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A CASE STUDY ON EFFLUENT TREATMENT AND BIOGAS GENERATION IN RUBBER SMALLHOLDINGS

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Majority of rubber smallholders allow the effluent generated in the processing of sheet rubber (RSS) to flow on to the land causing stagnated condition leading to foul smell. Biogas plants are very effective and useful in treating these effluents. This paper is a case study of effluent treatment and biogas generation among the smallholders in Akalakunnam Panchayat in Kottayam district. Biogas plant is installed in only below 10% of the holdings. Sixty seven RSS processing units with 1 m^3 to 3 m^3 biogas plants were surveyed. The average duration of gas production per day is 2 h in 1 m^3 plant and 3.5 h in 3 m^3 with an annual saving of Rs.3,240/- and Rs.5,670/- respectively with respect to LPG consumption. When both cowdung and RSS effluent are used in the same plant, 16 to 30% increase in gas production could be achieved compared to a plant with either of the substrate alone. The intake of effluent in most plants were beyond their recommended capacity. All the units were using the gas for cooking and five were using it for drying rubber sheets in the smoke houses and two for lighting purposes also. Out of the 67 units, 58 were Deenbandu type and nine KVIC model. The slurry from the plant when used for manuring the crops in kitchen gardens resulted in good growth and better yield. The treated water discharged from the plant was free from foul smell. All the growers who adopted this scheme were fully satisfied with the technology.

INTRODUCTION

Environmental pollution is a serious concern of the day. Pollution by any means has to be controlled. Waste water generated during the processing of sheet rubber (RSS) generally leads to environmental pollution. During the processing of natural rubber a large quantity of water is used and this water is loaded with traces of rubber and substances like carbohydrates, proteins, lipids, organic and inorganic salts and chemicals used in processing (RRIM, 1974). On an average 5 to 10 litres of effluent is generated by every kilogram of processed rubber (Mathew *et al.*, 1997). Majority of effluents from RSS units are allowed to flow into the field without treatment, thereby contaminating soil, water and air. Studies conducted by the Rubber Board have shown that this effluent could be treated anaerobically, generating biogas which could meet the energy needs in many ways.

Biogas is an alternative to LPG and firewood for domestic cooking and for drying of rubber sheets in smoke houses. It can also be used for house hold lighting in rural area. Realising the significance, Rubber Board has formulated a scheme for popularizing biogas plants in smallholdings for the treatment of rubber sheet processing effluents. The response for the scheme was very encouraging (Table 1). The primary objective of the scheme is to check pollution and the secondary objective is to generate additional income by using biogas in kitchen, smokehouse and lighting.

Table 1. **Year wise installation of biogas plants aided by Rubber Board**

Year	No
1998-99	322
1999-2000	1468
2000-2001	1879

The objective of the present study were: (1) to evaluate the extent of adoption of the scheme, (2) to study the performance of the treatment system and (3) to estimate the quantity of biogas generated.

MATERIALS AND METHODS

The study was conducted in Akalakunnam Panchayat in Kottayam District. The Panchayat has about 2000 ha. of mature rubber area owned by about 4500 growers. The average size of the holdings is 0.45 ha. Installation of biogas plant is done by only below 10% of the holdings. The rubber growers of this Panchayat have responded well in adopting the Biogas Scheme of Rubber Board. (Table 2). Data were collected from 67 units which accounts for 75% of the biogas plants in the Panchayat where rubber sheet processing effluents are treated in the biogas plants. Data collected included size of the holding, no. of sheets processed, quantity of effluent used, total gas per day, average gas per day and type and size of gas plants installed. The data collected was used to workout the economics of biogas plants.

Table 2. **Year wise installation of biogas plants in Akalakunnam panchayat**

Year	No
1990	2
1993	1
1994	1
1995	2
1997	1
1998	2
1999	3
2000	28
2001	16
2002	11
Total	67

RESULTS AND DISCUSSION

The 67 biogas plants from which the data were collected, were of three sizes *viz.*, $1m^3$, $2m^3$, $3m^3$ or a combination of two i.e., 2 x $1m^3$ sized plants or $2m^3 + 1m^3$ sized plants where the effluents are treated twice having common inlet and outlet. Total gas received in such combined units is higher than single stage treatment (Table 3).

Table 3. **Biogas production and its economics**

Size	No. surveyed	Total gas burnt (h/day)	Average gas burnt continuously (h/day)	Savings (Rs.)
$1m^3$	21	5	2.5	3240
$1 m^3$x2	6	6.5	3.5	5620
$2m^3$	33	6	3.2	5184
$2m^3+1m^3$	4	8	3.8	6156
$3m^3$	3	7	3.5	5670

The total cost of construction of $1m^3$ biogas plant comes to Rs. 6,500 and that of $2m^3$, $3m^3$, 2 x $1m^3$ and $1m^3 + 2m^3$ plants are Rs. 9000, Rs. 12000, Rs. 10000 and Rs. 16000 respectively (Table 4). But the actual expense incurred by the grower is much less as the grower availed financial assistance from Rubber Board and other agencies. The actual installation cost of a 1 m^3 plant from the farmer's side is only Rs.1,820/- after availing the financial assistance from Rubber Board and Ministry of Non-conventional Energy Sources.

Biogas production is found to be more in cases where two substrates are used in the plant i.e., rubber sheet processing effluent mixed with cowdung (Mathew, 1994) (Table 5). When both cowdung and RSS effluent are used in the same plant, 16 to 30% increase in gas production could be achieved compared to a plant with either of the substrate alone.

Quantity of effluent used in various plants were much higher than the

Table 4. **Expenditure and income of biogas plants**

Size	Total cost of construction (Rs.)	Subsidies Rubber Board (Rs.)	Others (Rs.)	Total (Rs.)	Actual expense (Rs.)	Annual income (Rs.)	Payback period (years)
1m³	6,500	2,380	2,300	4,680	1,820	3,240	2
1m³ x2	10,000	2,380	4,600	6,980	3,020	5,620	2
2m³	9,000	2,950	2,300	5,250	3,750	5,184	2
2 m³+1m³	16,000	2,950	4,600	7,550	8,450	6,156	2.5
3m³	12,000	3,550	2,300	5,850	6,150	5,670	2

Table 5. **Biogas production from different substrates**

Type of import	Size of biogas plant 1m³	1m³ x 2	2m³	2m³+1m³	3m³
Effluent alone					
No of units	1	–	11	–	1
Gas generated	2	–	2.5	–	3
Effluent + cowdung					
No. of units	20	6	31	4	2
Gas generated	3	3.6	3.2	3.8	3.5
Increase in gas generation over effluent alone (%)	50		28		16.67

Table 6. **Quantity of effluent and gas generation observed in the survey**

Size	Holding size (ha)	No. of sheets treated/day	Effluent generated (I)	Increase over the standard (%)	Gas (h)
1m³	0.99	28.8	110.7 (25)	342.8	3.0
1m³ x2	1.20	32.5	120.8 (50)	141.6	3.6
2m³	0.96	29.3	105.9 (50)	111.8	3.2
2 m³+1m³	1.30	41.7	140.0 (75)	86.6	3.8
3m³	1.80	53.0	183.3 (75)	144.4	3.5

Figures in parentheses indicate the recommended standard (volume)

recommended capacity. In 1 m³ plant, the rate of flow is 342.8% and in a 3 m³ plant it is 144% more of the recommended inflow. This has to be controlled for achieving the proper desired level of treatment and optimum biogas generation (Table 6).

In all cases the gas generated is used in the kitchen and almost satisfies the entire need of the household. More farmers are showing interest in using biogas in smoke houses. Use of gas for lighting is restricted because of the high initial cost of the lamp required. (Table 7).

Out of the 67 units, 58 are Deenbandu type and nine KVIC model. Deenbandu model is popular because of its lower cost of construction (Table 8). The two stage

Table 7. **Use of biogas**

Use	No. of households
Kitchen	67
Smoke house	5
Lighting	2

Table 8. **Types of effluent treatment plants installed.**

Type	No. of households
KVIC	9
Deenbandu	58
Total	67

treatment was found better than single stage. All these units had installed the gadget initially, but is not in use at present. Burners of the gas stoves, where gadget for H_2S removal is not used were found to be clogged with some solid materials. The vessels used were also found to have soot in the bottom. The slurry obtained from the plant after treatment was utilized as manure for kitchen garden. The growth and yield of crops were found to be better when this manure was used. The treated water discharged from the plant was found to be turbid and had no foul smell. Treated effluent is safe for irrigation (Table 9).

Table 9. **Characteristics of treated effluent**

Parameter	Treated effluent	Safe limit for irrigation
Colour	colourless	
PH	7.2	6-8
Total solids	846	2100
Suspended solids	58	200
Biological oxygen demand	68	100
Chemical oxygen demand	228	250

Source: Mathew *et al.*, (1997)

CONCLUSION

It can be concluded that the scheme is well accepted and adopted. Those who are using the biogas are satisfied with the performance of the system. Significant savings is made due to the use of biogas. The production of gas could be increased by the combination of cowdung and effluent.

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