Implementation Plan

National Domestic Biogas and Manure Programme in Bangladesh

Infrastructure Development Company, Ltd (IDCOL)

Netherlands Development Organization (SNV)

January 2006

Final editing April 2006

Acknowledgments

The implementation plan is the outcome of the intensive discussions, field visits, review of past biogas programmes and consultations process in which many knowledgeable individuals were involved. The formulation of the plan was a joint initiative of IDCOL, Dhaka and SNV-Nepal that was undertaken during the period of September to December 2005 by involving a multidisciplinary team comprising of Mr. Sundar Bajgain, Mr. Jahidul Islam, Mr. Zahidul Islam and Mr. Prakash Ghimire.

On behalf of the team I would like to express my gratitude to SNV-Nepal and IDCOL for intrusting us with the responsibility to formulate this plan. I am indebted to Mr. Matthias Moyersoen, Director SNV/Nepal; Wim J. van Nes, SNV/Biogas Practice Team Coordinator; and Dr. Fouzul Kabir Khan, ED and CEO, IDCOL for their necessary support and cooperation accorded to us to accomplish this task. Their valuable suggestions and comments, especially to improve the draft plan were found very helpful in order to elaborate the scope, content and quality of the plan. The staff of IDCOL also deserves special thanks for their cooperation in course of formulating the plan.

Last but not the least; I would like to express my sincere gratitude to all persons who have contributed the team by providing with their valuable information, suggestions and advices.

Sundar Bajgain
Coordinator
Implementation plan formulation team

National Domestic Biogas and Manure Programme

Fact sheet

Title of Programme : National Domestic Biogas and Manure Programme (NDBMP)

Duration of Project: Four years
- January to December 2006: Preparatory Phase
- January 2007 to December 2009: Implementation Phase

Target: 36,450 domestic size biogas plants

Objective: The overall objective of the NDBMP is to further develop and disseminate domestic biogas in rural areas with the ultimate goal to establish a sustainable and commercial biogas sector in Bangladesh.

Expected Results:

- Reduction of workload especially of women
- Improvement in health and sanitation condition
- Increase in agriculture production with proper utilization of slurry
- Employment generation
- Saving of conventional fuel sources such as firewood, agriculture residues and dried dung cakes
- Reduction in green house gas emission especially of CO2 and CH4

Plant Design: Fixed dome

Programme Area: 16 districts in 6 divisions during the preparatory phase. Programme area will be increased in later stage.

Target Group: All households who own at least 3 bovine (30 kg of dung per day) or keep at least 200 poultry birds (20 kg of litter per day) permanently and resides relatively in non-flooding areas.

Implementing Partner: Infrastructure Development Company Ltd. (IDCOL), a Government owned investment company based in Bangladesh.

Partner Organizations: Private companies, NGOs, financial institutes, government departments and consulting firms.

Investment Subsidy per Plant: Taka 7,000

Budget: Total programme cost is Euro 14.9 million. (Subsidy 3.1 million, credit 6.6 million, farmers direct contribution 2.7 million, programme implementation cost 1.8 million and SNV technical assistance 0 .7 million)

Sources of funding:

Government of Bangladesh –subsidy (14%)	Euro 0.4 million
Netherlands Government (DGIS) –programme cost and subsidy	Euro 4.5 million
Netherlands Development Organization (SNV)- TA	Euro 0.7 million
Credit (To be identified)	Euro 6.6 million
Farmers contribution (cash/labor)	Euro 2.7 million

Executive Summary

Bangladesh lies in the northeastern part of South Asia with the area of 147,570 sq. km. Most parts of the country consist of flat terrain except small ranges of hills along the Myanmar border. Monsoon generally starts in June and continues up to October during which almost 80 percent rainfall occurs. The average annual rainfall varies from 1,429 to 4,338 mm. About a third of country especially low-lying region is subjected to severe flooding due to monsoon. The temperature varies from minimum of 4^0C in winter to a maximum 42^0C in summer. An estimated current population of Bangladesh is about 144 million with a family size of 4.9.

The country's economy is based on agriculture. Fishing, exporting of garments products and remittances from several million Bangladeshis working abroad are the main sources of income. The annual GDP growth rate is about five percent.

Majority of the population of Bangladesh is depending on agriculture. About 80 percent of households are small farmers possessing less than 2.49 acres of land, whereas 57 percent of household owns less than half acre land. About 10 percent of the households are landless. Rice, jute, tea, sugarcane, tobacco, and wheat are the chief agricultural products. Around 60 percent of the labor force is employed in agriculture sector. Women labor force has been one of the main contributors in agriculture and rural economic productivity.

The cattle dung is still a principle source of fertilizer in Bangladesh. The total cattle dung production in the year 2000 was estimated to be 80 million tones of which only about 60 percent is used as fertilizer in the field. Declining of soil fertility in Bangladesh is attributed mainly to over-exploitation of land without proper replenishment of plant nutrients in soils. Crop residues and animal dung are widely used as fuel rather than fertilizer.

Most of the farm households keep livestock mainly cattle and buffalo. Livestock is mainly kept for milk, meat and fertilizer purposes. Most of the households collect forages from non-arable land due to the lack of sufficient arable land for livestock feed production. This has resulted into a gradual declining of cattle population per household.

It is estimated that about 55 percent of the country's energy is met through traditional energy (biomass) sources. Most of them are used for cooking. There is scarcity of fuel wood in the country as only 14 percent of the total land area is covered by forest. Agriculture residues and dung are commonly available in and around the household premises. Bangladesh has potentially very large natural gas resources with only small reserves of oil and coal, 66 percent of the commercial energy consumption is shared by natural gas, with the remainder contributed mostly by oil and limited amounts of hydropower and coal. Only around 30 percent of the population, mainly in urban areas has access to electricity, and per capita energy consumption is only 68 kilowatt-hours annually. The gas is being used for generation of electricity, direct use in some industries and as cooking fuel in major urban areas. Petroleum products are mainly used for transportation and rural lighting purposes.

Bangladesh, being a rather flat country, is not much suitable for hydro-electricity. The total potential is estimated to be 755 MW in which total 230 MW is being produced. More than 24,000 biogas and 60,000 solar home systems have already been installed in Bangladesh by December 2005.

In order to prevent further environmental and agricultural deterioration, it is necessary to promote new sources of energy technologies in this country. Among the other potential alternative sources of rural energy, biogas generated from animal dung is undoubtedly one of the most appropriate sources of energy in the rural communities. Biogas, mainly composed of methane (60-70%) and carbon dioxide (30-40%), is a combustible gas produced by anaerobic fermentation of organic materials by the action of methanogenic bacteria. The methane is odorless gas and burns with a clear blue flame without smoke. Family size biogas plant is appropriate only for the domestic use such as cooking and lighting.

The first floating-drum biogas plant based on KVIC Indian design was constructed in 1972 at the premises of Bangladesh Agriculture University (BAU). In 1976, another family size KVIC design plant was constructed at the premises of BCSIR. In 1981, Environment Pollution Control Department constructed about 150 floating-drum and 110 Chinese model fixed dome plants. Further efforts to promote biogas were undertaken by BCSIR, DANIDA, LGED, DLS and Grameen Bank. During 1989 to 1991 IFRD had imparted training to local youths who were able to construct in total 126 plants. A wider dissemination of biogas took place while BCSIR implemented the "Biogas Pilot Plant (1st phase) Project" during the period of July 1995 to June 2000. During this period, as many as 4,664 fixed dome plants were put forth throughout the country. Hence, following the successful completion of the first phase of the program, BCSIR implemented the 2nd phase of the Biogas Pilot Plant from July 2000 to June 2004 and was successful to establish 17,194 plants. The investment subsidy for the biogas households was Taka 7,500 per plant. In the period from October 1998 to June 2003, LGED also implemented a parallel biogas project and constructed 1,120 biogas plants. Recently, Grameen Shakti has started constructing biogas plants without subsidy. Some 120 such plants have already been constructed by this organization by December 2005. It has been observed that out of all the previously constructed biogas plants about 47 percent has been functioning well, while another 32 percent are partially functioning. Moreover, most of the biogas plants are found under-fed.

Bangladesh is considered to be a country which is highly feasible for biogas production as it fulfils all prerequisites to harness the technology. For example, high quality construction materials such as good quality cement, good quality bricks, iron rods and sand are easily available. Although gravel is very scarcely available, 'khoa' is widely used as its substitute. Water is commonly available through tube wells and local ponds. The temperature, which is governing factor for biogas production, is found best suited for biogas production in Bangladesh.

About the availability of cattle dung 8.44 million households keep 22.29 million of cattle/buffalo. Out of this about 952,000 households are used to keep more than 5 heads of cattle per household whereas another 2 million households keep 3-4 cattle per households. This figure indicates that about 3 million small sized biogas plants are technically feasible. Similarly, poultry droppings are also considered excellent feeding materials for biogas. Around 80,000 poultry farms are estimated to exist in Bangladesh that usually keep 200 – 1,000 poultry birds making the domestic size biogas plant highly feasible.

A limiting factor for the technical potential of domestic biogas could be monsoon-flooding, high water tables especially during rainy season, and declining number of cattle per household. Since dairy farms and poultry farms are more or less stable regarding rearing of livestock and poultry birds, linking biogas with such farms will resolve the problems of such limitation.

As per Household Income and Expenditure Survey 2002 the average income per household is Taka 4,816, whereas average expenditure is Taka 4,256. This shows a net saving of Taka 559 per household per month. The base analysis considering only saved biomass indicates a financial internal rate of return (FIRR) of 17 percent. Similarly, the FIRR becomes less than 10 percent when subsidy is Taka 3,000 or lower per biogas plant and 181 percent when the subsidy is Taka 17,000. The financial analysis indicates that an amount of Taka 7,000 as investment subsidy is generally sufficient to attract potential farmers.

Biogas has several benefits. Biogas as a clean fuel is quicker and easier for cooking than biomass. It enables to save approximately 1 hour time per day per family mainly due to the reduction on time used for collecting biomass, cooking food in the household and cleaning utensils. As biogas is smokeless and odourless gas, its use significantly reduces indoor pollution. In addition, construction of biogas plants results in better sanitation due to the connection of toilets, proper management of farm yard manure (FYM) and smoke-free environment inside the house. One biogas plant of 2.4 m^3 gas size saves about 2.4 tones of biomass per year. It reduces considerable amount of green house gases. The use of biogas significantly reduces the expenses on fuel for cooking and lighting. The slurry obtained from biogas plants can be used as organic manure thereby substituting the costly mineral fertilizers. This manure is more effective and of higher quality than farmyard manure. The accumulation of these savings from biogas plants makes it possible to recover the total plant construction cost within five years. These multiple benefits are the main motivating factors of rural households towards adoption of biogas technology.

Taking into consideration various parameters such as cost, quality, efficiency and construction materials, it is recommended to promote the fixed-dome design of biogas plant which is more efficient and durable.

The overall objective of the National Domestic Biogas and Manure Programme (NDBMP) is to further develop and disseminate domestic biogas plants in rural areas with the ultimate goal

to establish a sustainable and commercial biogas sector in Bangladesh. The National Strategy for Economic Growth, Poverty Reduction and Social Development prepared by the Ministry of Finance and Planning has also put emphasis on "creating a policy environment that is capable of providing right incentives to adopt new technologies". It has also emphasized on the integration of environmental conservation strategy into national poverty alleviation strategies. NDBMP also contributes to achieve millennium development goals set by the Government. Contribution of biogas in this regard will help poverty reduction through savings on energy expenditure and increase agriculture production by maximum utilization of bio-slurry[1] as fertilizer; gender equality through empowering women in decision-making and maximization of their participation in the programme; better health through clean cooking energy and improving sanitation with toilet construction connection to bio-digester. It also provides opportunity of local employment.

Under this programme a total of 36,450 plants are targeted to be constructed during 2006 to 2009. Several activities will be implemented to achieve this target. Promotion and subsidy administration will be one of the activities in which Taka 7,000 will be provided as investment subsidy. Similarly, construction of high quality plants will be ensured by enforcing parameters of quality standard and quality control system. To ensure proper functioning of the plant, guarantee on plants for 5 years and maintenance services will be provided for 3 years and training on operation and maintenance will be provided to each user. To optimize the use of biogas regular applied research and development (R &D) activities will be carried out. Different nature of trainings will be devised and imparted to the staff of the partner organizations to strengthen their capabilities enabling them to manage, operate and maintain the constructed biogas plants effectively and efficiently. Similarly, proper utilization of bio-slurry will be given high emphasis and several activities related to slurry will be implemented.

IDCOL will implement the programme by establishing a Biogas Programme Office with the involvement of several capable partners. These partners could be biogas plant construction companies, finance institutions, NGOs, Governmental departments and private consultants. The role and responsibilities of each partner organization will be defined.

Total budget of the programme amounts to Euro 14.9 million in which biogas households' contribution is 2.7 million; Government of Bangladesh is expected to contribute 0.4 million; DGIS contributes 4.5 million and SNV contributes 0.7 million as technical assistance and credit provision of 6.6 million. In addition to above budgetary sources there is an opportunity of generating carbon finance through trading carbon emission reduction from biogas plants.

It is assumed that the NDBMP will get full support from the Government of Bangladesh. Similarly, the stakeholders, who had lots of experience in the past and have tremendous

[1] Bio-slurry means digested slurry obtained from biogas plant

capacity to expand the technology, are also expected to be actively participating to launch the programme.

The credit fund for biogas households is highly required; however, the source of funding is yet to be decided. In case credit fund is not available, it will be difficult to meet the targeted number of biogas plants. The occasional flooding in Bangladesh may squeeze the potential market of biogas. On the other hand, per household cattle population over the years is in declining trend. If this trend continues, available dung will not be sufficient to operate biogas plant smoothly.

Regarding the implementation strategies, biogas plant can be linked up easily with direct income generation through integrating it with agriculture, fisheries and livestock initiatives. For generating income, slurry has to be used properly as composted organic fertilizer to increase crop and vegetable production. Similarly, institutionalization and strengthening of biogas companies for commercialization, repair and maintenance of already constructed but non-functioning plants and make them operational, enforcement of strict quality control system, encouraging toilet connection with biogas, start–up plant construction in easy and highly potential areas and gender mainstreaming are recommended as other implementing strategies.

Table of Contents

List of Annexes

List of Tables

List of Figures

Exchange Rate calculated: 1 Euro = 80 Taka

Abbreviations

ASS	After-Sales-Service
BARC	Bangladesh Agriculture Research Centre
BARD	Bangladesh Academy for Rural Development
BARI	Bangladesh Agriculture Research Institute
BAU	Bangladesh Agricultural University
BBBB	Bangladesh Bureau of Biogas and Bio-technology
BBS	Bangladesh Bureau of Statistics
BC	Biogas Company
B/C	Benefits-cost ratio
BCAS	Bangladesh Centre for Advanced Studies
BCCIC	Bangladesh Small and Cottage Industries Corporation
BCSIR	Bangladesh Council of Scientific Industrial Research
BDT	Bangladesh Taka /Taka
BLRI	Bangladesh Livestock Research Institute
BPDB	Bangladesh Power Development Board
BPO	Biogas Programme Office
BPT	Biogas Practice Team (SNV)
BRAC	Bangladesh Rural Advancement Committee
BSC	Biogas Steering Committee
BUET	Bangladesh University of Engineering and Technology
CDM	Clean Development Mechanism
Cft	Cubic feet (28.3 liters)
CH_4	Methane gas
CO_2	Carbon dioxide
CPO	Construction Partner Organization
CPR	Construction Progress Report
DAE	Department of Agricultural Extension
DANIDA	Danish International Development Agency
DGIS	Directorate General for International Cooperation
DLS	Department of Livestock Services
DNA	Designated National Authority
DoA	Department of Agriculture
DoE	Department of Environment
EIRR	Economic Internal Rate of Return
EPRC	Environment and Population Research Centre
ERD	Economic Relation Division/ Ministry of Finance
FI	Financial Institute
FIRR	Financial Internal Rate of Return

FY	Fiscal Year
GDP	Gross Domestic Product
GHG	Green House Gas
GI	Galvanized Iron
GIS	Geographic Information System
GOB	Government of Bangladesh
GPS	Global Positioning System
GS	Grameen Shakti
HH	Household
IDCOL	Infrastructure Development Company Ltd
IEC	Information, Education and Communication
KfW	Kreditanstalt fur Wiederaufbau (German Development Bank)
kgOE	Kilogram Oil Equivalent
LGED	Local Government Engineering Department
LPO	Lending Partner Organization
MFI	Micro Finance Institute
MoA	Ministry of Agriculture
MoFP	Ministry of Finance and Planning
MoU	Memorandum of Understanding
MPO	Manufacturing Partner Organization
MPR	Maintenance Progress Report
MW	Megawatt
NGO	Non Governmental Organization
NDBMP	National Domestic Biogas & Manure Programme
OC	Operation Committee
PCF	Pre-Construction Form
PCR	Plant Completion Report
PM10	Particulate Matter of size less than 10 Micro
PO	Partner Organization
QC	Quality Control
R&D	Research and Development
RE	Renewable Energy
REDA	Renewable Energy Development Agency
RET	Renewable Energy Technology
SHS	Solar Home System
SNV	Netherlands Development Organization
TA	Technical Assistance
UNDP	United Nation Development Programme
WB	World Bank

1. Introduction and Background

1.1 Country Background

Bangladesh lies in the northeastern part of South Asia. It is bordered with the Bay of Bengal in the south, India in the west and north and Myanmar and India in the east. The area of the country is 147,570 sq. km. Dhaka, the capital, is the largest city of Bangladesh whereas Chittagong is another major commercial city. Most of the parts of the country consist of flat terrain except small ranges of hills along the Myanmar border. Padma, Meghana, Jamuna, Brahmaputra, Teesta, Surma and Kamaphuli are the principal rivers that have made Bangaladesh as a great delta in the world.

Bangladesh has a sub-tropical monsoon climate. Monsoon generally starts in June and continues up to October in which almost 80 percent rainfall occurs. The average annual rainfall varies from 1,429 to 4,338 mm. Costal areas of Chittagong and northern part of Sylhet receives the highest rainfall. About a third of country especially low-lying region is subjected to severe flooding from monsoon rains, cyclones, and storm that bring major crop damage and high loss of life almost every year. Storms generally occur in the month of April-May and October-November. The temperature varies from minimum of 04^{O} C in winter to a maximum 42^{O} C in summer.

Figure-1 Map of Bangladesh

Bangladesh is one of the densely populated countries of the world. An estimated current population of Bangladesh is about 144 million with population densities of almost 1,000 persons per sq km with an annual growth rate of 1.7 percent. The number of households is estimated to be about 28 million and number of persons per family was reported to be 4.9. About 88 percent of the population is Sunni Muslim and rest 12 percent is Hindu, Buddhist and other ethnic groups. Over 80 percent population of Bangladesh resides in rural areas. Bengali is the nation's official language.

After its independence in 1971, Bangladesh is governed by the constitution promulgated in 1972. The president is chief of the state and the prime minister is head of the government. The nation is administratively divided into 6 divisions, 64 districts, 507 upazilas (sub-districts), 4,484 unions and 59,990 mouzas.

The country's economy is based on agriculture. Fishing is also an important economic activity. Exporting of garments products is one of the largest sources of national income. Remittances from several million Bangladeshis working abroad are also the important source of income. Economic performance has been relatively strong in the past decade, with annual GDP growth averaging five percent. The country has made considerable progress in reducing poverty in comparison of 80s when nearly one third of the population was poor by that time. However, agricultural laborers and small farmers fall under the high level of poverty.

1.2 Agriculture Sector

Majority of the population of Bangladesh is dependant upon agriculture. Small scale fragmented farming system combination of crop production and animal husbandry is the general scenario of rural households. About 80 percent of households are small farms with less than 2.49 acres of land whereas 57 percent of household owns less than half acre land. About 10 percent of the households are landless. Bangladesh is still maintaining self sufficiency on food production but majority of the population are lack of food security. Rice, jute, tea, sugarcane, tobacco, and wheat are the chief agricultural products. In contrary with the aim of agriculture development policies over the last four decades the role of agriculture in economic development is rather low (3.1 percent) whereas industrial and service sector growth rates are relatively quite high (8.8 and 8.6 percent).

About 60 percent of the labor force is employed in agriculture sector. Women labor force is the main contributor in agriculture and rural economic productivity. Women involvement is considered mainly in feeding, breeding, management, veterinary health care, marketing dairy products and household activities.

The cattle dung is still a principle source of fertilizer. The total cattle dung production in the year 2000 was estimated to be 80 million tones of which only about 60 percent is used as fertilizer in the field. Declining of soil fertility in Bangladesh is mainly due to over-

exploitation of land without proper replenishment of plant nutrients in soils. Crop residues and dung are widely used as fuel rather than fertilizer. Out of the 17.8 million acres of cultivated land chemical fertilizer is used in about 9.8 million acres of land. As a result of excessive use of chemical fertilizer, soil fertility is declining year by year. Similarly, organic matter content in 50 percent of agricultural land has decreased to less than 1.5 percent, the optimum being more than 3 percent (Sinha and Rahaman, 2005).

Most of the farm households keep livestock mainly cattle and buffalo. Livestock is mainly kept for milk, meat and fertilizer purposes. Cattle are fed principally on agricultural by-products, such as crop residues. Using shrub and trees leaves and tender shoots as fodder is also common in the villages. The arable land is in declining trend and remained only 62 percent of the total land. Increasing population day by day has exerted high pressure on the arable land thus fragmented in small–scale farming. Cattle generally are grazed on non-arable pasture land. Due to the lack of sufficient arable land for livestock feed production, most of the households collect forages from non-arable land. This has also resulted into a gradual declining of cattle population per household.

1.3 Energy Situation

Energy sources in Bangladesh can be broadly classified into three categories: a) traditional b) commercial and c) renewable. Traditional energy (biomass) includes fuel wood, agricultural residues, leaves and dried dung cake. It is estimated that about 55 percent of the country's energy is met through traditional energy sources. Most of them are used for cooking. Excessive use of biomass energy may already exceed the regenerative limit and there prevails energy crisis in rural areas (Asaduzzaman and Latif, 2005). An estimated total amount of traditional fuels (biomass) supplied in the year 2002/03 was approximately 11,199 million tones of coal equivalent. Table - 1 presents the traditional energy supply by source.

Table- 1
Traditional Energy Supplied in 2002/03

Fuel source	**Tonnes of coal equivalent**	**Percentage**
Rice hulls	2,926	26.1
Cattle dung	2,112	18.9
Rice straw	1,668	14.9
Twigs and leaves	1,536	13.7
Firewood	629	5.6
Bagasse	612	5.4
Jute stick	453	4.0
Other wastes	1,281	11.4
Total	**11,199**	**100**

S*ource: BBS, 2003*

The total forest area covers only 14 percent of the total land area in Bangladesh. Thus fuel wood collection from forest is difficult. Agriculture residues and dung are commonly available in and around the household premises. It becomes more difficult to collect biomass fuels in monsoon season especially during the flooding period.

Electricity, petroleum products, natural gas and coal are the major commercial energy sources. Bangladesh has potentially very large natural gas resources but with small reserves of oil and coal. 66 percent of the commercial energy consumption is shared by natural gas, with the remainder contributed mostly by oil and limited amounts of hydropower and coal. Only around 30 percent of the population, mainly in urban areas has access to electricity, and per capita energy consumption is only 68 kilowatt-hours annually, which is one of the lowest rates in the world.

The total recoverable reserves of natural gas are 439 billion m^3 of which 110 billion m^3 was produced up to June 2000. The gas is being used for the manufacturing of fertilizer, generation of electricity, direct use in some industries and as cooking fuel in major urban areas.

Petroleum products are mainly used for transportation and rural lighting purposes. The total consumption of petroleum in 2000 was 3.23 million ton, all of which was imported. The total coal deposits are 1.75 billion tones. Mining has started in a small scale. The yearly consumption of coal in the country is over 1 million tone. Bangladesh, being a rather flat country, is not much suitable for hydro-electricity. The total potential is estimated to be 755 MW in which total230 MW is being produced.

Biogas, solar, micro hydro and wind energy are known as renewable energy or also called alternative energy source. So far, in the process of the development of renewable energy, about 24,000 biogas systems and 60,000 solar home systems have already been constructed in Bangladesh by December 2005. These renewable energy systems alone are contributing to about 19 MW equivalent powers to the nation.

In Bangladesh the average cooking requirement per family per day is estimated to be 5 hours in rural households. Each household needs about 3 tones of biomass per year to cook their food. Assuming that 55 percent of households use biomass for cooking, about 40 million tones of biomass fuel will be required every year for cooking only. Supply of such large quantity of biomass can expert high pressure on the forest. Besides it will also cause indoor air pollution, as biomass smoke is considered to be a significant source of public health hazard, particularly to the poor and vulnerable women and children.

Use of agriculture and animal waste for cooking purposes rather than for its use as an organic fertilizer has adverse affect on maintaining the soil fertility, thereby reducing crop production and-productivity of land. Kerosene is mainly used for lighting in rural areas. Kerosene is an imported fuel and therefore, is very expensive.

In order to prevent further environmental and agricultural deterioration, it is imperative to promote new sources of energy technologies in Bangladesh. Among the other potential alternative sources of rural energy, biogas produced from dung is undoubtedly one of the most appropriate sources of energy for the rural areas of Bangladesh. It can have two folds benefits as household cooking energy; and as high quality fertilizer.

2. Biogas in Bangladesh

2.1 Introduction to Biogas Technology

Biogas, which is mainly composed of methane (60-70%) and carbon dioxide (30-40%) is a combustible gas produced by anaerobic fermentation of organic materials by the action of methanogenic bacteria. Methane is odorless gas and burns with a clear blue flame without smoke. It produces more heat than kerosene, fuel wood, charcoal and dung-cakes. When biogas is used in suitable designed burners, it gives a clean, smokeless, blue flame, which is ideal for cooking. If biogas is used in specially designed lamp it gives a light similar to the kerosene pressure lamps. Biogas can be used for other purposes such as electricity generation, refrigeration, space heating and running engines but higher amount gas will be required for these purposes. Family size biogas plant is appropriate only for the domestic use such as cooking and lighting.

2.2 History of Biogas

The first Indian KVIC model floating-drum biogas plant was constructed in 1972 at the premises of Bangladesh Agriculture University (BAU) for research and study purposes. Later, same type of another plant was constructed in Phulpur for cooking and lighting purpose. In 1976, next family size KVIC design biogas plant was constructed at the premises of BCSIR by IFRD followed by a plant at the KBM College in Dinajpur in 1980. A total of 72 such plants were constructed in households with technical assistance of IFRD. In 1981, Environment Pollution Control Department started its programme under a government grant through which about 150 floating-drum and 110 Chinese fixed-dome plants were constructed free of cost by the contractors. Other efforts were undertaken by BCSIR, DANIDA (few trench and bag type digesters), LGED (over 200 plants), DLS (about 70 plants) and Grameen Bank (17 plastic bag digesters). Under the "Fuel Saving Project" implemented from 1989 to 1991, IFRD trained local youths who constructed a total of 126 plants. In 1992, the IFRD and Dhaka City Corporation jointly built an experimental large-size bio-digester having 85 m^3 digester volumes at Dholpur. The digester was operated using city wastes.

In 1992, LGED constructed a Chinese–type fixed dome design plant in Karimpur village of Begumgong, Noakhali and another biogas plant using only human excreta in Faridpur Muslim Mission. LGED also constructed a biogas plant using water hyacinth at Mandaripur. Similarly, in 1994, LGED constructed a biogas plant using poultry droppings at Utter Khan, Dhaka and city waste based plants in 10 towns. In this way LGED had built about 200 biogas plants by 1994.

A wider dissemination of biogas took place while BCSIR implemented the "Biogas Pilot Plant (1st phase) Project" during the period of July 1995 to June 2000. During this period, as many as 4,664 fixed dome plants were put forth throughout the country. The biogas farmers received an investment subsidy of Taka 5,000 under the framework of the project.

Following the successful completion of the first phase of the program and considering the huge potential of biogas in the country, BCSIR implemented the 2nd phase of the Biogas Pilot Plant during the period July 2000 to June 2004. Out of the target of establishing 20,000 biogas plants for this phase, a total of 17,194 plants were finally completed. The investment subsidy for the owner was increased to Taka 7,500 per plant. In addition to the diploma civil engineers employed and paid on a monthly basis by BCSIR, an agency system was introduced on incentive basis. About 50 agencies were recognized and they were provided with a lump sum fee of Taka 5,000 per plant as service charge. About 1,000 masons and youths were trained under the project as well.

In the period from October 1998 to June 2003, LGED also implemented a parallel biogas project with the objective of constructing 1,900 domestic plants. As the investment subsidy for this project amounted to Taka 5,000 only, it proved to be rather difficult to motivate farmers during the implementation of the 2nd phase of the Biogas Pilot Plant Project as BCSIR had been providing Taka 7,500 in the past. Therefore, the LGED project was terminated prematurely, after having constructed 1,120 biogas plants. Under the Secondary Town Infrastructure Development Project-II, another 20 domestic plants were constructed using only the human excreta as feeding materials.

Recently, Grameen Shakti (GS) has started constructing biogas plants without subsidy. Some 120 such plants were already been constructed by December 2005 and GS aims to construct a total of 200,000 biogas plants within a period of five years. Since there is no formal biogas programme at this moment, some 200 plants were constructed by previously trained diploma engineers on individual basis. An overview of the number of plants constructed by various organizations can be seen in Annex-6. However, the figures are collected from various sources and may differ from one to another.

A recent survey conducted by SNV/IDCOL on technical aspects of existing biogas plants in Bangladesh comprising a sample of 66 biogas plants has indicated the following facts:

- 83 percent of the plants are found to be under-fed. 50 percent of the total plants are receiving less than 50 percent of the prescribed feeding.
- Water-dung ratio is more than the prescribed rate in 56 percent of the plants.
- The average maintenance cost of biogas plant is Taka 340 per year.
- 47 percent of the plants are functioning fully, 32 percent are functioning partly and the remaining 21 percent are not functioning at all.
- The average efficiency of biogas plants is 49.6 percent based upon the actual quantity of gas being used.
- 36 percent of the users are fully satisfied, 44 percent are partly satisfied and the remaining 20 percent are not satisfied with the functioning of their plants.
- The major reasons hindering the effective functioning of biogas plant are unavailability of feeding materials, ineffective operation and maintenance mechanisms, construction defects and improper selection of plant size.

It can be learned from the above findings that the plant designs has to be reviewed and strong quality control and maintenance system will have to be in place in this programme.

2.3 Potential of Domestic Biogas

2.3.1 Technical Potential

Biogas is generally considered feasible if temperature is warm (tropical and sub-tropical conditions); feeding materials such as water, cattle dung and high quality construction materials are easily available; transporting construction materials is easy; human resource for plant construction is locally available; and other household energy sources are either difficult to access to the community or are highly expensive. Looking into the above conditions, Bangladesh has higher prospects for the technology as it fulfils all of them. As regards the construction materials, good quality cement, good quality bricks, iron rods and sand are commonly available in this country. Though gravel is very scarcely available, 'khoa' (aggregates made up of high quality bricks) is widely used as its substitute. Water is commonly available through tube wells and local ponds. Availability of bcal labours and masons are not a problem in Bangladesh. As said, the temperature is best suited for biogas production in Bangladesh.

Regarding the availability of cattle dung, a livestock census carried out in 1996 revealed that 8.44 million households were reported to keep 22.29 million of cattle/buffalo (an average of 2.64 cattle per household). Out of this about 952,000 households used to rear more than 5 heads of cattle per household whereas about 2.1 million households keep average 3-4 cattle heads per household. Similarly, a study carried out by BCAS has estimated about 116,000 poultry farms operating in Bangladesh. Table - 2 presents classification of households based upon the number of cattle and poultry holdings.

Table- 2
Households with Cattle and Poultry Birds

	Size of cattle/poultry farm	**Number of households**
Cattle (Cowes and buffaloes)	With 1-2 heads	5,106,994
	With 3-4 heads	2,111,498
	With 5 heads and above	952,872
Poultry birds	Less than 249	15,000
	With 250-999	80,000
	With 1,000 and more	21,250
	Total	**8,287,614**

Source: Adapted from BBS, January 2005 and BCAS 2005.

van Nes, Wim J., et. al. in their report on *'Feasibility of national programme on domestic biogas in Bangladesh'* came out with the figure of about 950,000 households as potential to

construct biogas plants. These data are based upon the households who have five or more cattle heads. The dung produced by 5 cattle could be sufficient to feed a biogas plant with a gas output of 3 m3 per day.

The average cooking requirement was found to be 5 hours per day. However, as the NDBMP also envisions making access to biogas for smaller households, it is proposed to promote also smaller plants requiring a daily feeding of 30 kg of dung (3 cattle head). Such plant should be able to produce gas for cooking during at least 3 hours. If we consider these smaller sized biogas plants the total technical potential reach to about 3 million plants.

Similarly, poultry droppings are also considered to be an excellent feeding material for biogas generation. Poultry farming is seen as a big business in Bangladesh. According to an estimate (BCAS, 2005) about 116,000 poultry farms are in operation all over the country. Out of them about 80, 000 Poultry farms are estimated to exist that are capable of keeping 200 – 1, 000 birds, construction of domestic size biogas plant is quite feasible. In this context about 80, 000 biogas plants through using poultry droppings are considered to be technically feasible for domestic sized plants.

A limiting factor for the technical potential of domestic biogas could be monsoon-flooding as Bangladesh comprises of the largest delta in the world. Flooding in low land areas could damage the structure of the plant or disturb its operation through in-flow of water in the outlet and digester. However, as households have already avoided building their houses in low land, it is believed that flood will not significantly reduce the technical potential. Under such condition, proper site selection requires careful attention while selecting households for bio-digester construction. Due to high water table particularly during rainy season that lasts from June to October, the season for digester construction might be limited to six or seven months only.

Number of cattle per household shows a declining trend over the years. If it continues in the same trend in the future, households with small number of cattle may not be feasible for biogas. But at the same time, it is expected that once biogas is constructed and users are used to cook with biogas, they may continue to keep the required number of cattle to adequately feed and operate the biogas plant. Since dairy farms and poultry farms are more or less stable in keeping livestock and poultry birds, linking biogas with these farms can resolve such problems.

Biogas produced from cattle and buffalo dung is widely accepted as cooking fuel in Bangladesh. However, there exist reservation to attach a toilet to the biogas plant mainly because of two reasons; firstly, negative attitude of people to use gas generated from night-soil; and secondly, hesitation among people to handle the bio-slurry coming out of the toilet-attached biogas plant (Van Nes Wim J et. al, 2005). Nevertheless, there are still some biogas plants operating only with night soils and the users are happy with the outcome. This indicates

that with special attention on extension and promotion, people could gradually be motivated for the acceptance of toilet connection for biogas production.

2.3.2 Financial and Economic Potential

As per Household Income and Expenditure Survey 2002 the average income per household is Taka 4,816 whereas average expenditure is Taka 4,256. This shows a net saving of Taka 559 per household per month.

The financial analysis of an improved biogas plant with a daily gas production of 2.4 m^3 is also calculated based upon the capital cost of Taka 25,000. The benefits associated with the use of biogas are derived primarily from the savings of biomass that includes fuel wood, agriculture residues and dried dung. The base price per kg of biomass is assumed to be average Taka 1.50 (SNV/IDCOL Technical Survey 2005). Assuming a biogas plant life span of 15 years, the base analysis considering only saved biomass indicates a financial internal rate of return (FIRR) of 17 percent where as the cost benefits ratio was found to be 1.3.

Similarly, a sensitivity analysis on the amount of the subsidy provided to the plant is presented in Figure-3. The data indicate that the FIRR becomes less than 10 percent when subsidy is Taka 3,000 or lower per biogas plant and 181 percent when the subsidy is Taka 17,000.

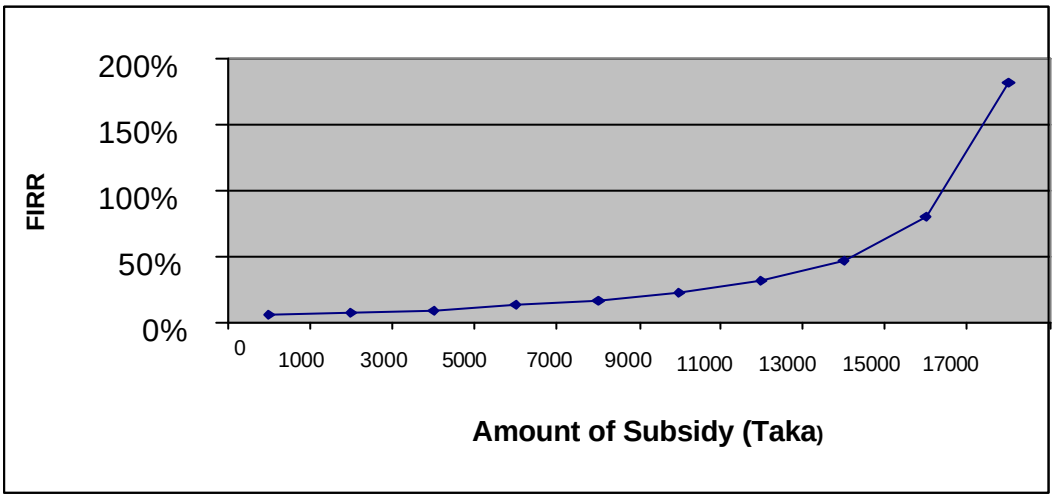


*Figure - **3 FIRR Vs. Amount of Subsidy***

The above financial analysis indicates that the FIRR becomes 17 percent when an amount of Taka 7,000 as investment subsidy is given therefore, this subsidy amount is generally sufficient to attract potential farmers while not being significantly excessive as to result in relatively high FIRRs for the household

While undertaking an economic analysis to assess the benefits of biogas to the society, an average size of 2.4 m^3 plant has been chosen. The Economic Internal Rate of Return (EIRR) was calculated based on the data as presented in Annex –13 that are derived from various sources. Economic benefits resulting from better sanitation through toilet connection and employment generation are not counted while calculating EIRR. While calculating all direct and indirect benefits including biomass, saved time, slurry nutrients, smoke reduction and carbon savings the total EIRR reaches to 49 percent although most of the biogas users do not count these benefits in terms of monetary value. Figure -2 presents the results of EIRR analysis on the total assumed benefits.

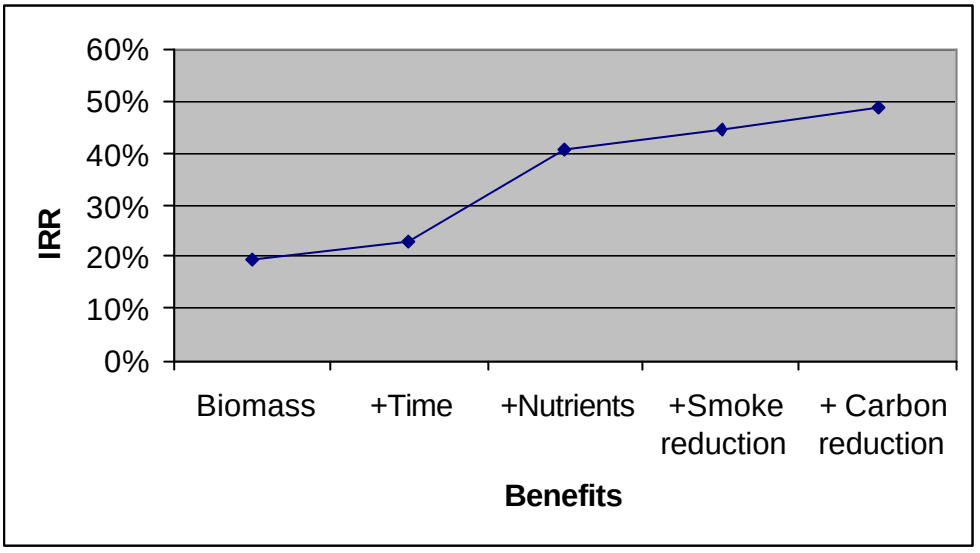


Figure- 2: ***EIRR vs. Total Benefits***

Considering the base economic price for biomass of Taka 1.5 per kg and adding a saving of 1 hour a day of domestic labour valued at Taka 1.5 per hour results in increasing the EIRR to 23 percent. Assuming an annual value of Taka 1,836 for the slurry nutrients in the manure that are saved and applied to the field as a result of biogas plant and adding it in the benefits the EIRR reaches to 41 percent. When adding economic value of smoke reduction with the rate of Taka 400 per year, the resulting EIRR increases to 45 percent whereas adding reduced carbon emission due to the use of biogas at the rate of Taka 1,750 per year, finally the EIRR reaches to 49 percent.

Based on the above economic analysis, it can be concluded that there is financial as well as economic potential of biogas. It also justify for the subsidy of Taka 7,000 per plant under the proposed programme.

2.4 Benefits of Biogas and Its Impact

Biogas is a reliable, easy and very useful source of household energy; hence, it is also a stable source of energy. Biogas has several benefits. These benefits are the main motivating factors of rural households towards adoption of biogas.

A survey on existing biogas plants was carried out by SNV/IDCOL in 2005 in which the benefits from biogas was also assessed. The surveyed sample plants were on average bigger sized (3.9 m^3 gas production) thus result comparatively high benefits. Since NDBMP aims to promote smaller sized (average 2.4 m^3) but highly efficient plants (at least 30 percent more efficient than surveyed plants), the benefits to be expected under NDBMP might be different as we might reach different group of customers. Based on the findings of the survey and considering the aim of promoting highly efficient smaller sized plants the assumed benefits from biogas are briefly discussed below:

Gender benefits: Biogas provides a direct benefit, especially to rural women, as a result of the reduction of the workload when shifting from cooking on conventional biomass to biogas. Biogas is quicker and easier for cooking than biomass. Moreover, biogas is smokeless and does not require constant attention while cooking; therefore, women can do other activities simultaneously. On an average, biogas enables to save approximately 1 hour 5 minutes time per day per family mainly due to the reduction on time used for collecting biomass, cooking and cleaning of utensils; whereas an increase in time has also been incurred for some additional works such as collection of water, feeding and caring of livestock. Table–3 presents the breakdown of time after construction of average 2.4 m^3 size biogas plants.

Table –3
Average Time Saving After Construction of Biogas Plant

Activity	Saving in time (min/day)
Cooking of meal	32
Collection of water	(4)
Plant feeding	(8)
Collection of biomass (fuel)	26
Cleaning of cooking vessels	21
Caring of cattle	(2)
Average time saving	**65 minutes**

Source: Adapted from SNV/IDCOL, 2005

This saved time can be used for childcare, income generating activities, education, recreation and other social works.

Environmental benefits: From individual perspective, the use of biogas significantly improves the indoor air quality. In addition, construction of biogas plants results in better

sanitation due to the connection of toilets, proper management of farm-yard-manure and smoke-free environment inside the house. One biogas plant of 2.4 m^3 gas size enables to save about 2.4 tones of biomass per year. It reduces considerable amount of green house gases from two perspectives: the carbon released from burning of biomass is minimized; and the saved forest can act as sink-basin to absorb carbon-dioxide. Biogas construction also helps manage poultry waste. The surroundings become clean healthy and odor-free if biogas plant is constructed in poultry farms using poultry droppings. It is estimated that about 116,000 poultry farms are in operation in Bangladesh that are spreading bad smells in and around the community.

Health benefits: A major problem for the rural people especially to the housewives is indoor air pollution due to exposures with smoke inside the kitchen while cooking with biomass. Poor indoor air quality is one of the major risks factors for acute respiratory infections especially with housewives and children. Biogas reduces the smoke exposures and significantly improves the air condition inside the kitchen which ultimately improves the health conditions because of reducing the incidences of eye infection, respiratory diseases, coughing, dizziness and headache. A study (NHRC, 2004) indicated that PM10 concentration level using biogas in kitchen was almost 3 times lower than using biomass.

Connection of toilet to biogas plant leads to better health and hygienic condition due to improved sanitation conditions in and around the house. One study indicates that because of better sanitation through biogas infant mortality rate was found reduced (Adhikari, 1996).

Economic benefits: Biogas reduces the expenses on fuel for cooking. The toilet connected biogas plants does not require the construction of septic tank thus curtails the total cost of sanitation system. The accumulation of the savings from biogas plants makes it possible to recover the total plant investment cost within four to five years.

Bio-slurry obtained from the plant has been proved to be excellent organic manure. This manure is more effective and is of higher quality than traditional manure such as farm-yard manure or compost. The use of bio-slurry as manure helps in increasing farm production and hence the farmer's income level is enhanced, besides preventing the high cost and adverse effects arising from the use of chemical fertilizers. Another important benefit from biogas especially in Bangladesh is the use of slurry as a food to fish. As slurry is considered to be a very good organic feed for fish, higher growth rate of fish is obtained compared with other feeding materials.

An interesting practice seen in Bangladesh was that the bigger poultry farms are selling biogas to their neighbors by distributing it through pipe systems. They usually charge about Taka 300 per month per family. This also could be a good source of income which eventually pays back the total cost of biogas at shorter time.

2.5 Proposed Plant Design

Several designs of biogas plants are applied in different countries. In fact, the design of plant should be appropriate based on the conditions of the country. These conditions which should be considered are: ambient temperature, availability of raw materials for plant feeding, availability of construction materials and appliances, transportation facilities, water table status, household structure and farming system, users' ability to pay and priority of use. Examining the above conditions, the study team recommends the development and promotion of a fixed dome design biogas plant under this programme. The designs will be basically two types; a) design for cattle dung and human excreta, and b) design for poultry droppings. Each design will have 6 sizes of different capacities. These sizes will be 1.2, 1.6, 2.0, 2.4, 3.2 and 4.8 m^3 gas production capacity. The gas produces from the last two sizes plants will be used for multiple houses where as other sizes will be used for single household. Details on the design can be seen in Annex-5.

3. Objectives of the Programme

3.1. Overall Objective

The overall objective of the National Domestic Biogas and Manure Programme (NDBMP) is to further develop and disseminate domestic biogas plants in rural areas with the ultimate goal to establish a sustainable and commercial biogas sector in Bangladesh.

3.2 Specific Objectives

The specific objectives contributing to its overall objectives are:

- To attract and strengthen organizations for sustainable development of the biogas sector,
- To increase the number of quality biogas plants by 36,450,
- To stimulate internalization of all benefits of the biogas plants,
- To ensure the continued operation of all biogas plants constructed under the program.

3.3 Linkages of Programme Objective to Government Policies

Although a concrete policy of Government of Bangladesh (GOB) on developing renewable energy is yet to come, lots of initiatives have been undertaken and keen interests are reflected on promoting renewable energy in the past. GOB intends to provide access to electricity to over 70 percent of households in the country by 2020 and majority of them may receive through developing renewable energy options as grid extension is not easy and viable in some areas of the country.

The National Strategy for Economic Growth, Poverty Reduction and Social Development prepared by the Ministry of Finance and Planning has also put emphasis on "creating a policy environment that is capable of providing right incentives to adopt new technologies". It has also emphasized on the integration of environmental conservation strategy into national poverty alleviation strategies.

Similarly, National Strategy for Accelerated Poverty Reduction published by Planning Commission of GOB has put forward very clearly seven-point strategic agenda for the goal of accelerated poverty reduction. These agenda are: employment, nutrition, maternal health, quality education, sanitation and safe water, criminal justice and local governance. There are eight specific avenues through which the goal of poverty reduction will be pursued. These are: supportive microeconomics, choice of critical sectors, safety net measures, human development of the poor, participation and empowerment of the poor, promoting good governance, improving service delivery and caring of environment. The sources of increased growth would involve: higher private investment in all sectors, increased efficiency and technological development including biotechnology, expanded growth of industry and service sectors, diversification in crop production and expansion of the export sector. Development

and extension of renewable energy is identified one of the critical sectors for pro-poor economic growth.

Bangladesh, together with almost all other countries in the world, has committed to attaining the targets embodied in the Millennium Declaration by 2015. The Millennium Development Goals (MDGs) include halving income-poverty and hunger, achieving universal primary education and gender equality, reducing infant and child mortality, and halving the proportion of people without access to safe water. NDBMP through the supply of clean energy and high quality organic fertilizer contributes to achieve some of these millennium development goals and poverty reduction strategies set by the Government. Contribution of biogas in this regard will help poverty reduction through savings on energy expenditure and increase agriculture production by maximum utilization of bio-slurry as high quality fertilizer; gender equality through empowering women in decision making and maximization of their participation in the programme; and better health through clean cooking energy and improving sanitation with toilet construction and connection to bio-digester. Once biogas is constructed by the households in local community, use of biomass will be reduced thus will be more accessible to the poor who do not have biogas. Besides, the NDBMP will strengthen private sector and local micro finance institution through the capacity development and maximum involvement of local people. This will help institutional development for sustainability of biogas sector in one hand and create employment for local people in the other. In this regard, the objectives of NDBMP are very much in line with the objectives of poverty reduction and millennium development goals set by the Government.

4. Output Targets

Looking into the strong need for harnessing alternative sources of energy and significant potential for the development of domestic biogas in rural Bangladesh, it is proposed to have two different phases of the NDBMP: a preparatory phase and an implementation phase. The preparatory phase shall include preparation, approval of implementation plan and construction of a number of plants to have demonstration effects. The preparatory phase will last for one year starting from January 2006 and ending in December 2006.

The implementation phase shall be of 3 years starting from January 2007 and ending by the end of 2009.

4.1 Plant Construction

Out of the targeted 36,450 domestic size biogas plants to be constructed within the project period, it is planned to establish 2,100 biogas plants during the Preparatory phase and another 34,350 plants in the Implementation phase. The plant construction target up to the end of 2009 has been projected as shown in Table-4.

Table- 4
Plant Construction Target

Year	2006	2007	2008	2009	**Total**
Construction target	2,100	4,200	12,150	18,000	**36,450**

4.2 Expected Benefits

Assuming that 36,450 plants are constructed by the end of the programme and at least 90 percent of them functions well, the following expected benefits, as presented in Table- 5, will be derived from the programme.

Table-5
Expected Benefits from the Programme

Benefits	**Per hh/ per year**	**Total benefits/ year**
Reducing workload	49 days (395 hours)	53,581 person month
Fuel wood saving	1,500 kg	49,207 tones
Agriculture residues saving	508 kg	16,665 tones
Dung cakes saving	409 kg	13,417 tones
GHG emissions reduction	2.5 tones	820,125 tones
Organic fertilizer available with significant plant nutrients (NPK)	917 kg	30,082 tones
Better sanitation (toilets) Reduction indoor air pollution	(20% hh) All hh	7,290 hh 32, 805 hh
Employment creation	-	3,000 persons

4.3 Sector Development

Strong and capable institutions are keys for the sustainable development of the biogas sector. Therefore, emphasis will be given for the development and strengthen of the institutions that are involved in biogas sector. The NDBMP targets to develop at least the following number of different institutions.

- 30 plant constructors and maintainers
- 8 biogas appliances manufacturers
- 15 biogas lenders

5. Activities and Inputs

5.1 Promotion and Subsidy Administration

5.1.1 Promotion

The major challenge in the construction of the biogas plants lies in motivating the potential households who are mainly farmers residing in remote areas and having small land holdings and some number of cattle for keeping the plant in operation. Adding to the challenge is the low-income level of this target group who thus have even low ability to investment in the plants as well as lack of know-how on biogas technology.

It is always necessary to keep in mind that a well functioning plant is the strong tool of promotion and a satisfied user is the best promoter. Therefore, construction of high quality plant, proper size selection, proper after-sales-services and users know-how on operation and maintenance are highly important for wider scale promotion of biogas technology.

Since significant number of biogas plants constructed in previous years is not functioning to the desired extent, a negative impression on biogas technology has been created among the potential biogas households. In this situation, it will be even more important to look not only into the quality of plants but also for maximizing the benefits of biogas plants.

Promotion activities need wide network to disseminate biogas information to a large segment of rural population. Therefore, organizations working with rural communities such as local banks, cooperatives, users or farmers' group, NGOs, and other functional groups will be mobilized for biogas promotion. Besides the local agencies, satisfied biogas users can be used for "words to mouth" promotion campaign. The satisfied user easily can convince his/her relatives, neighbors and friends through his/her practical experiences on biogas.

In relation to the biogas promotion activities, following activities will be implemented:

a) Develop and distribute different IEC (Information, Education and Communication) packages in local language such as: posters, pamphlets, and leaflets that contain information on biogas, its benefits, costs, services, constructors, and subsidy and loan provisions.
b) Develop video cassettes on promotion and extension of biogas and bio-slurry applications and broadcast them from TV/local cable.
c) Disseminate information on biogas through radio and cinema halls.
d) Organize orientation training to the potential users, staff of government line-agency offices, NGOs workers, school teachers and workers of local organizations.
e) Organize exhibition and demonstration.
f) Motivate biogas plant constructors to concentrate in cluster area construction and organize effective promotion campaign.

Besides the above mentioned activities on promotion, an additional activity will have to be carried out to ensure the functioning of existing plants to motivate potential users. It is

therefore, good to repair those existing plants that are not functioning due to lack of minor repair and maintenance works. Plants constructed in programme districts if found non-functioning, will have to be maintained through the biogas constructer that is certified to work in that district. This activity will help to market biogas in other households as well. Generally, biogas households are expected to pay the maintenance fee for these biogas plants. In special case with prior approval of BPO, a small fee for repairing these plants may be provided to constructors to motivate them for repairing these existing non-functioning plants.

5.1.2 Subsidy Administration

Since subsidy plays a vital role on biogas promotion and maintaining standardized high quality plants, a flat rate subsidy will be provided to each household who constructs biogas plant as per the plant construction standards and guidelines enforced by NDBMP. The average subsidy rate for the entire project period will be Taka 7,000 per plant regardless of sizes and districts. The subsidy rates can be reviewed and adjusted in later stage. Eligibility criteria for getting subsidy will be as follows:

- At least 3 stall-fed cattle (30 kg of dung per day) at home or 200 poultry birds (20 kg of litter per day) at farm,
- Only for one plant per household,
- Only for domestic size biogas plant for domestic purpose
- Only for approved plant design,
- Flooding free area.

Subsidy will be channeled through plant constructors. A general procedure for releasing subsidy will be as follows.

- Before construction of the plants, the plant constructors will have to submit a filled Pre-Construction Form (PCF) of potential farmers where the constructer will construct biogas plant (see Annex-9). Constructors will construct plant upon approval of the PCF.
- Constructors will construct biogas plant as per the standards and agreement signed with Biogas Programme Office (BPO).
- Once the construction of plant is completed and the plant comes into operation, plant constructors will send the standard Plant Completion Report (PCR) to the BPO along with the sales contract and subsidy receipt signed by the farmers. (see Annex-10)
- The PCR will be processed by the BPO and if necessary, BPO will check and verify the PCR at the site before approving the subsidy. Once the PCR is approved, the BPO will transfer the subsidy deducting the maintenance fee to the account of constructer.
- BPO will make sure whether the subsidy was ultimately received by household through checking the bills, sales contract and other documents on plant site.

Since plant constructors will have to pre-finance the subsidy amount while constructing the biogas plant and may encounter scarcity of working capitals, BPO will disburse the subsidy as

soon as possible once the PCR is received. The BPO will produce compiled construction progress report twice a month depending on the number of plants reported. The BPO will transfer the subsidy amount within a week after the publication of progress reports. The BPO may also apply alternates to overcome the problem of working capital with provision of certain subsidy fund as an advance once agreement is signed with plant constructors.

5.2 Quality Management

5.2.1 Quality Control

The quality of the biogas plants should be a major concern while implementing the programme and will remain an important activity of the NDBMP. As indicated in earlier chapter, in the past non-functioning biogas plants have created negative image of biogas technology. Therefore, it is imperative to safeguard the quality of biogas plants with the compliance of set quality standards during construction as well as operation and maintenance phases.

An important factor in the success of the NDBMP will be a strict enforcement of carefully determined quality and design standards. Enforcement of the quality standards may be achieved by imposing penalties for non-compliance found during inspection by random sampling. This enforcement will be instrumental in achieving the relatively high operational success ratio for biogas plants in terms of reliability, efficient performance and higher life of the plants. Assuming that the targeted number of biogas plants will be constructed, the target of quality control has been elaborated as shown in Table – 6.

Table- 6
Target of Quality Control Plants by Year

Description	**2006**	**2007**	**2008**	**2009**	**Total**
Construction Target	2,100	4,200	12,150	18,000	36,450
Control target					
New plants	630	1,260	3,645	5,400	10,935
After-sales-service	-	420	1,260	3,270	4,950
Total control	**630**	**1,680**	**4,905**	**8,670**	**15,885**

5.2.2 Regulations and Procedures of Quality Control

Plant constructors, who are pre-qualified by the BPO and involved in plant construction and after-sale-services, will have to follow certain regulations and procedures such as:

- Follow the conditions mentioned in the agreement with BPO,
- Use only trained and certified masons in plant construction,
- Follow strictly the approved quality standards,
- Construct/use only approved quality appliances/materials in biogas plants,

- Organize proper biogas user training and provide user manual to each biogas household,
- Provide 1 year guarantee on appliances and 5 years guarantee on the structure of biogas plant,
- Provide maintenance visit at least once a year for 3 years,
- Submit correct and complete plant completion and maintenance report to BPO timely.

Once the PCR are received, the BPO will select at least 30 percent plants randomly and check the quality as per the quality standards. Such quality control will be continued for 3 years to check the quality of after-sales-services. Sample of after-sales -service will be at least 20 percent of maintained plants. The main purpose of the quality control will be to ensure that the plant is constructed as per the standard and is of high quality. The quality control inspectors will use a standard questionnaire while inspecting the plant. The information collected through quality control visits will be entered into computer database and at the end of the year BPO will calculate the overall performance ratings of the biogas plant constructors. The performance of constructors will be one of the bases for renewing the agreement for next year.

Besides the quality check of biogas plants by BPO, Global Positioning System (GPS) may be introduced to make sure about the existence of biogas plants and also to locate them easily. All the plants constructed under the NDBMP will be recorded in GPS by the plant constructors and reported to BPO once plant is constructed.

5.2.3 After-Sales-Services

Construction of biogas plants only is not sufficient for making the plant functional for longer period of time since it needs regular and effective after-sales-services (ASS) as well. Biogas constructors are required to provide a guarantee of 5 years (on structure) on constructed plants and visit each constructed biogas plant for maintenance at least once a year, starting one year after completion of the construction. This is mandatory for plant constructors to provide maintenance services on plants for 3 years. The guarantee and maintenance charge of Taka 700 per plant for the guarantee and the ASS visits (two visits) will be deposited in a special account of BPO after deducting the required amount during the time of the disbursement of subsidy to the constructors. Payments from this account are made once plants constructer pays maintenance visit, submits maintenance report and gets approval on the report from BPO. The payment for maintenance visit will be Taka 350 per visit per year. To make sure whether the constructer has provided guarantee on plants for 5 years, BPO will act upon complains received from plant owners and also monitors the plants from time to time.

It is compulsory for the biogas plant constructors to send its staff for regular maintenance visit to each biogas plant constructed. The staff of constructors visits the constructed plants, maintains whatever is required, orients users on operation and minor maintenance, fills up the maintenance form in site and sends the form to BPO. If farmer complains to the constructer

on any technical problems, they will have to send its staff immediately for maintenance no matter how many times it is needed.

In case if the plant constructer does not want to continue working with NDBMP, with prior approval of BPO, it will handover all the constructed plants to another approved constructer with proper information to the users. Proper handover of plants to other capable constructors and assurance of proper maintenance of these plants will be the responsibility of BPO.

The BPO will set up a unit called "help desk" to allow users to lodge their complaints, provide proper information on biogas and taking necessary actions against the non-compliance of the term and conditions by the plant constructors.

5.2.4 Operation and Maintenance by Users

Quality construction is important for functioning of plant efficiently in the long run; however, equally important is the user's involvement in operation and maintenance of the plant. Users usually will have the following responsibilities to ensure the smooth functioning of the plant:

- Proper feeding of the plant;
- Proper use of biogas;
- Regular maintenance/cleaning of plant and appliances;
- Proper use of the composted slurry.

To make aware and enable the users to perform the above activities, users (mainly female) will be properly trained on these subjects. Such training will mainly be provided by the plant constructors; alternately, financing institutes and local NGOs will also be mobilized to provide proper information to the users.

Each biogas household will receive a biogas instruction manual containing all aspects of operation and maintenance as mentioned above. Users will be instructed to read the instruction manual carefully and also to act accordingly. It is also important to inform the users that they have to inform concerned biogas constructors if they have any problem that they are unable to solve. Contact address of BPO will be given to them so that they can send them their complaints provided biogas constructer does not listen to their request.

5.3 Research and Development

Applied researches are always necessary for improvement of the technology. R &D activities will mainly be focused on the following topics:

- Designing and standardization of biogas plant,
- Increasing efficiency on gas production,
- Cost reduction,
- Optimum utilization of gas,
- Proper methods of utilizing slurry,
- Increasing efficiency on stoves,

- Appliances development,
- Any other aspects as and when needed.

Research will be subcontracted on the basis of ToRs to capable research institutes. With its long experience on biogas research and well established physical facilities, BCSIR may be a capable partner to carry out biogas research.

5.4 Training

Training is one of the important components of the NDBMP. Varieties of training programs will be required for smooth running of the programme. Most of these training will be sub-contracted on the basis of ToRs to capable organizations. Following training are planned during the programme period.

5.4.1 Mason Training

Quality of biogas plants depends on the performance of properly trained masons. Therefore, priority will be given to high quality training to the masons. They will be mainly responsible for quality plant construction, proper after-sales-services and maintenance. Besides, masons also are the main biogas promoters in the rural areas. Therefore, they will be given training on construction, maintenance, promotion and slurry utilization. Local person who has at least reading and writing ability and has some experience on masonry works will be selected for the mason training. The training course will be of total 8 weeks including 1 week for theoretical training and seven weeks for on-the-job training under the supervision of a certified master mason. Masons already trained before by some other organizations on masonry works will be given high priority. These masons may not need complete 8 weeks training and as such the total duration can be decided based upon his/her level of competency.

5. 4. 2 Supervisors Training

Since biogas constructors are fully responsible for biogas plant construction and maintenance, the activities of masons will have to be regularly supervised and advised. In this context, well trained and sincere supervisors will be required and the gap will be filled with a well designed supervisor training. This training will focus on supervision skills with sufficient knowledge on biogas construction, quality control and reporting procedures. The course will be of 4 days' duration.

5.4.3 Refresher Training to the Existing Masons

A 2 days' refresher training to the existing masons will be organized in the second and consecutive years. The course will cover reviewing of over all performance on construction in previous year, identification of major areas to be improved, orientation on the changes on construction methods or standards (if any), and dissemination of other relevant information and instructions as necessary.

5.4.4 Refresher Training to the Existing Supervisors

A 2 days' refresher training to the existing supervisors will be organized. The course will cover reviewing of over all performance in previous year, identification of major areas to be improved, orientation on changes on construction methods or quality standards (if any), and dissemination of other relevant information and instructions as necessary.

5.4.5 Management Training

The biogas sector can grow healthy only if the biogas constructors are strong enough to deal with basic management issues efficiently. The manager of the company should have good knowledge on management, marketing and promotion strategies to ensure the company functions effectively. Management training for the managers of biogas plant construction companies is therefore proposed. This training aims to provide knowledge and skills to the managers on marketing techniques and strategies, financial as well as personnel management and total quality management of the company. The training will be of 5 days' duration.

5.4.6 Programme Orientation Training

At the beginning of every year a one-day training/workshop called programme orientation training/workshop will be organized for the managers of all biogas field offices. This training aims to inform all the field managers on new developments and regulatory frameworks. With this training biogas plant constructors will get clear information on the programme and procedures. At the same time the BPO will also have an opportunity to get feedback from field offices on improving its working procedures.

5.4.7 Training of Trainers

One week training for trainers and coordinators of Biogas Users Training will be organized. The training will include topics on training and facilitation methods, planning, organizing, evaluating and managing users training. The trainees for this training, who will be lead trainers in the future, will be selected from amongst biogas constructors, NGOs and if necessary, from financial institutes as well.

5.4.8 Surry Utilization Training

Gas production and utilization for cooking is one of the main purposes of biogas plant construction but at the same time proper utilization of slurry as organic fertilizer is also equally important. Without proper utilization of slurry one can not get optimum benefits from biogas plant. Therefore, to impart knowledge to the users on proper utilization of slurry a 3 days' training on slurry utilization to the staff of biogas constructors, NGOs and agriculture extension workers will be organized. These trained persons will work as resource persons to train biogas users on the importance and methods of composting and slurry utilization.

5.4.9 Loan Appraisal Training

Since biogas loan is a new area for the financing institutes in Bangladesh, a 3 days' training to the staff of concerned financing institutes on the topics such as basics of biogas technology, its benefits and lending procedures will be organized.

5.4.10 Biogas Users Training

The functioning of a biogas plant and its overall efficiency is for a large part determined by how effectively the user is operating and maintaining the plant. Apart from the instructions from the masons and supervisors, groups of female users will be trained on how the plant works, what output can be expected, how to use the slurry and what maintenance activities are required. This one-day training will be organized by the plant constructors in the field to provide factual information to the users.

5.4.11 Gender Mainstreaming Training

Maximum participation of female in the biogas programme will help to disseminate biogas information to the wider sector of households in the rural communities. Since women are the main beneficiaries of biogas; they will have to be well oriented about its usefulness. In this regard, training related to capacity strengthening of women on decision making, dealing with banks on borrowing and repayment of loan, income generating activities linking with biogas, health and sanitation improvement and plant operation and maintenance will be highly essential. All of such training will help to maximize the participation of women in the programme, thus helping them to maintain gender balance.

An overview of training and targeted number of trainees by year is presented in Table – 7.

Table- 7
Target of Training

Type of training	2006	2007	2008	2009	Total
New Mason	100	150	200	250	700
New Supervisor	25	35	50	75	185
Refresher to existing mason	50	150	300	500	1000
Refresher to existing supervisor	-	25	60	110	195
Management training to managers	9	30	45	60	144
Programme orientation to the field staff	25	50	75	100	250
Trainers training	10	20	40	60	130
Slurry utilization training	25	50	80	100	255
Loan appraisal training	-	15	30	30	75
Biogas users (female users)	2,100	4,200	12,150	18,000	36,450
Gender sensitization	-	25	50	100	175
Total	**2,344**	**4,750**	**13,080**	**19,385**	**39,559**

5.5 Slurry Extension

As pointed out earlier, biogas technology has two folded benefits: fuel as energy source and slurry as bio-fertilizer of high nutrient value. The ideas of ecological agriculture as reflected in the concepts of organic farming, natural farming and sustainable agriculture can be considerably enhanced with the adoption of biogas technology. From the points of view of nutrient recycling and sustained agricultural production the use of agricultural and animal wastes as fuel is not a desirable practice.

Application of bio-slurry improves both biological and physical qualities of soil which includes improvement in soil structure, improvement in water holding capacity, lesser soil erosion and provision of nutrients to soil micro-flora including nitrogen fixing and phosphorus solublizing organisms. Being digested the slurry is free from weed seeds.

It has been generally accepted that biogas slurry is a good starter for composting other organic waste materials. Majority of the research has ascertained that with composting the further reduction pathogens/parasitic ova will take place. Thus bio-slurry compost is taken as a product which has higher manurial value for field application and which is safer from health and sanitary point of view. Proper composting of bio-slurry increases both quality and quantity of manure, thus increases agricultural production. The liquid slurry also can be applied directly. Additional application of bio-slurry could be as seed dressing agent and pesticide. Bio-slurry is also used in vermin composting and mushroom production as well as feed fish.

Looking into the importance of bio-slurry as fertilizer, the NDBMP will put high emphasis on maximum utilization of slurry. Maximum number of biogas households will be trained on the method of proper utilization of bio-slurry. The slurry utilization activity will include the following:

- Proper composting methods through training and demonstration
- Proper application methods through training and result demonstration
- Training to the NGO workers and staff of Department of Agriculture
- Integration technique with other income generating activities
- Use of slurry for different purposes other than fertilizer

To carry out these activities, IEC packages such as training manuals, posters, and video-documentary films will be developed and distributed. The slurry extension activity needs high attention thus needs multiple actors. Staff members of biogas constructors are the prime persons who are constantly in touch with biogas users. Therefore, their role on advising and training the users on slurry utilization will be highly effective. It also will be a strong marketing tool for the biogas constructors. Similarly, staff of Department of Agriculture, financing institutes, LGED and local NGOs also can play an important role and they can integrate slurry with other income generating activities as well.

5.6 Institutional Strengthening

One of the objectives of the NDBMP is to strengthen the capacity of partner organizations who are involved in the biogas construction, financing, training, promotion and extension. In this regard, a provision is made to provide financial as well as advisory support to those institutes which will have certain defined stake on the program. These institutes will be supported to develop a long-term vision and planning to continue their stake in a more sustainable manner. Support will be provided for such institutes to build and strengthen their organization in delivering the services. The support will be based on proposal with clear objectives and output submitted by the concern institutes.

5.7 Monitoring and Evaluation

5.7.1 Monitoring

Overall progress (output) monitoring of the programme will be the responsibility of Apex body which will report the progress to concerned Government ministry as per the requirement. The Biogas Steering Committee will conduct this role as long as the Apex body is not established. Day to day (process) monitoring will be done by BPO which will make sure that plants of high quality are being constructed as per the plan and all the stakeholders are performing their roles as per the agreement. It regularly reports (monthly, half yearly and yearly) to apex body and donors in accordance with the prescribed formats.

Both apex body and BPO will monitor the progress as per the indicators presented in Table- 8.

Table – 8
Indicators for Successful Implementation of NDBMP

Activities	Success Indicator
Biogas plants constructed • Number • Construction defaults	Minimum 75% achievement Maximum 10%
Operation and maintenance • Functioning rate • Utilization of plant capacity • Users training	More than 90% Minimum 80% Minimum 80% (at least 75% female)
Institutional development • Number of constructors • Number of appliances manufacturers • Number of biogas lenders	At least 24 companies At least 6 manufacturers At least 12 lenders
Maximization of benefits • Improved sanitation (toilet	Minimum 18% hh

connection) • Saving of fuel wood • Saving of agriculture waste • Saving on dung cakes • Reduction workload • Proper use of slurry	 1,350 kg/hh/year 458 kg/hh/year 368 kg/hh/year 355 hrs/hh/year 70% of the biogas users

While conducting various surveys or studies as part of monitoring process, following studies will be required to get desired information on the impacts of biogas programme:

- Biogas users surveys – every year
- Real cost survey on biogas plants – every year
- Training evaluation – every year
- Slurry utilization and its effectiveness on crop/vegetable production- 2007
- Environmental impact assessment – 2008

5.7.2 Evaluation

An internal assessment will be done by the end of 2007 to review the progress, problems and suggest possible solutions for further improvements. An external final evaluation will be carried out by the end of 2009.

5.7.3 Gender Mainstreaming

Since women are primary users and managers of energy resources, the adoption of biogas technology largely depends on their needs and interests, even though men play primary role in decision-making at the household and community level. Hence, while planning biogas interventions, women's needs and priorities will have to be taken into account. Unless women's energy is accounted for and credited, biogas initiatives are likely to remain passive and unsuccessful. Biogas development will be greatly hampered if the women, as an active human element, so critical factor for sustainable development, are neglected. Ideally, women's active participation in alternative energy initiatives including planning and energy-based socio-economic activities will help women both to become empowered and to sustain the whole biogas system.

The role of women in biogas sector in Bangladesh will be enhanced by involving rural women in the programs as decision makers and by employing women staff to work as motivators. Hence, women will be involved in planning process as decision makers for adopting the technology and selecting appropriate site for biogas plant. For example in this program as primary users, women will be made familiar with the function of the biogas plant; proper method of feeding dung and water; the procedure for removing water from the pipeline; methods of cleaning stove components; and minor repairs like replacement of washer.

In light of the potential role of women in the biogas program, it should be well understood that:

- Adoption of technology will be most effective if local village women are involved in motivating others ; and
- Involvement of women would be greater if mobilized through village level institutions; however, instead of creating new institutions focus should be on utilizing institutions like Mother's groups.

Taking into consideration the above facts a detail plan for gender mainstreaming will have to be prepared and put in operation with the support from gender specialists.

6. Institutional Arrangements

6.1 Apex Organization

As an umbrella organization to coordinate renewable energy on behalf of the Government of Bangladesh, an APEX body will be required (See Annex-2 for institutional set-up). This organization will ensure endorsement of Government's renewable energy policies within the biogas sector. A task that will prove increasingly important for the sector is proper coordination between Government ministries, line-agencies and the stakeholders that have a stake on the biogas sector.

Since Government is in process of developing Renewable Energy Development Agency (REDA) for renewable energy policy, it is suggested to use this organization as an APEX organization for biogas as well. Until the REDA is approved, the IDCOL board in consultation with SNV will constitute a Biogas Steering Committee that will resume the work of APEX organization.

The main responsibilities of the APEX organization will be as follows:

- Coordination among the donors, GOB and renewable energy programmes.
- Policy formulation related to biogas programme
- Instruction/ advising on behalf of government
- Progress reporting to government ministries

6.2 Biogas Steering Committee

There will be a provision of Biogas Steering Committee (BSC) comprising of independent persons and officials from concerned organizations to look after the policy and programme matters related to biogas programme implementation. Tentative members of this committee are proposed as follows:

- One of the Board of Directors of IDCOL or independent person - Chairperson
- Energy professor from reputed University - Member
- Representatives from Gov-3 (MoA, NGOAB, ERD) - Member
- Representative from Palli Karma Sahayak Foundation - Member
- Representative from SNV - Member
- Programme Manager, Biogas Programme Office - Member Secretary

This committee will mainly be responsible to:

- Approval of the partner organizations (PO)
- Approval of the Annual Plan of Biogas Programme
- Endorsement of designs and quality standards of biogas and appliances.
- Decide on any policy and programme related matter which is deviating from the approved plan

Besides the BSC an Operation Committee (OC) will be formed to assist BPO in relation to research and standardization, promotion, training and slurry extension activities. This OC will give its opinion and advices to the programme as and when required. Representatives from partner organizations including concerned staff of BPO will be the member of this committee.

6.3 IDCOL/ Biogas Programme Office

IDCOL, a government undertaking experienced with the SHS-project, will be the main implementing institution. IDCOL is a public limited company managed by an independent Board of Directors. It has managed SHS programme very successfully and has established proper institutional arrangements. IDCOL will be the main responsible organization for the smooth implementation of the NDBMP. In this regard, IDCOL will set up a unit called "Biogas Programme Office" (BPO) and this unit will implement the programme (see Annex-3 for staff structure). All the activities mentioned below will be the responsibilities of BPO which will be implemented in close consultation with SNV/ Nepal and the donors. The main responsibilities of BPO are:

- Subsidy administration
- Quality control and quality management
- Internal monitoring of the programme,
- Maintain and disseminate biogas information
- Channelling of biogas credit and follow up of credit fund administration
- Initiate for any changes on biogas programme policy matters
- Accredit plant construction companies
- Support for strengthening partners organizations

Activities that have to be sub-contracted to other organizations through IDCOL are:

- Slurry extension programme
- Training and capacity building
- Applied research and development (R &D)
- Gender mainstreaming
- Survey and studies

6. 4 SNV-Bangladesh

SNV aims to develop and disseminate domestic biogas in developing countries around the world. With the long and successful experience of SNV in promoting biogas in Nepal and Vietnam, SNV has chosen Bangladesh as one of the potential countries to promote domestic biogas. In this regard, SNV will provide technical advisory services to the programme. In addition, SNV will make available a financial contribution to the programme which is received from DGIS the Netherlands. SNV- Bangladesh will support the NDBMP with the following activities:

- Approval of annual plans and budgets
- Provide biogas subsidy and programme management cost
- Provide technical as well as programme management advices
- Participation in monitoring the programme activities
- Participating in Biogas steering Committee
- Control of funds
- Through the technical assistance, SNV will make available advisor(s) to the programme who will assist for the programme implementation with the advices in the following main areas:
    - Plant/ appliances designing and standardization
    - Quality control procedures
    - Training curriculum and materials development
    - Research and development
    - Slurry extension and promotion methods
    - Any other advices as is required

Since NDBMP in Bangladesh is part of the SNV/Asia Biogas Programme (ABP), the SNV/ Biogas Practice Team Coordinator will be involved in advising on planning, monitoring, implementation and other activities whichever will be required.

6.5 Partner Organizations

There will be 3 types of partner organizations (PO) in the programme implementation level. These PO are: (a) Construction Partner Organizations (CPOs) (b) Manufacturing Partner Organization (MPOs) and (c) Lending Partner Organizations (LPOs). A list of potential partners can be seen in Annex- 8.

6.5.1.a Construction Partner Organization

Considering the construction target and geographical coverage of the biogas to be constructed under the framework of the programme, required number of Plant Construction Partner Organization (CPO) has been proposed. Since plant construction and maintenance needs highly trained technical human resources, it will take some time for the CPO to build their capacity and be fully prepared to take the challenge of quality construction. It is therefore envisaged that gradual inclusion of new CPO in the sector would be beneficial rather than including quite a large numbers of CPOs without building their capacity. Some criteria are set to identify and pre-qualify these CPOs. These criteria are:

- Experience in biogas or similar technology promotion
- Satisfactory management and financial position
- Grassroots involvement in plant construction areas with a well established office
- Good business plan and long-term planning
- Technically trained human resources, preferably from local areas

- Registered as company or NGO with clear mandate to be involved in biogas plant construction

Taking into consideration the above criteria, BPO will invite application from qualified and interested constructors as per need. These applications will be short-listed and based on the approval of Biogas Steering Committee; eligible CPOs will be selected and accredited for plant construction. For the first year of the program (2006) such qualified CPOs will be free to set up their own construction target. However, assuming 300-500 plants per constructer per year, the number of CPOs is proposed as per the Table- 9.

Table- 9
Number of Construction Partner Organizations Targeted

Year	**2006**	**2007**	**2008**	**2009**
No. of company	10	15	20	30

The BPO will not only monitor the activities of the accredited CPOs but also support for developing them as a strong entrepreneur through training, advices, business counseling and other capacity building initiatives.

CPOs will be the main service providers to the client. With technical assistance from BPO, CPOs will improve their professionalism on delivering quality services and marketing business services as per the demand. CPOs will have the following responsibilities:

- Construct good quality biogas plants,
- Provide guarantee and proper after-sales-service to the plant users,
- Provide operation and maintenance training to the users especially to female members at the household level,
- Handover subsidy to the farmers,
- Carry out effective promotion and marketing of the technology in own working areas.

6.5.1.b Manufacturing Partner Organization

Appliances used in biogas plants will be locally produced in Bangladesh as far as possible. However, the appliances require being of superior quality. The appliances used in biogas plant will be: mixer, water drain, gas stoves, gas lamp, gas tap, main gas valve, and gas pipe. Appliances manufacturers will be pre-qualified by the BPO based on their technical capability, human resources, workshop facilities and equipments, quality management system and short and long-term business plans. For the sustainability of these manufacturers and production of quality appliances, they will be monitored closely and their products will be checked regularly for quality control. The number of qualified appliances manufacturers will be increased as per the increment of biogas plants every year. The required number of manufacturers is proposed with the assumption that one manufacturer produces 1,500 -2,000 sets of appliances per year (see, Table – 10).

Table- 10
Number of Appliances Manufacturer Required

Year	2006	2007	2008	2009
No. of manufacturers	2	3	5	8

6.5.2 Lending Partner Organization

NDBMP is targeted to rural households who usually can not afford to pay cash for the construction of biogas plant. Aiming to increase the access of biogas to relatively small(er) farmers, credit provision is highly essential. It is assumed that about 81 percent of the potential biogas households need credit for biogas construction. With this assumption about 29,600 households will require loan. These households can have access of biogas technology only if loan is easily available and is accessible. In this respect lending institutions will play an important role on providing biogas loan to the potential households that will help development and dissemination of biogas technology in rural areas of Bangladesh. It is proposed to make available of a biogas credit fund to IDCOL which will be responsible to disburse this fund to financial institutions as biogas credit under its standard Line of Credit Facility. The eligibility criteria for selecting financial institutes will be as per its standing criteria for Solar Home System (SHS) programme. Potential organizations that can participate in biogas lending business are:

- Microfinance Institutes (MFIs)
- Non Governmental Organizations (NGOs)
- Commercial Banks
- Development Financial Institutes
- Merchant Banks
- Grameen banks/ cooperatives

The required number of biogas lenders including the one who can sign more than one agreement is proposed with the assumption that one lender can provide loan for 600 to 800 biogas households. The target set per year is as per Table – 11.

Table- 11
Number of Lenders Required

Year	2006	2007	2008	2009
No. of biogas lenders	3	6	10	15

The role of lending organizations will be:

- To identify potential biogas household
- To approve required credit (not exceeding the approved plant cost)

- To verify plant construction against the set standards and recommend endorsing the plant completion report
- To report to IDCOL on loan disbursement and request for reimbursement.

Organizations that are interested to participate in both construction and lending activities are also welcomed but they have to fulfill the criteria for both organizations.

6.5.3 Biogas Households

Desire of plant construction of supporting organizations will not be fulfilled unless potential users are ready for plant construction. Successful construction will heavily depend on the role of biogas household members. Biogas households' role will be:

- To show readiness for plant construction
- To fulfil basic technical requirements for plant construction
- To show readiness to pay up-front cost
- To maintain regular operation/feeding of the plant
- To carry out regular minor repair and maintenance
- To repay loans on time or pay in cash

Plant constructors and/ or financing institutions will have to access the capacity and readiness of the household based on the above criteria before selecting as a potential biogas customer. The household members will have to be properly informed about the above conditions and only have to proceed on for biogas construction once they are ready for these activities.

7. Programme Financing

7.1 Biogas Plant Cost

Quality plays a vital role while determining the cost of biogas plants. Biogas plant cost is very important for both households and companies. It will be difficult to promote expensive technology as a commercial product to the rural poor and at the same time biogas constructors may not be willing to be involved in this business if there is no profit. In this situation biogas cost has to be determined in a careful manner.

It is proposed that in the beginning of every year BPO will contract a competent independent consultant to conduct a biogas cost survey based on the standard bill of quantity. (see Annex - 4). The cost proposed by the consultant has to be discussed in the Biogas Steering Committee prior to giving approval on the proposal. Each of the recognized biogas constructors will have to follow the approved price list. This system safeguards the constructors from unhealthy competition among them and maintains a uniform price everywhere. While determining the cost of biogas plants, actual materials cost, labor costs and company service charge will be considered as total plant cost. The subsidy and farmers labor contribution (if any) then may be deducted from the total cost and remaining net cost shall be charged to the farmers.

7.2 Subsidy Requirement

The total amount of subsidy required, using the subsidy rate of Taka 7,000 per plant for the entire programme period to construct 36,450 plants, is Taka 248 million (Euro 3,098,250)

Estimated subsidy requirement for NDBMP (2006 – 2009) by year is presented in Table – 12.

Table -12
Subsidy Requirement (in Euro)

	2006	2007	2008	2009	Total
Construction target	2,100	4,200	12,150	18,000	36,450
Subsidy requirement	178,500	357,000	1,032,750	1,530,000	3,098,250

7.3 Credit Requirement

It is estimated that about 81 percent of the potential households will require loans to construct biogas plant. The number of households requiring loan will be less during the initial years and is expected to increase gradually. The amount of loan required for biogas programme is calculated based on the following assumptions:

- Since subsidy rate is fixed for the entire programme period, the loan requirement may be increased only if the cost of plant is increased. Therefore, the average loan size is calculated taking into account of annual 7 percent increment on current biogas cost. The average loan size is considered to be Taka 15,500 in 2006.

- The outcome of the recent survey report does not give high emphasis on credit, however, it is considered that the sample households were early adopters and were relatively rich family. High subsidy was given in the past, thus credit was not required and there was no credit provision as well.
- Since the NDBMP gives high emphasis on high level functioning rate of constructed plants with high quality construction and standard materials, the cost may be increased. The subsidy is also lower than the previous rates. Therefore, credit will be required. (See Annex- 13 for detail calculation).

Based on the above assumptions estimated credit requirement for the programme is presented in Table -13.

Table – 13
Estimated Credit Requirement for the Entire Programme Period by Year

	2006	2007	2008	2009	Total
Total construction target	2,100	4,200	12,150	18,000	36,450
Plants through Cash (no.)	1,198	944	2,450	3,001	7,593
Plants through loan (no.)	902	3,256	9,700	14,999	28,857
Total loan requirement **Taka**	13,981,000	54,000,760	172,136,000	284,794,852	524,912,612
Euro	**174,762**	**675,009**	**2,151,700**	**3,559,935**	**6,561,406**

The total investment on biogas including interest on biogas loan can be recovered within 4-5 years. Therefore, the duration of loan from PO to the households is proposed to be 5 years. For this purpose, a biogas credit revolving fund can be created and the fund will be utilized for biogas construction even after the project period. It is expected from donor (KfW) that a total Euro 6.6 million shall be available as a grant to IDCOL through GOB. This grant fund will be used as biogas loan to the biogas households. IDCOL will make available this credit fund to the approved PO for the period of 7 years including 1 year grace period with 6 percent interest rate on declining balance. Further PO will provide biogas loan to the biogas households and interest rates to the households is proposed to keep open expecting that the market competition will determine the rates. However, as the programme is targeted to relatively smaller farmers, it is proposed that interest rate should not be higher than 16 percent to biogas households.

7.4 Programme Budget

The total budget required to implement the NDBMP over 4 years will be Euro 14.9 million. The budget includes subsidy, credit, programme management cost, technical assistance and biogas household contributions. The component-wise budget breakdown is presented in Table – 14. Detail activity budget can be seen in Annex-12.

Table- 14
Total Budget Required for the Programme

Budget in Euro

	Description	2006	2007	2008	2009	Total
1	Subsidy	178,500	357,000	1,032,750	1,530,000	3,098,250
2	Credit	277,866	637,107	2,103,550	3,542,883	6,561,406
3	Programme Cost	340,825	421,500	496,900	582,000	1,841,225
4	SNV Technical Assistance	175,000	175,000	175,000	175,000	700,000
5	Households Contribution	183,110	349,381	949,982	1,297,531	2,780,004
	Total	**1,155,301**	**1,939,988**	**4,758,182**	**7,127,414**	**14,980,884**

7.5 Budget Sources

Out of the total amount required for implementing the programme, Government of Netherlands/DGIS will provide Euro 4.50 million for subsidy and programme operation cost whereas Government of Bangladesh is expected to contribute about Euro 0.43 million on part of subsidy at the rate of 14 percent of total subsidy amount. Taking into account the time for programme approval in 2006, the GOB contribution on subsidy will be effective from 2008 onwards. The source wise contribution is presented in Table -15.

Table-15
Budget Source

Source	Purpose	Euro				
		2006	2007	2008	2009	TOTAL
Biogas Households	Investment	183,110	349,381	949,982	1,297,531	2,780,004
GoB	Subsidy	-	-	172,513	265,450	437,963
DGIS		178,500	357,000	860,237	1,264,550	2,660,287
(KfW)?	Credit	277,866	637,107	2,103,550	3,542,883	6,561,406
SNV	TA	175,000	175,000	175,000	175,000	700,000
DGIS	Programme management	340,825	421,500	496,900	582,000	1,841,225
		1,155,301	**1,939,988**	**4,758,182**	**7,127,414**	**14,980,884**

7.6 Carbon Financing Opportunities

Households without biogas are mainly using fuel wood, dung cakes, and agriculture residues for cooking which emit high amount of green house gases to the atmosphere. Being a clean energy, use of biogas replaces this traditional biomass and reduces significant amount of

green house gas emission to the atmosphere. The reduced amount of green house gas can be sold to the international market under Kyoto Protocol, Clean Development Mechanism (CDM) and can generate significant amount of fund that can be utilized for further development of biogas programme after the programme period. Tentatively one biogas plant, if functions properly, can reduce about 2.5 tones of CO_2 per year. If 36,450 plants are constructed and 90 percent are in operation about 820,125 tones of CO_2 is reduced by which about 500,000 Euro (@ of Euro 6 per ton) can be easily generated every year. Therefore, emphasis has to be given to start this carbon credit scheme right from the beginning of the programme.

Since the pre-conditions of being eligible for CDM project, the ratification of Kyoto Protocol and nomination of Designated National Authority (DNA), are met by the Government of Bangladesh it will be easier to develop biogas as a CDM project and implement from the beginning. There are some technical issues on bundling small bio gas projects as one project, determinationof project boundaries of one kilometer distance and removal of non-sustainable biomass for CDM financing are to be clarified yet but more likely CDM Executive Board will find out ways to resolve these issues and will come out with a new methodology soon. Carbon fund can be an attractive and sustainable source of funding that will enable to continue the programme even after 2009 without external financial support.

8. Assumption and Risks

8.1 Assumptions

Supportive factors such as existence of a huge potentiality, an urgent need of alternative rural energy source, direct link with poverty reduction and association with attaining millennium development goals, make the biogas programme highly attractive to the Government of Bangladesh. Taking into account these facts and a lot of initiations and efforts taken in the past, it is assumed that the NDBMP will get full support from Government of Bangladesh. The programme is planned assuming that Government of Bangladesh will approve this programme before March 2006 and also contributes partial fund for subsidy. The stakeholders, who had lots of experience in the past and tremendous capacity to expand the technology, are also expected to be actively participating in the programme. Stakeholders will not only participate in the programme but will also be more quality and service oriented so that biogas users can get maximum benefits from biogas plants.

The source of credit fund required for the programme is not yet defined. It is assumed that the fund will be available by the donor (KfW) in the second half of 2006.

8.2 Risks

The credit fund for biogas households is highly required. However; the source of funding is not yet decided. In case credit fund is not available, the targeted number of biogas plants will be difficult to achieve.

IDCOL is identified as the programme implementing organization, which has proven records of success in solar programme but it does not have any experience with biogas. Establishing a biogas programme unit within the organization and capacitating this unit for continuing the biogas programme even after the programme period is also a challenge for the programme.

The occasional flooding in Bangladesh will squeeze the potential market of biogas. It will also add threats to already constructed plants if the high flood level exceeds its limit. Careful design of plant and judicious selection of construction sites will minimize this risk.

21 percent of the biogas plants constructed in the past are not functioning at all. It has passed a negative message on the usefulness of biogas to the community. This negative impact may cause a hindrance for production and hence, needs careful attention on repairing the old non-functioning plants.

Since there is abundant natural gas reserve in Bangladesh, the Government of Bangladesh may decide to supply the natural gas to the rural communities. If it happens, it will affect biogas production and also operation. Therefore, programme should focus more on those areas where supply of other energy sources is likely to be scarce in coming future.

Per household cattle population over the years is in declining trend. Even there are no major livestock development initiatives being implemented from the government side to check this rate of declining. If this trend continues, available dung will not be sufficient to operate biogas plant. Therefore, measures should be taken to make smaller size plants and also encourage farmers to connect toilet. Increasing price and sometime shortage of construction materials may also hampers the production.

The involvement and support from government in the biogas sector has been a matter of considerable concern. A degree of government ownership is critical to the long-term survival and sustainability of the sector. Therefore, an apex body that looks after the renewable energy sector in terms of policy formulation and overall regulation needs to be set up.

Coordination between sector institutions on program interventions, implementing and monitoring has not been seen to be effective in the past. It needs to be made more efficient. Biogas activities need to be coordinated and monitored effectively with the combined efforts of sector stakeholders.

9. Programme Implementation Arrangements

9.1 Implementation Strategies

9.1.1 Integration of Biogas with Other Activities

It is often expressed that biogas does not generate direct income and therefore low income people are not in a position to afford to harness this technology. In fact, biogas can be linked up easily with direct income generation activities through integrating it with agriculture, fisheries and livestock initiatives. For generating income, slurry has to be used properly as composted organic fertilizer to increase crop and vegetable production. Similarly, the liquid slurry can be used as feeding materials (algae growing catalyst) for fish. Such organic production may have higher value than other similar production which helps to increase income level of farmers. Hence, there exist promising possibilities for networking and coordinating biogas program with other institutional sectors like dairy farms, poultry farm association, fish farm association etc. for optimal use of slurry so that users will experience financial benefits. This integration approach will help to address the national objective of poverty reduction as well.

9.1.2 Maximum Utilization of Existing Masons

During the implementation of biogas program under the framework of BCSIR and LGED, about 1,600 masons were trained and involved in biogas construction and maintenance responsibilities throughout the country. Some of them are still being involved in biogas construction but many of them are without work at present. It would be worth to utilize these skilled and experience persons in biogas construction with some additional training especially on quality aspects. It would be even better to encourage them to establish biogas companies and start plant construction. This will save time and resources to train other fresh masons. Moreover, these trained personnel can immediately take over the responsibilities of plant construction once orientation is provided to them.

9.1.3 Institutionalization and Strengthening of Biogas Constructors for Commercialization

The biogas sector has to be developed as a commercially viable and market oriented industry so that private sector continues biogas construction in future even without external support. In this context, biogas constructors have to be developed as strong entrepreneurs and have to be strengthened in this line from the very beginning of project implementation. One of the major efforts of this program will be to facilitate these constructors to become institutionalized and to strengthen their capabilities to take up any role related to dissemination of biogas technology in the country.

9.1.4 Repair and Maintenance of Existing Plants

The recent study reveals that 21 percent of the biogas plants are not at all functioning because of various defects. Another 32 percent are functional but these plants too have series of defects. It is pity that these households have lost their investment in vain. Moreover, the non-functional plants are spreading negative messages to the potential users. In such circumstances, it is necessary to repair these plants as immediately as possible to make them operational so that the investment of biogas households pays back anticipated benefits to them in one hand and in the other acts as promotional tool. This activity helps households to get benefit of biogas with additional investment of small amount and also creates good image among the communities. Households may be ready to pay small amount to make their plant operational.

9.1.5 Enforcement of Quality Control System

Quality control system will have to be implemented strictly to safeguard the interest of the biogas households. Especially, at the beginning of the programme, strict enforcement of quality control system will be highly required so that the biogas constructors realize the importance of quality control and incorporate it in their management system.

9.1.6 Encouragement of Toilet Attached Smaller Sized Biogas Plants

A declining trend of cattle population per household over the past years imposes high risk for biogas program for wide-scale dissemination of the technology. Taking this risk into account, smaller sized biogas plants will have to be promoted and household will have to be encouraged to connect toilet with biogas plants to supplement even a small quantity of feeding to minimize the risks of under-feeding and plant failure. Toilet connection will not only help to produce more gas but also contributes to better hygiene and sanitation.

9.1.7 Initial Geographical Coverage

The biogas plant construction will be started from the districts that fulfill the following criteria. Once the programme implementation modalities and institutional arrangements are fully established, the construction coverage will gradually be expanded. Main criteria for selecting initial construction areas will be as follows:

- Districts with higher cattle population per household
- Districts with less vulnerability due to monsoon floods
- Districts with easy access to construction materials
- Districts without other energy sources

With the above criteria, initial working districts are proposed as given in Annex- 7.

9.2 Financial Disbursement

Each year BPO will prepare a detail programme and budget and submit them to the apex body/BSC and DGIS through SNV for approval. Upon approval of the plan and budget, SNV will transfer the approved budget 3 months in advance to the account of BPO. For this purpose BPO will open a separate bank account for biogas programme. Upon submission of expenditure statement, BPO will request SNV for disbursement of next 3 months budget. The budget can be reviewed half-yearly and can be adjusted accordingly.

It is also expected that the GOB releases the approved budget for the biogas subsidy to BPO in accordance with the prevailing procedures.

The biogas credit fund disbursement procedure shall be determined in separate document.

9.3 Reporting

Regular monthly financial reports, half yearly and yearly progress reports will be prepared and submitted by the BPO to Apex body/BSC and SNV through its apex organization in accordance with the prescribed formats.

9.4 Auditing

Auditing of programme expenditures from the DGIS fund will be done by registered chartered accountants every year. The auditor will be appointed by SNV.

ANNEXES

Annex- 1

List of References

Adhikari, Purna K. *A Case study of Biogas at Lamjung District*, Kathmandu, 1996.

Aktaruzzaman, Kaji, *Biogas Pilot Plant Projects. Background, Objectives and Achievements.* Bangladesh Council of Scientific and Industrial Research, Dhaka, June 2003

Ali, Monshof, *The Use and Status of Biogas Plants of Pabna District in Bangladesh*. (M.Sc. Thesis) March 2005

Asaduzzaman, M and Latif, A. *Study Report on Energy for Rural Households- "Towards a Rural Energy Strategy in Bangladesh"* prepared for World Bank- 2005.

Bangladesh Bureau of Statistics, *Statistical Pocketbook of Bangladesh 2002*. Dhaka, November 2004.

Bangladesh Bureau of Statistics, *Statistical Pocketbook of Bangladesh 2003*. Dhaka, January 2005.

Bangladesh Bureau of Statistics, *Report of the Household Income & Expenditure Survey 2000*. Dhaka, March 2003.

Bangladesh Centre for Advance Studies, *Feasibility Study on Biogas from Poultry Droppings (Draft Final)* 18 September 2005.

Bangladesh Council of Scientific & Industrial Research and Local Government Engineering Department, *Memorandum of Understanding for Research, Training and Dissemination of Biogas technology.* Dhaka, 8 October 1997.

Bangladesh Council of Scientific & Industrial Research, *Project Performa for Project: Biogas Pilot Plant (2nd Phase).* Dhaka, June 2001.

BRAC Development Programme, *Project Proposal for Biogas Pilot Project, draft*) September 2001.

Government of the People's Republic of Bangladesh, Planning Commission, *Unlocking the Potential, National Strategy for Accelerated Poverty Reduction, Draft Revised*. January 12, 2005.

Grameen Shakti, *Construction of 200,000 Biogas Plants to Save the Health, Wealth and Environment.* Dhaka.

Gurung, Jit Bahadur. *Review of Literature on Effects of Slurry Use on Crop production*. Biogas Support Programme, Kathmandu. June 1997

HMG/Nepal and SNV/Nepal, *Proposal Biogas Support Programme Phase III.* Kathmandu, February 1996

Infrastructure Development Company Ltd, *Project Implementation Plan for Solar Home System.* April 20, 2002

Infrastructure Development Company Ltd, *IDCOL's Renewable Energy programme*. Undated

Keizer, Cecilia. *Effects of biogas on the workload of women from a gender perspective*. SNV/Biogas Support Programme, Katmandu, March 1994

Nepal Health Research Council. *Situation Analysis of Indoor Air Pollution and Development of Guidelines for Indoor Air Quality Assessment and House Building for Health.* Katmandu, July 2004.

Sinha M.H and Rahaman M.M, *Environmental Management Practices of Poultry Waste*. Bangladesh Poultry Sector Development Project, 2005.

SNV/IDCOL, *Technical Study of Biogas Plants Constructed in Bangladesh.(Draft report*) October 2005

SNV/Nepal, *Programme Support to Nepal's Renewable Sector, Volume II, Support to the Biogas sub –sector, final Proposal.* December 2001.

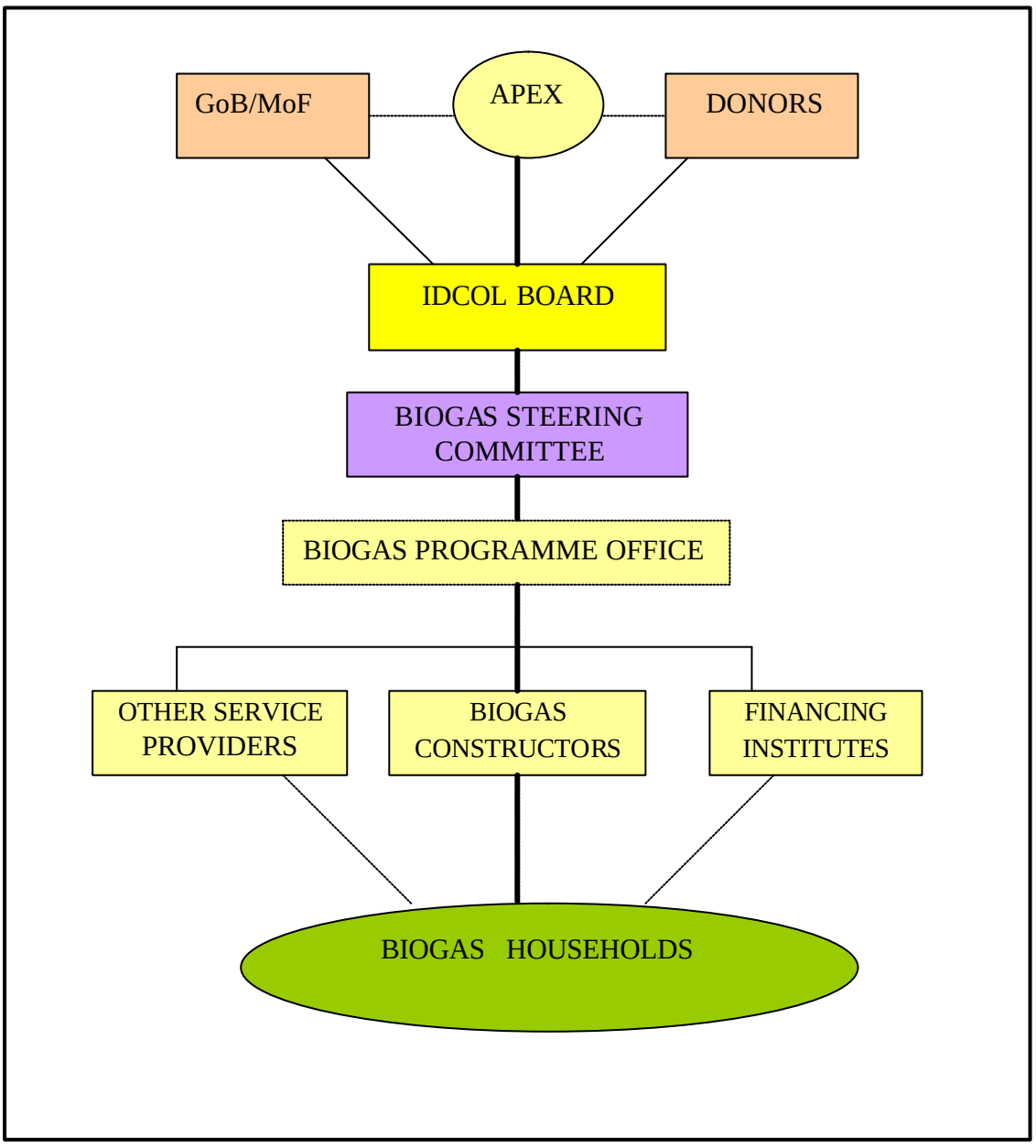
The World Bank, *Attaining the Millennium Development Goals in Bangladesh*. February 2005.

van Nes, Wim J. et.al. *Feasibility of a national programme on domestic biogas in Bangladesh*. Netherlands Development Organisation, Biogas Practice Team, the Netherlands, August 2005.

Annex- 2

National Domestic Biogas and Manure Programme

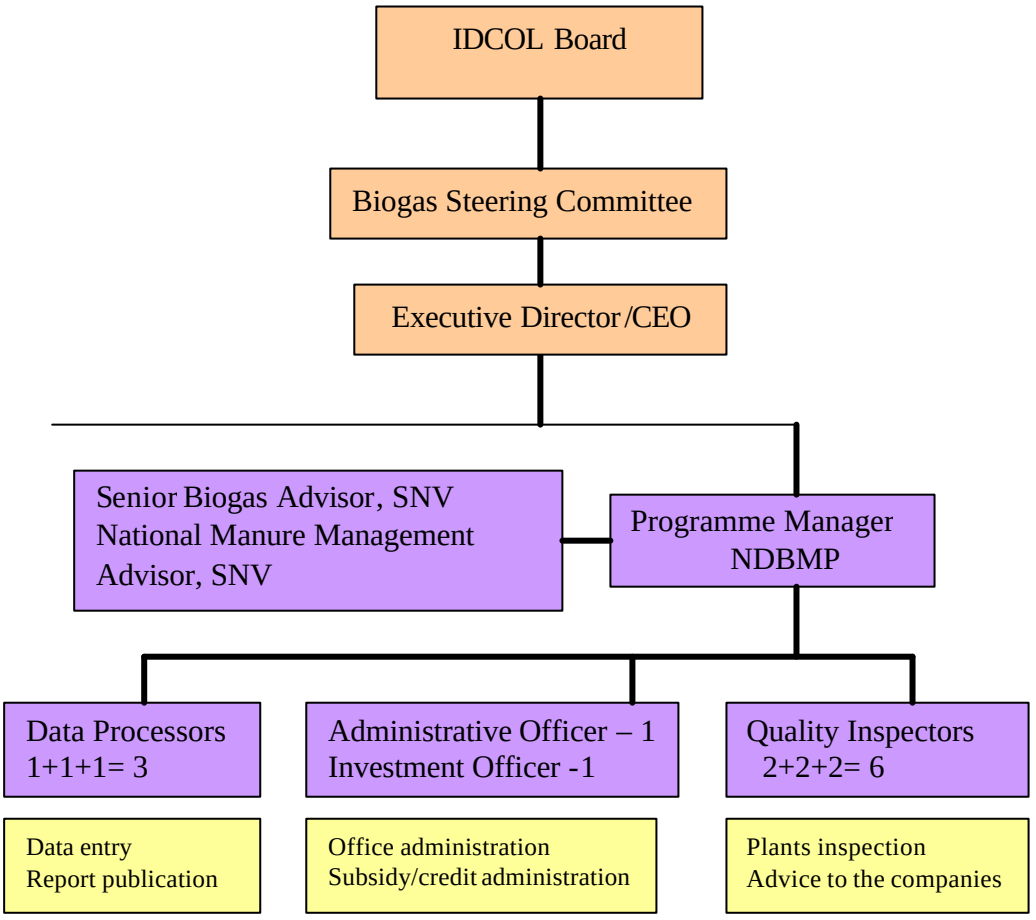
INSTITUTIONAL SETUP



Annex- 3

National Domestic Biogas and Manure Programme

STAFF STRUCTURE



+ indicates that every year required no. of staff will be added

Annex- 4

Estimated Bill of Quantities of Materials for Biogas Plants

(Size in m^3 gas production cattle dung based)

Items	Unit	1.2	1.6	2.0	2.4	3.2	4.8
Building materials							
bricks	piece	850	934	1124	1246	1470	1886
sand	m3	1.3	1.5	1.7	1.9	2.3	3.0
aggregate (khoa)	m3	0.28	0.34	0.42	0.48	0.62	0.88
cement (50 kg)	bag	11	13	15	16	20	26
rod for slabs (10mm)	kg	8	10	13	16	22	36
emulsion paint	liter	1	1	1	1	2	2
teflon tape (10 m)	roll	2	2	3	3	4	5
GI wire # 10	kg	1	1	1.5	1.5	2	2
polythene sheets	mtr	3	3	3	3	3	3
Construction labor							
masonry work	days	6	7	8	9	10	13
skilled labor		6	7	8	9	10	13
unskilled labor	days	12	15	17	19	24	32
Pipes & appliances							
mixer device	piece	1	1	1	1	1	1
inlet pipe (PVC 4")	mtr	4	4	5	5	6	6
centre gas pipe(1.5")	piece	1	1	1	1	1	1
GI gas pipe (0.5")	mtr	12	12	12	12	12	12
GI socket/elbow	piece	8	8	8	9	13	14
GI tee 1/2"	piece	1	1	1	1	2	3
GI nipple 0.5" * 2"	piece	3	3	3	3	4	4
main gas valve	piece	1	1	1	1	1	1
water drain	piece	1	1	1	1	1	1
gas tap	piece	1	1	1	2	2	3
flexible gas pipe	mtr	1	1	1	2	2	3
gas stove	piece	1	1	2	2	2	3
Maintenance fee	**Taka**	**700**	**700**	**700**	**700**	**700**	**700**
Comp. serv. charge	**Taka**						
Total cost of plant							
farmers (labor) contribution (-)	Taka						
subsidy(-)	Taka						
net cost to be paid by household	**Taka**						

* Gas lamp can be added if user wants light. Additional pipe may be requiring if more than one house use gas.

Annex- 4

Estimated Bill of Quantities of Materials for Biogas Plants

(Size in m^3 gas production poultry litter based)

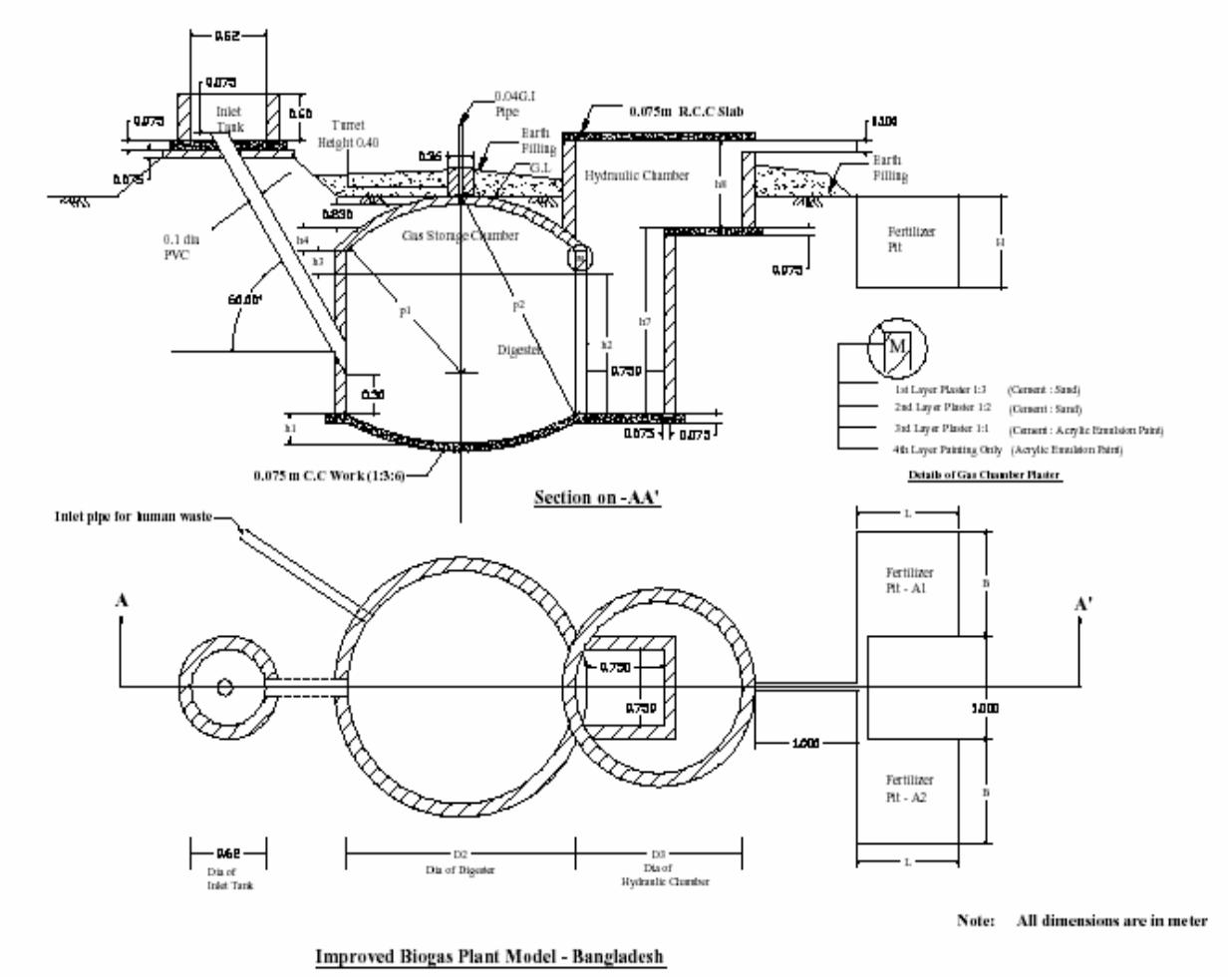
Items	Unit	1.2	1.6	2.0	2.4	3.2	4.8
Building materials							
bricks	piece	770	900	1020	1130	1334	1726
sand	M3	1.2	1.4	1.6	1.8	2.1	2.8
aggregate (khoa)	M3	0.25	0.30	0.40	0.50	0.60	0.85
cement (50 kg)	bag	10	12	14	15	18	25
rod for slabs (10mm)	kg	8	11	14	17	24	41
emulsion paint	liter	1	1	1	1	2	2
teflon tape (10 m)	roll	2	2	3	3	4	5
GI wire # 10	kg	1	1	1.5	1.5	2	2
polythene sheets	mtr	3	3	3	3	3	3
Construction labor							
masonry work	days	6	7	8	9	10	12
skilled labor		6	7	8	9	10	12
unskilled labour	days	10	12	14	16	20	26
Pipes & appliances							
mixer device	piece	1	1	1	1	1	1
inlet pipe (PVC 4")	mtr	4	4	5	5	6	6
centre gas pipe(1.5")	piece	1	1	1	1	1	1
GI gas pipe (0.5")	mtr	12	12	12	12	12	12
GI socket/elbow	piece	8	8	8	9	13	13
GI tee 1/2"	piece	1	2	2	2	3	3
GI nipple 0.5" * 2"	piece	3	4	4	5	6	6
main gas valve	piece	1	1	1	1	1	1
water drain	piece	1	1	1	1	1	1
gas tap	piece	1	1	2	2	2	3
flexible gas pipe	mtr	1	1	2	2	2	3
gas stove	piece	1	1	2	2	2	3
Maintenance fee	**Taka**	**700**	**700**	**700**	**700**	**700**	**700**
Comp. serv. charge	**Taka**						
Total cost of plant							
farmers (labor) contribution (-)	Taka						
subsidy(-)	Taka						
net cost to be paid by household	**Taka**						

* Gas lamp can be added if user wants light. Additional pipe may be requiring if more than one house use gas.

Annex- 5

Proposed Plant Design

(A detail report on design can be available on request.)



Note: All dimensions are in meter

Improved Biogas Plant Model - Bangladesh

Annex- 6

Number of Plants Constructed by Organizations
(1971 – 2005 December)

Organization	No. of plants
Bangladesh Council of Scientific and Industrial Research	22,072
Local Government Engineering Department	1,342
Department of Environment	260
Bangladesh Rural Advancement Committee	80
Department of Livestock	70
Grameen Bank/Grameen Shakti	120
Bangladesh Small & Cottage Industries Corporation	90
Bangladesh Agricultural Development Corporation	20
Danish International Development Agency	10
Bangladesh Agriculture University	2
Housing and Building Research Institute	2
Bangladesh Academy for Rural Development	1
Bangladesh Commission for Christian Development	1
Bangladesh Agricultural Research Institute	1
Bangladesh Rice Research Institute	1
Others	200
Total	**24,272**

Sources: Van Nes, Wim, et. al. 2005 and BCAS 2005

Annex-7

Initial Districts Identified for Biogas Construction

Division	District
Barisal	Patuakhali
Chittagong	Cox's Bazar
	Brahmanbaria
Sylhet	Sylhet
	Sunamganj
Khulna	Khulna
	Jhenaidah
	Jessore
	Magura
	Narail
Dhaka	Jamalpur
	Sherpur
Rajshahi	Dinajpur
	Naogaon
	Bogra
	Sirajganj

Annex- 8

List of Potential Partners for NDBMPExecution

1. Bangladesh Centre for Advance Studies (BCAS)
2. Bangladesh Council of Scientific Industrial Research (BCSIR)
3. Bangladesh Rural Advancement Committee (BRAC)
4. Bangladesh University of Engineering and Technology (BUET)
5. Dairy Farms Association (DFA)
6. Department of Agricultural Extension (DAE)
7. Department of Livestock Services (DLS)
8. Fish Farms Association (FFA)
9. Grameen Shakti (GS)
10. Local Government Engineering Department (LGED)
11. Micro Finance Institutes (MFIs)
12. Local Non-Governmental Organizations (NGOs)
13. Pali Karma Sahayak Foundation (PKSF)
14. Plant Construction Agency Holders (PIAH)
15. Poultry Farms Association (PFA)
16. Procounsil Sansad Pvt. Ltd (PSA)
17. Biogas Companies (BC)
18. SUBASHATHI

Annex-9

Pre-Construction Form
(Form to be filled -up by CPO before plant construction)

This form has to be filled-up by the constructors asking the following questions to the household owners and also observing the household premises by the staff of constructors. The purpose of this form is to make sure that the plant size is correct, feeding materials are adequately available and plant functioning in longer period is assured. Once the form is filled up, constructor will have to send it to the BPO and get approval before construction.

1	Name of the household head	
2	Address	
3.	No. of family members	
4.	No. of cattle or poultry birds	Cattle (cow/buffalo): ------ Poultry birds: -------
5.	Do hh wants to connect toilet?	Yes --- No ---
6.	How much dung is available per day?	Cattle dung: ------- Kg Poultry droppings ------Kg
7.	Gas requirement?	Cooking ------hours/day Lighting ------hours/day
8.	Proposed plant size	---------- m3 gas production
9.	How many houses use the gas if distributed to other hh?	------ house
10.	Estimated total cost (deducting subsidy)	------ Taka
11.	Do hh require credit for plant construction?	Yes--- No---
12.	If credit required, how do they manage?	-----

Annex- 10

Plant Completion Report
(To be filled out by CPO at plant site)

Reporting date:	BPO file No:
Construction starting date:	Completion date:
CPO Code:	Plant size: m^3
Construction PO Name:	
Full name of mason:	Mason reg. no:

Name of plant owner:		
Address:	Mouza	UpZilla
District:		

No of cattle/birds:	Total available dung:
No of family members:	Toilet constructed: Yes/ No/ Planned

Bags of cement used:	(including/not including toilet)
No. of burners installed:	Brand name:
Main gas valve brand name:	Dome gas pipe brand name:
Gas tap brand name:	Water drain brand name:
Gas pipe quality:	Sealing agent: Teflon tape/zinc putty /other
Mixer machine: Yes/No	Brand name:
Compost pits: Yes / No	If yes, no of pits: One/ Two/ three

Total investment cost:	Investment: Loan / Cash
Name of financial institute (if loan):	
Loan amount:	Down payment:
Subsidy:	Date of sales contact:

Instruction book provided: Yes / No	Instruction book serial no:
Guarantee card provided: Yes / No	If Yes, date of Issue:

All information mentioned is correct and complete.

Signature of plant owner:
Report filled out by: Designation:
Signature:
Signature of CPO manager:
Seal of office

Annex- 11

Activities vs. Executing Institutions

Institutions	Promotion	Subsidy administration	Training	Quality control	Monitoring	Research and development	Policy formulation /coordination	Credit administration	Quality standard	Slurry extension	Survey/evaluation
Apex body					sss		iii				
BSC						sss	sss		iii		sss
IDCOL	Sss	iii	sss	iii	Iii	sss	sss	sss		sss	sss
Fin Ins	Sss							iii			
Constructors	Iii	sss	iii	sss			sss		sss	iii	
LGED	Iii		iii							sss	
NGOs/DoAE	Iii		iii							iii	
BCSIR			sss			iii					
Consultants						iii					iii

Implementing role

Supportive role

Annex-12

Budget Required for National Domestic Biogas and Manure Programme

Programme Cost

All figures are in EURO

Budget Code	Activities	2006	2007	2008	2009	Total
A	Promotion	214,500	399,000	1,077,750	1,578,000	3,269,250
B	Quality control	35,000	55,000	68,000	80,000	238,000
C	Research & standardization	35,000	32,000	35,000	37,000	139,000
D	Training	34,525	50,500	90,000	110,000	285,025
E	Slurry extension	31,300	35,000	44,000	50,000	160,300
F	Monitoring/ studies/evaluation	25,000	50,000	40,900	65,000	180,900
G	Institutional strengthening	19,000	22,000	25,000	27,000	93,000
H	Programme management	112,000	120,000	132,000	145,000	509,000
I	Gender mainstreaming	13,000	15,000	17,000	20,000	65,000
	Grand Total	**519,325**	**778,500**	**1,529,650**	**2,112,000**	**4,939,475**

Detail Budget Breakdown
(In Euro)

A. Promotion

Activities	2006	2007	2008	2009	Total
Promotion materials	6,000	7,000	8,000	9,000	30,000
Radio/TV/Newspaper	4,000	5,000	6,000	6,000	21,000
Networking	7,000	8,000	8,000	9,000	32,000
Orientation class	12,000	14,000	15,000	16,000	57,000
Other activities	7,000	8,000	8,000	8,000	31,000
Subsidy	178,500	357,000	1,032,750	1,530,000	3,098,250
sub-total	**214,500**	**399,000**	**1,077,750**	**1,578,000**	**3,269,250**

B. Quality Control

Activities	**2006**	**2007**	**2008**	**2009**	**Total**
New plant (No)	*630*	*1,260*	*3,645*	*5,400*	*10,935*
After sales service(N0)	-	*420*	*1,260*	*3,270*	*4,950*
Total plants(N0)	-	*1,680*	*4,905*	*8,670*	*15,885*
Control cost	20,000	50,000	65,000	76,000	211,000
Other cost	15,000	5,000	3,000	4,000	27,000
Total cost	**35,000**	**55,000**	**68,000**	**80,000**	**238,000**

C. Research and Standardization

Activities	**2006**	**2007**	**2008**	**2009**	**Total**
Plant design and standards	14,000	1,000	1,000	1,500	17,500
Slurry utilization	6,000	7,000	6,000	7,000	26,000
Optimum gas utilization	0	5,000	6,000	0	11,000
Cost reduction	0	6,000	8,000	5,000	19,000
Appliances development	9,000	3,000	2,000	2,000	16,000
Others	6,000	10,000	12,000	21,500	49,500
Total	**35,000**	**32,000**	**35,000**	**37,000**	**139,000**

D. Training

Activities	**2006**	**2007**	**2008**	**2009**	**Total**
New mason	4,000	6,000	8,000	9,000	27,000
New Supervisor	750	1,050	1,500	1,500	4,800
Ref. mason	1,000	3,000	6,000	1,000	11,000
Ref supervisor	-	375	900	1,500	2,775
Mgt training	900	3,000	4,500	6,000	14,400
Pr. Orientation	375	1,500	2,400	3,000	7,275
Training of Trainers	1,000	2,000	4,000	5,000	12,000
Slurry utilization	500	1,000	1,600	2,000	5,100
Loan appraisal	-	1,125	2,000	2,200	5,325
Biogas users	10,500	21,000	53,000	72,000	156,500
Gender sensitization	0	1,250	2,500	3,000	6,750
Study tour	9,000	7,500	2,000	2,000	20,500
Training materials	3,000	500	600	800	4,900
Other costs	3,500	1,200	1,000	1,000	6,700
Total cost	**34,525**	**50,500**	**90,000**	**110,000**	**285,025**

E. Slurry Extension

Activities	2006	2007	2008	2009	Total
Slurry orientation	10,500	20,000	30,000	35,000	95,500
Extension materials	4,200	4,200	5,000	5,000	18,400
Result demonstration	3,200	3,000	2,000	2,000	10,200
Methods demonstration	3,200	2,000	2,000	2,000	9,200
Company/NGO staff	1,800	2,000	3,000	3,000	9,800
Farmers visits	900	1,200	1,200	1,500	4,800
Other costs	7,500	2,600	800	1,500	12,400
Total cost	**31,300**	**35,000**	**44,000**	**50,000**	**160,300**

F. Monitoring and Evaluation

Activities	2006	2007	2008	2009	Total
Biogas users survey	8,000	9,000	9,000	10,000	36,000
Real cost survey	5,000	5,500	6,000	6,500	23,000
Environmental impact assessment	-	-	16,000	5,000	21,000
Training evaluation	3,000	7,000	-	7,000	17,000
Slurry impact/utilization	6,000	6,000	-	6,000	18,000
Evaluation	-	15,000	-	20,000	35,000
Field visit for monitoring	3,000	6,000	7,000	8,000	24,000
Others	-	1,500	2,900	2,500	6,900
Total	**25,000**	**50,000**	**40,900**	**65,000**	**180,900**

G. Institutional Support

Activity	2006	2007	2008	2009	Total
Support to partner organizations	**19,000**	**22,000**	**25,000**	**27,000**	**93,000**

H. Programme Management

Activities	2006	2007	2008	2009	Total
Programme manager-1	12,000	12,600	13,200	14,000	51,800
Administrator/Invest.Offi-2	12,000	12,600	13,200	14,000	51,800
Data processor 1+1	4,000	4,200	8,500	9,000	25,700
Office cost	84,000	90,600	97,100	108,000	379,700
Total	**112,000**	**120,000**	**132,000**	**145,000**	**509,000**

I. Gender Mainstreaming

Activities	2006	2007	2008	2009	Total
Gender programme	**13,000**	**15,000**	**17,000**	**20,000**	**65,000**

Annex- 13

Estimation of Plant Construction and Cost Per Size

Plant Size	Per plant cost (Taka)	Total installation cost (Taka)	No. of plants	Total gas production (m^3)	Percent of each plant
1.2	20,000	72,900,000	3,645	4,374	10%
1.6	21,600	133,844,400	6,196	9,915	17%
2	23,700	207,327,600	8,748	17,496	24%
2.4	25,500	278,842,500	10,935	26,244	30%
3.2	29,600	107,892,000	3,645	11,664	10%
4.8	35,000	114,817,500	3,281	15,746	9%
Average 2.4	**25,120**	**915,624,000**	**36,450**	**85,439**	**100%**

Note: The above cost and construction of plant per size is calculated based on the improved design (both cattle dung and poultry droppings based) and average cost of the whole programme period including possible increment of price every year. The real construction costs and construction of plant per size will depend very much on the choice of the households and competitiveness and management efficiency of plant constructors.

Annex - 14

Data Used for Financial and Economic Analysis

Based on 2.4 m^3 daily gas production plant (improved design cattle dung).

	Costs in Taka
Investment costs	25,000
Annual Maintenance costs	350
Subsidy	7000
Net costs	18,000
Down payment by household	2,500
Loan amount	15,500
Annual payment	4,734
Interest on loan	16%
Project life	15 years
Repayment period	5 years

Energy sources	**Savings per year**	**Price (Taka)**	**Savings in Taka**
Biomass (Fuel wood-1500@ 1.9, dried dung-410@1.2 and agriculture residues-510@0.7)	2,420 Kg	Average-1.5	3,630

Source: * Technical survey 2005

Cost/Benefit Breakdown	**Financial**	**EF**	**Economic**
Costs	(Taka)		(Taka)
cement	4500	0.6	2700
materials	9000	0.75	6750
labor	4400	0.75	3300
appliances	2600	0.9	1980
fees & charges	4500	1	4500
Total Capital Costs	25000		
Ann. Maintenance Costs	350		191.1
Benefits			
biomass savings	3630	1.5	3630
nutrients		2	1836
labor time	-	0.75	411
tons C reduced		1	1750
smoke reduction		1	400
Total Annual Benefits	**3630**		**8027**