chabahil, Kathmandu	Health Education. Primary Health Care, Non-formal Education. Self-reliance programmes.	Indrayani VDC. Kathmandu, Rajgadh, Jhapa	To promote biogas programmes in Rajgadh, Rajgadh. Jhapa
3.	Association for Protection of Environment Culture Hatkhola Road, Biratnagar-10. Morang Tel: 021-21176. Fax : 977-21-25617 Contact Person (CP): Medini Bhandari	Wetland conservation programme study about the wetland species, wild water buffaloes and other wild animals in wetland area. study of wildlife and forest areas in eastern terai. various education programmes/talk programmes/audio/ visual programmes on wildlife, soil water and forest, tree plantation.	Koshi Tappu, Sunsari. Saptari, Udayapur, Morang, Terhathum, Taplejung, Panchthar and Bhojpur	To raise people's awareness in environment, to promote biogas programmes in the area
4.	Awareness Campaign Against Forest Fires, Central Office, Pokhara P.O. Box #6, Tel: 20299 CP : De\i P Aryal	Conservation of environment through public awareness and installation of biogas plants.	Terai, Chure range	To raise awareness GO biogas programmes
5.	Backward & Interest Group Empowerment Cenler (BIGEC) Taranagar. Gorkha CP : Khadga Bahadur Kumal	Adult literacy classes, establish nurseries. kitchen garden, farming of ginger and banana.	Gorkha	To implement integrated activities including biogas programmes
6.	Baivanath Yuba Club Tikapur. Kailali	Motivate community for plant installation. community development activities.	Tikapur	To be involved in biogas sector
7.	Basuki Yuba Club Kharkhare, Thankot	Motivate community to install biogas plant.	Thankot	Motivate community for biogas plant installation
8.	Bijaya Yuva Club Barathawa-4. Sarlahi	Various welfare projects	Sarlahi	To implement biogas related programmes
9.	BFDC Co-operation Committee Chitwan	Motivate community in biogas plant installation	Bharatpiir	To raise awareness biogas programme

S.N.	Name & Address	Current/Past Activities	Working Areas	Future Biogas Related Activities
10.	Center for Development Services Dharapani. Gorkha Bazaar CP: Manoj Acharya	Non-formal education, environmental sanitation, biogas extension & promotion	Gorkha	Biogas extension and promotion. credit facilities to install biogas plants
11.	Center for Disaster Management and Environment Protection, Naya Baneswor P.O.Box. 9229. Ph : 472516 CP : Krishna Pd. Poudel	Training, awareness programme on environment, adult literacy classes, income generation activities	Ka™	To implement biogas related programmes through community organization already formed by them
12.	Chetana Club Bijauri-5. Dang CP : Suduan Poudval C/- Pradip Regmi. Ph : 412674	Environmental protection, skill development programmes for women, tree plantation	Dang	To participate in biogas programme, to link biogas with livestock, and environmental programmes
13	Chura Foresl Development Lahan Siraha	Forest conservation motivate people for biogas plant installation	Lahan	Forest conservation through biogas plant installation
14.	Committee for the Promotion of Public Awareness and Dev. Studies Chakratirtha. Lamjung CP: DikendraKandel C/- P.O. Box : 5926. Kathmandu Ph . 414879	Rural literacy- & self reliance programme Raise Public awareness on biogas plant construction	Lamjung	To make aware the community on environmentally sound, energy alternative and to involve them in installation of biogas plants
15.	Community Dcv. & Research Center CP Hari P Pandev. Chana Phannac\, Maharajgunj Katlunandu Ph:418064	Adult Literacy Classes	Dhading	Participate in biogas programme including motivating community for biogas plant installation
16.	Ecological Sendees Center Narayangadh. Chitwan CP . Maheswor Ghimire Ph : 056-20560	Environmental protection including awareness building, agroforestry programme and biogas promotion and extension	Chilwan, Tanhun	Promote biogas as alternative energy source and motivate community lo install biogas plants

S.N	Name & Address	Current/Past Activities	Working Areas	Future Biogas Related Activities
17.	Environment and Population Awareness Programme 2049 Charikot, Dolakha CP : Shankar Upreti	Environmental conservation, non-formal education, skill development training, raise awareness.	Charikot, Dolakha	To participate in biogas related programmes
18.	Environmental Camps for Conservation Awareness P.O.Box :9210 Ph: 475210 Km CP ;Neeraj Nepali	Environmental camps, to raise sense of awareness among children about the need for conservation and better resource management	30 districts of Nepal and Bhutan	To dis seminate information regarding biogas program in the project area and train the local people.
19.	Forest Development Committee, Bandipur, Tanahun CP : Hari B Adhikari	Forest conservation, management and protect-ion, livestock extension services including fodder tree plantation, provide support to the communities to install biogas plants	Tanahun	Provide credit facilities to the community to install biogas plants and extension, organize and motivate communities
20.	Forum for the Community Development (FOCOD), Nepalgunj. Banke, Ph : 081-21169 CP : Sarita Devi Shanna	Adult literacy programme, raise public awareness and organize various workshops on environment and fuel consumption	Banke. Bajura	To be involved in biogas related programme and motivate people for the same
21.	Gaindakot Yoova Club Gaindakot-2, Nawalparasi CP : Tara N Lamichhane	Tree plantation and conversation, forest conservation	Gaindakot VDC	To interact between people on alternative energy and to promote biogas sector
22.	Ghusel Community Development Project Committee, Ghusel *CJ*- USC-Canada, Nepal, P.O. Box : 2223, Kathmandu	Integrated community development programmes	Ghusel VDC	Install biogas plants in working areas
23.	Glory Foundation Lazimpat, P.O. Box 10872 Kathmandu Ph : 977-1-230577 CP : K. M. Gautam	Planning, designing and conducting Trainings, seminars, workshops, study tours and information dissemination programmes and conducting applied research and socio-economic studies; and formulating. implementing and managing development projects and programmes on various aspects		

S. N.	Name & Address	Current/Past Activities	Working Areas	Future Biogas Related Activities
24.	Godavari Environmental Protection Forum Lalitpui, Godavary. Kathmandu	Involved in environmental protection		
25,	Gramin Jana Bikash Kendra Birtamod, Jhapa Ph : 023-29233 CP: Kundan Bhattarai	Awareness raising on education, health and community development	Jhapa	Awareness raising on biogas programmes
26.	Group for Environment Awareness and Research Sahid Marga. Gyaneswor Kathmandu Ph : 419652 Cp : Binod K Guragain	Environmental protection and awareness raising		To implement biogas related programme
27.	Helambu Ekikrii Vikash Pariyojana Sindhupalchowk P.O. Box: 3702, Ph: 416581 CP : Gopal Lama	Alternative energy, environmental education, health, agriculture, conservation of cultural heritage related programmes	Sindhupalchowk	Participate in biogas related Activities
28.	Him Ganga Dudhkoshi Sewa Kendra P.O. Box ; 5102. Kathmandu, Nepal CP ; Sita Ram Gurung Ph: 416611	Awareness raising programmes, tree plantation, literacy programmes, water source conservation and environmental education	Okahldhunga	To participate in biogas programme
29.	Human Welfare & Environment Protection Center, Tribhuban Nagar, Dang CA HWEPC, P.O. Box : 606, KTM. Ph : 082-60320, Fax : 082-60311 CP : Shreeman Neupane	Environmental education, distribution of first-aid medicines, rural agroforestry management sanitation education for rural community, literacy program, provide information regarding biogas.	Dang	Implement biogas programmes in the project area
30.	Integrated Rural Community Development Committee CP: Mukunda Naupane	Forest conservation plant conservation, plant construction	Chitwan	Installation of biogas plants
31.	Integrated Community Development Project Lele, C/-USC-Canada Nepal P.O. Box : 2223, Kathmandu	Integrated community development programmes	Lalitpur	Install biogas plants in the area

S.N.	Name & Address	Current/Past Activities	Working Areas	Future Bio gas Related Activities
32.	Jana Adarsha Yoova Club Mangalpur-3, Chitwan. Ph : 21240 CP : Ram Hari Thapa	Tree plantation, adult education, child and mother help programme, publication of "PUKAR"	Chitwan	To raise awareness about biogas Programme
33.	Jana Milan Yoova Club, Pulchovk C/- USC-Canada Nepal P.O. Box : 2223, Kathmandu	Integrated community development programmes	Dalchowki	Install biogas plants in the area
34.	Kailali Samudavik Parvavaran Tikapur, Kailali	Environmental conservation motivated people for plant construction	Dhanagadhi	To be involve in biogas sector
35.	MANAVOTTHAN, 1/453 Shivapath. Janakpur-1 Ph- 410406.056-20657 CP : Kamal Bachhar	Literacy and income generation programme, operation of CMA Campus. Malangavva	Mohattari, Rupandehi, Chitwan	Promotion of biogas programme by helping concerned agencies in installation of biogas plant
36.	Mulli Dimensional Development Forum Panchakanya-9. Jayamangala, Chitwan Ph : 523019, Kupondole CP : KishorCKhanal	Awareness programme on health education and community development	Panchkanya & Jutapani VDC. Chitwan	To promote biogas sector
37.	Multipurpose Community Development Center P.O .Box : 9684 Baneswor, Kathmandu Ph : 473606.476637 CP : B P Niroula	Income generation and informal education programme	Sankhuwasabha	Install alternative source for fuel viable in the local condition mainly the biogas plant in Arun III project area
38.	Neighbourhood Society Services Center. Maitidevi, Kathmandu P.O. Box. 7629 Ph: 414144 CP : Udava R Khatiwada	Water supply and sanitation, credit programme for income generation. NFE health and community development activities, environment protection	Katlimandu, Chitwan & Mohottari	To initiate biogas programme in Chitwan & Mahottari including motivation and promotion
39.	Nepal Capable Society Chabahil. Kathmandu Ph :474804.474797 CP : Sita Ojha	Environmental awareness, rural reliance programme	Lapsiphedi VDC. Sindhupalchowk	To participate in biogas related Activities

S.N.	Name & Address	Current/Past Activities	Working Areas	Future Biogas Related Activities
40.	Nepal Jesuit Social Work institute. GPO Box 50, Kathmandu Ph :524842 CP : Paras M Lama	Training of social works, community development activities	Bandipur, Sarlahi. Syanja Baitadi & Okhaldhunga	Co-operation in training and implementation of biogas plants in the project areas
41.	Nepal Rural Development Center P.O. Box :5367 Maharajgunj, Kahtmandu Ph : 10-418978, Fax : 977-1-413641 CP : C M Golay	Adult literacy classes, training and other community development activities		Participate in biogas related activities
42.	Nepal Sana Byabasahi Sangh Head Office, Dharan	Fruits & vegetable farming and other agricultural activities	Eastern Development Region	Promotion & extension of biogas technology, credit facilities to install biogas plant
43.	Nepal Sustainable Community Development and Research Center GPO Box : 6202, Kathmandu CP : R B Shrestha	Income generating activities, education on utilization of local resources bv the self-help group	Bhojpur & Jhapa	Motivate people residing in project sites for the installation of biogas and establish contact with Agricultural Development Bank
44,	New ERA P.O. Box : 722 Maharajgunj, Kathmandu Ph: 410803, 413603	Research & training activities in the field of education, manpower, agriculture, population, health, appropriate technology rural development etc.		Carryout research & development activities on biogas technology
45.	Nuwakot Gramin Sewa Shangh Bhalche VDC-4 Kola Gaon, Nuwakot CP : Lok B Ghale	Management for goat-raising and drinking water	Nuwakot	Motivate community to install biogas plants in local areas
46.	Patalekhet Samudayik Club, Patalekhet VDC-3, Kavre P.O. Box : 9064	Primary health care training, discussion programme on children's rights, drinking water & health programme, forest conservation	Kavre	To disseminate information regarding biogas programme, to play mediator's role
47.	People's Participation & Development Center, Maligaon, P.O. Box : 874. Kathmandu Ph ;412934 CP : Nita Pokhral	Services to child and mother once a month, conservation of Devghat area	Gokarna VDC Kathmandu, Devighat VDC Tanahu	To implement gobar gas programmes if support provided

S.N.	Name & Address	Current/Past Activities	Working Areas	Future Biogas Related Activities
48.	Pindali Yoova Club Pinda VDC. Ward # 2, Dhading CP : Pramod Raj Rupakheti		Dhading	To raise awareness on biogas programme
49.	Plant for Life, Hetauda, Makawanpur CP ; Rajesh Sharma	Mobilize community to biogas plant construction	Heiauda	
50.	Progressive Forest Conservation Committee. Gagangauda. Kaski CP : Shanker KC	Provide support on installation of biogas plant. forest conservation and management	Pokhara	Organize and motivate community, installation of biogas plant
51.	Project Approach Team for Rural Organization Nepal Dhankuta-5 Ph : 026-20036	Construction of 6 cum. biogas plant, skill development and income generation training. adult and non-formal education basic health. drinking water and conservation of environment programmes	To participate in biogas programme	Awareness raising and community motivating to install biogas plants.
52.	Red Cross Society Pokhara Branch	Assist communities in installation of biogas plant, community development programmes, such as : health education, water supply & sanitation, environmental protection	Pokhara	Assist communities in installation of biogas plant, community dev. programmes, including promotion. motivation and construction of biogas plant
53.	Rural Awareness Forum C/- Hem R Sharma Paiyunpala-1, Baglung CP : Tuk R Sharma	Saving and credit programme, adult literacy, awareness raising	Banglung	To implement biogas programmes in the project area
54.	Rural Community Development Society Dhulikhel-5. Kavre Ph: 011-61441/01-61069 CP : Yadav P ShTestha	Involvement in biogas programmes, such as links and coordinate between community and Gobar gas company, weaving training, income generation programmes, promotion of saving and trade scheme, promotion of non-formal education	Ka\re, Sindhupalchok, Dokakha & Sindhuli	To develop its' own manpower to work with BSP independently in promotion of biogas sector

S. N.	Name & Address	Current/Past Activities	Working Areas	Future Biogas Related Activities
55.	Rural Reconstruction Nepal P.O. Box 8130, Lazimpat, Kathmandu Ph : 415428 CP : R B Karki	Socio-economic rehabilitation in flood affected areas, training to the farmers which includes biogas, its importance and significance	Chitwan, Panchthar	Install more than 200 plants in the project area, provide biogas support service to more than 35 groups of farmers with more than 1500 members
56.	Safe Water and Environmental Conservation Group, P.O. Box 46, Dilli Bazaar. Kathmandu Ph : 410126, Fax : 977-1-411642 CP : Pankaj Shah	Water and waste treatment, sanitary programme	Katmandu and Janakpor	Implement biogas programmes using public toilets, hotel, lodges etc.
57.	SAGON Ph:214015 CP : Mukta Singh Lama	Awareness raising on biogas technology', action research on local indigenaration knowledge & skills on community development and human research development	Kabnie and Sankhmvasablia	Awareness raising and community motivation for biogas plant installation
58.	Sri Jana Shanti Adarsha Yuba Club Mangaltar, Kabhre	Motivate community for installation of biogas plants	Kabhre	
59.	Samaj Bikash Samiti. Kavre Rikhebagar, Salyan Contact Add : Nagendra Shah, Himalayan Princep Smriti School. Tahachal, Kathmandu, Ph : 270898	Literacy classes	Salyan	To apply biogas training in the field
60.	Samaj Kalyan Pariwar Chhoprak, Gorkha CP : Ramcsh C. Pokharel	No activities started (new organization)	CtfooprakVDCGoifcha	To participate in biogas programme
61.	Samaj Sewa Uddhar Club. Khiratadi VDC-8, Bijagada. Bajhang CP : Toya R Joshi	Adult literacy, health, environment programme	Bajhang	To participate in biogas programme
62.	Sami-Bhaniyang Samaj Siidhar Sangh, Sami-Bhanjvang. Lamjung CP : Bal K Joshi C/- Bishnu K Shrcstha. CECI Ph : 414430	Programmes on environment, bee keeping, agricultural farm, based on permacultural principle	Sami Bhanjyang and Bhodetar VDCs Lamjung	To install biogas plants in the project area

S. N.	Name & Address	Current/Past Activities	Working Areas	Future Biogas Related Activities
63.	Sarbodava Sewa Sangh Mangalbare. Sarlahi		Sarlahi	To provide information about biogas. to facilitate the community people to install biogas plant
64.	Save The Environment of Nepal Chandranigahapur-1. Rautahat Ph : 053-50243 CP : S B Ghimire	Environmental programme, sanitation programme and tree plantation	Rautahat	To promote biogas sector, to provide assistance in mobilization community
65.	Self Reliance Society Service Center Besi sahar, Lamjung CP : S B Ghimire	Environmental sanitation programme, non-formal education programme, rural credit. promotion of biogas programme and plant installation, masons training etc.	Lamjung	Promotion, extension and construction of biogas plants with toilet connection, mason's training, biogas users training and other biogas related activities
66.	Subba KrishnalaJ Smriti Sewa Ssmiti Kathajor, Ramechhap	Adult literacy, agro-forestry extension programmes	Ramechhap	To install 100 biogas plants in project area
67.	Small Farmers Development Group Ghvalchowk, Gorkha	Motivate community for biogas plant installation	Gorkha	Motivate community for biogas plant installation
68.	Social Development and Motivation Center Jorpati, Ph; 472301 CP . Kalpana Rana	Free health camp and adult literacy programme, training for women on skill development	Gokarna, Nayapati. Kapan, Chaunikhel. Baluvva VDC in Kathmandu	To participate in biogas programmes and its implementation in the project areas
69.	Society for Integrated Development Cha-3-701-1, Nayabazar, Kathmandu CP : Bharat J Upreti	Rural women development programme, adult literacy classes, smokeless stoves, toilet construction, calendar distribution	Nuwakot	To raise peoples' awareness on biogas plants to protect environment
70.	Society of Local Volunteers' Effort Dhankuta-6 P.O. Box 5556 Ph : 026-20076, Fax : 977-1-220219	Human resource development, education income generation and skill development training, community development	Dhankuta and Rasuvva districts	Participate in biogas activities
71.	Society for Partners in Development Gyaneswor. Kathmandu P.O. Box : 2594, Ph: 418281, Fax: 977-1-220161	Sericulture development, income veneration, non-formal education. agro-forestly and environmental protection activities, community development, group formation, group saving etc.	Lapsiphedi VDC S indhupalchowk	To promote biogas programme in the project area which is potential for it

S. N.	Name & Address	Current/Past Activities	Working Areas	Future Biogas Related Activities
72.	Society for Participatory Cultural Education, Chakupath, Lalitpur Ph :523774 CP : Keshav Gautam	Non-formal education, biogas technology promotion and extension, organize training for community development workers on biogas, rural credit programme	Sindhuli, Kapilvastu & Rupandehi	Promote biogas programme. provide credit facilities to potential users and organize biogas users Training
73.	Social Service Center, Siwa Shaktipur. Jamuni-2. Bardia CP : Udava R Bista	Education programme and agricultural extension programmes	Bardia	To participate in Bio-gas Programme
74.	Village Development & Save The Environment Forum Kalikot, Nepal CP : Hem R Sanjval	Literacy programme and rural co-operative saving programmes	Kalikot	To participate in biogas Programme
75.	Women Self Reliance Center Mclamchi, Sindhupalchoek C/- Rural Development Area 1 Action Aid Nepal Bahunepati, Sindhupalchowk Ph :410929 CP : Bhagabati Nepal	To organize- motivate, educate women to conserve, environment, improve health education programmes on girls trafficking. ATDs awareness	Sindhupalchowk	To involve in biogas programme for improvement of women's health and environment Conservation
76.	Youth Club Narayangaih Chim an-NepaJ Ph :21456 CP : Tika R Sapkota			
77.	Action Aid Nepal Lazimpat. P.O. Box : 6257 Phone:410929.419115 Fax : 977-1-419718 CP : Bimal Phnuval	Integrated community development programmes	Sindhuli, Smdhupalchok, Nawalparasi	Extension and promotion of biogas technology including training to community construction workers on biogas plant construction
78.	CARE International/Nepal Krishan Galli. Lalitpur Phone:522153 CP : Nalini Subba	Integrated community development programmes	Gorkha. Mustang. Syanja, Solu Bajura. Mahottari. Kaski	Extension and promotion of biogas Technology

S. N.	Name & Address	Current/Past Activities	Working Areas	Future Biogas Related Activities
79.	Plan International P.O. Box 1670 Tripureswor, Kathmandu Phone: 216310	Integrated community development including financial support to community to install a biogas plant	Kathmandu, Rautahat, Bhojpur. Morang, Makawanpur. etc.	Motivate farmers to install biogas plants and provide additional financial help to the farmers to install such plants. Provide O&M training to biogas plant owners.
80.	Save The Children USA P.O. Box 2218 Maharajgung, Kathmandu Phone: 412447 CP : Keshav Dutta	Intrigated community development activities including raising awareness for promotion of biogas related activities. including raising awareness for the promotion of biogas related activities.	Siraha	Raise awareness on biogas related activities and motivate the farmers for plant installation
81.	South Asia Partnership/Nepal Nepal India Conservation of Environment P.O. Box : 3827. Kathmandu Phone : 476163	To motivate, educative and organise people in general to conserve their environment in the Terai region of Mid-Western Nepal; to form and foster people's organization and group for extension and promotion of Biogas, smokeless Chulas, development of afforestation, livestock and low cost sanitation; to enrich human resource by imparting skill training in construction of biogas, smokeless Chulas and the development and management of live-stock. Afforestation and sanitation; to complement and supplement in the international and national effort of conserving and managing the environment.	Bardia	Continue the ongoing activities
82.	Agricultural Development Bank, Nepal	Promotion & extension and provide loan facility to fanners to ipsiall biogas pbrts. Involve in R & D works.	Nepal	Promotion & extension and provide loan facility' to farmers to install biogas plants. Involve in R & D works.

S.N.	Name<& Address	Current/Past Activities	Working Areas	Future Biogas Related Activities
83.	Asian Development Bank, Manila Nepal Office	Supported installation of some 5000 biogas plants which due conciliation of second trench of the agreements has been reduced to 2,500. This support is given as a loan earning an interest of l -2 % to HMG/N which passes this loan to the farmers as subsidy	Nepal	
84.	Centre For Rural Technology P.O. Box : 3628 Tripureswore, Kathmandu Phone: 211919 CP : Lumin K. Shrestha	Promotion & dissemination of rural technologies		Provide necessary technical support services to needy individuals and institutions for biogas promotion & dissemination
85.	Consolidated Management Services Nepal (P) Ltd., P.O. Box 10872 Lazimpat. Kathmandu Phone-421654. 410498 Fax: 415886	Research & development on biogas related activities		Research & development works on biogas related activities
86.	Development Partners - Nepal P.O.Box : 5517 Battisputali. Katlunandu Phone 476264 CP : Prakash C Ghimire	Various consulting services on engineering, socio-economics, action researches and gender issues		Conduct various training programmes relating to biogas technology[1] promotion, plant installation & other related research & development activities
87.	FAO UN Building, Pulchowk, Lalitpur Phone : 523239, 523200 Ext. 300-312	Support for the development of national Biogas programme	All over the country	To assist the government in designing and developing a national biogas programme and in upgrading the human resources necessary to implement it
88.	GTZ, Lamjung Self-reliance Project. Phone:523110 CP : Dr Kcshav Shakya	Integrated community development activities including assisting local NGOs to promote and construct biogas plant, organize technical training etc.	Lamjung	Future programme remains under planning process. There has been an opportunity for the HMG/N of obtaining funding from the GEF programme (a total of 6.5 million US$)

S.N.	Name & Address	Current/Past Activities	Working Areas	Future Biogas Related Activities
89.	Ma Shakti Traders C/- Manikaj Consulting Services Birendra Nagar. Surkhet	MuJtipurpose turbine, solar water, biogas rural water supply, consultancy service	Surkhet	Promote biogas technology
90.	Nepal Bank Limited, Nepal	Recently started to provide loan facility through it seven branches to install biogas plants	Nepal	Recently started to provide loan facility through its seven branches to install biogas plants.
91.	No-Frills Consultants Man Bhawan. Lalitpur P.O. Box : 3445. Kathmandu Phone : 523245. 522782 CP : Badri Kavastha	Consulting services on agriculture related activities		Motivate community to install biogas plants.
92.	Rastriva Banijva Bank. Nepal	Recently started to provide loan facility through its some branches to install biogas plants.	Nepal	Recently started to provide loan facility through its some branches to install biogas plants.
93.	Rural Water Supply and Sanitation Project. Bultval P.O.Box: 12. Tel: 73-20782	Drinking water (tube-wells and gravity schemes), sanitation, health education and human resource development	Six districts of Lumbini zone	To participate in biogas programme
94.	Small Farmer Developing Group Mahottan. Phone : 044-29028	Conduct different small farmer development related activities including biogas programme	Mahottari	Promotion and extension of biogas technology, motivate the community lo install biogas plants.
95.	SNV/Nepal Biogas Support Programme Lalitpur	To support in promotion and extension of biogas technology in Nepal by providing subsidy for plant construction and carrying out R & D works to make biogas more attractive to small farmers. Help government in policy making to promote biogas programme.	Nepal	To support in promotion and extension of biogas technology in Nepal by providing subsidy for Plant construction and carrying out R & D works to make biogas more attractive to smaller farmers. Help government in policy making to promote biogas programme.
96.	UNICEF, Kathmandu UN Building, Tel: 523200	Financed some 970 biogas plants bus stopped in 1991. Provided assistance to attach latrines in biogas plants.	Nepal	UNICEF is supporting the biogas programme from an environmental and sanitation point of view.

S. N.	Name & Address	Current/Past Activities	Working Areas	Future Biogas Related Activities
97.	Water and Energy Commission Secretariat, Kathmandu	Develop water resources potentiality, prepare future policies on water energy and environmental programmes Recently, organised a training course for masons	Nepal	
98.	Women Development Division, Tansen, Palpa	Raise awareness for biogas plant installation	Palpa	Willing to motivate and mobilize community if support provided.
99.	Women Development Division, Lalian, Sirana	Raise awareness for biogas plant installation especially focus on woman	Siraha	Willing to motivate and mobilize community if support provided

Source: BSP

Extension of Biogas: A Working Model

Phase I Promotion	**Phase II** Information/Education	**Phase m** Personal Persuasion	**Phase IV** Decision/Adoption	**Phase** V Training	**Phase VI** After-Sales-Services
Target group : all potential users	**Target group** : potential users with differentiation in	**Target group** : potential users who have shown active interest in biogas		**Target group**: users (men and women)	**Target group** : users (men and women)
Aim : - to create awareness on the advantages of biogas technology - to raise interest in biogas technology	**Aim** : to raise active interest of potential usei s in a way that they can evaluate the advantages and disadvantages for a possible adoption of the biogas technology	**Aim:** to give the final 'push' for adoption	the time period between awareness and adoption is influenced by and social/cultural factors and by the individual characteristic of the adopter	**Aim**: to provide the necessary knowledge and skills for proper 0 & M to use the biogas plant efficiently and effective	**Aim** : to have good functioning plants in operation with satisfied and positive users, leading to farmer-to-farmer-motivation
Actors : - GGC,ADB/N, other construction companies, HMG	**Actors** : - GGC, other construction companies, GO, NGO, INGO	**Actors** : - GGC, other companies, GO, NGO, INGO		**Actors** : - GGC, other construction companies, ADB/N, training institutes, GO, NGO, INGO	**Actors** : - GGC, other biogas companies
Means : - mass communication - after-sales-services - subsidy	**Means** : - group approach communication with use of extension	Means : - personal worker to potential - farmer-to-farmer communication		**Means** : - training on the spot **or** elsewhere	**Means** : - fast and reliable service after complain - regular (yearly) visits with emphasis on O&M

Promotion (Phase I) leads to awareness, information and education (Phase II) to evaluation, personal persuasion (Phase III) to decision/adoption (Phase IV) to use, training (Phase V) to effective use, and after-sale-service (Phase VI). This Hill keep the plants in good function which is a precondition for the promotion of biogas (Phase 1).

SESSION NINE

QUALITY STANDARDS

SESSION NINE

Quality Standards

9.1 Introduction

Biogas is a relevant technology to make use of our development opportunities and to deal with various constraints being faced, as discussed in the previous sessions. However, the gap between the potential and its realization is so wide that there is an urgent need to expedite the rate of adoption of this technology in a mass scale.

The decision for adoption of biogas technology is made at the household level A majority of families in Nepal are still not aware of the technology. Only a few of them have developed interest in it and still fewer are actually ready to adopt it. A well functioning plant with satisfied users, which is a prerequisite for its adoption, is the only reliable means to develop and maintain people's confidence in the technology.

Poorly installed biogas plants result in inefficiency and mal-functioning systems which lead to capital loss, frustration among owners, promoters and the donors as well This will also damage the reputation of biogas technology causing negative impact on its adoption. The only precaution to take against such a possibility is to ensure that die desired quality is maintained for each plant that is constructed.

This session deals with various parameters required to ensure the quality of biogas plants. By the end of this session, the participants will be able to:

explain why quality control measures for the construction of biogas plants are important; and enumerate the measures being taken to ensure high quality biogas plant construction and their improved performance.

9.2 The Need for Quality Control

In the early years of 1990s, the biogas sector of Nepal witnessed (a) sharp rise in the demand of biogas plants, mainly augmented by new subsidy policy, (b) emergence of more than 20 new biogas companies with varying degree of technical capability and institutional strength as a result of the government privatization policy, (c) growing interest of NGOs. banks and other organizations to get involved in the promotion of biogas technology, and (d) implementation of a comprehensive biogas programme with long term vision, i.e., BSP phases I. II and **III** (BSP, 1992; de Castro, ct al.. 1994; BSP. 1996).

The crucial factor that led to these developments was the satisfactory performance of more than 90 percent of the plants installed. This high rate of success is taken for a period when most of the plants were of GGC design constructed by a single company (GGC). Thus. Nepal moved from a "Single-Agency, Single Model" to "Multi-Agency. Multi-Model" approach to biogas development in the country. This change favoured the strategy for rapid realization of the potential but also created a greater concern for maintaining a high rate of successful plants attained in the past Therefore, quality control and quality assurance has become a subject of concern to all institutions involved in the biogas sector.

Till now, Nepal does not have any government agency with the mandate and capability to implement programmes for controlling the quality of plant construction and use of standard biogas appliances. It is in this context that BSP Phase II developed programmes and procedures for quality control and started the implementation procedure.

9.3 Development of a System for Quality Control

BSP has devised 66 parameters for ensuring the quality of plant construction and its proper functioning (Lam and van Nes. 1994). The parameters are grouped into three categories and are presented in Annex 9.1. Any plant that fails to meet the stated parameters in category' 1 is not provided subsidy. Failure to meet specifications of category 2 requires the biogas company to pay a penalty to BSP in addition to correcting the faults without any additional fee to the user. The concerned company is warned not to repeat the mistake for failure to comply with requirements of category 3 parameters.

9.3.1 Enforcement of Quality Control Measures

The quality control system consists of four steps : Agreement on standards, agreement on penalties, control visits and calculation of the total penalty payment as described briefly below.

Agreement on Standards : All companies and banks involved in the BSP implementation have to agree on the parameters, their classification and definitions as given in Annex 9.1. This is a prerequisite for a biogas company to get involved in the construction of biogas plants under BSP. These parameters and their classification can be revised in agreement with all agencies involved in the programme.

Agreement on Penalties : All companies and banks involved in BSP implementation have to agree on the penalty system designed to enforce the quality standards. The penalty amount for different categories of defaults or failure to maintain the quality arc given in Annex 9.2.

Control Visits : BSP has a core group of staff/technicians who regularly make field visits to check if the agreed parameters of quality control are actually followed in the field. They randomly select 5 percent of the plants constructed by each company in the recent past (one year) for field checking. The sample includes both plants in use (filled plants) as well as plants under construction (non-filled plants). Information on these sample plants are collected through a standard questionnaire and forms developed for (a) interview with the owner of the biogas plant or, if not at home, with a relative of the owner; (h) making notes on observations; and (c) taking measurements of the plant visited. In doing so. the presence of a staff or representative of the concerned company is also required. The information thus collected by BSP staff has to be signed by the collector as well as by the representative of the company present during information collection. A report thus generated is compiled and sent to die concerned company for comments.

Calculation of the Total Penalty Amount : The penalty system requires companies to enter into an agreement with BSP to pay the penalty sum for any construction work that does not meet the pre-set standards. After the end of a fiscal year, the total penalty amount to be borne by the company is calculated. This is done by multiplying the penalty amount for sample plants with the 'population factor". For example, if the average penalty for different defaults found in 5 percent of the sample plants amounts to Rs 100 per plant, and if the company has constructed 20 plants in that fiscal year. the total penalty to be paid by the company would be Rs 2.000. This method is justified as long as the sample has been taken at random.

A total of 271 plants equivalent to 5 percent of the total plants constructed in FY 1995/96 were inspected by BSP staff/technicians. The average penalty per plant was calculated at Rs 98.78. This amount is substantially lower than the average penalty for the previous year. This reduction in penalty amount can be taken as an indicator of improvement in the quality of plants constructed this year compared to those of the previous year. A clear and long term policy on the use of penalty fund thus generated is yet to be formulated.

9.4 Important Parameters for Quality Control

Brief descriptions on some of the important parameters for quality control are discussed below.

9.4.1 Designs

The importance of different design has been dealt with in Session One. The concrete dome digester popularised by GGC was approved by BSP to be eligible for subsidy (Karki, et al., 1993). Besides this, the Deenbandhu design was approved by BSP last year for its eligibility to receive subsidy Prior approval of BSP is necessary for (a) introduction of new designs, and (b) altering the dimension of approved designs. Failure to comply with this requirement would lead to cancellation of subsidy.

The general engineering diagram of these two designs have been presented in Session One (sec Figures 1 2 and 1.3). The list of construction materials, appliances and accessories required for different volumes of GGC model biogas plants (4, 6, 8, 10, 15, 20 m^3) is presented in Annex 9.3. A typical sketch of the GGC model plant is given in Figure 9.1. Figure 9.2 presents detailed dimensions of an average family size GGC plant of 8 m^3 capacity. Dimensions mentioned in the drawings for each part of the plant, i.e., fermentation chamber, gas chamber, inlet and outlet, must be maintained within the allowable tolerance limit.

9.4.2 Decision on the Size or Capacity of a Plant

Installation of a correct size of biogas plant is important both for economic efficiency and trouble free operation. Many of the existing plants in Nepal are over-sized and hence underfed. The average size of plants constructed each year is on decline from 10 m^3 in 1992 to 9.25 m^s in 1995. Efforts are being made to bring the average size further down to about 8 m' which is more appropriate in view of the animal holding and gas requirement of an average potential user household (de Castro, et al.. 1994),

The main criteria to decide on the correct size of plant are the cooking and lighting requirements of a family along with the number of cattle heads for die availability of feeding materials. A 8 to 10 m^3 capacity biogas plant produces 1.5 to 2.0 nr of gas per day which is sufficient to cook for a family of 6 to 8 members. On an average, about 0.3 m^3 of gas is needed per person per day for cooking, and biogas lamps consume 0.10 m^3 to 0.15 m^3 of gas per lighting hour {Karki and Dixit, 1984). A thumb rule of 6 kg of dung in 24 hours per m^3 of gas production can be used to estimate required amount of dung and die size of a digester.

9.4.3 Site Selection

Following are the factors to be considered in selecting the appropriate site for plant construction.

– The site should be exposed to the sun.

– The plant should be close to the animal shed and water source. It should also be close to the kitchen to minimize the cost of gas delivery pipe.

- It should be at least 10 m away from well or any other groundwater sources to avoid groundwater pollution

– As far as possible, plant construction should not be encouraged if the water source is located at a distance of more than 20 minutes' walk.

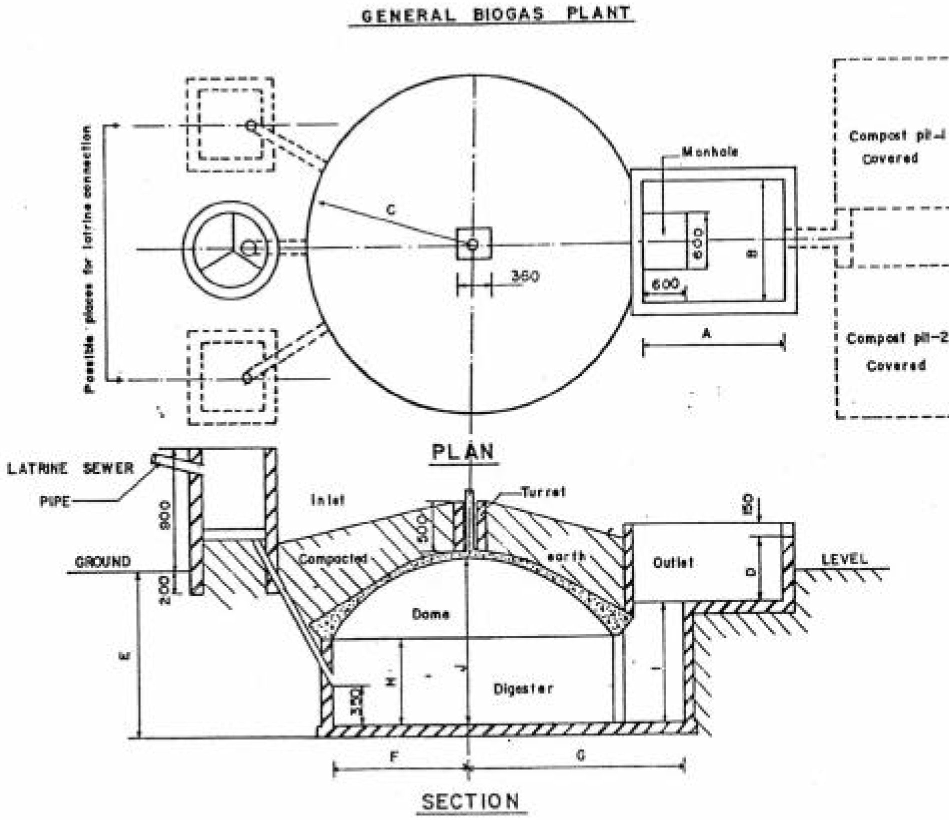


FIGURE - 9.1 GGC CONCRETE MODEL BIOGAS PLANT

COMPONENT	PLANT CAPACITY (m^3)					
	4	6	8	10	15	20
A	1400	1500	1700	1800	2480	2640
B	1200	1200	1300	1250	1250	1760
C	1350	1510	1700	1830	2050	2330
D	500	600	650	680	840	860
E	1540	1550	1720	1680	1800	2030
F	1020	1220	1350	1540	1750	1990
G	1850	2080	2210	2400	2610	2880
H	860	920	1050	940	1150	1150
I	1120	1160	1270	1240	1320	1370
J	1510	1600	1750	1710	1930	2030
ALL DIMENSIONS ARE IN mm.						

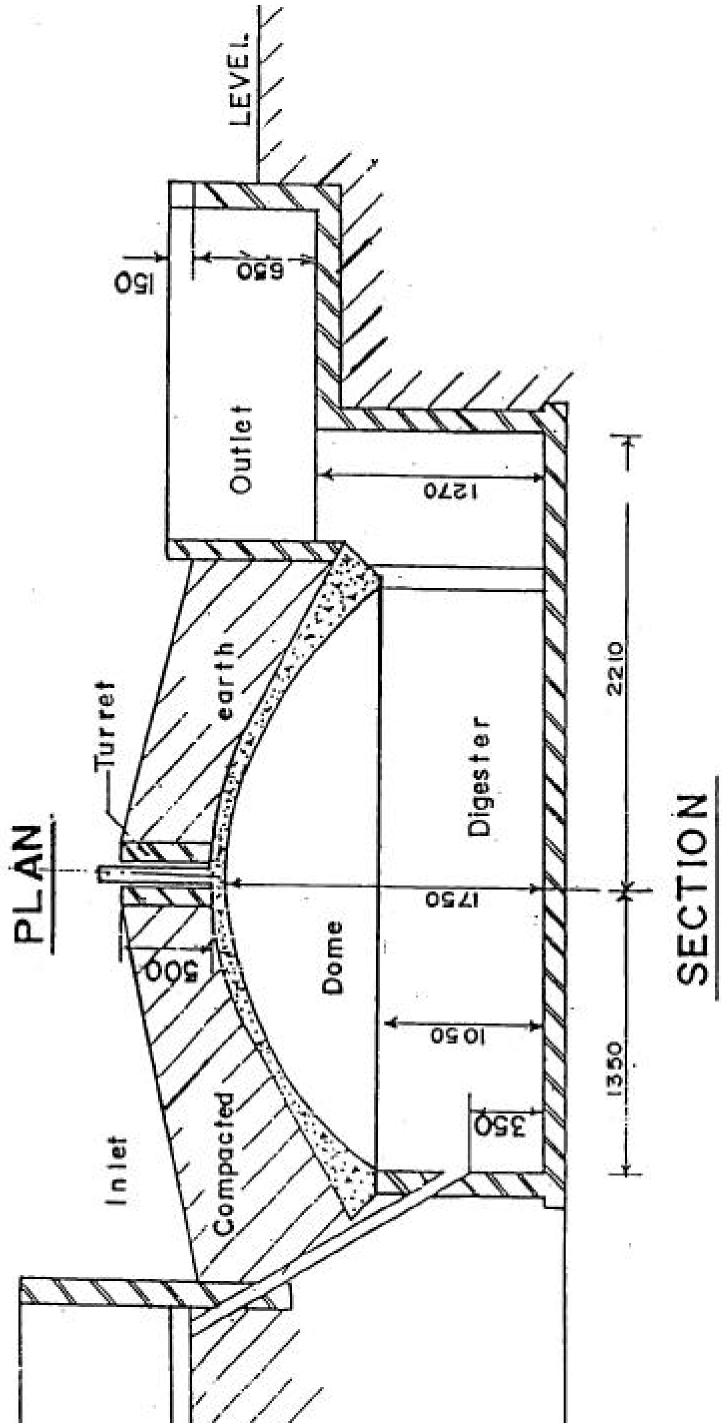


FIGURE – 9·2 8 m^3 GGC MODEL BIOGAS PLANT (DIMENSIONS IN MM)

9.4.4 Construction Materials and Trained Masons

Even if the approved design and trained masons are used, the actual construction work could still suffer due to the use of the poor quality construction materials such as cement, sand, bricks, water and aggregates.

Cement : Cement containing $3CaCO_3$.Al2O3 and $3CaCO_3$.SiC>2 is preferred because of its fast hydration rate and less shrinkage. Cement containing impurities may lead to poor quality structure. Cement should be fresh (not more than six months old), without lumps and should be stored in a dry and cool place.

Sand : Sand containing more than 3 percent dirt or soils should not be used. Preferably, sand should be washed with clean water before mixing it with cement.

Gravel/Aggregates : The dome thickness of GGC design is not more than 7 5 cm. Therefore, gravel of 10 to 20 mm size should be used. If gravel is mixed with soils, it should be washed in clean water.

Water : Water is needed to prepare mortar for masonry work, concreting and plastering. It is also required for washing the aggregates, bricks and the stones used for construction. To ensure the quality of construction, clean water should be used for masonry work Water from ponds and irrigation canals containing sediments and colloidal materials should not be used for masonry work.

Bricks : Bricks are generally used in the construction of biogas plants in the plains and in urban areas where it is easily available. Well baked bricks with uniform dimension should be used. The quality of the baked bricks can be judged by hitting two bricks together. Well baked bricks produce metallic sound when struck against each odier. It is necessary to soak bricks in water before use. If the bricks are not wet, they will absorb moisture from the cement mortar which will weaken the joints.

Stones : Usually stones are used in those places where bricks are not easily available, particularly in the hills and mountains. Hard, clean and good quality stones should be used. If they arc dirty, they should be washed with clean water before use.

Use of Trained Mason : Masons from biogas companies are well trained in all aspects of the construction including site selection. They are assigned to the construction work only after providing theoretical and practical training for two months. Therefore, the services of well trained masons from the recognized biogas companies should be used for plant construction.

9.4.5 Critical Stage of Construction

Although every stage of the construr-inti is important, the following stages are considered critical. Once a feulty structure is established, it will be very difficult to rectify it and sometimes, the whole structure needs to be demolished. These stages should be carefully noted and corrected on time to save the wastage of the scarce resources as well as to keep up the popularity of the technology among users and potential users.

Locating the Central Point : Special attention has to be paid for fixing the central point of the biodigester. If the central point is not properly located, the plant size **will** differ which leads to malfunctioning of the plant. Therefore, before excavating the pit for the construction of the plant, the central point should be well located and the same reference point should be used to locate other points in the course of construction. The method of the fixing the central point has been illustrated in Figure 9.3.

Dome Casting : Casting of dome is a critical stage of construction. After construction of the digester wall, the plant is filled with soil up to its highest point in such a way that it should take a shape of a dome Required shape of the dome can be maintained precisely by using a template (Figure 9.4). A thin layer of sand is spread over the desired shape of dome so that the soil can be removed easily after casting the dome. Cement, sand and gravel are used at the ratio of 1:4:8 for dome casting. Concrete work needs to be completed in one day Curing of the dome should be done properly. A simple method of curing is to cover the dome with well soaked gunny bags for at least seven days.

Back Pilling : The gap between the wall of the structure and outer excavated part should be carefully filled with sufficient amount of soil Then, it should be rammed well for compaction. Digester walls may show cracks if the back fill is not sufficiently compacted.

9.5 Appliances and Accessories

Among various appliances, the biogas users need gas stove (burner), lamps and accessories like main stop cock, gas tap and other fittings. These appliances, mainly the burners and lamps, are imported from India. Presently, due to rapid increase in the installation of biogas plants in Nepal, import of large number of appliances is becoming difficult day by day Suitable types of biogas burners are being manufactured in Nepal, especially by GGC Workshop at Butwal, and the quantity produced does not meet the demand of all the biogas companies. Therefore, import of these appliances from India is necessary. As reliable quality of the main stop cock is not available in Nepal and India, it is being imported from the Netherlands and is costly. The quality of biogas accessories available in the market vary widely.

Some of the materials available in the nearest market are too expensive or last for only a short period. The users have to replace them very frequently. This is the reason for importing the main gas valve from the Netherlands.

The specification of biogas burner manufactured by GGC Workshop is given in Figure 9.5. A list of BSP approved appliances and their manufacturers is given in Annex 9.4.

BSP performs quality test of biogas appliances and provides approval certificate to the suppliers or producers in Nepal and India. It also verifies whether the appliances are according to the required sizes. BSP also provides limited support to encourage in-country production of biogas appliances.

The companies that produce or use such standard appliances need to provide a one year guarantee services to users. If there is a malfunction in these appliances within the guarantee period, the companies are required to replaced them free of charge. However, applying quality control measures on lamps has been comparatively difficult as they have to be imported from India. GGC has made some attempt to produce lamps in Nepal but this is still in the experimental stage.

9.6 Commissioning

After construction, the plant is loaded with a mixture of dung and water. For example, if cow dung is used, one part of water should be mixed to one part of fresh dung for achieving the desired consistency of the slurry (see Session One). Depending upon the season and ambient temperature, it may take from one week to about 4 weeks for the production of combustible gas in the digester. Addition of effluent from operating plants have been found to reduce the gas generation time. The gas first generated has high CO_2 content and does not burn. Therefore, the initial gas volume needs to be vented to release excessive CO_2. Regular feeding of digester with recommended amount of input mixture has to be continued till the gas starts burning smoothly. Regular feeding of inputs in required quantity and

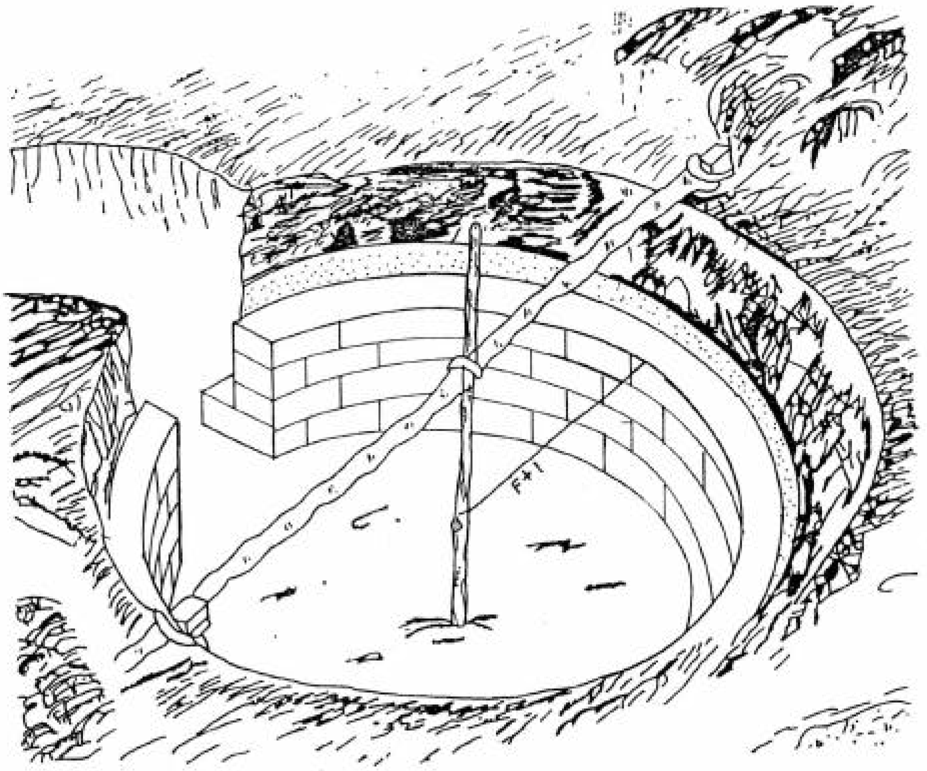


FIGURE-9·3 FIXING THE CENTRAL POINT OF BIODIGESTER

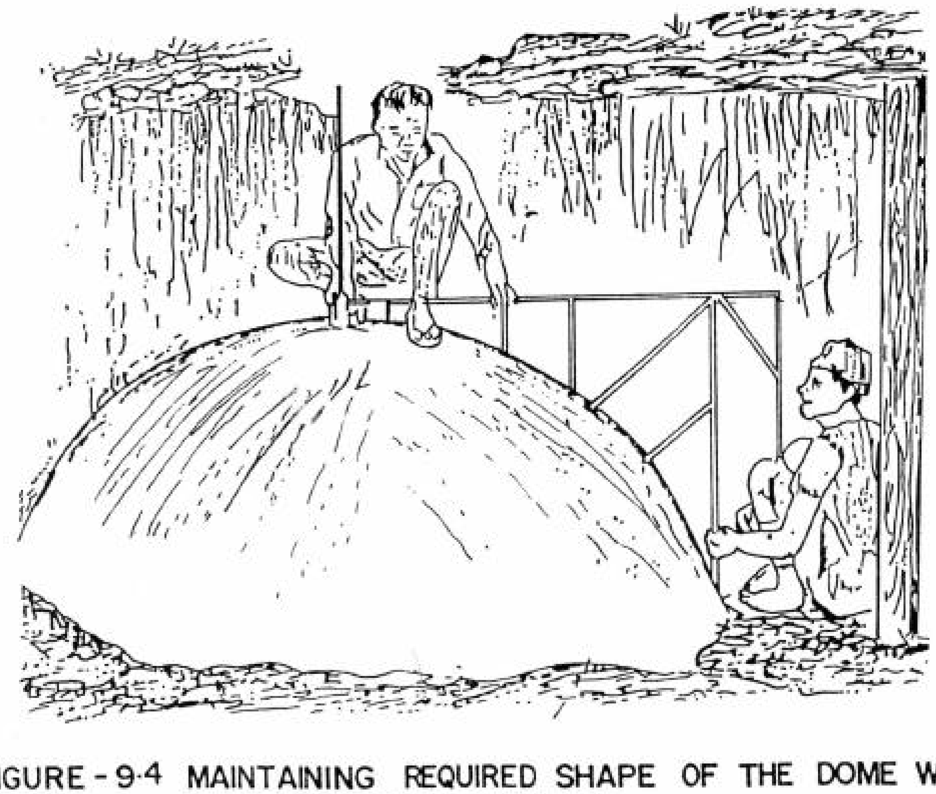
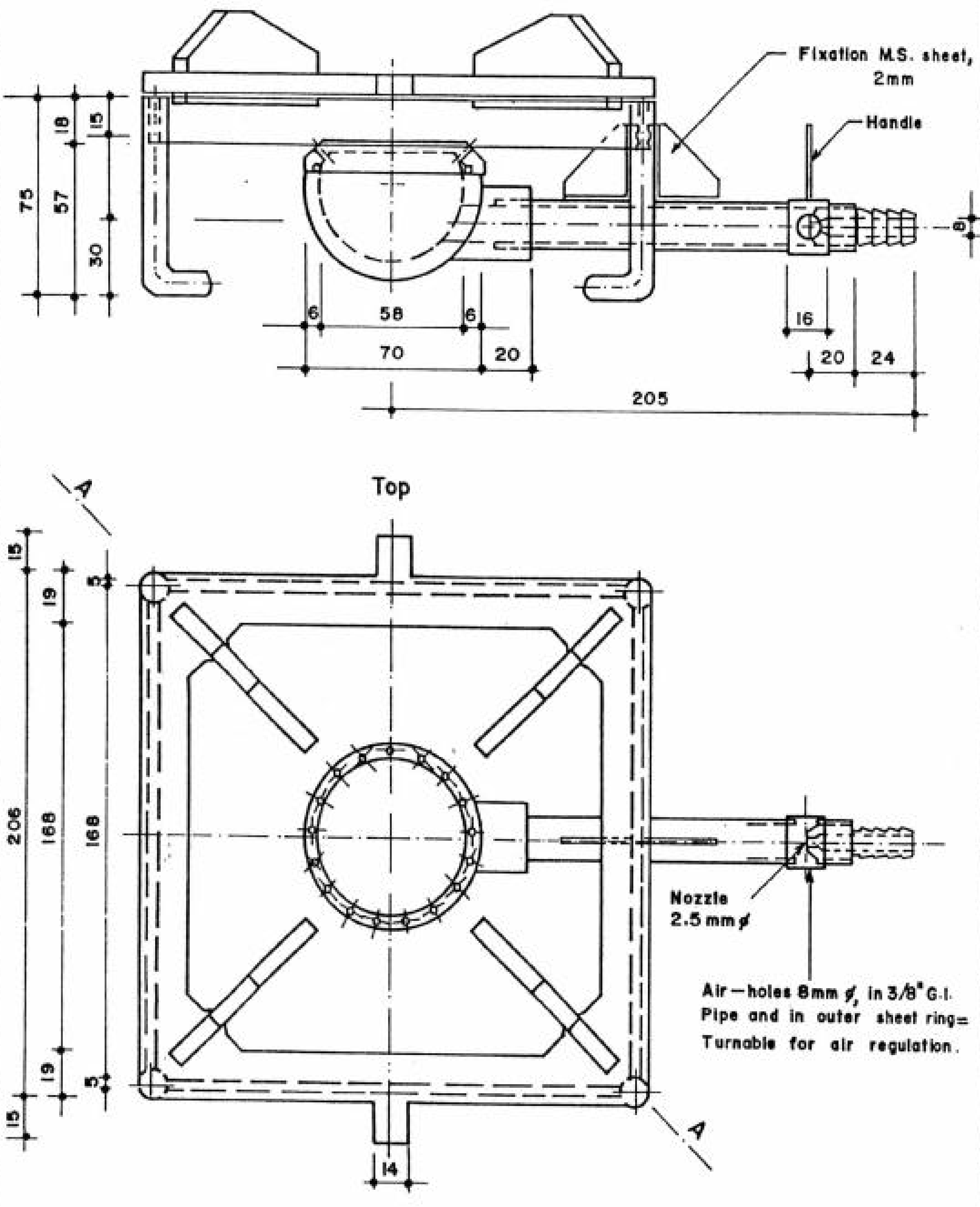


FIGURE - 9·4 MAINTAINING REQUIRED SHAPE OF THE DOME WITH THE HELP OF A TEMPLATE



Figure—9·5 Specification Of Biogas Burner Manufactured At GGC Workshop, Butwal, Nepal.

all measurements in mm.

regular use of the gas will ensure trouble-free operation of the biodigester (Karki and Dixit, 1994; Khandelwal and Mahdi, 1989).

First hand knowledge on operation procedures of biogas plants is provided to the users by the masons at the time of plant construction. Following their instructions, the users operate their plants for six months. Then, the biogas company organizes users' training for the benefit of users of nearby areas. Women users are given priority in such training.

Various problems encountered during initial plant operation phase arc discussed in the training. The training covers different aspects of plant operation including technical problems and their possible solutions, proper utilization of digested slurry, advantages and disadvantages of biogas plants, after-sale-services of the biogas companies and repayment of bank loan. Due to geographical inaccessibility, it is very difficult to cover all biogas plants by group training and therefore, they are also supported by after-sale-service

s of the companies. The users" training and users-to-users contact encourages beneficiaries to operate their plants with improved performance and this also motivate non-users for biogas plant installation.

9.7 After-Sale-Services

After-sale-services consist of six years guarantee on structural part of the plants and one year guarantee on appliances and fitting works. Furthermore, guarantee fee paid by the plant owners also covers annual follow-up visits up to the guarantee period of six years. The technicians inspect the plants and repair/replace the defective parts of the plants free of cost within the guarantee period. The cost of repairing the defects after the expiry of guarantee period has to be borne by the plant owners.

There is a general complain that the biogas companies have the tendency to ignore the post installation services. In principle, it is the duty of the company to rectify the defects noticed in the plants within the guarantee period Many users nave reported that there is a delay on the part of the company to send their technicians for timely inspection after construction. The users have also been instructed to lodge complaints in case problems arise but they generally fail to do so. They are reluctant to report in writing. On the other hand, there is a general tendency that the representatives of the companies ignore the verbal complaints of the users.

One of the measures taken by BSP to ameliorate such problems is to deposit the guarantee fee charged by a company in a bank account jointly operated by BSP and the company. A part of this deposit is released to the company only after a report is submitted by the company on die visits made to plants constructed in the previous year.

9.8 Mobile Team for Supervision, Follow-up and Monitoring

Biogas companies tend to construct as many plants as possible within a short duration. Their intention is to make more profit by economizing the construction materials. There is also a possibility of using low quality materials by the companies to take advantage of limited knowledge and ignorance of the users To deal with such possibilities, BSP has employed a mobile team of technicians.

It is physically difficult to inspect every plant constructed by all of the 23 companies and NGOs involved in the construction of biogas plants. Therefore, the mobile team randomly selects 5 percent of plants to be visited every month. Appropriate forms and questionnaire have been developed to record information on the plants visited. Based on the report of this team, BSP informs companies about the problems of the plants and suggests necessary repair works. Depending upon the type of the problems, the company is charged a penalty amount.

9.9 Common Problems in Plant Operation

A properly installed biogas plant with regular maintenance provides trouble-free services to the user for years. It is important to educate the users on O&M of the plants. Some of most common problems in the course of day-to-day operation as reported by the biogas users in Nepal are discussed below (Karki. etal., 1994;Gautam, 1996).

Leakage from Pipe Line : The low quality plumbing materials and their fittings have been the main cause of gas leakage from the joints of the delivery pipes. When low quality pipes such as thin walled PVC pipes are used for gas delivery, they tend to burst frequently. Compared to GI pipes. PVC pipes are more affected by temperature differences and degrade faster. Taking this into consideration, BSP strictly prohibits the use of PVC pipes for biogas conveyance and recommends the use of GI pipes.

Leakage from Main Gas Valve : Leakage from the main gas valve is one of the most common and senous problems The valves found in the market are not durable and need to be changed frequently. Several products which have already been tested are proved to be inefficient in this regard This has caused inconvenience to the users. However, attempts are being made to locally manufacture these products. At present, high quality main valves are imported from the Netherlands.

Slurry in the Pipe Line : Entry of slurry into the gas pipe has been a problem in appreciable number of biogas plants. Some of the reasons for this problem are described below:

- In course of feeding the digester for the first time, users generally tend to fill it upto the uppermost level leaving little space for the collection of gas. In this situation, when gas production starts, the pressure thus developed pushes the slurry into the gas pipe.
- Gas production decreases m the winter. The users continue to feed the digester with the same amount of dung as in the summer. In such overfilled digesters, the upward pressure of gas trapped at the bottom and the suction effect created at the top (gas chamber) cause the slurry to flow into the pipe system.

To solve this problem, some slurry should be taken out from the outlet and the gas pipe should be disconnected and cleaned thoroughly.

Carbon Deposition in the Gas Burner : Carbon collected in the burner jets blocks the flow of gas when kitchen appliances are not regularly cleaned after use. To overcome this problem, the cooking stoves should be cleaned daily after use.

Lamps : So far as cooking is concerned, the users are satisfied with the performance of biogas stoves and burners. No major problems have been reported. Compared to biogas stoves, the biogas lamps have more problems in terms of frequent gas leakage and breakage of glass and mantles. The attention of the manufacturing companies has to be drawn to improve the quality of their lamps based upon the feedback from the users.

Over-sized Plants : The users generally tend to install larger size plants than they require or can feed with the amount of dung available. In many cases, plant sizes do not correspond to the number of cattle that the user possesses, or more specifically, the amount of dung available and hence the plants are underfed. Construction of such over-sized plants results in added financial burden to the user without any additional benefit.

Moisture in Drain Pipe : Water vapour together with the gas condense in the pipe line. After a lapse of time, water accumulates inside the pipe and thereby restricts the flow of gas. To drain this water, a moisture trap is installed at the lower level of the gas pipe. Sometimes, gas also leaks from the drain pipe as the gasket of the stop cock gets loosened. In such cases, a rubber disk is attached to the gasket and tightened.

Gas Formation During Winter : During the winter season, microbial activities decrease as a result of the decrease in the atmospheric temperature which affects the rate of gas production. To overcome this problem, various methods have been tried but no effective solution has been found as of yet. For example, the slurry was warmed in the sun during the day time and was then fed into the digester in the late afternoon. Another method tried was to insulate the digester by covering it with a thick layer of straw which was then covered with a plastic sheet. These methods were found useful to raise the temperature of the digester to some extent but no appreciable difference in gas production was noticed.

Most common problems in plant operation and their possible remedies are given in Table 9.1.

Table 9.1
Common Problems with Biogas Plants and Their Remedies

Defect	Cause	Remedy
1. Installation		
- Cracking of digester wall	Sinking of foundation or improper back filling	Repair and do proper back filling
- Gas leakage	Improper sealing of joints	Check and repair
- Accumulation of water in pipe lines	Improper installation of water trap	Check level and set the water trap at correct position. Drain water on a weekly basis.
2. Operation		
- No gas after first filling or plant	Lack of time	It may take 3-4 weeks
- Slurry level does not rise in outlet chamber even insufficient gas is coming.	Insufficient amount of feeding Leak in pipe	Add more dung and water Check and correct
- No gas in the stove but plenty in the plant	Gas pipe blocked by water condensation	Remove water from moisture trap.
- Gas does not burn	Wrong kind of gas	Add properly mixed dung
- Flame far from burner	Pressure too high or deposition of carbon on the nozzle	Adjust gas outlet valve and clean nozzle
- Flame dies quickly	Insufficient pressure	Check quantity of gas production and feeding
- Clogging inlet and outlet pipes	Addition of materials other than clean dung	Use dung only after filtering other materials. Clean inlet and outlet with a bamboo stick
- In sanitary condition around biogas plant	Improper digestion Improper disposal of slurry	Add correct quantity of dung and water Regularise

Source: Khandelwal and Mahdi, 1989

9.10 Session Plan

Activity No	Topic and Area of Discussion	Time {min.)	Methods of Training	Teaching Aids
1.	Highlighting Hie importance of quality control	3	Lecture	Transparent sheets, flip chart
2.	The need for quality control and programme development	4		
3.	Development of a system for quality control	4		
4.	Important parameters for quality control	4	Lecture cum discussion	O/H projector, screen, and flip chart
5.	Various parameters for quality standards	6	Lecture cum discussion	O/H projector
6.	Bringing the plant to operation	4	Lecture cum discussion	O/H projector
7.	After-salc -services	4	Lecture cum discussion	O/H projector
8.	Mobile team for supervision, follow up and	4	Lecture cum discussion	O/H projector
9.	Supervision, follow up and monitoring, after sales	5	Lecture cum discussion	O/H projector
10.	Common problems in plant operation	7	Lecture cum discussion	O/H projector
11.	General discussion	15	Discussion	
	Total Time	**60**		

9.11 Review Questions

- Why is quality control so important for the promotion of biogas system, especially in the present context?
- List the important parameters for quality control.
- What appliances are manufactured in Nepal?
- Why is selection of plant design based on the feeding materials available for biodigester?
- Explain different critical stages in biogas construction.
- What are the after-sale services that a biogas company is required to provide?
- How is the penalty system enforced on biogas construction companies?
- List the common problems of biogas plants and their solutions.

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9.13 Further Reading Materials

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BSP Standards as to Quality of Biogas Plants (Fy 2050/51)

S.N.	Quality Standards	Category	Specification
A,	**General**		
1.	Only one plant per family	1	
2.	No, of plants fed with only night-soil	1	Inlet should be constructed and used
3.	One year guarantee on appliances and	1	Except mantle and glass of gas lamp
4.	Six years guarantee on structure	1	
5.	six years after-sales -service	1	According to annex of letter
B.	Labour		
6.	Certified mason	1	Trained by GGC for minimal 60 days and certified
C.	**Design**		
7.	Based on GGC - drawings dated (14-05-	I	Plant sizes: 4. 6. 8, 10, 15. 20 m^3 including round wall
D.	**Construction materials**		
8.	Good quality bricks	3	Best quality locally available
9.	Good quality sand	2	Less than 3% impurity by bottle-test
10.	Good quality gravel	2	Clean; size; 0.5-1.5 cm temporarily maximum; 4 cm
11	good quality stones	3	clean
12.	Good quality cement	2	Fresh; no lumps
13.	Acrylic emulsion paint	2	
14	Rod (to be used (o reinforce slabs)	3	Diameter minimum 6 mm
E.	**Construction**		
	(a) Digester		
15.	Accuracy radius of round-wall	2	± 2% on basis of plastered wall
16.	Accuracy plumb of round-wall	3	± 1 cm
17.	Accuracy height of round-wall	2	±5 cm
18.	proper Back -filling brick wall	3	By a compacted mix of small stones and water
19.	Proper back -filling stonewall	3	Against the pit side
20.	Well finishing of inside round-wall	3	Smooth layer of plaster (mix = 1 :3 sand), no cracks
	(b) Dome		
21.	Proper use of template make mud mould	2	Template as fabricated by GGC
22.	Accuracy height of dome	2	±5 cm
23.	Accuracy radius of dome	2	± 2% on basis of plastered dome
24.	Proper treatment inside dome	2	To GGC instructions; clean and surface; no cracks
25.	Gas pipe at centre point	3	± 2% of radius round -wall
26,	Proper top-filing done	3	Min 40 cm compacted earth, protected against erosion
	(c) Turret		
27.	Proper diameter to protect gas pipe	2	Round (diameter min 36 cm) or (min. 36x36 cm)
28.	Proper height lo protect gas pipe	2	Top turret maximum 5 cm below reduction elbow
29.	Gas pipe in centre of turret	3	Minimal 12 cm support at every side

S.N.	Quality	Category	Specification
	(d) Outlet		
30.	Accuracy of length	2	**±3%**
31.	Accuracy of width	2	**±3%**
32.	Accuracy of depth	2	± 5 cm
33.	Accuracy plumb of walls	3	+ 1 cm
34.	Proper back-filling walls	3	Upto overflow level with enough earth body
35.	Well finishing inside walls	3	Smooth layer of cement plaster (1:3); cracks
36.	Covered by proper reinforced slabs	2	Manage able without problems. reinforced at 2 cm from bottom
37.	Accuration distance "bottom outlet-top manhole"	3	±4 cm
	(e) Compost pits		
38.	Digging of at least two compost pits	3	Total volume minimal equal to plant volume
	(f) Met		
39.	Proper position	2	In straight line with turret and manhole
40.	Maximum height	3	Maximum 100 cm above ground level
41.	Well finishing inside wall	3	Smooth layer of cement plaster (1:3); crack
42.	Proper installation mixing device	3	Firmly attached to structure
43.	Easy to operate	3	
44.	Straight inlet pipe	2	
	(g) Toilet attachment		
45.	Proper position inlet pipe	2	Minimal 135° with turret and manhole
46.	Proper position toilet pan	2	Level minimal 15 cm higher then level overflow of outlet
F.	**Appliances and pipes**		
47.	Dome gas pipe	2	Length: 75 cm; 1.5 GI-light quality 1239-1979); anchors
48.	Main gas valve	2	Holland made ball valve (vhs)
49.	Pipe and accessories	2	GI-light quality (IS 1239-1979); 0-100 m, 0.5*; 100-200 m; 0.75*
50.	Water drain	2	Made by GGC-work shop
51.	Gas tap	2	Tested by GGC Workshop at 300 m pressure
52.	Gas stove	2	Made by GGC Workshop or from India (IS 8749-1978)
53.	Rubber hose	3	No cracks when folded
54.	Gas lamp	3	In working condition at delivery
55.	Inlet pipe	2	At least 10 cm internal diameter
56.	Mixer	3	Made by GGC workshop (galvanised)
G.			
57.	No fittings between reduction elbow and valve	2	
58.	No unnecessary fittings in pipe line	3	
59.	No gas leakage in pipe line	3	

S. N			Category	Penalty (Rs)
35.	Plaster not smooth or cracked		3	
36.	No slabs		2	100
37.	Bottom outlet -top man hole not within ± 4 cm	(***)	3	
	(e) Compost nits			
38.	No or insufficient volume compost pit		3	
	(f) Met			
39.	Not in straight line with turret and manhole		2	100
40.	More than 100 cm above ground level		3	
41.	Plaster not smooth or cracked		3	
42.	Mixing device not firmly attached		3	
43.	Not easy to operate		3	
44.	No straight inlet pipe		2	50
	(g) Toilet Attachment			
45.	Inlet pipe (135 degrees with turret and		2	50
46	Level toilet pan (15 cm higher than overflow level)		2	50
F.	**Appliances and Pipes**			
47.	Dome gas pipe not according to specification		2	100
48.	No Holland made ball valve		2	150
49.	No GI - light quality		2	200
50.	Water drain not made by GGC workshop		2	50
51.	Gas tap not tested by GGC workshop (300 m		2	50
52.	No GGC or India /IS approved stove		2	
53.	Rubber hose cracks when folded		3	
54.	Not in working condition at delivery		3	
55.	Inter diameter inlet pipe less than 10 cm		2	50
56.	No GGC mixer (galvanised)		3	
G.	**Fitting and Layout of Gas Pipes**			
57.	Fitting s between reduction elbow and gas		2	150
58.	Unnecessary fittings in pipe line		3	
59.	Leakage in the pipe line		3	
60.	No proper sealing agent		2	50
61.	Pipe buried less than 30 cm		3	
62.	Pipe not safe against damage by animals &		3	
63.	Drain not able to trap all water in pipe	(*)	2	50
64.	Drain not easy accessible		3	
65.	Drain not easy to operate		3	
66.	Drain not protected by proper pit with cover	(*)	2	50

Default related to (*) will be penalised only once.
(***) higher toleration's in filled plants due to measuring faults.

Source: Gobar Gas Sahayog (BSP) Gobar gas plant ko Gunastar Niyantran (in Nepali) F.Y. 2052/53 (A working document on quality control 1994).

Lists of Construction Materials and Appliances

S. N.	Particular	Unit	4 m^3	6 m^3	$8m^J$	10 m^J	15 m^3	20 m^3
1.	**Building Materials**							
	Bricks	piece	1,200	1,400	1,700	2,000	2,400	2,800
	Sand	bag	60	70	80	90	110	120
	Gravel	bag	30	35	40	50	60	70
	Cement	bag*	11	13	16	19	27	34
	6 mm rod	meter	50	60	70	70	90	100
	Paint	liter	1	1	1	2	3	4
2.	**Building Labour**							
	Skilled labour	days	8	8	11	11	13	15
	Unskilled labour	days	20	25	30	35	45	55
3.	**Pipe and Appliances**							
	Vertical mixture device	piece	1	1	1	1	1	-
	Horizontal mixture	piece	-	-	-	-	-	1
	Inlet pipe	piece	2	2	2	2	2	2
	Dung gas pipe	piece	1	1	1	1	1	1
	G 1 pipe	piece	12	12	12	12	12	12
	Sockets	piece	3	3	3	5	5	6
	Elbow	piece	5	6	8	8	10	12
	Tee	piece	1	2	2	3	4	5
	Union	piece	1	1	1	1	1	1
	Nipple	piece	3	3	4	4	6	6
	Main gas valve	piece	1	1	1	1	1	1
	Water tank	piece	1	1	1	1	1	1
	Robber hose	meter	1	1	1	2	2	2
	Gas stove	piece	1	1	1	2	2	2
	Gas lamp	piece	-	1	1	1	2	3
	Teflon tape	roll	2	2	2	3	3	4

* In case of stone masonry, the extra cement required for different sizes of plants is given below:

for 4 and 6 m^3	1 extra bag of cement
for 8 and 10 m^3	2 extra bags of cement
for 15 and 20 m^3	3 extra bags of cement

Most Common Defects and Penalty Categories including the Penalty Amount

S. N	Default		Category	Penalty (Rs)
A.	**General**			
1.	Second, third etc. plant per family	(*)	1	All subsidy deducted
2.	Plant fed with only night soil	(*)	1	"
3.	1 year guarantee on appliance/pipes not	(*)	1	"
4.	6 years guarantee on structure not provided	(*)	1	"
5.	6 years after -sales -services not provided	(*)	1	"
B.	**Labour**			
6.	No certified mason	(*)	1	"
C.	**Design**			
7.	Other design than 04-05-2047(no round-wall)	(*)	1	"
D.				
8.	Unnecessary low quality bricks		3	
9.	Impurity in sand more than 3%	(**)	2	700
10.	Size gravel bigger than 4 cm	(**)	2	700
11.	Dirty stones		3	
12.	Not fresh cement or with lumps	(**)	2	700
13.	No acrylic emulsion paint		2	150
14.	Diameter rod not less than 6 mm		3	
E.	**Construction**			
	(a) Digester			
15.	Radius of round - wall not within ± 2%	(***)	2	100
16.	Plumb of round -wall more than ± lcm		3	
17.	Height of round -wall not within ±5 cm	(***)	2	100
18.	No proper back -filing brick wall		3	
19.	Stone wall not constructed against pit wall		3	
20.	Plaster not smooth or cracked		3	
	(b) Dome			
21.	No use of template	(**)	2	700
22.	Height of dome not within ± 5 cm	(***)	2	50
23.	Radius of dome not within ± *2%*	(**)	2	50
24.	Not like GGC instructions; not smooth or		2	700
25.	Gas pipe not within ± 2% of radius round-wall		3	
26.	Less than 40 cm top-filling on done		3	
	(c) Turret			
27.	Diameter less than 36 cm		2	100
28.	Top turret more than reduction elbow		2	25
29.	Less than 12 cm support at any side		3	
	(d) Outlet			
30.	Length not within ± 3%		2	25
31.	Width not within ± 3%		2	25
32.	Depth not within ± 5 cm		2	25
33.	Plumb of walls not within l cm		3	
34.	Black-filling more than 5 cm below overflow		3	

S.N.	Quality Standards	Category	Specification
60	Use of proper sealing agent	2	Jute & plant, zinc putty or Teflon
61	Pipe buried at least 30 cm, if possible	3	
62	Pipe safe against damage by animals &	3	
63	Drain able to trap all water in pipe	2	
64	Drain easy accessible	3	
65	Drain easy to operate	3	
66	Drain protected by proper pit with cover	2	

Category I means: No subsidy, 2: penalty; 3: no penalty

Source: Jan Lam and Wim J. VanNes (1994) Enforcement of Qualify Standards upon Biogas Plants in Nepal. BSP

SESSION TEN

MONITORING AND EVALUATION

SESSION TEN

Monitoring And Evaluation

10.1 Introduction

This chapter deals with monitoring and evaluation (M&E) of the biogas sector in Nepal. In doing so, a review is made of the existing data base, some relevant indicators and the process adopted. Effort is also made to introduce monitoring tools and relevant theories and processes. By the end of this session, the participants will be able to:

- explain the basic principles of M&E as relevant to the biogas sector in Nepal;
- discuss the M&E system of BSP; and
- explain the logical framework approach in M&E.

10.2 Definitions

Monitoring and evaluation are two different concepts. At times, it becomes difficult to be definite on whether an activity should be taken as monitoring or evaluation. Because of this difficulty, these two technical terms, i.e., monitoring and evaluation, are generally expressed together, M&E in short.

Monitoring is a continuous or periodic review and surveillance by management at every level of the hierarchy of the implementation of an activity. It is more of a feedback system for problem solving during programme and/or project implementation phase.

Evaluation is an intermittent activity in the organizational process which takes a broader view for improving performance guided by the information obtained:

- during implementation (on-going evaluation);
- at completion of an activity {terminal evaluation); and
- after completion of an activity and when it is expected to have some impacts (post evaluation).

The M&E process as an unified system provides basis for decision making through collection, analyses and syntheses of information. A well established data or information system is a pre-requisite for an effective M&E system. Therefore, the following presentation include M&E as a unified system with discussions on data base as they relate to the biogas sector in Nepal.

10.3 Indicators and Data Base

Indicators are the elements or factors that reflect the performance of a programme or an activity which can be measured or quantified for comparison against the desired target or goal. Some of the important performance indicators of the biogas sector in Nepal are presented below.

Government Commitment

Following are some of the important factors that reflect the strong government commitment for biogas development in Nepal.

- Continuation of government subsidy since biogas promotion started in Nepal on a programme basis in 1976. The level or amount of subsidy varied with the availability of subsidy fund from bilateral and multilateral donor agencies except for the year 1976 when the subsidy was provided through government's own resources (Karki, et al., 1993).

- Inclusion of national targets for biogas construction for the first time in Seventh Five Year Plan (1985-1990) and its continuation in the Eighth Five Year Plan (1992-1997).

- Existing provision for government tax exemption on import of biogas appliances and accessories.
- Government decision of mid-1996 to establish AEPC with biogas as an important component.

– Facilitating role that the government has been playing in the initiatives taken by the private sector such as formation of biogas companies and attending training and seminars in and out of country.

– Integration of biogas programme in specific projects.

Number of Biogas User Households

The rate of adoption of the technology at the household level is increasing as was discussed in the previous sessions. However, with the present installation rate of about 10,000 household plants each year, it would take about 130 years to make full use of the present potential.

Performance of Plants Constructed

A comprehensive survey of all GGC model plants constructed between 1979 and 1990 was carried out in 1991. The survey found that 90 percent of the plants were functional. However, only 77 percent of the users had trouble free operating plants.

Distribution

Most of the users belong to the medium and large scale farmers in terms of their land holding, number of servants and livestock.

Reason for Installation

Most important reason for installation of biogas plants are (a) cost effective cooking fuel (55 percent), (b) lighting ease (20 percent), and (c) time saved in firewood collection (16 percent).

Institutional Lending

The percentage of users taking loan for biogas plant installation is decreasing.

Quality of Construction Works

A survey of 1991 showed that 33 percent plants have deviation in outlet volume by more than 10 percent. 34 percent plants deviated in dome volume by 20 percent and 29 percent had a deviation of digester volume by 20 percent.

Extension

The main motivators were the neighbors who had installed biogas plants (36 percent) followed by staff of ADB/N (27 percent) and GGC (27 percent).

After-Sale-Services

29 percent users were not visited by technicians after installation and only 4 percent were visited more than five times a year.

Loan Repayment

53 percent users repaid loan by selling crops, 32 percent by saving on firewood, 7 percent by sale of land, and 1 percent from other income sources such as business and salary.

Perception of User on Profitability of Plants

72 percent users expressed that it was profitable for them to have a plant, while 14 percent did not agree with this.

Quality of Information on O&M

77 percent users were satisfied on the quality of information given to them on O&M of the plant.

Users' Level of Information on Financial Arrangements

Only 31 percent users were aware that they had received subsidy.

Use of Slurry

51 percent users preferred the use of slurry as fertilizer instead of FYM.

In addition to these, many more indicators could be defined to generate specific information on different aspects of performance of biogas technology. The relevance of an indicator and the importance of its accurate measurement depend on the type of decision to be made on the basis of such information.

Frequent surveys should be avoided while ensuring that sufficient and updated information are available for decision making. For example, surveys are essential to establish a data base. However, once the data base has been established through surveys, it could be updated through effective systems of record keeping and reporting in the implementation process. This would reduce the need for frequent surveys and make the information readily available at the time of need.

The early 1990s marks the publication of a large number of reports on surveys, evaluations, and need assessments on biogas technology in Nepal. The publication of such reports became more frequent with the initiation of BSP in 1992. This has generated strong baseline information needed for effective M&E of BSP implementation. Some of these reports include the following.

- Survey of GGC Plants, conducted in 1991 and published by GGC in 1994.
- Biogas Users' Survey, by East Consult for BSP, 1994.
- Various Studies on Effects of Biogas on Women's Work Load, by BSP and others.
- Annual Progress Report of GGC, 1992/1993.

10.4 M&E as Integral Part of Program Implementation Process

Until the early 1990s, GGC remained the only major organization for the implementation of all biogas programs in Nepal. It carried out M&E activities as part of its regular institutional activities in the field (M&E of programme implementation) as well as in its research center at Butwal (M&E of performance of the technology). Information generated through these activities were provided to GGC Headquarters through periodic performance reports from the filed offices. The use of such information was limited in the formulation of annual programmes. No efforts were made to create a systematic data base at the Headquarters.

Various programmes run before 1990 did not put much emphasis on establishing a strong baseline information or a data base. Therefore, detailed information on many of the plants constructed in earlier years are not readily available even with GGC.

BSP is the first comprehensive biogas programme of Nepal which is being implemented with long term perspective and wide coverage of subject areas as well as the geography. BSP in its earlier phase carried out various surveys to create a data base which is updated with subsequent surveys and field reports. This is also the first programme with well integrated M&E system in the implementation process. It has computerized detailed information on each of the plants constructed. Its reporting system is so designed that it also continues to receive updated information on the after-sales-services by the biogas companies. This is continuing since last five years. As all on-going biogas development activities are supported by BSP, the country now has a well established data base for effective M&E of the biogas sector.

10.5 M&E at Different Levels

10.5.1 User Level

Users are the key persons to monitor and evaluate the performance of their plants They provide written or verbal information to the concerned biogas companies on operation and quality related problems. If no complaint is received, the plant is considered to be performing satisfactorily. There lies a theoretical possibility of unreported malfunctioning of plant. BSP's mobile team carries out field inspection and verification to address this issue (Lam and van Nes, 1994).

10.5.2 Biogas Company Level

All biogas companies are required to maintain a filing system that corresponds to the filing system of BSP at the central level. This system requires detailed information on each plant constructed in the current year, regular visits made to the plants constructed in previous years for the guarantee period of six years, and plants visited at the request of the users. Such information are submitted in the form of a monthly report to BSP.

Masons or the contact person of the company send the physical progress report on the plants that they construct. The company records the progress on a hard cover register book in which users' name, and address, bank's name, date of coupon, work start and completion dates, mason's name, BSP's file number, etc. are entered.

Similarly, the company headquarters keep records on the plant maintenance progress in a hard cover register book in which users' name and address, plant inspector's name, signature, inspection date, findings of inspection, suggestion made by the inspector and maintenance undertaken, etc. are recorded.

10.5.3 Programme Level

The compilation of monthly and annual reports received from the companies provide the updated information on performance of each plant. The information thus received is validated and supplemented with the monthly field report from the BSP mobile team. In addition, BSP also uses the services of individual consultants and consulting firms for periodic M&E of other activities such as training conducted, impact on workload on women and efficient use of subsidy fund.

BSP has developed forms for collection of information on each of the plants constructed. All companies are required to fill these forms and submit them to BSP on a monthly and annual basis. BSP records such information in a computerized data base and processing system. This enables BSP to generate detailed and updated information on the companies, districts, sizes, masons, etc. Similarly, the maintenance status as reported by the companies is also processed and analyzed. Finally, a monthly report of the progress on the plant construction and maintenance is prepared by BSP. The Job Completion Form and the Plant Maintenance Form developed by BSP are shown in Annexes 10.1 and 10.2, respectively.

The quality control system of BSP is well integrated with the systems for monitoring, on-going evaluation and updating of the data base. The system consists of selecting at least 5 percent of the plants constructed by each company in a year, recording measurements and observations of thus selected plants and comparing the information with the set standards and norms.

Such M&E activities of BSP has led to the identification of training needs of masons, users and that of companies. Accordingly, programmes have been developed and implemented.

In addition to on-going M&E activities, BSP also has been conducting periodic evaluation of the program as a whole. The mid-term evaluation of BSP programme for the period of 1992 to 1997 was carried out in 1994. Some of the main findings and recommendations of this evaluation included the following (de Castro, et al., 1994):

Successful

- BSP has been successful in making biogas more attractive to small formers in the hills. Under BSP. the plants constructed in the hills cover 60 percent while this was 40 percent in 1992, i.e., before BSP implementation
- The average size of plants has decreased from 13.7 m^3 in 1992 (before BSP) to 9.6 m^3 in 1994. Approximately 90 percent of BSP fund has reached the target group in the form of subsidy while 10 percent covered the cost of staff salary, training, research, consultancy services and the overheads.

Shortcomings

- The need of improvements in the information and skill level of the users for proper O&M of plants.
- Poor after-sale-services.

Recommendations

- Activities to improve coordination with banks, private sector companies and NGOs. Certification of trained masons, users and extension workers.

BSP has also made several other studies on the impact of biogas on users, privatization, and subsidy review. These study reports form part of the quantitative data base on impact of the biogas programme.

BSP Phase in has been formulated with due considerations to the findings and recommendations of the mid-term evaluation (BSP, 1996). The objectives and corresponding indicators for M&E of this phase are presented below in Table 10.1

Table 10.1

Indicators for BSP Phase III Objectives

Specific Objectives	Corresponding Indicators
Biogas industry	
- Commercially viable	- Max. 25 percent loss in the total number of companies - 360 persons trained in management
- Market oriented	- 360 persons trained in marketing
Installed Biogas Plants	
- 100,000 plants	- Min. achievement of 75 percent
- Average plant size	- Max. 8.0 m^3
- Percentage of construction defaults,	- Max. 10 percent
O&M	
- Failure rate (no biogas use)	- Max. 10 percent
- Utilization of plant capacity	- Max. 85 percent
- Female user training	- Min. 75 percent achievement
Development of Appliance	
- Valve, tap and lamp	- Entirely produced in Nepal
Maximization of Benefits	
- Improved sanitation	- Min. 60 percent users attach toilets
- Saving on fuel wood	- Min. 1,700 kg/year for average user household
- Saving on agricultural waste	- Min. 720 kg/year for average user household
- Saving on dung cakes	- Min. 400 kg/year for average user household
- Saving on kerosene	- Min. 50 lit/year for average user household
- Reduction in work load	- Min. 2.8 hours per day for average user household
- Better use of slurry	- Min. SO percent of user household have two compost pits in use within 1.5 years after plant construction
Institutional Development	
- NBPG	- Coordinate activities in biogas sector
- Apex organization	- Responsible to oversee the development of biogas sector in Nepal

M&E of BSP against the above set target and indicators will be undertaken by independent research institutes, biogas companies or consulting firms. While monitoring is included as a part of regular implementation process, evaluation is planned towards the completion of the programme period with one mid-term evaluation during implementation.

10.5.4 National Level

The decision for the establishment of AEPC has already been taken, but it has not started functioning yet. In the absence of any specific government agency (ministry or department) to oversee the performance of biogas sector as a whole on a functional basis, the government has to rely on the M&E of BSP. WECS and ADB/N have been occasionally involved in M&E of biogas programmes in the country. The ADB/N's M&E on biogas programme is limited to information on disbursement of loan and its recovery.

ADB/N branch offices report the progress of biogas plant construction and the amount of loan taken by the users in a monthly basis. The ADB/N central office completes the physical and financial progress reports in a monthly basis based on the information on cumulative progress on plant construction, the loan amount provided to the users and the status of payback of loan as reported by its branch offices. BSP coordinates with ADB/N to cross check and verify the data collected.

10.6 The Logical Framework

Discussion on Logical Framework is included here as a comprehensive method for effective M&E of any development program including that of biogas.

The Logical Framework is defined as a tool which provides a structure for specifying the components of an activity and the logical linkages between a set of means and a set of ends. It places a project in its larger framework of objectives within the programme. It serves as a useful tool for defining inputs, time tables, assumptions for success, outputs and indicators for monitoring and evaluating performance.

The Logical Framework approach involves first analyzing the situation (identifying the key problems, constraints and opportunities), developing objectives from the key problems, assessing alternative interventions, choosing a strategy and finally taking decisions based on the findings of the analysis. The output of this approach is the Logical Framework Matrix (hereafter simply called Logframe). The Logframe is as an aid for decision making. The logframe for a hypothetical biogas development project has been illustrated in Annex 10 3.

10.7 Session Plan

Activity No.	Topic and Area of Discussion	Time (min.)	Methods of Training	Teaching Aids
1.	Introduction and highlight of the objectives of session	2	Lecture cum discussion	O/H projector, screen and flip chart
2.	Definitions	3	Lecture cum discussion	O/H projector, screen and flip chart
3.	Indicators and data base	10	Lecture cum discussion	O/H projector, screen and flip chart
4.	M&E as Integral part of programme implementation process	5	Lecture cum discussion	O/H projector, screen and flip chart
5.	M&E at different levels	10	Lecture cum discussion	O/H projector, screen and flip chart
6.	The Logical Framework	**5**	Lecture cum discussion	O/H projector, flip chart
7.	General discussion	**15**	Discussion	
Total Time		**50**		

10.8 Review Questions

- What is programme monitoring?
- What is programme evaluation?
- What is a logical framework approach?
- Explain the monitoring and recording system of Agricultural Development Bank.
- How do the biogas construction companies monitor the performance of plants that they construct?
- Explain BSP's biogas plant construction monitoring system.
- Explain BSP's biogas plant maintenance monitoring system.
- What are the three main findings of the Mid-term evaluation of biogas Phase I & II programmes?

10.9 References

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Job Completion Form of Gobar Gas Plant - 1995/96

(To be filled in Nepali Script Before and After Plant Installation)

Company code No : .... Office address :	BSP file No : ....
Plant owner's name : .... Address : Ward No........ VDC/Municjpalit .... District :	Name of plant construction technician : .... Date of work completion : .... Plant capacity : .... m^3
No. of cattle (Above one year) : .... Total production of dung : .... Kg/d»y Water source distance : .... Waiting minute If gas plant attached to toilet ? : .... Yes/No Construction of toilet . Yes/Not yet/ Not planned Family members of a Kitchen :.............. Persons	Total investment (except toilet) Rs : .... Grand amount Rs. : .... Investment : credit/cash Name of Bank : ADB.'NBL/RBB not any Address of Bank : .... Bank coupen dispatch No : ....
Type of round wall : Stone/brick No. of installed stove :............ No. of installed light :............. Brand of gas pipe : .... Brand of gas tap :............. Type of gas pipe : .... Dung mixing machine :Yes/No Type of dung mixing machine : Horizontal/vertical Compost pit ; Not constructed/one/two	Total quantity of cement used (except toilet) : .... sac Brand of stove : .... Brand of light :........................ Brand of main gas valve : .... Brand of water outlet machine:............... Quality standard of gas pipe: .... Type of dung mixing machine; .... Galvanised dung mixing machine:.......Yes/No Material used to join the pipe: .... Teflon tape/zinc putting/jute and enamel/others if any ....
Users Manual provided : Yes/No	Guarantee card provided : .... Yes/No
Name of Form Filler : .... Signature :	Port : .... Office stamp :

(Fill up the measurements of main parts of plant as shown in back of this page)

Gobar Gas Plant Maintenance Report
(To be filled annually)

Company Code No	....	BSP file no	………………………………
Supervisor's owner name	....	Office address	………………………………
Capacity of plant	....	Date of supervision	………………………………
Date of installation	....	Address : Ward no	….. VDC/municipality ………………
Relation with plant owner	....	District	………………………………
		Name of respondent	………………………………
		Signature of respondent	………………………………

Do the user has felt any problem : (If yes, specify)

……

……

……

Number of cattles of above one year old

Total using time of Stove ……………………….. Hour/day

Total lighting lime ……………………….. Hour/day

Supervision

Detail	*Condition*		
I. Inlet :	Good/poor	12. Leakage in main gas pipe line :	Yes/No
2, Dung mixing machine :	Not installed/good/ poor	13. Leakage in main gas valve :	Yes/No
3. Regularity of gobar feeding :	Yes/No	14. Leakage in pipe joint:	Yes/No
4. Outlet :	Good/poor	15. Soil filled above possible places of pipeline:	Yes/No
5. Cover of outlet:	Good/poor	16. Water outlet pit:	Good/poor
6. Slurry-from outlet:	Diluted/optimum/thick	17. Water discharge equipment:	Good/poor
7. Numbers of compost pit:	0/1/2/3	18. Leakage in gas tap :	1. Yes/No 2. Yes/No
8. Other organic material mixed in compost pit:	Yes/No	19. Rubber hose pipe :	1. Good/poor 2. Good/poor
9. Use of slurry :	Yes/No	20. Condition of gas stove used	1. Good/poor 2. Good/poor
10. Dome covered with soil :	Good/poor	21. Condition of gas light used :	1. Good/poor 2. Good/poor
11. Turret:	Good/poor	22. Regularity of gas use :	Yes/No

Repaired works done during regular supervision :

………
……

Works to be done immediately after supervision :

………
……

Signature of Office Chief: .... **Post...** .... **Office Stamp**

Narrative Summary	Verifiable Indicators	Mean of Verification	Assumptions
GOAL To improve the quality of life of people	- Increased Irving standards - Increased sanitation and health of general people	- Socio economic survey report - Health and sanitation survey report	- Government continues to provide subsidy to farmers for Biogas development
OBJECTIVES To save forest (environment) To improve the health of rural People To increase the production of Agricultural crops	- Decreased rate of deforestation - Decreased environmental problems - Decreased rate of eyes and lungs problem - Increased agricultural production	- Forest survey - Land inventory - Hospital record of sick person - Crop yield survey	- Forest areas are not changed to other types of landuse - No significant eyes and lungs diseases - Occurs due to other causes
OUTPUTS & ACTIVITIES **OUTPUTS** Biogas Slurry	 - Amount of biogas produced (tons) - Amount of slurry produced (tons)	 - Household survey report of biogas - Household survey report of biogas	
ACTIVITIES Construction of biogas plants Operation of Biogas plants Training of masons & users	 - No. of biogas plants constructed - No. of biogas plants in construction - No. of persons trained	 - Physical progress report - Occasional household survey report - Farmers complains (Proxy progress report on training	 - Subsidy is continued - Adequate and timely supply of inputs
NPUTS Input cost schedule	 - Expenditure made according to input cost schedule	 - Monthly financial report	
MANPOWER - Project staffs - Masons - Farmers	 - Project staff recruited and used in time - Masons hired and used in time - Farmers willing to establish and operate the plants	 - Monthly financial report - The staff attendance book - Administrative record of hiring and progress report - Loan sanction record	 - Timely release of budget, etc. - Adequate budget appropriations are made - Procurement and recruitment procedures are effectively managed - Suitable staff are available

Narrative Summary	Verifiable Indicators	Mean of Verification	Assumptions
MATERIALS -Brick - Cement - Iron rods - Rock - Pipe & fittings -Paint -etc. **EQUIPMENTS** - Project equipment (vehicles) - Gas stoves - Masons equipment -etc.	- Sufficient biogas plants construction - Materials supplied - Equipment's purchased and used	- Farmer application for biogas plants - Biogas construction companies complains - Store record	

Appendix -1

REGISTRATION FORM

District Level Training in Biogas Technology 1996

1. Training Venue (Tickmark the appropriate one)

   In Kathmandu : Nepal Administrative Staff College, Jawalakhel, Lalitpur
   In Chitwan : Uncles' Lodge. Narayan Ghat, ChJtwan

2. Dates of Training (Tick mark the appropriate one)

2, 3 &4 June	16, 17 & 18 June	1 , 2 & 3 July
16, 17 & 18	31 July, 1 & 2 August	

3. Detail of Participants

   (1) Name of Participants :...

   (2) Post ....:

   (3) Organization :...

   (4) Address

   (a) Office address

   ……………………………
   ……………………………
   ……………………………
   ……………………………
   ……………………………
   ……………………………

   (b) Residential address

   ……………………………
   ……………………………
   ……………………………
   ……………………………
   ……………………………
   ……………………………

Date ……. / ……/1996

Appendix - 2

TRAINING SCHEDULE

Venue

First Pay

Time	Topics	Resource Person
10:30-11:00	Registration and inauguration	
11:00- 11:40	System approach to biogas technology	Dr. **Amrit B Karki**
11:40-12:00_	Discussion on above	
12:10- 12:50	Relevance of biogas technology to Nepal	Mr Krishna M Gautam
12:50- 13:10	Discussion on above	
13:10- 13:40	Tea break	
13:40- 14:25	Biogas programmes	Dr. Amrit B Karki
14:25-14:45	Discussion on above	
1445- 15:30	Utilization of slurry- as feed and fertilizer	Dr. Kirshna B Karki
15:30- 15:50	Discussion on above	

Second Day

A. Class Room Lecture :- 10:00-12:50 hours

Time	Topics	Resource Person
10:00- 10:40	Installa tion cost and financial viability of family size biogas plants	Mr Krishna M Guatam
10:40- 11:00	Discission on above	
11:10- 12:00	Subsidv and institutional financing	Mr. Govinda Kandel
12:00-12:20	Discussion on above	
12:20-12:35	Participants' experience on biogas	
12:35- 13:00	Tea break	

B. Field Trip to Visit at Least 2 to 3 Biogas Plants:- 13:00 - 16:30 hours

Third Day

Time	Topics	Resource Person
10:00 -10:40	Extension support services for biogas	Dr Krishna B Karki
10:40-11:00	Discussions on above	
11:05- 11:40	Quality standards of biogas technology	Dr Krishna B Karki
11:40- 12:00	Discussion on above	
12:05-12:40	Monitoring and evaluation	Mr. Govinda Kandel
12:40- 13:00	Discussion on above	
13:00-13:30	Tea break	
13-30- 13:50	Participant experience	
13:55- 14:25	Video film show on biogas	
14:25- 15:25	Open-house discussions	
15:25-15:55	Evaluation by the participants	
16:00-16:20	Closing	

DISTRICT LEVEL TRAINING COURSE IN BIOGAS TECHNOLOGY 1996
FIFTH TRAINING COURSE (31 July - 2 August 1996) .
EVALUATION FORM (to be filled in by the participants)

Tickmark the appropriate ones

1. How do you rate the various sessions presented by the trainers?

	Very Clear	Clear	Not Clear
Session 1. System Approach to Biogas Technology	Very Clear	Very Clear	Very Clear
Session 2. Relevance of Biogas technology to Nepal	Very Clear	Very Clear	Very Clear
Session 3. Biogas Programme	Very Clear	Very Clear	Very Clear
Session 4. Utilization of Slurry as Feed	Very Clear	Very Clear	Very Clear
Session 5. Installation Cost and Financial Viability of Family Size Biogas PLants	Very Clear	Very Clear	Very Clear
Session 6. Subsidy and Institutional Financing	Very Clear	Very Clear	Very Clear
Session 7. Field Visit to Observe Biogas Plants	Very Clear	Very Clear	Very Clear
Session 8. Extension Support Services for Biogas	Very Clear	Very Clear	Very Clear
Session 9. Quality Standard	Very Clear	Very Clear	Very Clear
Session 10. Monitoring and Evaluation	Very Clear	Very Clear	Very Clear

2. The information content of the training manual is

Very Useful	Useful	Less Useful

What topics would you like to be incorporated further in the text ?

a. ....
b...
c...
d...

3. Do you find that the field visit (Session Seven) was useful to increase your practical understanding about biogas technology?

Very Useful	Useful	Not-useful

4. What are your opinions and impressions about the field visit?

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…………………………………………………………………………………………….

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…………………………………………………………………………………………….

5. Do you think that the training facilities inside the classroom are adequately met?

[Yes]   [No]

If no, what are your suggestions?

a …………………………………………………………………………………………….

b …………………………………………………………………………………………….

c …………………………………………………………………………………………….

6. Are you satisfied with the refreshment served during tea break.

[Yes]   [No]

7. Do you think that the three days' training period is adequate? Tick mark the appropriate ones.

[Adequate]   [Inadequate]

If inadequate, what should the appropriate period?

[4 days]   [5 days]   [6 days]

8. What is your overall rating about the successful of the training?

[Very successful]   [Successful]   [Not Successful]

9. Please give your comments and suggestions to improve the future training courses.

a …………………………………………………………………………………………….

b …………………………………………………………………………………………….

c …………………………………………………………………………………………….

d …………………………………………………………………………………………….

e…………………………………………………………………………………………….

Name of Participant ………………………………….. Date…………. /……… /1996

BSP Approved Appliances and Their Manufacturers
June 1996

Appliance	Manufacturer	Colour Code
Gas Lamps	No restrictions vet	
Mixers (H)	Gobar Gas Company (GGC), Workshop Butwal	Sky Blue
Mixers (V)	Gobar Gas Company (GGC). Workshop Butwal Nepal Bio Gas Products & Engineering Services (NBGP), Nil Kamal Iron Udyog (NKIU). Bharatpur Rastriya Gobar Gas (RGG). Bharatpur Shiva Engineering Works (SEW), Biratnagar Kantipur Metals Workshop (KMW). Kathmandu	Sky Blue Green Red T.A. Grey Dark Blue Grey
Gas Taps	Gobar Gas Company (GGC). Workshop Butwal "Kapur" Hardware and Spares. Butwal Bhawana Industries, Haryana. India Nil Kamal Iron Udyog (NKIU). Bharatpur Rastiiya Gobar Gas {RGG). Bharatpur Nepal Bio Gas Products & Engineering Services (NBGP).	Sky Blue - - Red T.A. Grey Green
Water Drain	Gobar Gas Company (GGC). Workshop Butwal Nepal Bio Gas products & Engineering Services (NBGP), Nil Kamal Iron Udyog (NKIU). Bharatpur Birat Biogas Company (BBC), Lagankhel Kantipur Metals Workshop (KMW), Kathmandu Rastriya Gobar Gas (RGG). Bharatpur Shiva Engineering Works (SEW), Biratnagar " Kapur " Hardware and Spares (Kapur). Butwal	Sky Blue Green Red Yellow Grey T. A. Grey Dark Blue Yvory
Main Gas Pipe	Gobar Gas Company (GGC). Workshop Butwal Nepal Bio Gas Products & Engineering Services (NBGP), Nil Kamal Iron Udyog (NKIU}. Bharatpur Birat Biogas Company (BBC), Lagankhel Kantipur metals Workshop (KMW). Kathmandu Rastriya Gobar Gas (RGG), Bharatpur Shiva Engineering Works (SEW). Biratnagar	Sky Blue Green Red Yellow Grey T. A. Grey Dark Blue
Stoves	Gobar Gas Company (GGC). Workshop Butwal Nepal Bio Gas Products & Engineering Services (NBGP), Nil Kamal Iron Udyog (NKIU). Bharatpur Birat Biogas Company (BBC). Lagankhel Kantipur Metals Workshop (KMW). Kathmandu Rastriya Gobar Gas (RGG), Bharatpur Metal Cast Pvt (MCP). Butwal Shiva Engineering Works (SEW). Biratnagar Indian type stoves according IS 8749-l')88 Narayan Metal Cast Udyog (NMCU), Butwal Indian type stoves according IS 8749-1988	Sky Blue Green Red Yellow Grey T. A. Grey Orange Dark Blue Dark Blue Brown
Main Valve	**VHS ball valve. Hivcrsum, The Netherlands**	

CERTIFICATE

FAO
FIAT PANIS

PHOTO

HMG

Miss/Mr/Mrs … … … … … … … … … … … … … … … …... … … … … … … … … … … … … … …

From… … … … … … … … … … … … … … … … …... … … … … … … … …

Successfully participated in

TRAINING ON BIOGAS TECHNOLOGY

Jointly Organized by

Ministry of Forest and Soil Conservation

Food and Agriculture Organization of the United Nation (FAO)

and

Consolidated Management Services Nepal Pvt. Ltd. (CMS)

From … …... … … … … … … … … **to** … …... … … … … … … …**1996**

FAO Representative	Training Coordinator	Project Coordinator