BIO-GAS PLANTS

IN

HIMACHAL PRADESH

AN EVALUATION STUDY

Issued by

PLANNING DEPARTMENT
(EVALUATION WING)
HIMACHAL PRADESH
SHIMLA-171002

EVALUATION STUDY

OF

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FOREWORD

The introduction of bio gas plants in Himachal Pradesh and other parts of the country has gained considerable momentum in the recent past. Himachal Pradesh has not lagged behind in its popularisation inspite of the adversities of climatic conditions in the major areas of the Pradesh. The response of the rural folk towards the adaptability of bio-gas plants is very encouraging and the favourable results of the study reveal that the large scale introduction of such plants is likely to bring revolution in the social life and economic outlook of the Pradesh. Its success is more significant in the context of Himachal Pradesh where the ecological considerations and reducing the burden of fuelwood drawals from our forests is imperative.

Having realised this importance and the momentum which the programme has gained in the later half of the 6th Plan, an evaluation study of the work done was felt necessary. The work was assigned to the Evaluation Cell of the Planning Department and its findings/suggestions are likely to be of considerable use for future planning in this direction. I wish that the Implementing Department would critically study the report and derive benefit from its findings and suggestions for future planning and implementation of the programme.

S. M. KANWAR,
Financial Commissioner-cum-*Secretary* (*Planning*)
to the Government of Himachal Pradesh.

DATED :
Shimla, the 12*th September,* 1985.

PREFACE

The use of bio mass in the present day context in our country is of great significance. The State of Himachal Pradesh has also made a humble beginning through its participation in the relevant programmes. Among various uses of bio mass, installation of bio-gas plants as an alternative to conventional cooking system has proved to be very successful for the rural economy. Looking to the progress of past three years (1982-83 to 1984-85), it is seen that the rural population has responded very favourably to the adoption of bio-gas technology. As a result, the demand of domestic installations is envisaged to expand considerably in the near future, *i.e.* within the 7th Five-Year Plan period.

Evaluation of past performance is necessary for continuation and expansion of appropriate programmes. As such, the Government of Himachal Pradesh felt it necessary to conduct such a study in selected areas of Himachal Pradesh on a sample basis. The job was assigned to the Evaluation Cell of the Planning Department which has completed the study and brought out results. We hope that the findings would prove useful for the future planning and implementation of this programme. Some of the important findings and recommendations as detailed in the report and summarised in Chapter-IV are as under:—

(*i*) Due to increase in the estimated cost of bio-gas plants, the cost/subsidy pattern needs an immediate revisions.

(*ii*) Bio-gas plants of $3m^3$ were found to be in most common use as compared to other sizes.

(*iii*) The coverage of Scheduled Caste population was not in proportion to their population. The same is true of the population in lower income brackets.

(*iv*) There is a significant saving in the quantity and value of firewood as also of time which can improve the economic conditions of farmers significantly.

(*v*) The functioning of the plants is satisfactory and the adaptability by the masses is encouraging.

In order to popularise the bio gas plants among the poor farmers with meagre holdings, it is also suggested that this programme may be linked up with animal husbandry/dairying programmes. This will also raise the economic status of such section of population which, due to small holdings, are otherwise not able to maintain a bio gas plant.

The results of the study reveal that in the near future, the adoption of bio gas plants is likely to gain considerable momentum in the rural areas resulting in improvement of the economic conditions of the farmers. Beside the direct benefit of the supply of fuel almost free of cost, the other social and economic benefits would accrue in the form of availability of more and better quantity of manure; a solution to the scarce availability of energy; protection to forest wealth; check on environmental pollution; saving in time and overall improvement in public health and domestic hygiene.

The Evaluation Cell of the Planning Department has done good work to bring out this report, the result of which are expected to prove very useful for future planning and implementation of the programme. The co-op`ration extended by the Department of Agriculture, H.P. is gratefully acknowledged. I also express my gratitude to the beneficiaries who were kind enough to spare time with our field investigators.

D. K. SHARMA,
Director (Planning),
Himachal Pradesh.

DATED :
Shimla-2, the 12th September, 1985.

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CHAPTER I

INTRODUCTION

1.1 The use of energy is one of the essentials for the very survival of mankind and with the economic growth it is becoming more and more important, with its various uses for domestic, commercial and industrial purposes. Broadly, this use can be classified into two categories *viz.* domestic purposes and commercial purposes. The later term also includes its use in all types of industries. The domestic uses of energy are mainly for cooking, heating and lighting purposes.

1.2 Indian economy is mainly based on agriculture and allied activities and more than 75% of its population depends upon this occupation alone. Till now the villagers make use of the traditional types of fuels like firewood, coal and dung cakes etc. and the energy requirements are also supplemented to a little extent with the use of electricity and kerosene oil. According to the National Sixth Five-Year Plan document, most of the total energy used in household sector is available in the form of non-commercial types and the percentage of households fully or partially depending on such sources was roughly estimated at approximately 90% of the total. The constant use of coal, firewood and dung cakes coupled with ever-increasing population, demand for fuel and declining supplies have posed serious problems. On the one hand, this has denudated the valuable forest cover of the nation resulting in various adverse effects on the social and economic life of the people and on the other hand, it has resulted in an upward trend in their prices which is now beyond the reach of a common man. Moreover, the use of dung cakes as fuel deprives the Indian farmer of its intrinsic fertiliser value which he could otherwise derive with its use as manure.

1.3 "Necessity is the mother of invention", an old saying was very much applicable to Indian condition and the invention of a bio-gas plant was done in the year 1937, by the Indian Agricultural Reserach Institute (I.A.R.I). It was unfortunate that it could fine its way to the rural masses practically from the beginning of the previous decade and gained popularity only during the current decade with the begining of the Sixth Five-Year Plan. The scheme was initially implemented by the Khadi and Village Industries Commission, (KVIC). At a later stage the job was assigned to the Department of Agriculture. On the recommendations of the National Development Council, the Government of India had transferred the scheme of (Capital) subsidy for construction of bio-gas plants to States from the year 1979-80. The present rates of subsidies as applicable in Himachal Pradesh for different plant sizes are as under:—

TABLE 1.1

SUBSIDY PATTERN

(*Rs.*)

Size of plant	Subsidy (% and amount)	
	SC/ST/SF/MF (80%)	Other (60%)
$2m^3$ ..	2,960	2,200
$3m^3$ ..	3,680	2,760
$4m^3$ ..	5,120	3,840
$6m^3$ ..	6,560	4,920

1.4 The mechanism of the bio-gas plant is quite simple and this can be constructed in a small available open space with the house of the farmer. This consists of two parts *viz.* (*i*) the digester and (*ii*) the gas holder called the dome. The digester is a sort of a well of masonry work dug and built below the ground level at a depth varying between 3.5 to 6 metres. The well has a partition wall in the middle and two slanting pipes reach the bottom of the well on either side of the partition wall. These two pipes have their openings on the surface of the ground by the side of the top of the well. One pipe serves as an inlet and the other as an outlet. The cattle dung is mixed with water in proportion of 4:5 to feed the plant. The digester is initially filled up with the mixture so that whenever cattle dung and other material is put in from the inlet pipe, equal quality of slurry goes out from the outlet pipe. A dome like structure constructed of mild steel sheets is fitted like a cap on the digester where it dips in the slurry and rests on the edge constructed inside the digester. In certain types of bio-gas plants, the dome is constructed of cement concrete material. In that case, it remains fixed with the digester. With the fermentation of the bio mass, the gas bubbles out from the cattle dung slurry, collects in dome and flows out through a pipe provided at the top for use.

1.5 The progress of the instalation of bio-gas plants in Himachal Pradesh which is being discussed in chapter III para 3.1.1 of this report was found to be quite encour ging since the very beginning of the Sixth Five Year Plan and the adaptalility of rural folks was also satisfactory. This necessitated the Government to conduct a small evaluation study of the programme so as to initiate suitable plans and policies for its development in future. The object of the study are specifically explained in chapter-II of this report.

CHAPTER—II

A SYNOPSIS OF THE STUDY

1. Objects :

2.1.1 In a meeting of 20-point programme, it was decided that the Evaluation cell of the Planning Department Himachal Pradesh may conduct an Evaluation Study to assess the benefits of the bio-gas plants installed in Himachal Pradesh. As such a small study on sample basis was initiated in the year 1982-83 with the following main objectives in view:—

(*i*) To make a general assessment of the working of the Bio-gas plants in Himachal Pradesh and to find out whether the beneficiaries are satisfied with its working;

(*ii*) To work out the economy of the Bio-Gas Plant over the traditional type of fuels being used by the beneficiaries prior to the installation of Bio-Gas Plants by finding out the average daily hours of gas generation and its price equivalent to the traditional fuel. A quantitative estimation of fuel saving was also to be made, based on the above results.

(*iii*) To estimate the saving in the traditional type of fuel after the installation of Bio-Gas Plants.

(*iv*) To estimate the saving of manpower in collection/use of traditional type of fuel like firewood, coal and kerosene oil.

(*v*) Qualitative analysis of other benefits related with the installation and use of Bio-Gas Plants such as its use for heating and lighting etc and impact on domestic and village environment.

2. Scope and Coverage :

2.2.1 According to the available lists of beneficiaries supplied by the Department of Agriculture, Himachal Pradesh for nine districts, 590 Bio-Gas plants were installed during the year 1982-83 in Mandi, Kangra, Kullu, Solan, Hamirpur, Shimla, Sirmaur, Una and Chamba districts. The list of Bilaspur, was not available by the time of study and no installation of bio-gas plants has been done in the remaining two districts of Kinnaur and Lahaul & Spiti due to the fact that these two districts are very cold regions and bio-gas plant may not prove a success.

2.2.2 On the presumption that there may not be much variation in the benefits/working of bio-gas plants in different areas of Himachal Pradesh it was not felt very necessary that this study be taken up all over the area of its operation. Hence a small study was planned and only four districts *viz.* Mandi, Solan, Hamirpur and Una were selected for the study. Another reason for this restricted selection was that out of 590 installations, 425 were located in these four districts only which was about 72% of the total. This means that the maximum number of such plants were concentrated in these four districts out of which sample selection was made and field study conducted.

3. Framework of the Study and Sample Design :

2.3.1 The design of the survey was a stratified random sampling design taking the 425 household of the four districts as the population, administrative districts of Mandi, Solan, Hamirpur and Una as strata and the selected households as the basic sample unit. After stratification of the area, wide variation was seen in the number of bio-gas plants which ranged between 28 in Solan district to 301 in Mandi district. A sample of 5% was considered to be justified looking to the available infrastructure with the Department and on the presumption that there may not be much variation in the results of the study. However, since the number of beneficiaries in Solan and Hamirpur were only 28 and 41 respectively a minimum of two household were selected in these areas. The selection of final unit *i.e.* the beneficiary household was done on the basis of systematic sampling with a random start. Strata-wise total number of beneficiaries and number of selected sample is depicted as below:—

TABLE 2.1

NUMBER OF BENEFICIARIES AND SAMPLE SELECTED

District	Total No. of beneficiaries	Selected sample
1	2	3
1. Mandi ..	301	15
2. Solan ..	28	2
3. Hamirpur ..	41	2
4. Una ..	55	3
Total ..	425	22

4. Field Work/Compilation/Report Writing :

2.4.1 A household schedule was devised to be convassed to each selected household for collecting information about the social and economic status, occupation and various details of the economy of his bio gas plant. A copy of the household schedule is annexed as Annexure to the report. The information was collected through personal investigation by two Technical Assistants of the Planning Department. The data so collected was scrutinized, compiled and analysed for presentation of this report.

CHAPTER III

ANALYSIS OF RESULTS

1. Progress of the Bio-Gas Installations in Himachal Pradesh :

3.1.1 Prior to the commencement of Sixth Five-Year Plan, the installation of bio-gas plants in Himachal Pradesh was first undertaken by the Khadi and Village Industries Commissi on through Khadi and Village Industries Board. A f w plants were installed during this period. Later on, during the first two years of the Sixth Plan, this work was assigned to Rural Integrated Development Department. Later on work was transferred to the Department of Agriculture. The year-wise and districtwise progress of the installation of bio-gas plants from 1982-83 onwards is depicted in table below:—

TABLE 3.1

YEAR-WISE/DISTRICT-WISE PROGRESS OF THE INSTALLATION OF BIO-GAS PLANTS IN HIMACHAL PRADESH

Name of the district	Years			
	1982-83	1983-84	1984-85	Total Sixth Plan
1	2	3	4	5
1. Shimla ..	20	53	68	141
2. Solan ..	30	50	385	465
3. Sirmaur ..	13	40	184	237
4. Una ..	12	65	162	239
5. Bilaspur ..	30	70	180	280
6. Mandi ..	70	260	1,045	1,375
7. Hamirpur ..	20	40	98	158
8. Kangra ..	58	150	152	360
9. Chamba ..	2	37	112	151
10. Kullu ..	15	35	124	174
Total ..	270	800	2,510	3,580

3.1.2 It is seen from the above table that the progress in respect of year to year installation of bio-gas plants has been remarkable. Taking the year 1982-83 as the base period this increase in terms of percentage during the subsequent years is 196% in the year 1983-84 and 830% in the year 1984-85. Taking the cumulative total of the three year by the end of the Sixth Plan this percentage over the first year works out to 1226%. This however, cannot be taken as a long term trend line but the performance of the year 1984-85 in the real scale of future operations in this context. The Seventh Plan target for installation of family sized bio-gas plants is 15000 and keeping in view the climatic and topographic constraints, this is a formidable task. The pace for achieving this has however, been set during 1984-85.

2. Expenditures Incurred :

3.2.1 Total expenditure incurred on bio-gas during the Sixth Five-Year Plan had been Rs. 77.86 lakh with its yearly spread as under:—

TABLE 3.2

YEAR-WISE EXPENDITURE

(*Rs. lakh*)

Year	State	Central
1	2	3
1980—83 (82-83) ..	26.11	10.13
1983-84 ..	18.65	20.92
1984-85 ..	38.72	92.29
Total: ..	83.48	123.34

3.2.2 It is seen from the above figures as well as the physical achievements in table 3.19 that the progress in respect of installation of bio-gas plants in Himachal Pradesh has been quite encouraging in the last year of the Sixth Five year Plan. Looking to the importance of the scheme and encouraging results during the last two years of the Sixth Five-Year Plan, the outlay for the Seventh Plan 1985—90 and Annual Plan 1985-86 under State Sector have been kept at Rs. 450.00 lakh and 65.00 lakh respectively. The central contribution will continue to be available to the state Government on the same principles as applied during 1984-85.

3. Socio-Economic structure of Selected Households :
Family Composition:

3.3.1 Out of the 22 selected beneficiary households in the sample study, 2 were in Hamirpur, 15 in Mandi, 2 in Solan and 3 in Una districts. The family composition *i.e.* the number of adults, children and total members is depicted in table 3.3 below:—

TABLE NO. 3.3

HOUSING COMPOSITION

District	Total sample households	No. of members			Average per household		
		Adult	Children	Total	Adult	Children	Total
1. Hamirpur	2	16	14	30	8	7	15
2. Mandi	15	79	44	123	5	3	8
3. Solan	2	18	5	23	9	2	11
4. Una	3	25	2	27	8	1	9
Total...	22	138	65	203	6	3	9

3.3.2 It is seen that on an average, a beneficiary household consisted of 9 persons *i.e.* 6 adults and 3 children. The district-wise variation is large, ranging from 8 persons to 15 persons. The everage household size of the beneficiary households is much large than the normal family size which is 6 according to 1981 census for the state as a whole. As it is, the sample households generally represent a diametrically opposite family composition than usual in terms of the number of adults and children.

Occupation :

3.3.3 Generally, in rural areas, a household is engaged in more than one occupation. As such the occupational classification of the sample households was primarily done into two catagories viz (i) Primary occupation and (ii) Subsidiary occupation. The Primary occupation being the one from which the household derives maximum income. The subsidiary occ pations may be more than one for a single household. On the other hand some house-holds may not be having any subsidiary occupation. Both the primary as well as the subsidiary occupations were further sub-classified into the type of occupations such as agriculture, horticulture, service, business and others. The data so collected from the sample households has been consolidated in terms of the percentage of households under each sub-category and depicted in the sub-joined table.

TABLE 3.4

OCCUPATIONAL DISTRIBUTION OF SAMPLE HOUSEHOLDS

District	Sample H.H. Nos.	Primary occupation			Subsidiary occupation				
		Agr.	Service	Busi-ness	Agr.	Hort.	Service	Busi-ness	Pension
1	2	3	4	5	6	7	8	9	10
1. Hamirpur	2	1 (50.0)	— (0.0)	1 (50.0)	1 (0.0)	— (0.0)	1 (50.0)	1 (50.0)	— (0.0)
2. Mandi	15	12 (80.0)	2 (13.3)	1 (6.8)	2 (13.3)	2 (13.3)	6 (40.0)	2 (13.3)	2 (13.3)
3. Solan	2	1 (50.0)	— (0.0)	1 (50.0)	— (0.0)	— (0.0)	— (0.0)	— (0.0)	— (0.0)
4. Una	3	2 (66.7)	1 (33.3)	— (0.0)	1 (33.3)	— (0.0)	— (0.0)	1 (33.3)	— (0.0)
Total ..	22	16 (72.7)	3 (13.6)	3 (13.6)	4 (18.9)	2 (9.1)	7 (31.8)	4 (18.9)	2 (9.1)

3.3.4 It is seen from the above table that for all the four districts, 72.7% households had agriculture as their primary occupation. The remaining two primary occupation were service and business with 3 households (13.6%) in each category. As regards the engagement in subsidiary occupations, agriculture was subsidiary occupation of 4 households (18.9%) horticulture for 2 (9.1%) service for 7 (31.8%) business for 4 (18.9%) and pension for 2 (9.1%).

3.3.5 The above facts also depict that besides the agricultural households, the service and business households have also evinced interest towards the installation of bio-gas plants.

Social classification according to caste :

3.3.6 An important aspect of any socio-economic study is to assess the number and percentage of the beneficiaries falling under the economically weaker and socially under privileged classes of society. Accordingly, the total number of sample beneficiaries have been classified on this attribute and depicted in Table 3.5 below:—

TABL 3.5

SOCIAL CLASSIFICATION ACCORDING TO CASTES

District	Sample household Nos.	No. and (percentage of)			
		Scheduled caste	Scheduled Tribes	Backword Classes	Others
1	2	3	4	5	6
1. Hamirpur ..	2	— (0.0)	— (0.0)	— (0.0)	2 (100.0)
2. Mandi ..	15	3 (20.0)	— (0.0)	— (0.0)	12 (80.0)
3. Solan ..	2	— (0.0)	— (0.0)	— (0.0)	2 (100.0)
4. Una ..	3	— (0.0)	— (0.0)	1 (33.3)	2 (66.7)
Total ..	22	3 (13.6)	— (0.0)	1 (4.6)	18 (81.8)

3.3.7 From the above data, it is revealed that under the coverage of different categories of population under the scheme, it is not in strict proportion of the total population in these substrata. Whereas the percentage of scheduled caste population to total population in Himachal Pradesh is over 24%, the coverage in the present study works out to 13.6% only which is much below the percentage of their population to total population. The probable reasons for short coverage of scheduled caste population can be as under:—

(*i*) Generally they are either of non-agricultural class or agriculturists with limited holdings in their command as a result of which the minimum number of livestock required for the installation of a bio-gas plant is not possessed by the households;

(*ii*) many of them being un-educated and illiterate persons may not be having any knowledge of the benefits of the bio-gas.

(*iii*) since bulk of the scheduled caste households are below the poverty line, many of them may not be having adequate resources even to meet out 20% of the total cost for bio-gas plants.

3.3.8 Whatever be the reasons for low coverage of Scheduled Castes, it should remain a continued endeavour of the implementing department to enlarge the coverage of SCs./S.Ts., under this programme. Despite a preferential subsidy element, if it has not picked up, the Government should pay

greater attention on publicity and also arrange bank finances, wherever required, to popularise the installation of bio-gas plants among the scheduled castes/scheduled tribes.

Annual Income from all sources:

3.3.9 Income from various sources is another important factor to assess the economic status of the beneficiary. The annual income of the beneficiaries from all sources has been computed and given in table 3.6 below:—

TABLE 3.6

ANNUAL INCOME FROM ALL SOURCES

District	Total sample household	Average annual income from all sources				
		Agriculture	Animal Husbandry	Horticulture	Other	Total
1	2	3	4	5	6	7
1. Hamirpur ..	2	6,000	300	—	22,500	28,800
2. Mandi ..	15	3,274	813	560	8,413	13,060
3. Solan ..	2	1,100	1,860	—	4,000	6,960
4. Una ..	3	2,937	1,100	—	2,800	6,827
Total ..	22	3,776	898	382	8,694	13,750

3.3.10 Although there is a vide variation in the average income per household which ranges from Rs. 6,960 in Mandi district to Rs. 28,800 per household in Hamirpur district, the average works out at Rs. 13,750 per annum per household. From this it can be very well concluded that most of the beneficiaries are such persons which fall under the high income groups. Frequency distribution of households under various income ranges is depicted as under:—

TABLE 3.7

FREQUENCY DISTRIBUTION OF THE HOUSEHOLDS ACCORDING TO INCOME CLASSIFICATION

Income Groups	No. of Households
1	2
3,500	Nil
3,500—6,000	5
6,000—12,000	8
12,000 and above	9

3.3.11 It is observed from the above table that the maximum number of households benefited by the installation of bio-gas plants fall under the higher income brackets. Out of the 22 selected households none was found

to be below the annual income of Rs. 3,500 per annum which is classified as the category for persons below poverty line and only 5 households (22.7%) were in the income group of Rs. 3,500 to 6,000. All the remaining 17 households (77.3%) were having income of more than Rs. 6,000 per annum. The largest number of 9 out of 22 were having income above Rs. 12,000 per annum.

4. Size of plant:

3.4.1 Bio-gas plants can be constructed in varied sizes depending upon the requirements and availability of inputs. Normally for a family, the plants from 2cub. metres to a 4cub metres are in common use. A single biogas plant for a community/village can also be constructed but the same have so far not been installed in Himachal Pradesh. In the coverage of current study, persons were using plants varying from 2 cup metres to 4 cup metres. The number of persons with different plant sizes are given below in Table 3.8.

TABL 3.8

HOUSEHOLDS WITH VARIOUS PLANT SIZES

District	Total No. of sample house-holds	No. of households with different size of plants cub. metres) 2	3	4
1	2	3	4	5
1. Hamirpur ..	2	1	—	1
2. Mandi ..	15	2	13	—
3. Solan ...	2	—	1	1
4. Una ..	3	1	1	1
Total ..	22	4 (18.0)	15 (68.3)	3 (13.7)

3.4.2 It is seen from the above table that the bio-gas plants of 3 cubic metre size are most common in Himachal Pradesh as 68.3 per cent beneficiaries are using the plant of this size followed by the 2 cubic metre size which is being used by 18.0 per cent families.

5. Cost and subsidy pattern:

3.5.1 The Government of Himachal Pradesh has adopted the pattern of subsidy as prescribed by the Government of India, Department of Non-Conventional Energy Sources. The estimated cost per bio-gas plant along with the subsidy pattern for each type *i.e.* for 2, 3 and 4 cubic metre plants is given in

Table 3.9 beow:—

TABL 3.9

ESTIMATED COST AND SUBSIDY PATTERN

Size of plant (Cu. Mts.)	Estimated cost per plant	Subsidy (amount and %) SC/ST/SF/MF (80%)	Others (60%)	Actual cost as works out by study	Difference between actual and estimated cost
1	2	3	4	5	6
2	3,700	2,960	2,220	4,125	425
3	4,600	3,680	2,760	5,355	755
4	6,400	5,120	3,840	6,573	173
Weighted average over 22 Samples ..	4,682	3,745	2,984	5,297	615

Average subsidy per houseold .. 3,537
Net average expenditure per household .. 1,760

3.5.2 It is concluded from the above table that the actual cost of a bio-gas plant is marginally higher than the estimated cost to the extent of Rs. 615 for all the three sizes (Rs. 425 in case of 2cmt. plant, Rs. 755 for 3 c mt. size, and Rs. 173 for 4 c mt. size). With the hike in prices these are likely to increase further.

It is, therefore, sugg sted that the estimates of cost and subsidies should be further revised taking into the account the current prices and further revisions to the same should be kept in view looking to the future rise in prices.

6. No. of Livestock possessed:

3.6.1 As possession of livestock is an essential pre-requisite for installation of a bio-gas plant, (which is at least 3 heads of cattle per household), it was necessary to collect information about the possession of livestock. The number of all types of livestock including young stock in possession of the sample house hold was collected and has been depicted in Table 3.10 below:—

TABL 3.10

NO. OF LIVESTOCK POSSESSED

District	No. of sample household	Total number of livestock	Average per household
1	2	3	4
1. Hamirpur ..	2	11	6
2. Mandi ..	15	81	6
3. Solan ..	2	23	11
4. Una ..	3	21	7
Total ..	22	136	7

3.6.2 The above facts reveal that average no. of livestock in possession with each household varies from 6 to 11 in the four districts. The overall average works out to 7 which is sufficient to keep the bio-gas plant in regular operation.

7. **Quantity and Value of Dung used for bio-gas plants:**

3.7.1 During the course of field investigaions, information was also collected on the quantity of dung used in the bio-gas plant after once fully feeding it. The average daily quantity of dung and the average number of days in use perannum are depicted in Table 3.11 below:—

TABLE 3.11

QUANTITY OF DUNG USED FOR BIO GAS PLANTS

District	Total sample household	Average qty. and value of dung daily used	Average No. of days in use per household
1	2	3	4
1. Hamirpur ..	2	40.00	300
2. Mandi ..	15	38.67	242
3. Solan ...	2	42.05	210
4. Una ...	3	40.60	230
Total ..	22	39.10	243

3.7.2 It is seen from the above table that on an average one household uses 39.1 kg. of dung. The average number of days per annum of the use of bio-gas plants worked out at 243. It may be added here that in rural areas, there is no value of dung in the real sense. Although the same was enquired in view of the fact that it has a manurial value as well as the fuel value, the value of dung used has not been accounted for as the cost of inputs for the reason that the quantity of dung used in the bio gas plant turns out in the form of dung slurry which is used as manure and the manurial value of the same is not less than the value of dung.

8. **Quantity of Gas Generated:**

3.8.1 Himachal Pradesh being a cold region of the country, it is not possibl to make the use of the bio-gas throughout the year. During the winte seasons the bio-gas plants either remain out of use or the quanity of ga generated is not sufficient to solely depend on bio-gas. Moreover, some o these plants have been installed during the same year which was the referenc period of the study due to which the data for full year was not available. Th average number of days per household and the average annual hours of use o

bio gas are depicted in Table 3.12 below:—

TABLE No. 3.12

NO. OF MONTHS/ANNUAL HOURS OF GAS GENERATION

District	Total sample house-holds (Nos.)	No. of days of use of bio-gas		Annual hours of use		Average daily hours of use (hrs. min).
		Total	Av. per h. h.	Total	Av. per h. h.	
1	2	3	4	5	6	7
1. Hamirpur ..	2	300	10.00	2,670	1,335	4-25
2. Mandi ..	15	242	8.06	14,320	954	3-57
3. Solan ..	2	210	7.00	3,208	1,604	7-38
4. Una ..	3	230	7.66	1,380	460	2-00
Total ..	22	243	8.09	21,578	980	4-03

3.8.2 It is seen from the above table that the average number of day per year during which a household used bio-gas for cooking purposes worked out to 243 and the daily average hours of use at 4 hours 3 Minutes.

9. Quantity and Value of Alternative Fuels Used:

3.9.1 Inspite of the installation of bio-gas plants, almost all the households were found to be making the use of alternative fuels like firewood and kerosene oil during the winter months and prior to the installation of bio-gas plants. The average quantity and value of such fuel used is depicted in Table 3.13 below.

TABLE 3.13

AVERAGE QUANTITY AND VALUE OF ALTERNATIVE FUEL USED

District	Total sample h.h.	Quantity and value of alternative fuel used				Total
		Firewood		K. Oil		
		Qty.	Value (Rs.)	Qty. (Litres)	Value (Rs.)	Value (Rs.)
1	2	3	4	5	6	7
1. Hamirpur ...	2	46.0	2,300	—	—	2,300
2. Mandi ...	15	17.5	883	8	17	900
3. Solan ...	2	30.0	900	—	—	900
4. Una ..	3	21.0	760	—	—	760
Total ..	22	21.7	997	0.4	1	998

10. Annual Quantity and Value of Fuel used prior to the Installation of Bio-Gas Plant:

3.10.1 For making a comparative study of the benefits of the bio-gas plants in terms of money savings it was necessary to collect the data on the quantity and value of fuel used prior to the installation of bio-gas plant. As such relevent data was collected from each household for the year prior to the refrence year. The same is depicted in Table 3.14 below:—

TABLE 3.14

AVERAGE QUANTITY AND VALUE OF FUEL USED BEFORE THE INSTALLATION OF BIO-GAS

District	Total Sample h.hs.	Total fuel used prior to installation of bio-gas plant						
		Firewood		Coal		Kerosene oil		Total
		Qty. (Qtls.)	Value (Rs.)	Qty. (Qtls.)	Value (Rs.)	Qty. (Lits)	Value (Rs.)	Value in (Rs.)
1	2	3	4	5	6	7	8	9
1. Hamirpur	2	110	5,500	—	—	—	—	5,500
2. Mandi	15	40	1,990	3	6	9	20	2,016
3. Solan	2	91	2,745	—	—	12	25	2,770
4. Una	3	93	3,033	—	—	15	31	3,064
Total	22	59	2,520	0.1	0.2	2	3	2,523

3.10.2 It is seen from the above table that prior to the installation of bio-gas plant, the average value of annual fuel consumption per household was Rs. 2,523 which was mainly on firewood. The consumption of other types of fuel such as coal or kerosene was just negligible. The average quantity of firewood consumption worked out at 59 quintals.

3.10.3 Comparing the data given in Table 3.13 with 3.12 (Col. 9 of Table 3.13 and col. 7 of Table 3.12), it is seen that the average annual saving per household in terms of the market value of fuel works out Rs. 1,525 per annum.

11. Man-hours devoted in collection and use of firewood:

3.11.1 It is implied that collection, cutting, storage and splitting of firewood is quite a time consuming job, otherwise this time can be very well utilised for other economic purposes. Thus saving in time as result of the installation of bio-gas plant and its economic utilisation is one of the very important aspects of this evaluation study. As such, data was also collected on this important aspect as how much time the house hold was devoting to collection cutting,

spliting of firewood and its use prior to the installation of the plant. The data so collected is depicted in Table 3.15 below:

TABLE 3.15

MAN-HOURS DEVOTED TO FUEL COLLECTION PRIOR TO INSTALLATION OF BIO-GAS

(*Average per household*)

Sl.No.	District	Total Sample household	Annual man-hours devoted for Collection of fuel	Use of fuel	Total
1	2	3	4	5	6
1.	Hamirpur ..	2	1,380	2,220	3,600
2.	Mandi ..	15	894	1,102	1,996
3.	Solan ..	2	240	540	780
4.	Una ..	3	230	280	510
	Total ..	22	788	1,041	1,829

3.11.2 The facts in the above Table reveal that on an average a household was devoting 1,829 manhour only on the collection of firewood and its use for cooking purposes. Dividing these figures by the number of days *i.e.* 365, the daily manhours spent works out at 5 hours per day.

12. Saving after the Installation of bio-Gas Plants:

3.12.1 The annual saving in the cost of fuel is worked out on the basis of simple arithmatical calculations *i.e.* the market value of fuel used prior to the installation of bio-gas plant and during the year under reiew. The value of cow dung used in the plant for this purpose is taken as 'Nil' for the reason that the residue (dung slurry) is used as manure by every household and its value after the release of combustible methane gas does not reduce. In fact this manurial value slighly increases by 2% to 3% but taking some amount as wastage we can take it as the same. The average annual saving per household are calculated as under:—

	Rs.
(*i*) Market value of fuel used prior to the installation of Bio-gas plant (as per Table 3.13)	2,523
(*ii*) Value of fuel used after the installation of the Bio-gas Plant	998
(*iii*) Net annual saving per household (i)—(*ii*)	1,525

3.12.2 From the above figures of Rs. 1,525 we may deduct the interest at the rate of 12% per annum of the expenditure incurred by the house hold. In that case the annual saving per house hold works out as under:—

Rs. 1,525—(12% of Rs. 1,760-211.
=Rs. 1,314.

13. Net Saving of the Quantity of Firewood:

3.13.1 From the earlier paragraphs, it is seen that the quantity of firewood being used by one household prior to the installation of the plant was 59.0 quintals per annum which was reduced to 21.7 quintals after the installation of the plant. Thus the net saving of the firewood works out to 59.021—. 21.7=37.3 quintals.

3.13.2 It may, therefore, be seen that one bio-gas plant, on an average, replaces about 37 quintals of fuelwood per annum. If we go by the projected targets for the 7th Plan, we would have about 19,000 bio-gas units by the 7th Plan end. This would mean an annual estimated re-placement of 7.03 lakh quintals of fuel wood from 1,991 onwards.

14. Saving in Time:

3.14.1 Saving in time is another important aspect of this study. In table 3.4 paragraphs 3.11.1 and 3.12.2, it has been worked out that prior to the installation of the bio-gas plant, a household used to devote 5 hours per day on collection/storage/use of fuel. It is also seen that the use of fire wood has reduced from 59 quintals per day to 21.7 quintals per day. Accordingly we may work out the time devoted before and after the installation of the plant on *pro rata* basis and time saved after the installation of the plant as under:—

(*i*) Daily man-hours on collection and use of fire-wood prior to the installation of plant	.. 5 hours.
(*ii*) Daily man-hours on collection and use of fire-wood after the installation of plant	.. $\frac{5}{59} \times 21.7 = 1.84$ hours or one hour and 50 Mts.
(*iii*) Saving of daily man-hours	3 hours 10 mts.
(*iv*) Less time devoted in the use of bio-gas plant (approximately 30 minutes a day) ..	(—) 0 hrs. 30 mts.
(*v*) Net saving of time	2 hrs. 40 mts.

3.14.2 As all the households had been utilising the saved man-hours for one or the other economic activities, the saved time also has its value in economic terms. It is difficult to work out exactly this benefit in terms of money. However, taking at the normal rates of wages for unskilled labour in rural areas at Rs. 1.25 per hour, the benefit for 2 hours and 40 minutes per day works out at Rs. 3.35 per day per household.

15. Net Gain Per Annum:

3.15.1 On the basis of the overall results of para 3.12.2 and 3.15.2 the total benefits per household with the use of bio-gas plant works out as under:—

	Rs.
(*i*) Saving in firewood	1,314
(*ii*) Saving and utilisation of saved time	1,220
Total ..	2,534

16. Social Benefits:

3.16.1 Besides the economic benefits accrued from the use of bio-gas plants as briefly summed up above, the social benefits cannot be overlooked. It has a direct effect on the environmental improvements, maintenance of neat and clean surroundings within the house, check on atmospheric pollution, check on deforestation and over and above all, an improvement in public health by way of check on respiratory diseases and other diseases caused by flies and mosquitoes etc. However, at the present stage, it is not possible to quantify all these benefits due to various reasons including the time factor. Moreover most of these benefits can only be assessed in the long run when use of bio-gas is sufficiently popularised and becomes a way of rural life. For that it is suggested that after about five years period, a detailed study including various technical aspects of the social benefits of bio-gas plants and its indirect effects may be undertaken.

3.16.2 In the present study, all the selected house-holds were found to be fully satisfied with the working of biogas plants.

17. Non-functionalrity aspect of the Bio-gas plants:

3.17.1 According to the information available to us from the Directorate of Agriculture, only 17 out of the 3,580 bio-gas plants installed upto 31-3-1985 were reported as non-functional or defunct on a variety of reasons, largely non-technical in nature. This implies that the percentage of reported non-functional or defunct units was less than 0.5 per cent. However, accordingly to this micro-study of a sample of 22 units, none of the units were found to be non-functional. No beneficiary complained low gas out-put during winters.

18. Comments and suggestions:

3.18.1 Comments and suggestions of the household were obtained during the field visits but very few households offered the same except that they are very well satisfied with the installation of the plant. A few comments/ suggestions received were as under:—

(*i*) the plant installed is of a smaller size and these should be installed in the desired size keeping in view the number of members and livestock in the family.

(*ii*) pipes and chullahs should be supplied free of cost.

(*iii*) Chullahs should be of the choice of the beneficiary.

(*iv*) technical guidance in the operation of the plant should be provided from time to time.

(*v*) some way out to operate agricultural machinery on bio-gas may be explored if it is possible.

(*vi*) the plant is very useful for checking the deforestation and installation of more plants in every part of Himachal Pradesh, should be done with a very rapid pace.

CHAPTER IV

SUMMARY OF FINDINGS/RECOMMENDATIONS

FINDINGS:

1. The subsidy pattern adopted by the Government is satisfactory (para 1.3).

2. The progress of the installation of bio-gas plants is very encouraging and so are the targets fixed for future (para 3.3.1).

3. The position of expenditure is satisfactory (para 3.2.1).

4. Average size of a household works out at 9 constituting of 6 adults and 3 children (para 3.3.1 and 3.3.2).

5. Out of 22 selected households, 16 (72.7%) had agriculture, 3 (13.6%) service and 3 (13.6%) business as their main occupation. All the household also had one or the other occupation as their subsidiary occupations (para 3.3.3 and 3.3.4).

6. The percentage of scheduled caste beneficiaries to total beneficiaries was 13.6 which is less than the overall percentage of scheduled caste population which shows the disproportionate coverage of scheduled castes (para 3.3.6 to 3.3.8).

7. The average annual income per household from all sources works out to Rs. 13,750 per annum. The different (constituents) of income are agriculture (Rs. 3,776), animal husbandry (Rs. 898), Horticulture (Rs. 382) and others (Rs. 8,694) (para 3.3.10).

8. From the result at Serial Nos. 7 it is concluded that the beneficiaries covered are mostly the persons in the higher income brackets.

9. Maximum number of persons *i.e.* 15 out of 23 (68.3%) have installed the plants of 3 cu. metre size. Hence the plants of this size should be popularised (para 3.4.1 & 3.4.2).

10. The actual cost of the plant works out at Rs. 5,297, the subsidy amount of Rs. 3,537 and the net amount borne by the beneficiary at Rs. 1,760. The estimates of cost and subsidy need a revision in view of increase in prices, (para 3.5.2).

11. The number of livestock possessed by the household including sheeps, goats and young cattle works out at 7 per household (para 3.6.2).

12. The quantity of dung available with each household for use in bio-gas plant works out at 39.1 kgs. per day (para 3.7.2).

13. The number of days of the use of plant works out to 243 days per annum per household (para 3.7.2.).

14. The annual hours of use of the plant works out at 980 (table 3.12). The daily average of the use of bio-gas thus works out at 4 hours and 3 minutes (para 3.8.2).

15. Every household is making use of alternative fuel in addition to bio-gas which is mostly firewood. This use is generally made during the winter months when the requirement of energy increases for heating and the supply of gas goes down (para 3.9.1).

16. The quantity of firewood used in addition to bio-gas is 21.7 quintals of firewood. The use of any other type of fuel is negligible (para 3.10.1).

17. The market value of the conventional fuelwood used works out at Rs. 998 per annum in addition to the bio-gas (table 3.13).

18. The quantity of firewood being used prior to the installation of plant was 59 quintals per annum. The market value of fuel used during this period was 2523 per annum (para 3.10.1).

19. The daily man-hours devoted in fuel collection, cutting, splitting, storage and use etc. prior to bio-gas installation was 5 hours per day (para 3.11.2).

20. Gross annual saving in the cost of fuel per household has been estimated at Rs. 1525 per household. After making a provision for the cost of installation of plant, the net annual saving per household works out to Rs. 1314 (Para 3.12.1 & 3.12.2).

21. Net saving in the quantity of firewood per household works out to 37.3 quintals. This is the annual estimated replacement of fuelwood on account of the installation of the bio-gas plant per household.

22. The net saving in time of the household works out of 2 hrs. and 40 mts. per day (para 3. 4.1).

23. The minimum equivalent of saved time is estimated at Rs. 3.35 per day (para 3.14.2).

24. The annual gain per household in term of fuel savings is Rs. 1314 and in saving and utilisation of time is Rs. 1220. Both combined together give an estimated added Rs. 2534. (Para 3.15).

25. Besides economic gains, there are numerous social benefits which are difficult to be quantified at present.

RECOMMENDATION

1. As the adaptability of people towards bio gas plants is very encouraging and it can save valuable forest wealth, these should be popularised on a massive scale.
2. The coverage of scheduled caste population should be enlarged.
3. Maximum number of 3 cu. metre plants should be installed.
4. For persons below poverty line, rates of subsidies should be further enhanced as they are not able to afford even the present share of 20% of the cost or alternately, soft bank loans could be arranged.
5. Animal Husbandry programme should be encouraged among the persons who have installed bio-gas plants or intend to install one so that there may be no shortfall in the requirement of dung.

6. The cost and subsidy pattern should be suitably revised in view of increased cost of material and construction.

7. A follow up evaluation study purely of the social benefits be conducted after a suitable period.

8. Necessary education and technical guidance should be provided to the beneficiaries and non-beneficiaries.

9. A small industry for the manufacture of stoves and lighting equipment be opened in the Pradesh itself.

ANNEXURE

PLANNING DEPARTMENT

EVALUATION STUDY OF BIO-GAS PLANTS IN HIMACHAL PRADESH

HOUSEHOLD SCHEDULE

1. Name of Head of household _____

2. No. of household members

   Adult : _____

   Children (Below 14 years) _____

   Total: _____

3. Occupation

   (*i*) Primary _____
   (*ii*) Subsidiary
   (Specify) _____
   (*a*)
   (*b*)
   (*c*)

4. Whether belongs to : (Mark in the relevant box)
   S.C.
   S.T.
   Backward Classes.

5. Annual income from all sources
   (*i*) Agriculture (Rs) _____
   (*ii*) Animal Husbandry (Rs.) _____
   (*iii*) Horticulture (Rs.) _____
   (*iv*) Other (Specify) _____
   (*a*)
   (*b*)
   (*c*)
   Total:

6. Size of the plant (Cubic Meters) _____
7. Date of installation of Bio-gas plant Date——Month——Year—
8. Total cost of the Bio-Gas Plant (Rs.) _____
9. Subsidy (Rs.) _____
10. Net amount (Rs.) (Total Cost-subsidy) _____
11. Annual Expenditure incurred on maintenance of Bio-Gas Plant (Rs.) _____
12. No. of Cattle
    Adult _____
    Young _____
    Total _____
13. Quantity of dung available for daily use (Kg.) in the bio-gas plant _____
14. Value of dung (Rs.) _____

15. Quantity of gas generated and its consumption

Months	Average monthly hours	Alternative fuel used								Total value of alternative-fuel
		Fire-wood		Coal		K. oil		Other		
		Qty.	Value	Qty.	Value	Qty.	Value	Qty.	Value	
1	2	3	4	5	6	7	8	9	10	11
January										
February										
March										
April										
May										
June										
July										
August										
September										
October										
November										
December										
Total ..										

16. Quantity of fuel consumed before the installation of the bio-gas plant.

Month	Fuel used prior to Bio Gas installation								Total Value (Rs.)
	Fire-wood		Coal		K. oil		Other		
	Qty.	Value	Qty.	Value	Qty.	Value	Qty.	Value	
1	2	3	4	5	6	7	8	9	10
January									
February									
March									
April									
May									
June									
July									
August									
September									
October									
November									
December									
Total ..									

17. Total Man-hours devoted in (16 above)
(*i*) Collection of fuel ——————
(*ii*) Use of fuel ——————

18. Utilisation of residual dung as manure (kg). ——————

19. Value of residual dung (Item 15 above) (Rs.)		_____
20. Are you also using the Bio-Gas for heating/lighting purposes	Yes	No
21. If yes, Qty. and value of fuel equivalent to Bio-Gas used for above purpose.	Qty.	Values
22. Are you fully satisfied with the working of Bio-Gas Plant.	Yes	No

23. If not, why, Explain in details.

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