UNITED NATIONS
CAPITAL DEVELOPMENT FUND

EVALUATION OF ON-GOING PROJECT
DRAFT REPORT

Country:	**NEPAL**
Project Number:	**NEP/85/C01**
Project Title;	**Financing and Construction of Biogas Units**
Sector:	**Natural Resources (03)**
Sub-Sector:	**Non-Conventional Energy (0350)**
Government Executing Agency	**Agricultural Development Bank of Nepal (ADBN)**
Total Project Cost	**$1 124 431**

Project Financing:

UNCDF	**(Loan):**	**508 641**
	(Grant):	**532 819**
Government and farmers' contribution:		**75 971**
	UNDP:	**7 000**

Date of signing; **26 August 1986**

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Dates of Evaluation: **15 July 1991 to 6 Aug 1991**

Date of Report: **14th August 1991**

List of Abbreviations

ADBN	**Agricultural Development Bank of Nepal**
AsDB	**Asian Development Bank**
DCS	**Development and Consulting Services, Butwal**
GGC	**Gobar Gas Company**
GM	**General Manager**
HO	**Head Office**
SFDP	**Small Farmers' Development Program**
UNCDF	**United Nations Capital Development Fund**
UNDP	**United Nations Development Program**

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ONGOING PROJECT EVALUATION

DRAFT SUMMARY

Background

1.01 The main energy sources for domestic use in the rural areas of Nepal (and many people in the urban areas) are fuelwood for cooking and kerosene for lighting. As part of an overall strategy to reduce both pressure on forests and the cost of imported energy, the government of Nepal has been putting emphasis on renewable sources of energy, such as biogas.

1.02 The Agricultural Development Bank of Nepal (ADBN), established in 1968, was given the responsibility of financing the extension of biogas technology in Nepal, mainly by providing loans to individual farmers to purchase biogas plants. The Gobar Gas Company (GGC), set up in 1977 as a subsidiary of ADBN, had built most (1490) of the 1898 biogas plants built in Nepal up to the middle of 1985.

The Project

1.03 The project's development objective was to replace fuelwood and kerosene with an alternative fuel, biogas, to improve the quality of life of rural families, especially in the hill areas and to save foreign exchange spent on imported energy and fertilizers.

1.04 To do this, 970 biogas plants (670of 10 m^3 and 300of 6 m^3) were to be built under the auspices of the project,providing grant (subsidy) financing for part of each installation (to cover the cost of imported materials) and loan finance for the rest, although the farmers are expected to contribute towards labor costs. The GGC facilities were also to be upgraded by providing the finance for two new workshop-office-storage buildings and equipment. Further grants were available for the purchase of motor-cycles, to cover additional transportation costs to build 7 0 of the plants in remote districts and for staff training.

1.05 By mid-1991, 927 biogas plants (636 of 10 m^3 and 291 of 6 m^3) were built, although only $213 523 of the $493 382 of the loan money set aside for building plants had been disbursed. Also construction work on the new buildings for the GGC had not been started, nor had equipment for these buildings been purchased.

Results

1.06 All parties, the Ministry of Finance, ADBN and GGC have indicated a strong commitment to the project. GGC and ADBN have furnished extensive documentation showing how the project has been implemented, including a full list of names of farmers for whom biogas plants have been built under the project, by district.

1.07 **The project seems to have been well administered according to the project plan, apart from some minor problems. Instead of using grant money to purchase materials, ADBN used it as a direct subsidy to farmers. GGC used the working capital fund to purchase the materials required to build plants in 1988/89. ADBN inadvertently double accounted part of the loan fund, but the error has been pointed out to them.**

1.08 **The government and ADBN's input to the project includes land provided to the GGC, worth Rs.7,000,000 ($233,333). The government also provided a subsidy of Rs.4,360,945 ($145,364) to 6 and 10 m^3 biogas plants built over and above the UNCDF project total. ADBN continued to pay subsidies at the same rate (25%) out of its own capital, of which Rs,3,287,659 ($109,589) was for 6 and 10 m^3 sized plants, when political instabilities stopped the government subsidy between July 1990 and July 1991. ADBN underestimated the demand for biogas and set low budgets between mid-1988 and mid-1990, so they were unable to request finance from UNCDF to cover loans already given to farmers.**

1.09 **The field survey covered 34 biogas plant owners and 15 non-owners in six districts including two designated "remote". The time allowed and the monsoon season meant that the sample of plants was heavily biased towards those near an all-weather road in accessible areas. Travel was difficult and farmers were usually very busy in their fields, so visits were usually made early in the morning or in the evening in an attempt to find people at home.**

1.10 **Study was also made of five other surveys of biogas plants in Nepal. One by the GGC of 150 plants is taking over a year to do, including over 130 man-days of field visits. The results of these surveys were fairly well in agreement with the results of this evaluation survey.**

1.11 **The whole process of selling biogas plants, organising loans, obtaining materials, building plants and doing follow-up work seems to be fairly well organised, despite the somewhat bureaucratic system involved. Both the ADBN and GGC allow a fair degree of decentralised decision making, giving their local offices the responsibility of approving customers, making loans and confirming plant completion for payment. The project is effectively monitored by both ADBN and GGC head offices.**

1.12 **The Butwal workshop, that makes most of the components for biogas plants, is equipped with old machines and needs major refurbishment. New workshops are required to meet future demand for biogas plants.**

1.13 **The system seemed to work less well in East Nepal. Some of the plants were poorly built, suggesting that better training and supervision of technicians is required, together with better field checking and follow-up, both from the GGC and ADBN offices in the area. The planned course in India, under the UNDP grant might encourage a better management approach.**

1.14 **The growth in the biogas program was not well predicted, ADBN local offices found themselves exceeding their loan targets for biogas plants by up to 500% between 1988 and 1990. The future growth of the biogas program in Nepal is expected to be even higher, with a target set for 1991 to 1996 of at least 20,000 biogas plants. UNCDF's contribution to the larger program has been in helping to build up GGC to be able to meet this expanding target. New buildings and equipment for GGC should have a high priority.**

1.15 **The Dutch government (SNV) is proposing to fund 20,000 biogas plant subsidies between 1991 and 1996 and also a study on how to privatize the extension of biogas technology. GGC already subcontracts some of its plant building work to local masons. Emphasis should be placed on helping GGC to have a more commercial approach to its work.**

1.16 **All users found cooking by biogas easy, quick and without the attendant smoke of wood fires. The women who did the cooking gained the most benefit. The savings on fuelwood were estimated to be of the value of Rs.2 million or 1200 m^3 of wood per year, since the savings are not usually in cash. Savings in kerosene and chemical fertilizer are estimated to be almost Rs.1 million a year, although farmers are not using the effluent slurry as fertilizer in the most effective way. Improvements need to be made in the reliability of biogas lights and gas production at lower temperatures.**

1.17 **ADBN have used the popularity of biogas plants to encourage the building of latrines linked to the plants. While some cultural resistance needs to be overcome, this does not act as a disincentive to setting up the biogas units.**

1.18 **The penetration of biogas technology into "remote" or underdeveloped areas is slow, with only 15 plants having been built in the five assigned districts. The most effective way to publicize biogas technology is through people seeing a working plant in operation. In the two underdeveloped areas visited, the demonstration effect was beginning to work and interest in biogas technology was increasing among non-users.**

Conclusions

1.19 a) Biogas is a technology that is well suited to conditions in Nepal and is meeting a basic need for cooking fuel, that is reducing the use of firewood and the attendant problems of deforestation, land erosion etc.

a) Biogas technology tends to reach the middle income groups in rural and semi-urban areas. It is penetrating into the Small Farmers' Development Groups, but they have a problem in finding cash to repay the loans.

b) The most popular plants were of the 6 and 10m^3 size, as they can meet the domestic energy needs of most small farmers.

c) The system set up by AD BN and GGC for building biogas plants is effective, with checks to ensure the loan and subsidy are used for the purpose for which it was intended.

e) A major problem for many farmers was the removal of interest rate subsidies in 1990, as they were promised they could pay a rate of only 7.5% for the whole of their loan period (7 years).

f) As part of the process of selling biogas plants, ADBN and GGC are helping farmers become more conscious of the problems of deforestation and the environment.

g) The direct beneficiaries of biogas technology are the woman who can cook food in half the time and are saved from the bad effects of a smoke filled kitchen.

h) There are still problems with the use of biogas technology in Nepal, such as helping farmers find the best way to use the effluent slurry as fertilizer, finding a more reliable design of lamp and improving biogas production in cold weather. 90% of all of the plants built by GGC are still producing biogas.

Recommendations

1.20 General project operation

a) The management structures of GGC should be further strengthened, by building up the evaluation and monitoring division in the Kathmandu HO, to do more field surveys of plants built and spot checks on local office operations.

b) The future organizational structure for the extension of biogas technology needs to be carefully considered, especially in the light of a desire to privatize the process as far as possible.

c) ADBN should check its accounting system for the loan component of the UNCDF funds.

1.21 UNCDF present project

a) Loan disbursements should be made to ADBN, as requested against plants built, up to the budget limit ($207,668 remaining).

b) **The remaining grant money be used to subsidize biogas plants up to the budget limit ($73,146 remaining).**

c) **Grants should be made for plants built in "remote" areas for 15 more plants. Any remaining money should be re-allocated to the subsidy budget ($5,683 remaining).**

d) **The planned building at Itahari should be constructed on the land available, but with a reduced budget allocation ($33,000). The remaining $11,000 should be assigned to the Butwal workshop for upgrading the building.**

e) **The bulk of the workshop equipment budget ($37,000) should be used to purchase machinery for the Butwal workshop, with the remainder being used to set up a small workshop in Itahari.**

f) **The remainder of the office equipment and transport budgets ($10,475) should be used to purchase a computer for the Kathmandu HO.**

g) **Any remaining money still available could be put towards a 4-wheel drive pick-up.**

h) **The UNDP money ($7,000) should be disbursed to send GGC officers on a suitable course in India.**

1.22 **Further UNCDF and UNDP project involvement.**

With a the proposal for funding subsidies for 20,000 biogas plants in the next five years and the expected signing of the Sixth Credit Plan for loan finance from AsDB to ADBN, the major need is to build up GGC to meet the expected demand for biogas plants, but also to prepare it for privatization. A second phase of UNCDF funding is recommended, mainly to build up the production capability of GGC. UNICEF should also be involved in the promotion of biogas technology as it does directly improve the daily life of women in Nepal as well as family health.

1.23 **A second phase of project funding should include:**

a) **workshops in Itahari and Nepalganj;**

b) **equipment for these workshops and computers for the Regional offices;**

c) **Provision of subsidy grants for up to 5,000 more biogas plants;**

d) **Encouragement for joint R & D work with institutions such as the Rampur Agricultural campus and the Forestry Institute at Pokhara in such areas as the best use of effluent slurry as a fertilizer and the best ways to improve gas production at low temperatures;**

e) **support for training of research workers in R & D at eg. Reading University in UK;**

f) **support for training of supervisors and extension workers so they can advise farmers of the best ways to use biogas technology.**

DRAFT REPORT

PART A: FACTUAL PRESENTATION OF THE PROJECT RESULTS

A1. PRESENTATION OF THE PROJECT AS ORIGINALLY DESIGNED

Background

2.01 Nepal lies between China and India and sits on the Southern part of the mid-Himalayas. The high mountain region (15% of the total area of 147 000 sq.km) is permanently covered with snow, but most people live in the hills, the middle region (68% of the area) . The richest and most productive area, the Terai, is on the edge of the Ganges plain and although it covers only 17% of the total area of the country, it had almost half (6.5 million) the population (15 million) in 1981, with a growth rate of 4.2% (compared to the country average of 2.7%) .

2.02 The main part of the Nepal economy (90% of the population and 67% of its GDP) is based on agriculture, much of this being subsistence farming in the Hill region. Population growth has led to a deterioration of the standard of living in the hills region, with increasing pressure on land and the resultant deforestation (by 50% between 1963 and 1985) due to clearing of land for agriculture and to provide fuel. While migration to the Terai has helped mitigate these pressures in the past 30 years, this has almost reached its limit. The pressures in the Midland Hill and Mountain regions are likely to increase, with the effects of deforestation, such as flooding, soil erosion and landslides, getting worse.

2.03 The main energy source for domestic cooking in the rural areas of Nepal (and also for many people in the urban areas) is fuelwood. In 1981 fuel wood provided 94% of all energy needs in the country. With the pressure on remaining forests increasing, the availability of this traditional fuel is decreasing, with the tendency that it is becoming more costly, both in local market terms, and in terms of human effort to collect wood from less accessible places. As fuelwood becomes less accessible, many poorer people turn to agricultural residues for fuel, such as dried cow dung. This destroys the nitrogen fertilizer value of the dung, which would otherwise have been used on the land.

2.04 The main source of energy for lighting in rural areas is kerosene which has to be imported into the country and then transported to remote areas by vehicle and on people's backs. This makes kerosene very expensive for both rural families and the country. A disagreement with India around 1988 meant that all petroleum fuels imports were stopped for several months, highlighting the vulnerability of people dependant on these fuels.

2.05 As part of an overall strategy to reduce both pressure on forests and the cost of imported energy, the government of Nepal has been putting emphasis on renewable sources of energy, especially biogas and hydro-power. A biogas program was started by the Nepal government in the 1970s. Biogas was seen as a way of using dung and other agricultural residues as a source of fuel, while retaining, or even improving, their fertilizer value.

2.06 Responsibility for the biogas program was given to the Agricultural Development Bank of Nepal (ADBN) in 1977. ADBN was set up in 1968 to provide institutional credit to farmers for a variety of projects. In 1985, it had 360 field offices, two Appropriate Technology Units and 163 Small Farmers Development Project (SFDP) offices. SFDP was set up to help small farmers, with limited income and land holdings, use the loan facilities provided by ADBN. ADBN was given the job of financing the extension of biogas technology in Nepal, mainly by providing loans to individual farmers to purchase biogas plants. Between 1974 and 1985, ADBN had financed 1820 biogas units and the loan repayment rate is considered satisfactory.

2.07 In 1977 Gobar Gas Company (GGC) was set up as a subsidiary of ADBN, to develop, promote, manufacture, commission and service biogas plants throughout Nepal, setting up area offices, sales centres and workshops for this purpose. By mid 1985, GGC had built 1520 of the 1988 biogas plants established in Nepal at that time. In 1985, the Company had 150 staff on its payroll, of which 100 were masons and helpers. GGC builds two types of biogas plant, the floating cover type and the fixed dome type, both of which are made in a range of sizes. There has been a swing away from the drum plants which are more expensive and much less reliable than the dome plants. Few drum plants are now being built.

2.08 The Nepali calendar is used extensively in local business, so much of the information provided to the team used this method for dates. The Nepali calendar year starts in mid-March, but the fiscal year starts mid-July. The exact date varies from year to year, as the calendar is linked to the lunar cycle. The project period, August 1988 to July 1991, the evaluation date, cover the Nepali fiscal years 2045/46, 2046/47 and 2047/48. The new fiscal year 2048/49 started on 18th July 1991.

2.09 There was a change of government during the project period which caused some disruption. In April 1990, the old "panchayat" system of electing members of parliament was dismantled and an interim government took over. A new parliament was elected under a new "party" electoral system in March 1991. The overall policy towards energy was not changed by the new government; they still put emphasis on renewable energy, such as biogas.

However, the interim government had to cut back, on some of its financial commitments, such as subsidies for biogas plants, in preparation for the elections.

2.10 One consequence of the political instabilities that led to the change of system of government has been rapid inflation. During most of the project period (1988 to 1990) , the exchange rate between the US dollar and the rupee remained around $1 = Rs.28 and this is the rate used in the project document and the evaluation of past spending. When the evaluation mission visited Nepal, the exchange rate had become about $1 = Rs.42, which is the rate used to predict future project spending.

The Project

3.01 The project's development objectives were:

a) to minimize the use of fuelwood by replacing it with an alternative fuel, biogas, to provide cooking and lighting to rural families,

b) to improve the quality of life of rural families, especially in the Hill region and

c) to save foreign exchange (1.4 million NRs = $68 600) through reduced need for imported energy and fertilizers.

3.02 The immediate objective was to support the construction and financing of 970 biogas-units, i.e. 300 units of 6 m^3 and 670 units of 10 m^3. Of these units, 70 are to be installed in 6 remote districts.

3.03 These immediate objectives were to be achieved through:

a) The upgrading of the GGC facilities:

i) GGC was to build 2 workshop-office-cum-storage buildings; the Government donating 2 plots of land. UNCDF was to finance up to US$ 44 000 construction costs and US$ 42 000 for office and machinery equipment as grants.

ii) GGC was to purchase 10 motorcycles, financed by a UNCDF grant of US$ 20 000.

iii) UNCDF was to provide a grant of US$ 85 000, to be used as a revolving fund: initially as working capital to GGC and to be repaid to ADBN. AD BN was to use the fund to support loans to farmers-biogas purchasers.

iv) An additional grant of US$ 7 000 was to be used as transportation cost support for the installation of 70 biogas units in 6 remote districts. GGC was to hire 3 extra inspectors and assign them to these districts.

v) An UNDP grant of US$ 7000 was to be used to cover Technical Assistance, in the form of a training in India for 10 GGC officers.

b) As an incentive to the farmers, and also in the form of a grant, UNCDF was to finance part of each biogas installation, totalling US$ 194 000.

c) UNCDF was to provide capital as an interest free loan of US$ 493 382 to the Government of Nepal, repayable in 7 years after a 3 year grace period, and only to be used to provide loans at low interest rates to farmers/bio-gas installers. A loan service charge of US$ 25 459 is also covered by UNCDF.

3.04 ADBN was to be overall responsible for project execution, including financial management, procurement, loan appraisals, progress chasing and reporting. ADBN was to delegate to GGC the technical and field work, especially installing of the biogas plants. Identification of potential customers and site inspections was to be done jointly by ADBN and GGC staff.

3.05 Other responsibilities were defined:

a) The government of Nepal was to:

i) Promote biogas technology on radio and other media,

ii) Make land available for the two new office sites,

iii) Arrange tax-free imports for required equipment,

iv) Provide appropriate measures to allow the project to proceed.

b) The specific responsibilities of ADBN were to:

i) Record all details of UNCDF money dispersed, separating: Loan, Revolving Fund Grant and Grant components.

iI) Perform financial management of the project, processing and approving loans, disbursing funds against approved requests, collecting repayment of loans and keeping detailed audited accounts for the project, reporting six-monthly to UNCDF.

c) The joint responsibilities of the ADBN and GGC were to:

i) Plan and arrange construction of two office-workshop-storage buildings on land provided by government.

ii) Arrange for the purchase of necessary equipment for the project according to agreed specifications.

iii) Select eligible farmers customers for biogas units.

iv) Ensure appropriate grant, loan, extra charge and revolving grant funds are transferred at appropriate times (eg. after completion of biogas units).

d) The specific responsibilities of the GGC were to:

i) Ensure selected customers meet pre-conditions for the construction of a biogas unit, transport materials to sites and construct biogas units and train the customers in their use, for a total of 97 0 biogas units of which 70 are in the six new districts.

ii) Appoint trained inspectors to inspect and follow-up constructed biogas units and do maintenance as required. In particular three new inspectors/ extension workers were to be appointed to cover the six new districts.

iii) Send ten members of technical staff to India for appropriate training.

iv) Recruit two or three new graduate officers to strengthen its managerial set-up.

e) The responsibilities of the farmers/customers were to:

i) Provide land and labour for the construction of their own biogas plants and run the plants as directed by the GGC staff.

ii) Repay the ADBN loan according to ADBN rules.

3.06 The operational plan suggests that the main part of the work was to be finished in the first year, including construction of new buildings, procurement and installation of machinery and equipment and training of GGC staff. New staff appointments, such as extension staff for the new districts and graduate officers for management should also have been done within the first year. The construction of the 970 biogas units would continue over the three year project period.

3.07 ADBN was responsible for submitting the following reports to UNCDF:

a) a detailed workplan of the project made within 60 days of the signing of the agreement,

b) six-monthly progress reports,

c) after 3 years, a semi-annual financial status reports of the project together with loan repayments to UNCDF.

3.08 The expected outputs from the project should include:

a) the hardware that is planned for purchase or construction:

i) two office-storage buildings in Itahari (with also a workshop) and Lalbundi,

ii) 970 biogas plants built for customers, of which 70 must be in the six new districts,

iii) appropriate office and workshop equipment and ten motorcycles, purchased and used to improve the effectiveness of the work of GGC;

b) the changes in staffing of the GGC, including:

i) ten existing staff trained in India,

ii) three new inspectors/extension workers appointed to work in new remote districts,

iii) two or three graduate officers to strengthen the management setup of GGC;

c) less easy to define "software" such as:

i) rural families (including the women) who feel that their quality of life has been improved by the purchase of a biogas unit,

ii) reduced use of fuelwood by these farmers,

iii) reduced use of kerosene by these farmers,

iv) reduced use or reduced potential use of fertilizer by these farmers.

The "software" outputs can be determined from surveys of biogas users and non-users.

A2 . PROJECT IMPLEMENTATION RESULTS

Delivery of Inputs

4.01 The main channel through which the government of Nepal is involved in the project is the ADBN. The bank now has 724 offices, including 254 zonal and field offices, 465 small farmer development projects and 4 appropriate technology units. At the beginning of 1991, it had 4262 employees of which about 30% are technically trained [1,2].

4.02 The actual biogas programme is wider than the terms of reference of the UNCDF project. During the first part of the project period, from August 1988 to August 1990, 2466 biogas plants were built of all sizes, of which 1552 were of the sizes 6 and 10 m^3. The government gave a 25% subsidy to all these plants during this period, not only the ones under the UNCDF project (a total of 927 plants over the same period) . Taking only the non-UNCDF plants of 6 and 10 m^3, the government's commitment to the overall programme was Rs.4,360,945. Taking the whole biogas programme, the government's contribution was Rs.20,112,510 .

4.03 Political uncertainties in the Nepali fiscal year of 2046/47 (1990/91 starting and ending mid-July) meant that no government subsidy was available for the biogas programme that year. However the ADBN continued giving grants for biogas plants out of its own capital. During the 9 months July 1990 to April 1991 (part of the Nepali fiscal year 2046/47) 461 plants were built, of which 428 were of the 6 and 10 m^3 sizes. The subsidy cost to ADBN of these plants was Rs.3 793 000, of which Rs.3 287 659 was for the size of plant supported by the UNCDF project.

4.04 In the recent budget for the new fiscal year starting 17th July 1991, the finance ministry of the government has committed itself to a fixed subsidy of Rs.7000 on all biogas plants up to 20 m^3 in size. An extra subsidy of Rs.3000 will be made available for such plants in remote areas and for biogas plants that are organised on a community basis. The government is hoping for a grant from the Dutch government to cover these subsidies. The proposal written for the Dutch government suggests a target of 20 000 biogas plants built over 5 years.

4.05 Loans for building of biogas plants are provided by the ADBN area offices according to the rules of the bank. Finance for loans not provided under the UNCDF project was funded from money loaned by the Asian Development Bank under an on-going series of five year credit agreements to provide finance for a range of ADBN activities, including biogas. The Fifth Credit Agreement finished with the past financial year and is being replaced by the Sixth Credit Agreement, starting 17th July 1991. Finance is provided to cover loans for biogas plants over five years, for the fiscal years 2047/48 to 2051/52 (1991/92 to 1996/97).

4.06 The direct government input into the UNCDF project was the provision of land at Itahari and Lalbundi. The land was provided before March 1990, 0.14 ha at Itahari and 0.20 ha at Lalbundi with a total value of Rs.7 000 000 ($233 333) at present prices.

4.07 ADBN set up appropriate accounts for the money disbursed by UNCDF. Request is made for disbursement from the GGC to ADBN, either to pay directly for items, such as the motorbikes, or against coupons issued on the completion of biogas plants for individual farmers.

4.08 GGC has been importing materials for building biogas plants since 1977 and has long experience in defining specifications, organising tenders and procuring materials. The supply of appropriate materials has always been a difficulty for the biogas programme, but GGC have managed to keep sufficient materials in stock to keep the programme running. For the UNCDF project, cement was purchased from a government agency at a price fixed by the government. Other materials, such as gas pipes and gas fittings were put out to tender and quotations sought. In the future it is planned to purchase these materials direct from the factory, as a dealer, as this approach offers a 5 to 10% reduction in cost. The main gas valves for biogas plants are purchased from Holland, as there is no local (Nepali or Indian) supplier capable of meeting the required specifications.

4.09 The working capital loan was directly used to purchase materials by the GGC. The materials were sufficient to make 131 6 m^3 and 329 10 m^J plants in the financial year 1988/89. The ADBN's role in this was to claim the money from UNCDF and pass it to GGC. The capital part of the grants to farmers was not made as supplies of materials to the GGC. The full cost of each biogas unit was paid to the GGC on completion, but the farmer's loan account was credited with the appropriate subsidy amount at that time.

4.10 The GGC has a Head Office in Kathmandu, Regional Offices in Biratnagar and Butwal, four Sub-Branch Offices, seven Depots and a Research Unit in Butwal [3] . Each office covers between two and five districts. The staffing level at the beginning of the project (August 1988) was 13 officers and 132 others. At the present time, this has been increased to 17 officers and 178 other staff. The officer grade relates to government and bank rules and usually is filled by graduates.

4.11 While 10 staff of the GGC were nominated for training in India in April 1989 and an appropriate short course found for them, the $7000 allocated for this purpose has not yet been released by UNDP.

4.12 Of the 927 plants built up to July 1991 under the UNCDF project (Table 1), 52% were built in the Eastern and Central Terai (plains) regions of Nepal

and 24% were built in the Western and Mid Western hills. 11% were built in the East and Central hills region, while 10% were built in the Western and Mid-Western Terai. Only 3% of the plants were built in the least developed Far Western region, with only 1% in the hills area [4]. Only 15 plants were completed of the planned 70 in the 6 "remote" districts. The term "remote" should be replaced by "less-developed" as it includes Bhaktapur district in the Kathmandu valley. People in this and other "less-developed" districts have a more conservative attitude to development, so are less ready to accept technologies such as biogas.

Region	No. plants	% plants
Eastern Hills	5	0.5%
Eastern Terai	200	21.6%
Central Hills	279	30.1%
Central Terai	96	10.4%
Western Hills	212	22.9%
Western Terai	74	8.0%
Mid-Western Hills	18	1.9%
Mid-Western Terai	19	2.0%
Far-Western Hills	17	1.8%
Far-Western Terai	7	0.8%
Total	927	

Table 1. Distribution of UNCDF biogas plants by region

4.13 The field survey took 12 days and covered 34 users and 15 non-users. Given the time available and the monsoon season, the sample was not random, being heavily biased towards plants close to an all-weather road in relatively accessible areas. Despite the relatively poor monsoon rains, travel was difficult, with landslides on some of the main roads and unsealed tracks turning into soft mud. Six districts were covered: Bhaktapur in the Kathmandu valley, Rupendehi, Chitwan and Morang on the Terai and Kaski and Dhankutta in the hills. Bhaktapur and Dhankutta were included in the list of "remote" or less-developed districts.

4.14 Since farmers are usually very busy in the fields during the monsoon, planting rice and harvesting other crops, visits were usually made from 6.30 am or, occasionally, after 5 pm. Even so, in some farms the plant owner had gone to the fields, so an older person or teenagers gave answers.

4.15 Bank files gave a very limited picture of the loan applicants, so the field survey data was used to give a picture of a typical plant owner. The average family size, from the 34 respondents, was 6.5 persons (counting children under 10 as 0.5), although the range was from 3 to 18. The average number of animals was 4 (taking calves as 0.5), with a range of 1 to 17.5. The average land holding was 1.9 ha, with a range of 0.3 to 13.6 ha, although one respondent had no land.

4.16 To overcome the limitations of the evaluation field survey, the results of five other surveys were studied (see Appendix 2) [5, 6, 7, 8, 9] . These ranged from a thorough survey done by Development and Consulting Services, Butwal (DCS) in 1979 of 50 plants in the Terai region around Butwal [5] to one done by a student at the Institute of Forestry campus in Pokhara for a final year project [7]. A Dutch volunteer in the Research Wing of GGC was in the process of a fully randomised survey of 150 plants across the country which was taking over a year, including 130 man-days of actual field work [9]. His initial conclusions were based on results from 145 plants. The results from surveys are in good agreement with each other and with those from the evaluation survey.

4.17 The procedure for building a biogas plant for a farmer relies on close cooperation between the area staff of the GGC and ADBN. The process of getting a plant built usually involves staff from the GGC going out into the field to persuade farmers to buy a biogas unit. In areas where biogas technology is well established, the demand is growing, so less effort is required to sell plants. Once a potential customer is identified, the local ADBN office is approached for a loan. A staff member from the bank office usually visits the farmer and confirms his suitability for a loan for a biogas plant. Ownership of the land given as security, usually the land around where the biogas plant is built, must be proved, as well as Nepali citizenship. A letter is sent to the land registry preventing the owner selling the land used as security being sold. The customer's finance record is also checked, especially to see if he or she has defaulted on any previous loans.

4.18 Once the paperwork is complete (which can be very daunting for a semi-literate farmer) the local GGC office is issued a coupon for the plant. The GGC draw up a detailed bill for materials, some of which may be supplied by the farmer. Once the materials are on site, a team of 2 or 3 masons are assigned to build the plant.

In the past, these masons have been fully employed by GGC, but there is a move to employ local masons on a contract basis for each plant, to reduce Company overheads.

4.19 During the building process, the plant is visited regularly by a GGC supervisor, to check on quality and progress. Forms are used internally by the GGC office staff for progress chasing. Once the plant is completed, the GGC office sends a request to the local ADBN office for payment against the coupon. A member of ADBN staff visits the plant to ensure it is producing gas before approving payment. Once payment is made, the farmer's loan account is credited with the 25% subsidy.

4.20 The local GGC offices keep detailed files on each of their customers, giving information on the type of plant built, the date each part of the work is done, including completion and the exact cost. The ADBN local office also keep records, detailing the farmer's loan finances, including the security offered against the loan.

4.21 In general, people who had purchased biogas plants were very pleased with the technology. It saved them obtaining firewood and reduced the labour and time involved in cooking. One or two people were less happy, as they had technical problems with their plants. The respondents' views on the affordability of biogas was less clear, since the majority of people had not purchased wood, but taken time and effort to collect it from the forest. While the economic value of that time and effort may be sufficient to give a benefit:cost ratio of between 1.3 and 1.7 [8], the farmers do not see the benefits in the form of the cash required to repay a loan.

4.22 The main loan application constraint is the bureaucracy involved. Forms have to filled in and letters written, which can be very difficult for illiterate or semi-literate farmers. However, most families now have literate members who can help and GGC staff are usually helpful in helping customers approach ADBN offices.

4.23 The GGC staff usually^ act as salesmen for biogas plants, visiting_ potential customers to persuade them to take a loan and have a plant built. ADBN staff come for a general site inspection to access collateral for the loan, which is usually the land on which the plant is built. Once the loan application process is under way, GGC staff make a site inspection to decide on the best place to build the plant. Most respondents agreed that this takes about half-an-hour.

4.24 Once the loan is agreed the coupon issued by the ADBN local office states that the plant should be started within 15 days. Most respondents thought that the plant was started within a month of the loan agreement being signed.

As the mason builds a plant, he fills in a progress form, which is included in the customer's file when the plant is built. The supervisor also completes a check list when the plant is finished. A member of staff of the local ADBN office should also visit the plant and ensure it is producing gas, before payment is made to GGC. In many cases, they seem to rely on the GGC informing them that the plant is finished.

4.25 According to GGC rules, each plant should receive three follow-up visits during the first year after construction and one visit per year for the seven year period of the loan. Many respondents were happy with the number of times they had received visits from GGC staff. There appeared to be a problem with the plants built under the Biratnagar office in East Nepal, where several owners complained that GGC staff had not visited them after the plant was complete. They were also very slow at responding to requests for visits to repair faults.

4.26 Detailed invoices were available in all GGC customer plant files, showing material and equipment costs in detail. GGC seem to use a fixed cost for each plant, regardless of actual material and transport costs. GGC overheads are included as a separate item under "Construction and guarantee charge".

4.27 The customer is given a loan to cover the full amount of the cost of a biogas plant by the loans section of the local ADBN office. Once the plant is complete and the GGC bill is paid, the 25% subsidy is credited to the customer and the account passed to the accounts section with a detailed repayment schedule. A passbook is issued to the customer in which all transactions are recorded. In principle, repayments should be six-monthly, although they are usually made yearly. The interest charges are calculated according to the prevailing ADBN rules at the time of repayment. This caused a problem for some farmers, when the 50% interest subsidy was removed in July 1990, making the farmers pay 15% interest instead of the subsidised 7.5%. If farmers had a plant completed late in the financial year, they found they had to pay 15% if they paid the first instalment after July 1991, in spite of being promised 7.5%.

4.28 A sample of three local ADBN offices quoted repayment overdue rates of 9,13 and 14%. Several farmers suggested they may not repay their loans because of the loss of interest subsidy. However, one ADBN manager commented that most people eventually do repay their loans, usually because they are likely to need another loan in the future.

4.29 No interviews were taken from rejected loan applicants, mainly because it was difficult to find any. A sample of five rejected applicants taken from the ADBN branch office in Butwal suggested that the main reasons for rejection was lack of collateral or a poor repayment record on past loans.

One farmer was rejected because he had no animals. In general, ADBN local offices seemed very keen to approve loans for biogas, even exceeding their loan targets by up to 1500% in financial years 1988/89 and 1989/90.

4.30 The interviews with the sample of non-users occasionally turned into a biogas sales campaign. With representatives of both ADBN and GGC involved on the interview team, an interest in the technology was taken to mean a potential customer. In general, non-users were cautious, but interested. Many had seen a biogas plant in operation and the women of the family were very keen, but the farmers themselves were concerned about paying back the loan. In Bhaktapur, a leading farmer saw taking a loan as making him lose social status. This is an unusual attitude and not common in the rest of Nepal. This farmer was fairly keen to install a plant, despite the social stigma involved.

4.31 In general, the major restraint to the installation of biogas plants is financial. The removal of the interest subsidy in the financial year 1990/91 was a disincentive to farmers. However, both ADBN and GGC staff see the increased capital subsidy for 1991/92 (Rs.7000 per plant of any size up to 20 m^3, over 50% for a 6 m^3 plant) as acting as an increased incentive for the future.

4.32 In general, the technical quality of the biogas installations was high. The GGC survey suggests that 90% of all dome plants installed by GGC are still producing gas. The few construction failures, usually due to poor quality cement (spoilt by the monsoon) or masons still developing their skills, are rebuilt under the GGC guarantee scheme. There is a problem with poor quality main gas valves and taps made in India. The gas fitting work is only guaranteed for a year, after this time the farmer has to pay for any replacements. As far as possible, Dutch ball valves are used, but the import of these takes time and requires a lot more paper work. A Dutch volunteer in the GGC workshop is developing a design of valve that can be made in Nepal and should be more reliable. The design can be adapted to make the gas taps that control gas flow to the burners.

4.33 The general good quality of the biogas installations was less evident in the plants visited around Biratnagar. In some plants the pipework was inadequately installed, eg. it was placed above ground, rather than being buried underground, as in the GGC supplied design. Some plants had inadequate backfilling of soil above the dome. The weight of soil above the dome supports it against the internal pressure of stored gas, so inadequate backfilling can lead to movement of the dome and cracking of the digester pit.

4.34 ADBN had introduced a modification to the biogas program in persuading people to attach latrines to the plants. There is a certain amount of cultural and religious resistance to this idea, as cattle dung is considered ritually "clean", which human excreta is not. While ADBN had not made a rule that a loan could not be given for a biogas plant without a latrine attached, their field staff strongly implied that this was the case. The demand for biogas technology was such that few people refused to attach the latrine to their plant. The mixing of night soil with cattle dung should increase gas production, as long as excess water is not introduced into the plant via the latrine.

Financial Management Aspects (see Appendix 3)

5.01 The number of plants built up to July 1990 under the UNCDF project was agreed to be 291 of 6 m^3 and 636 of 10 m^3, making a total of 927. The cost of each plant has risen each year with inflation (see Table 2). The total value of these plants is Rs.15 415 149 ($550 541 at the $1 = Rs.28 exchange rate appropriate before July 1990) , of which 7 5% should be charged to the UNCDF loan account (Rs.ll 561 364 = $412 906) (Table 3).

Year	Cost of 6 m^3	Cost of 10 m^3	Interest Rate
1988/89	Rs 12,459	Rs 18,346	7.5 %
1989/90	Rs 12,991	Rs 19,380	7.5 %
1990/91	Rs 13,794	Rs 20,132	15.0 %

Table 2. Cost of biogas plants during the project period

5.02 Of this figure, ADBN requested and received Rs.8 000 000 ($285 714) before July 1990. This figure reflects ADBN's budgeted amounts for the fiscal years 1988/89 and 1989/90 which were entered in the Ministry of Finances "red book" and could not be exceeded. ADBN expected GGC to build plants under the UNCDF project at a much lower rate than actually achieved. The rest of the loan amount has been requested by ADBN from UNCDF, but not yet disbursed.

5.03 There seemed to be some confusion in ADBN's loan requests, in that 100% of the value of each plant was included (a total of Rs.15 415 149, rather than Rs.ll 561 364) . Since the 25% grant subsidy was also requested for each plant this means that ADBN was inadvertently asking for 125% of the value of the plant. This error has been pointed out to ADBN, with the request that they correct their request forms.

5.04 The working capital loan of Rs.2 423 000 ($85 000) was claimed in full and used to purchase materials. The ledger has been checked and the accounts audited by external auditors. When GGC finishes a biogas plant and requests payment from ADBN, half of the "construction and guarantee" component of the cost goes directly towards repaying ADBN for the UNCDF working capital loan and other similar loans.

5.05 The grant for imported materials for biogas units was to be used by ADBN to purchase materials to be held in stock for GGC to use to build biogas plants. The cost of each biogas unit was to be subsidised "in kind". In practice, this money was held by ADBN and given as direct financial subsidies to people taking a loan for biogas plants.

When payment was made to GGC from a farmer's loan account for a biogas plant, the farmer was credited with 25% of the cost as a subsidy.

A total of Rs.3 396 065 ($120 854) has been claimed by ADBN from UNCDF, out of an expected cost of Rs.3 854 065 for 25% subsidy on 927 plants.

5.06 Grants for capital items for GGC, such as motorbikes and office equipment, were purchased using routine ADBN procedures. GGC specified what was required and obtained quotations. The quotations were assessed by a technical committee with members from ADBN and GGC and orders placed. ADBN requested direct payment from UNCDF for these goods ($11 333 for motorbikes, out of a budget of $20 000, leaving $8667, and $3192 for a typewriter, a photocopy machine and five calculators from a budget of $5000, leaving $1808). These accounts have been audited, with the rest of ADBN and GGC's finances, by a firm of external auditors.

5.07 The ledgers of ADBN Branch offices in Butwal and Pokhara were studied to understand the system of record keeping. Th^ UNCDF funds were not kept in separate accounts, so could not be separately audited. The accounts of all the local ADBN and SFDP offices are carefully monitored by the Head Office in Kathmandu, using monthly reports to produce consolidations of all ADBN's activities.

Gobar Gas Company Office Location	Aug 1988 - Apr 1989				Apr 1989 - Sep 1989						Sep 1989 - Jul 1990				TOTAL			
	6 m³		10 m³		6 m³			10 m³			6 m³		10 m³		6 m³		10 m³	
	No.	Loan	No.	Loan	No.	No.	Loan	No.	No.	Loan	No.	Loan	No.	Loan	No.	Loan	No.	Loan
Biratnagar	5	46 721	45	619 195	4	4	37 377	52	50	717 064	5	48 716	0	0	14	132 815	97	1 336 259
Birthamod	5	46 721	19	261 438	7	6	65 809	17	17	233 918	11	107 176	0	0	23	219 706	36	495 356
Lahan	14	130 820	4	55 040	8	8	74 754	11	11	151 359	12	116 919	0	0	34	322 493	15	206 398
Janakpur	6	56 066	8	110 079	6	5	56 465	10	10	137 599	11	107 176	0	0	23	219 706	18	247 678
Lalbandi	1	9 344	15	206 398	5	5	46 721	18	17	248 453	11	107 176	0	0	17	163 241	33	454 851
Birgunj	4	37 377	6	82 559	8	7	75 153	14	8	197 289	15	146 149	0	0	27	258 679	20	279 848
Butwal	8	74 754	64	880 632	9	7	84 896	64	63	881 408	24	233 838	0	0	41	393 488	128	1 762 040
Bharatpur	25	233 606	67	921 912	9	6	85 295	39	29	544 387	20	194 865	0	0	54	513 767	106	1 466 299
Pokhara	2	18 689	83	1 142 070	3	1	28 831	37	25	518 417	27	263 068	0	0	32	310 587	120	1 660 487
Dang	0	0	5	68 799	0	0	0	2	2	27 520	0	0	0	0	0	0	7	96 319
Dhangadi	0	0	3	41 280	2	2	18 689	13	#3	178 878	1	9 743	0	0	3	28 432	16	220 158
Nepalgunj	0	0	7	96 319	1	1	9 344	6	6	82 559	1	9 743	0	0	2	19 088	13	178 878
Kathmandu	9	84 098	3	41 280	9	6	85 295	24	18	334 888	3	29 230	0	0	21	198 623	27	376 168
TOTAL	79	738 196	329	4 527 001	71		668 629	307		4 253 738	141	1 373 798	0	0	291	2 780 623	636	8 780 740

Total No. of Biogas Plants Installed 927

Total Amount of Loans to Farmers Rs.11,561,362

Table 3. Table of loans to farmers for biogas plants

5.08 The grants for transportation of biogas units in less developed areas were given directly to GGC on completion of each plant built in each of six districts: Dhankuta, Bhaktapur, Doti, Dadeldhura, Salyan and Kanchanpur. The total built in these districts up to July 1990 was only 13, at a cost of Rs.37 000 ($1317). Another two plants had been built in Bhaktapur between July 1990 and July 1991. The survey found another two plants completed in Dhankuta that were still being processed through the system.

5.09 `The money for new buildings and workshop equipment has not yet been disbursed by UNCDF. Detailed plans and quantity estimates for the building at Itahari have been drawn up by DCS for GGC. The cost at July 1991 was estimated to be Rs. 1 703 284 ($40 554 at $1 = Rs.42) . Detailed lists of workshop equipment have been drawn up and tender costs called from suppliers.

5.10 The local ADBN offices keep separate files on each farmer taking a loan for biogas plants. Each file contains the loan application form, usually filled in by the farmer with the help of GGC and ADBN staff members. The file includes copies of the farmer's certificate of citizenship, certificate of land holding and land tax payments and, if the farmer belongs to a SFDG or cooperative, a recommendation from that group that the farmer is a member of good standing. The file often contains a certificate from the farmer's neighbours that the land belongs to the farmer.

5.11 The loan officer who visits the farmer fills in a visit form assessing the value of the land used for collateral, as well as other information on the farmer. Only one bank office (Butwal) included a form giving other details such as cattle ownership and family size. The loan is approved by a loan committee of bank officers, based on the above assessments, the cost of the plant and the repayment schedule. A loan agreement between the bank and the farmer is then drawn up and a coupon sent to GGC to build the plant. The farmer certifies that the plant is built and this is sometimes, but not always, checked by a member of ADBN staff.

5.12 Once the plant is built, the account is transferred from the loans section to the accounts section in the ADBN local office. The account is credited with the 25% subsidy for the plant, a revised repayment schedule is calculated and the farmer issued with a pass book giving details of the repayment amounts and dates. The interest payments are calculated using the bank rules current when each repayment is made. The farmer is expected to come to the bank office to make repayments every six months, although in practice they tend to come yearly.

Production of Outputs

6.01 Most of the fanners building a biogas plant were involved in finding labour to dig the digester pit and using their own transport (usually a bullock cart) to bring materials, such as sand, gravel, bricks and cement) to their site. In the field survey, the farmers did not see this as a financial input to the plant. Some farmers were given a cash advance on their loan to purchase materials from the local market; other farmers relied on GGC to do this.

6.02 All farmers interviewed found the operation of the biogas plant very simple. As long as dung was added each day and well mixed with water, either by hand or with the mixing machine supplied with the plant, the plant produced gas, the flow of which could be controlled by the main gas valve or the gas taps at the burners or lights. Simple maintenance, such as the removal of water from the gas line each week and clearing of the dried slurry from the reservoir outlet, also seemed easy for the farmers. More complex maintenance, such as greasing of gas valves and taps and the cleaning of gas lights, was not done well. The farmers need more training in these areas.

6.03 Repair work, such as the replacing of broken gas valves and taps, was done by GGC staff. Faults were picked up during follow-up visits or farmers came to the GGC office to report the problem. In most areas, the repair work was done quickly and well, although farmers did complain if they had to pay for a new valve, if it failed after the one year guarantee period set for pipework and gas equipment. In the area covered by the Biratnagar office, a plant was found which had been non-operational for two months^ but the owner had not visited the GGC office. The problem seemed to be a leak in the gas pipeline, which had not been installed properly.

6.04 The Butwal office was training some plant owners to act as repair agents for people with plants in the surrounding community. These people would do jobs such as greasing valves, cleaning lights and replacing broken valves for a fee. If the plant was still under the one year pipework guarantee, GGC would pay the fee, otherwise the plant owner would have to pay.

6.05 In general, women were very keen on biogas technology, as it halved the time they took to cook a meal and meant they could work in a clean atmosphere, not polluted by wood smoke. Some women thought they were healthier using biogas instead of wood. Blowing a wood fire gave them a headache and the smoke irritated their eyes. On the plains, people were very pleased that the biogas stoves did not heat up the kitchen as a wood fire did. In the hills, this was more of a disadvantage, especially in the winter. Some women seemed to have organised the purchase of the biogas plant themselves, usually because they were widows. In one household, the husband knew very little about the biogas plant and the wife answered all the questions.

In most households, though, the women had a more subservient role, although they were still able to persuade their men-folk of the advantages of biogas in private.

6.06 In most cases, biogas replaced all other fuels, such as firewood, agricultural residues and kerosene, as a cooking fuel. Some people still used other fuels to cook animal food and when they have large numbers of visitors. Several had to use other fuels in the winter, when the gas production was reduced. Two respondents had switched from wood fuel to kerosene for these extra cooking jobs.

6.07 A questionnaire survey relies on people's own assessment of the weight and value of items, such as the fuelwood saved by the use of a biogas plant. These assessments are far from accurate, especially as many people collected wood from the forest themselves and had little idea of the mass or value of the wood collected. The average value of the estimates of the wood saved, by those prepared to make an estimate, was Rs.2071. With an average value of Rs.1.50 per kg, this suggests a saving of 1380 kg of wood per year or about 1.3 m^3 of timber per year, which is about two medium sized trees per plant per year.

6.08 One respondent had a different motivation to installing a biogas plant in that he had been arrested while illegally cutting firewood in the forest. People are becoming more conscious of the environment and there is a growing concern to reduce deforestation by finding an alternative source of cooking fuel. One of the effects of the biogas sales campaign is to make people more concerned about the environment around them.

6.09 One of the biases introduced by the sample of plants surveyed being close to all-weather roads, was that two thirds of the households surveyed were connected to an electricity supply. Even when gas lights were installed in these houses, people found the electric lights so much more convenient that the gas lights were almost never used.

6.10 Of those who did use gas lights, there was a very wide range in the estimates of the kerosene saved. The average figure was Rs.971, although this includes two negative values, where people use kerosene instead of wood for extra cooking tasks such as cooking up animal feed and for cooking in the winter. The positive saving estimates ranged from Rs.120 per year to Rs.3978. Taking the average saving of Rs.971 for 75% of the plants built (assuming 25% are in places with electricity) the project can be estimated to save Rs.675 088 ($16 074) of kerosene per year.

6.11 The use of slurry as a fertilizer is less well established. While most respondents did use their slurry on their fields, only half claimed they saved chemical fertilizer. The average estimated saving of fertilizer was

Rs.286 per year, including those who claimed no saving. This gives a total saving of Rs.265 122 ($6 312) on chemical fertilizer for the 927 plants already built.

6.12 There is a need to help farmers use their biogas slurry more effectively as a fertilizer. Most owners sun dry the slurry in pits by the biogas plant and spread the dried slurry on their fields before planting a crop. This approach loses nitrogen from the slurry, which evaporates as ammonia. A much better approach is to absorb the liquid effluent in straw and other vegetable matter and allow compost to form. The dry matter absorbs the nitrogen and prevents it evaporating. More research needs to be done on the best use of slurry with different crops.

6.13 The range in perceived economic benefits from the installation of biogas plants was so wide that a generalised cost:benefit analysis has little meaning. One family did not save money from the purchase of wood and kerosene, but did use the time saved to do casual paid labour. The men (two brothers) saved about 30 man-days a year from not going to the forest to cut wood. Their wives were able to spend each morning in paid labour because they could have food cooked and eaten in time to get to the fields. Even with the low wages paid to agricultural labourers (Rs.40 per day for men and Rs.28 per day for women), this gives an extra income of Rs.6800 per year, assuming the women work the equivalent of 200 man-days per year.

6.14 Taking the average benefits of Rs.3085 per year over a plant lifetime of 20 years, benefitrcost calculations for a range of assumptions are given in Table 4. For a 6 m^3 plant with 25% capital subsidy and 50% interest rate subsidy, the benefit:cost ratio is 2.13 and the internal rate of return is 44%. While a 10 m^3 plant should produce more gas and therefore a higher benefit, the survey results showed no correlation between benefit values and plant size. The gas produced depends far more on the amount of dung available. Taking the same average benefit, a 10 m^3 plant has a benefitrcost ratio of 1.46 and an IRR of 30%.

6.15 For the future, with a fixed subsidy of Rs.7,000 per plant, the economics of a 6 m^3 plant are improved(B:C - 2.55 and IRR - 52%), while those of the 10 m^3 plant are reduced (B:C - 1.32 and IRR - 27%).

Benefit:Cost Analysis for biogas plants

Assumptions:

Loan: 15% Interest rate over 7 years
Discount rate: 20%
Plant lifetime: 20 years
Average Benefits: Rs. 3 085 per year
Nett Present Value: Rs.15 023 of benefits

Type of Subsidy	6 m^3			10 m^3		
	NPW	B: C	IRR	NPW	B: C	IRR
No subsidy	3 072	1.26	26%	-2 420	0.86	17%
25% Capital	6 059	1.68	35%	1 940	1.15	23%
25% + I = 7.5%	7 982	2.13	44%	4 747	1.46	30%
Rs.7 000	9 136	2.55	52%	3 645	1.32	27%

Table 4. Benefit:Cost calculations for different types of subsidy.

Notes NPW - Nett present worth
B:C - Benefit:Cost ratio
IRR - Internal rate of return.

PART B. ASSESSMENT OF THE ACHIEVED PROJECT RESULTS

B1. Efficiency of implementation performance

7.01 **ADBN seems fairly efficient in its role as UNCDF project Executing Agency, keeping track of moneys spent and targets achieved and in supervision of GGC. The loan and grant portions of the project have been properly monitored, with ledgers used to record moneys spent that are properly audited by external auditors.**

7.02 **Both ADBN and GGC operate monitoring and evaluation systems, based on detailed customers files in local field offices that keep track of plants built and loan accounts, combined with a monthly reporting system that allows the head offices a clear picture of the progress of the project.**

7.03 **The project agreement was signed in August 1988 and the construction of plants proceeded fairly quickly. GGC produced a detailed work plan in April 1989 as required by the agreement, although somewhat late. The Project Monitoring Committee had representatives from ADBN, GGC and UNCDF. It met five times, between January 1990 and January 1991, when the project was suspended pending the mid-term evaluation. According to the minutes, the Monitoring Committee received a clear picture of the progress of the project, based on GGC's and ADBN's own monitoring systems.**

7.04 **ADBN seemed to have taken a unilateral decision to change the approach defined in the project agreement in one respect. Money was allocated for purchase of "imported materials", which would be provided to GGC as a 25% subsidy on the cost of each plant built. In practice, the money was used to give a financial subsidy directly to the farmer, as a 25% reduction in their loan account. ADBN did not have the storage or logistical capacity to provide subsidies in the form of building materials.**

7.05 **ADBN did make one inadvertent error in the administration of the project. They claimed 100% of the cost of each plant built from the loan account and also claimed 25% of the cost from the grant subsidy account, making a claim of 125% in all from UNCDF. This error has been explained to ADBN, with the request that they correct their records and claim forms. The accounts relating to these claims had been checked by the General Manager of ADBN and properly audited by external auditors, but this error had not been detected.**

7.06 **The administration of GGC seems well organised. Local offices have files for each customer recording details of each biogas installation. As with ADBN, GGC offices send monthly reports to Kathmandu head office, so that consolidated progress reports can be made. Bookkeeping also seems well done and is carefully supervised by ADBN, which is the major shareholder of GGC**

7.07 Most of the GGC offices seem well organised for sales, installation and follow-up of biogas plants. Most customers seemed happy with how fast plants were constructed, once loans had been approved, the basic training offered by GGC staff in running the plant and in the number of visits by GGC staff after the plant was completed. Any major faults in the construction of a plant, due to poor quality materials (eg. cement that has degraded in the monsoon) or inexperienced masons, are quickly put right under GGC's guarantee scheme.

7.08 Basic maintenance, such as removal of water from the gas line and cleaning of dried slurry from the outlet, is straightforward. The teaching of more complex maintenance, such as greasing of gas taps and cleaning of gas lights, could be improved. Most customers also seem happy about the response of GGC staff when called out for repair work, such as the replacement of a broken gas tap.

7.09 One exception to the overall good performance of local GGC offices was the one in Biratnagar, where customers complained of a lack of follow-up visits and poor response to repair calls. The quality of the plant construction seemed poor, with pipework not buried underground and inadequate back-filling over the dome. The management practices and field supervision in this office do need to be improved.

7.10 It is notable that at all offices, except Biratnagar, the manager joined the survey team, at 6.30 am and took us to the sites of accessible biogas plants that had been built under the UNCDF project. They were willing to have their working day completely upset by the survey team and they knew where their customers' were located. At Biratnagar, the manager sent a subordinate member of staff who was unsure of the sites of suitable UNCDF plants.

7.11 Storage of materials does seem to be a problem for GGC, especially if future targets of 4000 plants a year are to be met. Most of the materials, such as pipework, cement, reinforcing steel etc. are stored in the Butwal regional office or in local offices. Parts for plants are manufactured in the workshop in Butwal and stored until they are needed.

7.12 Distribution between offices is by local bus or by truck, through local transport contractors, and is an expensive part of the operation. As far as possible, materials are purchased in markets close to area offices, but this can also be expensive. Transport from area offices is usually the responsibility of customers, using their own ox carts or other transport. Transport to remote areas, especially in the hills, often involves employing porters to carry goods, either organised by the customer or by the GGC office.

7.13 The achievement of the target of 70 plants to be built in remote areas has been poor. Only 15 plants have been built in these areas up to July 1991 and GGC thinks it can only build another 15 in the new financial year. Penetration of a new area is slow. Plants are first built for a few pioneering people in the area, often people who have moved into the area from outside. Other people in the area watch the new plants for several years to make sure that the technology is reliable before they take an interest.

7.14 The demonstration effect is the main means of persuading people to install biogas plants. Once people are convinced that the technology is effective, they are willing to install their own plants. The survey found a growing interest in Bhaktapur among non-users, suggesting that the demonstration effect was beginning to work after the first plants were built in 1988. In Dhankutta, the first plants were built in 1989, so interest in the area has yet to develop.

7.15 The Regional office in the East of Nepal is in rented accommodation in Biratnagar, but it seems to lack storage space. The land in Itahari (23 km North of Biratnagar) is available and was inspected by the survey team. The new Regional office cum store cum workshop is important if the future targets for biogas plants are to be met. In Lalbandi, too, GGC is using rented accommodation, but storage space is limited. Storage facilities are poor and several asbestos/cement inlet pipes in the store were broken.

7.16 The land provided by the government in Itahari and Lalbandi for the GGC to construct the buildings planned by the project is valued at Rs.7 000 000 at present prices. The government has shown its commitment to biogas in providing subsidies for biogas plants over and above the UNCDF project in financial years 1988/89 and 1989/90. The government's commitment continues into the future with subsidies announced for the new financial year 1991/92.

7.17 The main agent for promoting biogas is GGC. Company staff are the ones that visit farmers and persuade them to buy plants. The government has done little to promote biogas technology, apart from a few radio programs and articles in the newspapers.

7.18 GGC staff are the main people to select potential biogas installers. ADBN and SFDP offices have given a fairly low priority to biogas, among their many other projects. However, ADBN local staff have proved very responsive to farmers who have become interested in biogas, even to the extent of giving loans well beyond their yearly targets.

7.19 Loans are given to farmers with only one animal, although loans have been refused to customers not owning any animals, who claim they can collect dung from the streets.

Those who have a limited supply of dung seem to be able to adapt their cooking practices to make the most of the limited gas supply. One farmer with only one cow claimed that he had sufficient gas, even in the winter, when gas production is reduced. Another farmer with five animals claimed the gas supply was inadequate. However, he allowed his cattle to graze in the fields, so did not collect all the dung and the family admitted they made tea several times during the day.

7.20 ADBN loan officers seem to be experienced in appraising applications for loans for biogas plants. The process of assessing land ownership for security purposes seems fairly time-consuming, but effective. The collection rate of loan repayments is considered reasonable with default rates around 11%.

7.21 The Appropriate Technology Unit in Dhankutta, designated as a "remote" or less-developed area, did include biogas as one of the technologies that they are promoting. The problem with ADBN, as one of the SFDP managers explained, is the number of different programs in which they are involved.

7.22 Most of the GGC staff seem to be keen to go to remote areas to promote biogas technology. However, there is a conflict between a growing demand in areas where biogas is already popular and the much more difficult task of persuading people to accept a new technology in areas where few plants have been built. GGC uses a fixed price for its plants, regardless of where they are built, so as not to penalise people in remote areas with the increased transport cost. The actual cost of constructing plants and the Company overheads has not been accurately assessed.

7.23 GGC seems well experienced in the procurement of materials for biogas plants and their distribution to area offices and to installation sites. All customers, including those in "remote" areas, thought that their plants had been started within a month of the loan agreements being made. Cement had to be purchased at a price fixed by the government. Other materials (such as pipes and fittings) had been put out to tender, but the GGC GM (General Manager) thought that prices could be reduced in the future, if the Company became a retail agent for one supplier, since it would receive commission on goods sold.

7.24 The biogas installers varied in their willingness to provide labour for constructing their biogas plant. Some were willing to do a lot of the work themselves, others expected that GGC staff should do everything for them. Farmers who did do some of the work for themselves received a cash advance on their loan towards the cost of that work. If they were able to do the work cheaper than the price quoted by GGC, this meant they were able to keep the difference as cash.

7.25 Most owners seemed well able to cope with running the plant, using the biogas for cooking and lighting and doing routine maintenance. No one interviewed had done a major emptying and cleaning of the plant, but this should not be required for five years or longer after the plant is built. Owners were less able to cope with more complex maintenance, such as the greasing of gas taps and valves and the cleaning of gas lights. Some GGC offices were training certain owners to do these tasks and act as repair agents for other owners in their area.

7.26 Owners were less effective in their use of the effluent slurry as fertilizer. The ADBN local survey in Biratnagar found that 76% of owners used slurry on the fields, 2% is sold to neighbours and 22% is unused. This result seems typical of the results of all the surveys. Even those who use the slurry, do not do so in the most effective way. Few compost the slurry with straw and vegetable residues, which retains the plant nutrients that are available in the slurry. Most sun dry the slurry, which reduces the nitrogen content.

B2. Project Impact

8.01 The main impact of the project on GGC was to enable it to increase the number of biogas units that it installed during the project period by providing subsidy grant and loan finance for biogas plants. The provision of motorcycles and office equipment has assisted GGC staff in their work. The working capital fund allowed GGC to purchase materials for the financial year 1988/89 and to improve their stocks.

8.02 The project is having a definite effect on fuel wood consumption in Nepal. It is estimated that 1854 medium sized trees will be saved a year, about 12 00 m^3 of wood, from the 927 plants already built.

8.03 The projects impact on actual kerosene and fertilizer import savings is less than those claimed by the project document, estimated to be Rs.940,210 per year from the plants already built ($33,579 at $1 = Rs.28). The potential saving is much higher, if biogas owners learn to use their effluent slurry more effectively, allowing them to save on chemical fertilizer.

8.04 The process of selling biogas plants is making people conscious of the problems of deforestation. Most of the owners of biogas plants recognise the advantages of saving wood, both for themselves and also for the environment.

8.05 The women of families who have biogas plants do benefit greatly from using the gas for cooking. They claim to save half the time they used for cooking on wood fuel. Cleaning pots and pans is much easier without the soot that coats them when used on a wood fire. During hot weather, women find it much easier when cooking, as a biogas stove heats up the room much less. This is less of an advantage in cold weather in the hills, where people like to gather around a wood fire to keep warm.

8.06 Cooking in an atmosphere without smoke helps the health of women. Smoke tends to irritate people's eyes and lungs and the smell clings to clothes and hair. Women claim that blowing a wood fire to get it going gives them headaches.

B3. Project preparation and design

9.01 The project appears to be successful, in that biogas technology is becoming widely accepted in Nepal as a valid alternative to using fuelwood as a cooking fuel. Biogas is also a valid alternative to the use of kerosene for lighting, but only where electricity is not available. The use of effluent slurry as a fertilizer is accepted, but more development is required in this area to make it more effective.

9.02 The original project design did not anticipate the rapid expansion of the whole biogas program. In practice, the program grew to become much more than just the project, with the Nepal government providing subsidies to a value of over four times that provided by UNCDF. The growth in interest in biogas technology was not expected by ADBN which found itself giving loans well above its targets.

9.03 The original project objectives are being realised. Taking into account the whole biogas program, the number of plants built means that the objectives of reducing fuel wood use and saving imports of kerosene and fertilizer have been met several times over.

9.04 The original project design saw the UNCDF funding as the primary support for the biogas program. In the event, the high demand for biogas plants allowed GGC to become slightly more profitable and to rent accommodation for offices and stores. However, little money has been available to invest in modernising the Butwal workshop, let alone setting up new workshop facilities. If the program is to expand as planned by the Nepal government, ADBN and GGC, the office-cum-storage building in Itahari needs to be constructed and money put into both the existing workshop in Butwal and in a new workshop in Eastern Nepal.

9.05 In practice, GGC took on more responsibilities than defined in the project document. GGC staff were responsible for the procurement of materials, for selecting customers for biogas units and for planning the new buildings. ADBN delegated these jobs to the GGC, since GGC staff are more experienced in these areas and ADBN staff are involved in so many other areas. The project appeared to run efficiently and there did not appear to be any constraints introduced by wrongly assigned responsibilities.

9.06 Loans for biogas have been made by ADBN using funds provided by the Asian Development Bank (AsDB) under a series of five-year credit plans. The Fifth Credit Plan, which finished in July 1991, did have money allocated for loans for biogas plants. Since the biogas program developed at a faster rate than expected by ADBN, the extra loan money available from UNCDF did mean that AsDB loan finance could be used for other programs. The Sixth Credit Plan, which was in the process of being finalised during the evaluation visit, does have money for loans for biogas plants, although it is not seen as a priority

B4. Relevance and effectiveness

10.01 The targeted beneficiaries were rural families who needed alternative fuels for cooking and lighting. 927 families have received biogas plants, so have reduced their use of firewood, kerosene and chemical fertilizer.

10.02 All the surveys suggested that those who benefit most from biogas technology are the middle income people in rural areas. Farmers need a minimum land holding to get a loan and alsoneed at least one cow to provide dung for the plant.

10.03 In a new area, such as the "remote" areas listed in the project document, the people who responded to the selling of biogas were the better educated and more well-informed, as they were prepared to try a new idea. Those interviewed in Dhankutta, for example, were mainly associated with the university campus there. Once other farmers had seen biogas plants working well, they were willing to take loans to set up their own plants. In an area where biogas technology is well established, such as Butwal and Pokhara, the two places in Nepal where biogas plants were first built in 1975, the survey met people from SFDP groups who had been willing to install their own biogas plants. So the technology is beginning to penetrate the lower income groups.

10.04 The survey indicated that biogas plant owners do save firewood. The average saving was estimated to be Rs.2071, although this figure is based on people's own impressions of the value of the wood they saved, so is not likely to be accurate. Using this figure, the total value of the wood fuel saved, at local market prices, by the project to date is Rs.1,919,817 from the 927 biogas plants already built. A more accurate figure for wood fuel saving would require a much more elaborate survey in which firewood use was measured over the year for biogas plant owners and non-owners.

10.05 The size of the project was such that the effect on the import of kerosene and chemical fertilizer could not be assessed from import statistics. The survey did indicate that some farmers did save on the purchase either kerosene or chemical fertilizer or both. Again, the survey relied on people's own assessment of savings, so figures are far from accurate, but they suggest that the saving from the 927 plants already built are close to Rs. 1 million.

10.06 The project was very effective in providing a substitute energy source for wood fuel that was much easier to use, saved time and effort especially for women and improved the lifestyle of people living in rural areas.

10.07 The use of biogas in place of kerosene certainly saved people money and the problems of having to purchase kerosene from a store that may be some distance away.

Biogas lights are not very reliable and do cause problems, but they are not more difficult to use than kerosene pressure lamps. Better training of owners in cleaning and maintaining their lamps would improve reliability:

10.08 The penetration of biogas technology into remote areas is slow, but follows a recognised pattern. Owners interviewed in Bhaktapur and Dhankutta were very pleased with their plants and there were signs in Bhaktapur that other people were becoming very interested. The process of persuading people to accept a novel technology is slow and cannot be speeded up. Experience from areas where biogas technology is well established suggests that the demand for biogas plants will grow in these remote areas, once people have had a chance to see that the existing plants are reliable and are helping the households who have purchased them.

B5. Critical Issues

11.01 The whole future of GGC and the way the biogas extension program should develop is under consideration. While GGC is set up in the form of a private limited company, it is primarily owned by ADBN, so is a subsidiary of a government corporation. A better model for the organisation of the construction of biogas plants would be a series of small local private contractors building plants in their own areas. There has been a move in this direction by GGC in that they are training local masons to build biogas plants under contract to GGC, rather than being directly employed by the company. The GGC provides training, supervision, sales and follow-up, but sub-contracts the building work.

11.02 As part of this move forward and as part of a project to subsidise the construction of 20,000 biogas plants over the next five years, SNV, the Dutch voluntary aid agency, is asking a local consulting group to look at the profitability of GGC, its actual overhead costs and the pricing policy for biogas plants. In the past, GGC has set high construction targets and set a price for the plants and a budget based on these targets. When, as usually happened, the company failed to meet its targets, it made a loss. The financial years 1988/89 and 1989/90 were an exception in that GGC almost met and then exceeded its targets, so made a small profit.

11.03 A later part of the SNV project will involve a detailed study of the future form of GGC and the biogas extension project. While the construction side of the work can be privatised in the form of small local companies, some form of organisation needs to exist that can be involved in publicity, quality control, follow-up and R & D work. How this "Biogas Institute" would be funded is open to discussion. It could be made part of the overhead cost of each plant, as at present, by making a levy on each of the sub-contracting companies, through a fee for a licence to build biogas plants. It could become a division within ADBN or become a separate, government funded organisation. It could become an Institute under the direction of Tribhuvan University, since R & D would be an important part of its work.

11.04 Before GGC can be reorganised into an appropriate structure that would allow for privatisation in whatever form seems appropriate, it does need sufficient investment in the production side of its work to ensure its survival. There has been very little investment in the Butwal workshop in the last seven years and it is in need of modernisation and improvement. There is also a need for the workshop in Itahari, so that parts for biogas plants can be made and repaired in Eastern Nepal, without the high transport costs involved in bringing parts from Butwal. As the demand in the remote areas of the Far Western Region increases, another workshop is needed in Nepalgunj to serve this area of Nepal.

11.05 Whatever investment is made in GGC, it must not influence the work that SNV is doing in seeking the best way forward for the biogas extension work. Any future proposals for UNCDF funding need to be discussed with SNV, as well as ADBN, so that the investment does not cause difficulties for any planned changes that may need to be made.

11.06 The profitability for GGC in installing biogas plants in remote areas is questionable. However, the GGC GM sees these plants as a good investment for the future. As the demonstration effect begins to work, the demand in these areas will increase to the point where it will be profitable for either GGC to open its own office in the area, or more likely, train local masons to set up their own construction company in the area.

11.07 The profitability of biogas plants for their owners is, in theory, fairly good. A cost:benefit analysis, based on an average of the responses from the survey (Table 4), suggests there is a reasonable return on investment, as long as the biogas plant is subsidised.

11.08 However, the theoretical analysis uses the market value of the wood saved. In practice, many farmers use their own labour and time to fetch firewood, so do not save cash. While the time and labour saved is used to earn a cash income by some owners, others do not have this opportunity, so finding money to repay the loan can be a problem.

B6. Findings, recommendations and lessons learned

12.01 The evaluation came to several conclusions.

a) **Biogas is a technology that is well suited to conditions in Nepal and is meeting a basic need for cooking fuel, that is reducing the use of firewood and the attendant problems of deforestation, land erosion etc.**

b) **Biogas technology tends to reach the middle income groups in rural and semi-urban areas. It is penetrating into the Small Farmers' Development Groups, but they have a problem in finding cash to repay the loans.**

c) **The most popular plants were of the 6 and 10m^3 size, as they can meet the domestic energy needs of most small farmers. Farmers with an inadequate supply of dung, such as from only one cow, can adapt their cooking practices to make the best use of the gas that they have.**

d) **The system set up by ADBN and GGC for building biogas plants is effective, with reliable checks to ensure the loans and subsidies are used for the purpose for which they were intended.**

e) **A problem for many farmers was the removal of interest rate subsidies in 1990, as they were promised they could pay a rate of only 7.5% for the whole of their loan period (7 years).**

f) **As part of the process of selling biogas plants, ADBN and GGC are helping farmers become more conscious of the problems of deforestation and the environment.**

g) **The direct beneficiaries of biogas technology are the woman who can cook food in half the time and are saved from the bad effects of a smoke filled kitchen.**

h) **There are still problems with the use of biogas technology in Nepal, such as helping farmers find the best way to use the effluent slurry as fertilizer, finding a more reliable design of lamp and improving biogas production in cold weather. 90% of all of the plants built by GGC are still producing biogas.**

12.02 The evaluation offers recommendations on the general operation of the project.

a) **The management structures of GGC should be further strengthened, by building up the evaluation and monitoring division in the Kathmandu Head Office (HO), to do more field surveys of plants built and spot checks on local office operations.**

b) **The future organisational structure for the extension of biogas technology needs to be carefully considered, especially in the light of a desire to privatise the process as far as possible. This will be done under the Dutch SNV project, due to start in late 1991.**

c) **ADBN should check its accounting system for the loan component of the UNCDF funds.**

12.03 The evaluation offers recommendations on the future use of funds from the existing UNCDF project. (Appendix 3 gives more details of the budget, money spent and money remaining in the project).

a) **The remaining grant money should be used to subsidise biogas plants up to the budget limit ($73 146 remaining). ADBN requests for subsidies for the 927 plants built up to July 1990 come to Rs.458 000. Further requests for subsidies for plants built between July 1990 and July 1991 come to Rs.2 12 6 000. Using an exchange rate of $1 = Rs.42, this leaves Rs.488 132. This remaining subsidy grant will need to be provided under the new rules in the July 1991 budget, ie. Rs.7000 per plant of either 6 or 10 m^3, allowing another 69 plants to be built. Finance should be available from the Sixth Credit Plan to cover the loan component for these plants.**

b) **Loan disbursements should be made to ADBN, as requested against plants built, up to the budget limit ($207 668 remaining = Rs. 8 722 044, once the original request forms have been adjusted). Remaining requests for loans for the 927 plant built to July 1990 come to Rs.3 561 364, after adjustment, leaving Rs. 5 160 680. The loan charge for plants built between July 1990 and July 1991 comes to Rs.6 378 000, so the remaining loan fund can be allocated towards this amount.**

c) **Grants should be made for plants built in "remote" areas for 15 more plants. Any remaining money should be re-allocated to the subsidy budget ($5683 remaining = Rs.238 686, allowing another 34 plants to be built).**

d) **The planned building at Itahari should be constructed on the land available, but with a reduced budget allocation ($33 000) . Space should be left, so the building as originally planned can be completed at a later stage. The remaining $11 000 should be assigned to the Butwal workshop for upgrading the building, such as improving the electric wiring and the ventilation.**

e) **The bulk of the workshop equipment budget ($37 000) should be used to purchase machinery for the Butwal workshop, with the remainder being used to set up a small workshop in Itahari.**

f) **The remainder of the office equipment and transport budgets ($10 475) be used to purchase a computer for the Kathmandu HO. The use of a local firm, such as HiTech is recommended, as they can provide after-sales service. A computer course in DCS, Butwal is also recommended for staff who will use the computer.**

g) **Any remaining money still available could be put towards a 4-wheel drive pick-up.**

h) **The UNDP money ($7000) be disbursed to send GGC officers on a suitable course in India.**

12.04 The evaluation offers recommendations on possible further UNCDF and UNDP project involvement. With a commitment by the government of Nepal to subsidies for biogas (based on a proposal for funding to the Dutch government (via SNV) with a target of more than 2 0 000 units in 5 years) and the expected signing of the Sixth Credit Plan for loan finance from AsDB for ADBN, the major need for the future is to build up GGC to meet the expected demand for biogas plants, but also to prepare it for privatisation. A second phase of UNCDF funding is recommended, mainly to build up the production capability of GGC. UNICEF should also be involved in the promotion of biogas technology, as it does directly improve the daily life of women in Nepal as well as family health.

12.05 A second phase of project funding should include:

a) Workshops in Itahari and Nepalgunj to improve GGC's capability to manufacture components for biogas plants. These workshops could be set up as private companies in the future, as and when GGC is privatised;

b) Equipment for these workshops and computers for the Regional offices. ADBN is using more computers in its operation and its record keeping is much improved.

c) Provision of subsidy grants for up to 5000 more biogas plants, especially for plants built by producers other than GGC, but with quality control provided by ADBN or GGC staff. Emphasis could be placed on plants being constructed in the hill districts of Nepal.

d) Encouragement for joint R & D work with institutions such as the Rampur Agricultural campus and the Forestry Institute at Pokhara in such areas as the best use of effluent slurry as a fertilizer and the best ways to improve gas production at low temperatures. UNDP could give grants for biogas research projects at these institutions with the proviso that they are done in cooperation with staff from GGC.

e) Support for training of research workers in R & D at eg. Reading University in UK. The education system in Nepal and India does not encourage the independent thinking required by effective research workers. An M.Sc. course in Europe or USA exposes people to this way of thinking. The M.Sc. course at Reading University on "Renewable Energy and the Environment" exposes students to renewable energy technologies and includes a research project in which they can learn effective patterns of thinking.

f) Support for training of supervisors and extension workers so they can advise farmers of the best ways to use biogas technology. These training courses should be organised in cooperation with the research work being done jointly with the campuses at Rampur and Pokhara, so that supervisors and extension workers can offer the best and most up-to-date advice to farmers.

Appendix 1

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