

Economics and Constraints in the Operation of Biogas Technology

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Abstract Beneficiaries of biogas plant does not use the dung cakes as fuel and hence result in reduction of use of traditional fuels. Saved dung can be used as FYM to increase the soil fertility. The amount of gas production is higher in summer as compared to rainy and winter seasons. The constraints should be removed by training the biogas plant owners.

Key words Biogas, Benefit-cost ratio, Net present value, Pay back period, Constraints, Fuels

The Government of India is propagating the use of biogas plants in rural areas and providing incentive in the form of subsidy. So, it is necessary to study the different economic aspects of biogas plants. In the present study an attempt has been made to analyse the economics and the constraints in the operation of technology with special emphasis on 3 m³ biogas plants.

Materials and Methods

In Himachal Pradesh majority of family size biogas plants installed are of 3 m³ capacity. The Lambagoan block of district Kangra was selected for study, because majority of biogas plant owners had 3 m³ sized biogas plants in this block. Sample of 25 biogas plant owners had been selected randomly. Survey for the study was conducted during 1991-92. The fixed cost comprised of interest of fixed capital and depreciation. The variable cost included in the analysis consists of cost of labour, dung and minor repairs. The economic life of the biogas plants has been assumed to be 25 years. Two discounts rates have been considered (10 and 12%). Ten per cent is rate of interest charged by the banks on the loan taken for biogas plants. Depreciation was calculated by straight line method.

The gross returns from biogas plants were 'biogas' and 'slurry' (FYM). The total gas produced were estimated as follows :

$$G = \sum_{j=1}^{12} D_j \sum_{i=1}^n C_i H_{ij}$$

Where, G = Gas produced plant⁻¹ annum⁻¹,

C_i = Capacity of i th outlet unit (burners, light, gas engine etc.),

H_{ij} = Average number of hours of usage of i th outlet unit in j th month,

D_j = Number of days the gas plant worked in the i th month,

n = Number of outlet units.

Where, i = 1,2,3, . . . n and j = 1,2, 12 (1 January, 2 February, 12 December)

Biogas was evaluated in terms of firewood and kerosene. The quantity of slurry produced from biogas plant was taken as total quantity of FYM in the output. One m³ of gas produced was taken as equivalent to 3.47 kg of firewood. The thermal equivalent of 1 m³ of gas was taken as 0.62 of kerosene oil (Veena 1986).

Results and Discussion

Livestock inventory : The number of livestock in a household is important for installation of biogas plants. The total daily dung available determines the capacity of the plant to be installed. It can be

Table 1 Livestock inventory on sample households

Animals	Number household ⁻¹
Bullocks	1.57
Cows	
(i) Dry	0.74
(ii) Milch	0.96
Buffaloes	
(i) Dry	0.79
(ii) Milch	1.63
Others	2.25

Table 2 Quantity of dung used and gas generated in biogas plants

Items	Amount
Average quantity of dung fed per day (kg)	54
Recommended dose (kg)	70
Average hours of gas generated	
(i) November to February (winter)	451 (23.16)
(ii) March to June (Summer)	795 (40.84)
(iii) July to October (rainy)	701 (36.00)
(iv) Total hours	1947
Average daily hours of gas generated	5.40

seen from the Table 1 that the farmers were keeping more milch animals than dry animals.

Dung used in biogas plants : The quantity of dung fed has a direct bearing on the quantity of gas generated. Under feeding of the biogas plant hampers the rate of gas production. The average quantity of dung fed per day was 54 kg as against the recommended dose of 70 kg. Generation of gas was low in winter season compared to the other seasons (Table 2).

Saving of fuels and time : It can be seen that installation of biogas plant reduced the dependence upon the traditional fuels. Before the installation of biogas plants, average expenses on fuels by farmers were Rs. 1979 per annum. About 57% (Rs. 1125) of traditional fuels annum⁻¹ household⁻¹ has been replaced with the installation of biogas plant (Table 3).

The use of firewood and dung cakes for fuel is time consuming as considerable time is required for collection and burning of wood etc. It was opined by the biogas plant owners that saving of time was reported after the installation of plants. It

Table 3 Saving in fuels and time after installation of biogas plants.

	Fuels (Rs.)			Total	Time (Manday year ⁻¹)
	Fire-wood	Dung cakes	Kero-sene		
Before installation	1514 (76.50)	391 (19.76)	74 (3.74)	1979 (100)	84
After installation	824	—	30	854 (43.15)	49
Saving	690	391	44	1125 (56.85)	35

was observed that installation of biogas plants resulted in saving of 35 man days annum⁻¹ household⁻¹ (Table 3).

Cost and return in the operation of biogas plants : The construction cost is the standard cost suggested by the State Government. Sand, concrete materials, bricks, labour and cement were the major cost components. These components together accounted for more than 90% of the cost. Total fixed cost, comprised of interest on capital and depreciation, while variable cost consisted of cost of dung, labour and maintenance cost (Table 4). Of the total variable cost, dung accounted for about 53%, labour cost 37% and 19% on minor repairs.

The gross returns from biogas plants represents the total income derived from the biogas

Table 4 Cost and returns in the operation of 3 m³ Janata type biogas plant

(A) Construction cost	Rs. 7815
Subsidy	Rs. 5400
Net cost	Rs. 2415
(B) Fixed Cost	
i) Interest on fixed capital (10%)	
(a) Without subsidy	Rs. 781
(b) With subsidy	Rs. 241
ii) Depreciation cost	
Total fixed cost	
(a) Without subsidy	Rs. 1075
(b) With subsidy	Rs. 535
(C) Variable cost	
i) Cost of dung	Rs. 720
ii) Labour cost	Rs. 515
iii) Maintenance	Rs. 127
Total variable cost	Rs. 1362
(D) Gross returns	
i) Value of biogas in terms of firewood	Rs. 916
ii) Value of biogas in terms of kerosene	Rs. 1062
iii) Value of FYM obtained as slurry	Rs. 1558
iv) Total gross returns	
a) Firewood + FYM	Rs. 2474
b) Kerosene + FYM	Rs. 2620
(E) Net returns	
i) Without subsidy	
a) Firewood + FYM	Rs. 37
b) Kerosene + FYM	Rs. 183
ii) With subsidy	
a) Firewood + FYM	Rs. 577
b) Kerosene + FYM	Rs. 723

Table 5 Economic viability of 3 m³ biogas plant

Particulars	Economic indicators						
	B/C ratio		NPV		PBP		IRR
	10%	12%	10%	12%	10%	12%	
(A) Without subsidy							
Firewood + FYM	1.02	1.00	567	249	18.46	20.92	11.40
Kerosene + FYM	1.08	1.06	1745	1027	11.12	13.37	14.85
(B) With subsidy							
Firewood + FYM	1.20	1.24	4635	3479	5.31	5.39	26.40
Kerosene + FYM	1.38	1.34	6157	4815	5.12	5.18	29.18

production and slurry (FYM). Biogas was evaluated in terms of firewood and kerosene. The total returns obtained from biogas plants was Rs. 2474 and Rs. 2620. The Net returns ranged from Rs. 37 when output was evaluated in terms of firewood + FYM (without subsidy) to Rs. 723 (with subsidy) when output was evaluated in terms of kerosene + FYM. It could be observed that net returns were positive under all the situations, suggesting the economic feasibility of 3 m³ biogas plants in the study area.

Economic viability of biogas plant : It was observed that benefit-cost (BC) ratio was more than unity under all situations indicating the economic viability of biogas plants. As discount rate increases, B/C shows a marginal decrease. Net present value (NPV) was observed to be positive. It varied from Rs. 249 to Rs. 6357 under different methods of evaluation of output and discount rates. Payback period (PBP) was less than expected life of Janata type of biogas plants. PBP increases with increase in discount rate. Internal rate of return (IRR) was higher than rate of interest charged on capital indicating economic feasibility of 3 m³ biogas plant. All the four parameters indicated the economic viability of biogas plant under all situation.

Constraints in the operation of biogas plants : There are various problems associated with the operation of biogas plants.

(i) *Socio-economic problems* : The family members do not like mixing of cowdung with night soil as reported by majority of the respondents (72%) followed by no direct cash income (55%). About 48% of the plant owners reported that slurry is too

watery and difficult to dispose it off before solidification which required more labour.

(ii) *Administrative constraints* : Majority of biogas plant owners (64%) reported the lack of training in the installation and maintenance of biogas plants. About 41% complained the delay in the supply of accessories. Biogas beneficiaries also faced the problems of delay in the disbursement of subsidy and in the supply of cement.

(iii) *Technical constraints* : Seasonality of gas production was reported by all the farmers. This is due to the low temperature in the winter season. Seasonality of gas production can be solved to some extent with the addition of urine of animals, poultry excreta, sugar cane molasses, etc. About 70% complained about the scum formation. Choking of inlet and outlet was reported by 56% of biogas plant owners. Other technical problems faced by biogas plant owners were water accumulation in gas pipe (47%), cracks in walls and dome (52%), deposition of carbon in burner (38%) and leakage of gas (25%)

It was found that amount of gas production was considerably higher in summer followed by rainy and winter seasons. The installation of biogas plants had reduced the dependence upon traditional fuels. The study revealed that beneficiaries have not used dung cakes as fuel after the installation of biogas plants. Saved dung can be used as FYM and can increase the crop production. There is also a saving of man days with the adoption of biogas technology. The net returns and economic indicators were positive under all the situations

The identification of above constraints could be removed to a greater extent by training and education of biogas plant owners. The extension

workers should visit biogas plant owners more frequently and dispel some of the false notions about biogas technology. Seasonality of gas production is an important constraint which need to be attended by research workers.

References

- Anonymous 1985 *Biogas Plants in Himachal Pradesh*. An evaluation study - A report, Department of planning, Govt. of HP. 23.
- Bhati SK & Laharia SN 1985 *A study of Socio-Physiological and Organisational Constraints in the Promotion of Biogas Technology*. Ph. D thesis, HAU Hisar.
- ICAR 1976 *The Economics of Gobar gas Plant* - A Report, ICAR, New Delhi.
- Moulik TK & Srivastava UK 1975 *Biogas Plants at Village Level, Problems and Prospects in Gujrat*. Centre for Management in Agriculture. IIM Ahmadabad, Monograph No. 59.
- Singh Balwinder 1986 *Economic Feasibility of Biogas Plants in Rural Areas*. M.Sc. thesis (Agri. Econ.) PAU. Ludhiana.
- Veena DR 1986 *Biogas Technology - A study of Community Biogas Plants*. Ashish Publication house, New Delhi.
- Wadhvani NK & Prasad A 1985 *Economics of Biogas Plants in Allahabad District of UP. Financing of Agriculture* 17 18-22

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