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Research Article

ANALYTICAL STUDY ON THE POSSIBILITY OF BIO-GAS GENERATION IN SIVAGANGAI DISTRICT, TAMIL NADU

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A B S T R A C T

India has a large renewable resource that can be used to overcome the energy crisis of the economy, so as to promote sustainable energy and economy. Bio-gas has a potential in India towards achieving energy sustainability using locally available organic wastes, which may also help in reducing Green House Gas (GHG) emission and supplying good quality bio-fertilizer for the farmers. India has the largest cattle population in the world. The government views bio-gas technology as a vehicle to reduce rural poverty and as tool in its derive for rural development. The cattle production in India is mainly in the hands of small and marginal farmers and landless labourers who maintain this to earn supplementary income. World is facing energy crisis due to various factors like over population, industrial development, booming of construction sector, etc. To solve the energy crisis, the world is having paradigm shift towards renewable energy in recent years. The benefits to the farmers is to boost up their income who install bio-gas plants and utilisation of bio-gas and slurry.

INTRODUCTION

Energy is the vital factor for the economic development in every nation. India has a large renewable resource that can be used to overcome the energy crisis of the economy, and promote sustainable energy and economy. In India, the realised potential of renewable energy is only 12.95 per cent of the total estimated potential of renewable energy source which is yet to be untapped. The world is now looking into green energy technologies for the future needs.

Bio-gas

Bio-gas consisting mostly of methane gas could be produced from animal wastes, human excreta, agro-wastes, aquatic plants etc. Bio-gas is a smokeless fuel produced in a digester by anaerobic fermentation which also given digested slurry an excellent organic manure (Bhatnagar *et.al*., 1990).

The scarcity of petroleum leads to increase the cost of Liquefied Petroleum Gas (LPG) cylinders. The management of waste is another important issue in the present world. Both problems could be solved through kitchen waste bio-gas plant. Bio-gas can be utilised for cooking and slurry can be utilised for farming. It has been an easily accessible, sustainable source of renewable energy as it can be adopted at household level (Shamsundar Subbarao, 2013). Bio-gas has a potential in India towards achieving energy sustainability using locally available organic wastes, which may also help in reducing Green House Gas (GHG) emission and supplying good quality bio-fetilizer for the farmers. India has the largest cattle population in the world. Cows and buffaloes stand at 29.96 crore, and contribute 58.5 per cent of total livestock population in the county. Bio-gas Development and Training Centre (BDTC), a research team at IIT Delhi has estimated the total bio-gas generation potential in India is nearly 50 thousand million cubic metre annually. The aim of National Bio-gas Manure Management Programme (NBMMP) is to specially utilise bio-gas energy in order to address the deficiency in adequate cooking energy sources in India. The government views bio-gas technology as a vehicle to reduce rural poverty and as a tool in its derive for rural development. The Ministry of New and Renewable Energy (MNRE), Government of India is contemplating National Bio-gas Mission for setting up of 1 crore bio-gas plant by 2022. All kind of bio-waste for bio-gas production can be used for cooking, power generation to provide energy security and promoting organic agriculture in the country (Virendra Kumar Vijay *et. al*., 2016). In some parts of the world, like Nepal, bio-gas is a reliable source of rural electricity. By converting cow dung into methane bio-gas instead of letting it decompose, besides global warming gases could be reduced by 99 million metric tons. In recent years, bio-gas system has attracted considerable attention as a promising approach for organic wastes recovery (Ipeghan J.Otaraku and Evelyn. V.Ogedengbe, 2013). People in rural areas have recognised the need for bio-gas unit in their farms. Families purchase 15 per cent or more of their total firewood requirements are finding bio-gas units are economical (Sudarshan Naidu, 2004). In India, around 4,600 public

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toilets are connected to bio-gas digesters by the local Non-Governmental Organisations (NGOs) to improve social living conditions of the people (Karthik Rajendran *et.al*., 2012).

Cattle Population-India and World

India has the significant size of livestock population in the world. The cattle products sector plays a vital role in the welfare of rural population. Income from livestock production accounts for 15-40 per cent of the total farm households income in different states. The cattle production in India is mainly in the hands of small and marginal farmers and landless labourers who maintain the bio-gas plants can earn supplementary income (Ramalingaiah and Basava Raja, 2010). The advantages of bio-gas plants are; The bio-gas has improved the health of women and reduced the drudgery of cooking. It helped to reduce the consumption of firewood. In rural areas cattle rearing becomes inevitable to make some additional profit. Slurry can be used as a major fertilizer. Slurry will lead to more attention in agriculture. The rate of chemical fertilizer would reduce considerably. Women will get more time for social interaction and relationships because they do not need to struggle for firewood collection (Kurian, 2004).

Significant Factors in Utilisation of Bio-gas

The major CO_2 emitters in the world are china, United States of America, European Union and India. India is compelled to reduce the CO_2 emission through international pressure (Earth Summits). Hence, India has to shift to Green Energy Technologies including bio-gas generation. In India 4.4 GW of electricity is generated from bio-gas (2015). In next 7 years, India has planned to increase to 10 GW electricity through bio-gas utilisation. Eventually, the bio-gas utilisation in the world would give a positive impact to solve the energy crisis (Vidhya Venkat, 2015).

Potential of Bio-Gas Generation from the Dung Availability

A study made by Gandhi Gram Rural Institute on the possibility of bio-gas generation from the available dung (cattle) is given below. The following table explains the excreta quantity of domestic animals (per day) and its possibility of bio-gas generation.

Table 1 Possibility of Bio-Gas Generation (from Per Kg. Dung)

S. No.	Items	Dung or excreta (Per Day)	Gas yield (Per Kg.)
i)	Country Cow	2 ½ Kg.	36 gram (0.036 Kg.)
ii)	Buffalo	3 Kg.	36 gram (0.036 Kg.)
iii)	Sheep and Goat	800 gram (0.8Kg.)	26 gram (0.026 Kg.)

Source: Ghandhi Gram Rural Institute Report.

The table (1) explains the potential of bio-gas generation from the available dung. A country cow's excreta (dung) is approximately 2½ Kg. per day. A buffalo's excreta would be 3 Kg. per day. The ratio of dung (per day) for a Sheep / Goat is 800 gram. The possibility of bio-gas generation from a Kg of dung is 0.036 and 0.026 from Cow dung and Sheep / Goat dung respectively. Keeping the base as table (1), the potential of bio-gas in Sivagangai District has been analysed.

MATERIALS AND METHODS

India faces energy crisis particularly after the take-off stage. Hence, utilisation of renewable energy is the main concern and bio-gas is one among them. Realising that, this research paper focuses on cattle population, possibility of bio-gas plants (using cow dung), potential of bio-gas and availability of slurry with monetary value. To make a scientific research, the agriculture based Sivagangai district in Tamil Nadu has been chosen as the study area. This research is purely based on secondary data which is collected from the Veterinary Department, Sivagangai with analysing the 19th Census of Livestock Population (year 2012-13). A report by the Gandhigram University, Dindugal, Tamil Nadu is the base for this research. The report shows that a country cow's excreta (per day) is 2.5 Kg and buffo's excreta is 3 Kg. The potential of bio-gas is 0.036 Kg from 1 Kg of cow or buffalo's dung. Based on this report, the availability of dung, possibility of bio-gas plants, potential of bio-gas, derivation of slurry with monetary value were analysed in Sivagangai district. With percentage analyses, the findings were derived for the research problems.

RESULTS AND DISCUSSION

Potential of Bio-gas in Sivagangai District (From Dung availability)

In Sivagangai District, agriculture is the dominant occupation, besides that, there is a reasonable number of cattle population exist. The following table explains the population of cattle (cow, bull and oxen), buffalo, sheep and goat in this district. Potential of bio-gas from cattle (cows, bulls and oxen) in the study area is explained with the help of the following table 2 (block wise).

Table 2 Potential of Bio-gas from Cattle (Cows, Bulls and Oxen) Population in Sivagangai District (Block Wise)

Sl. No.	Name of The Block	No. of Cattle Population	Availability of Dung (Per Cattle 2.5 Kg.)	Potential of Bio-gas from Per Kg. Dung is 0.036 Kg.
i)	Sivagangai	2,8180 (12.5)	70,450.00	2,536.20
ii)	Manamadurai	8,271 (3.6)	20,677.50	744.39
iii)	Ilayangudi	8,740 (3.8)	21,850.00	786.60
iv)	Kalayarkovil	24,026 (10.7)	60,065.00	2,162.34
v)	Thiruppuvanam	10,621 (4.7)	26,552.50	955.89
vi)	Kannangudi	17,733 (7.9)	44,332.50	1,595.97
vii)	Singampunari	12,850 (5.7)	32,125.00	1,156.50
viii)	Devakottai	29,143 (12.9)	72,857.50	2,622.87
ix)	Kallal	20,676 (9.2)	51,690.00	1,860.84
x)	Sakkottai	34,444 (15.3)	86,110.00	3,099.96
xi)	Thiruppathur	22,933 (10.2)	57,332.50	2,063.97
xii)	S.Pudur	6,571 (2.9)	16,427.5	591.39
	Total	2,24,188 (100)	5,60,470	20,176.92

Source: Secondary Data (Veterinary Department in Sivagangai District).

Figures in Brackets Indicate Percentage Value.

The table (2) shows that Sakkottai block has the highest cattle (cow, bulls and oxen) population numbering 34,444 (15 per cent) and the availability of dung from these domestic animals is 86,110 Kg. Supposing, all the availability of dung is been converted into bio-gas, then, 591.39 Kg. of bio-gas can be generated. Devakottai and Sivagangai blocks follow second and third in terms of cattle population respectively. S.Pudur is the least cattle populated block in Sivagangai District. In total, the cattle population in the study area is 2, 24,188 and the availability of dung is 5, 60,470 Kg. (per day), in addition to that the potential of bio-gas is 20,176. 92Kg.

Potential of bio-gas from Buffalo population in Sivagangai District (block wise) is analysed below.

Table 3 Potential of Biogas from Buffalo Population in Block Wise

Sl. No.	Name of the Block	No. of Buffalo	Availability of Dung per Buffalo is 3 Kg. (Per Day)	Potential of Bio-gas from Per Kg. of Dung is 0.036 gram
i)	Sivagangai	79 (2.0)	237	8.532
ii)	Manamadurai	0 (0)	0	0
iii)	Ilayankudi	0 (0)	0	0
iv)	Kalayarkovil	115 (2.9)	345	12.42
v)	Thiruppuvanam	33 (0.8)	99	3.564
vi)	Kannangudi	257 (6.5)	771	27.756
vii)	Singampunary	57 (1.4)	171	6.156
viii)	Devakottai	948 (24.0)	2,844	102.384
ix)	Kallal	149 (3.7)	447	16.092
x)	Sakkottai	2,235 (56.5)	6,705	241.38
xi)	Thiruppathur	50 (1.2)	150	5.4
xii)	S.Pudur	27 (0.6)	81	2.916
	Total	3,950 (100)	11,850	426.6

Source: Computed Data.

Figures in Brackets Indicate Percentage Value.

The table (3) explains that Sakkottai block has the highest buffalo population numbering 2,235 (56.5 per cent) and the availability of dung from buffalo population is 6,705 Kg. If all the availability of dung has been utilised for bio-gas generation, then, the amount of bio-gas would be 241.38 Kg. Devakottai and Kannangudi blocks follow second and third respectively in terms of buffalo population. S.Pudur block has very less buffalo population only (0.6 per cent). The total buffalo population in this study area is 3,950 and the availability of dung is 11,850 Kg. (per day), also the potential of biogas would be 426.6 Kg.

The table (4) explains that among the 12 blocks in the study area Sakkottai block has the highest sheep/goat population (1,05,088) and the availability of dung is 84,070.4 Kg. Assuming that if all the availability of dung is been converted into biogas, then, 2,186 Kg. bio-gas would be generated. Kalayarkovil and Ilayangudi blocks follows second and third in terms of sheep/goat population respectively. S.Pudur is the least sheep / goat populated block.

Table 4 Potential of Biogas from Sheep and Goat Population in Sivagangai District (Block Wise)

Sl. No.	Name of the Block	Number of Sheep and Goat	Availability of Dung Per Sheep or Goat is 800 gram	Potential of Bio-gas from / Goat Per Kg. Sheep Dung is 0.026 gram
i)	Sivagangai	32,247 (6.6)	25,797.60	671
ii)	Manamadurai	25,322 (5.2)	20,257.60	527
iii)	Ilayankudi	54,340 (11.2)	43,472.00	1,130
iv)	Kalayarkovil	95,624 (19.7)	76,499.20	1,989
v)	Thiruppuvanam	23,496 (4.8)	18,796.80	489
vi)	Kannangudi	26,270 (5.4)	21,016.00	546
vii)	Singampunary	19,344 (3.9)	15,475.20	402
viii)	Devakottai	27,397 (5.6)	21,917.60	570
ix)	Kallal	23,530 (4.8)	18,824.00	489
x)	Sakkottai	1,05,088 (21.7)	84,070.40	2,186
xi)	Thiruppathur	39,466 (8.1)	31,572.80	821
xii)	S.Pudur	11,642 (2.4)	93,136.00	242
	Total	4,83,766 (100)	4,70,835.20	10,062

Source: Computed data

Figures in Brackets Indicate Percentage Value.

The total sheep /goat population in the study area of Sivagangai District is 4, 83,766 and the availability of dung is 4,70,835.2 Kg. (per day), also the potential of biogas would be 10,062Kg.

The total population of selected domestic animals in Sivagangai district (cattle, buffalo, and sheep / goat) are 30,665.52. The following table (5) analyses the block wise population of domestic animals.

Figures in Brackets Indicate Percentage Value.

In Sivagangai district, the possibility of bio-gas generation (From the dung of cattle, buffalo and sheep / goat population) is 30,665 Kg. per day. If it is converted into 15 Kg. cylinders, then 2,044 cylinders can be obtained. This would give the monetary value of Rs. 13, 28,839 per day. For one year, the monetary value would be Rs.48,50,26,308 (48.5 Crore). The result of the table (5) highlights that Sakkottai and Devakottai blocks have the highest potential of biogas. S.Pudur block is the least potential of biogas because the total population of domestic animals are very less in the study area.

Possibility of Bio- Gas Plants in the Study Area

In Sivagangai district (the study area) there are 2,24,188 number of cattle, 3,950 buffalo and 4,83,766 sheap / goat. For the possibility of installing bio-gas plants, only cattle population (cows, bulls, and oxen) has been taken for the analysis. Since there are 2,24,188 number of cattle, the possibility of number of bio-gas plants are 44,837.6 (for every 5 cattle one bio-gas plant can be set up).

Table 5 Possibility of Bio-gas Generation in Sivagangai District

Sl. No.	Name of the Blocks	Possibility of Bio-gas Generation in Kg. (Cattle, Buffalo And Sheep/Goat)	Conversion into 15 Kg. Cylinders	Monetary Value (Per Day)	Monetary Value (Per Year)
1.	Sivagangai	3,215.732 (10.4)	214.382	139,348.386	5,08,62,160.89
2.	Manamadurai	1,271.39 (4.1)	84.759	55,093.566	2,01,09,151.59
3.	Illayangudi	1,916.6 (6.2)	127.773	83,052.666	3,03,14,223.09
4.	Kalayarkovil	4,163.76 (13.5)	277.584	1,80,429.6	6,58,56,804.00
5	Thiruppuvanam	1,448.454 (4.7)	96.563	62,766.34	2,29,09,714.10
6	Kannangudi	2,169.726 (7.0)	144.648	94,021.46	3,43,17,832.90
7	Singampunari	1,564.656 (5.1)	104.310	67,801.76	2,47,47,642.40
8	Devakottai	3295.254 (10.7)	219.683	1,42,794.34	5,21,19,934.10
9	Kallal	2,365.932 (7.7)	157.728	1,02,523.72	3,74,21,157.80
10	Sakkottai	5,527.34 (18.0)	368.489	2,39,518.066	8,73,26,016.40
11	Thiruppathur	2,890.37 (9.4)	192.691	1,25,249.366	4,57,16,016.40
12	S.Pudur	836.306 (2.7)	55.753	36,239.926	1,32,27,572.99
	TOTAL	30,665.52 (100)	2,044.363	13,28,839.2	48,50,26,308.00

Source: Computed data.

Table 6 Possibility of Bio-gas Plants and Slurry Values (In Sivagangai District)

Sl. No.	Cattle Population	Possibility of Bio-gas Plants	Available Slurry (In Litre)	Monetary Value (In Rs)	
				Per Day	Per Year
i)	2,24,188	11,209.4 (25%)	11,20,940	22,41,880	81,82,86,200
ii)		22,418.8 (50%)	22,41,880	44,83,760	1,63,65,72,400
iii)		33,628.2 (75%)	33,62,820	67,25,640	2,45,48,58,600
iv)		44,837.6 (100%)	44,83,760	89,67,520	3,27,31,44,800

Source: Computed data.

The following table explains that the number of bio-gas plants for covering 25 per cent, 50 percent, 75 per cent and 100 per cent of cattle population and slurry derivation in monetary value.

The table (6) explains that, if 25 per cent cattle covered, then 11,209.4 number of plants can be set up and 11,20,940 litre of slurry would be obtained per day. The monetary value would be Rs. 22,41,880 per day and 81,82,86,200 per year (each litre of slurry is Rs.2).

If 50 percent of cattle covered, 22,418.8 number of plants can be set up and 22,41,880 litre of slurry would be available per day. The monetary value would be in Rs. 44,83,760 per day and 1,63,65,72,400 per year. If 75 per cent of cattle population covered, 33,628.2 number of plants can be set up and 33,62,820 litre of slurry would be available per day. The monetary value would be in Rs. 67,25,640 per day and 2,45,48,58,600 per year. If all 100 per cent of cattle covered, then, 44,837.6 number of plants can be set up and 44,83,760 litre of slurry would be available per day. The monetary value would be in Rs.89,67,520 per day and 3,27,31,44,800 per year. It is very difficult to install the bio-gas plants covering all cattle population. It is assumed that, 50 per cent of cattle could be covered for installing bio-gas plants. In that case, 22,418.8 number of bio - gas plants could be set up. From that, 22,41,880 litre of slurry can be derived and it would give Rs.44,83,760 per day and Rs.1,63,65,72,400 per year as the income from slurry (apart from bio-gas for cooking). Hence, this would enable the farmers to get additional income by avoiding the chemical fertilizers, ultimately, it will lead towords organic farming.

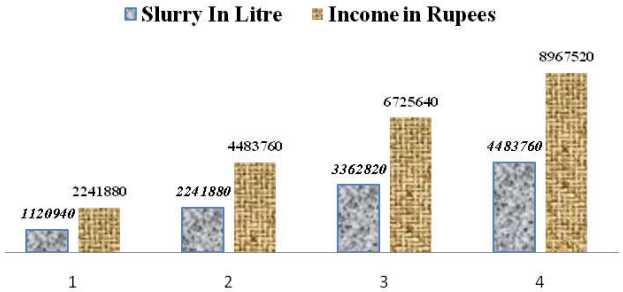

Figure 1 Possibility of Bio-gas Plants and Slurry Values in Sivagangai District

The Important Findings are; there are 12 blocks in Sivagangai District. The total number of cattle is 2,24,188 and Sheep / Goat is 4,83,766 in this district. Compare to cattle and sheep / goat population, the buffalo population is very meager with only 3,950 in this district of study area. Sakkottai block has the highest number of cattle (34,444) and sheep / goat (1,05,088). The lowest number of cattle (6,571) and Sheep / Goat (11,642) in S.Pudur block. Regarding the buffalo population, Manamadurai and Ilayangudi blocks are not having even a single Buffalo. Devakottai block has the highest number of buffalo population with 948 numbers. In the entire

Sivagangai district, the total number of buffaloes are only 3,950. Compared to the population of cattle and sheep / goat, the size of buffalo population is far distant nature. Since, Sakkottai block has the highest cattle (cow, bulls and oxen) population numbering 34,444 (15 per cent) and the availability of dung from these domestic animals is 86,110 Kg and to total potential of bio-gas generation 591.39 Kg. Devakottai and Sivagangai blocks follow second and third in terms of cattle population respectively. In total, the cattle population in the study area is 2, 24,188, the availability of dung is 5, 60,470 Kg. (per day), and the potential of bio-gas is 20,176. 92Kg.
Regarding the buffalo population too, Sakkottai block has the highest numbering 2,235 (56.5 per cent) and the availability of dung from buffalo population is 6,705 Kg. The potential amount of bio-gas would be 241.38 Kg. Devakottai and Kannangudi blocks follow second and third respectively in terms of buffalo population. S.Pudur block has very less in buffalo population (only 0.6 per cent). The total buffalo population in this study area is 3,950 the availability of dung is 11,850 Kg. (per day), and the potential of biogas would be 426.6 Kg. Among the 12 blocks in the study area, Sakkottai block has the highest sheep/goat population numbering 1,05,088 and the availability of dung from sheep/ Goat is 84,070.4 Kg and the potential of bio-gas is 2,186 Kg. Kalayarkovil and Ilayangudi blocks follow second and third in terms of sheep/goat population respectively. S.Pudur is the least in cattle, and buffalo, sheep / goat populated in the study area of Sivagangai district. The total sheep /goat population in the study area of Sivagangai District is 4,83,766 and the availability of dung is 4, 70,835.2 Kg. (per day), and the potential of biogas would be 10,062Kg.

In Sivagangai district, the possibility of bio-gas generation (From the dung of cattle, buffalo and sheep / goat population) is 30,665 Kg. per day. If it is converted into 15 Kg. cylinders, then 2,044 cylinders can be obtained. This would give the monetary value of Rs. 13, 28,839 per day (average rate of a cylinder is Rs.650/-). For one year, the monetary value would be Rs.48,50,26,308 (48.5 Crore). There will be many difficulties to cover all domestic animals dung to set up bio-gas plants. Hence, it is assumed that 50 per cent is possible. Then, 1,022 cylinders can get and the monetary value would be Rs.6,64,300 (per day). It is very difficult to install the bio-gas plants covering all cattle population. It is assumed that, 50 per cent of cattle could be covered. In that case 22,418.8 number of bio-gas plants could be set up. From that 22,41,880 litre of slurry can be derived and it would give Rs 44,83,760 per day and Rs.1,63,65,72,400 per year as the income derived from slurry (apart from bio-gas for cooking). Hence, this would enable the farmers to get additional income by avoiding the chemical fertilizers, ultimately, it will lead towards organic farming.

The important suggestion for the better utilisation of bio-gas particularly the gobar-gas plants in the study area of Sivaganga District.

Instead of individual bio-gas plants, the community level plants would be very much successful. Normally, rural areas have more cattle population. Hence, one or two even more number of community level plants in each village would benefit the entire village.

In recent years, organic farming is becoming popular, but still most of the farmers adopt inorganic farming method. The farmers should be made awareness to go far organic farming method. The agricultural produce through organic farming will fetch higher prices. So the farmers can apply more slurry to get more yield, besides will reduce the expenditure for the inorganic fertilizer.

In India, cattle census in taken quinquennially (once in five years). The census should be modernised and updated every year. Since cypher technology is becoming advanced, a digitalised data collection about the cattle population is very much essential in the modern era. Instead of utilising bio-gas directly from the plants for the cooking purpose, if it is in cylinder form definitely more number of people would come forward to utilise it. Majority of the people do not have awareness on bio-gas and slurry. Generally people may not like the foul smell of bio-gas. Hence, a device may additionally set up to convert the bad into pleasant smell of bio-gas at the time of utilisation.

CONCLUSION

World is facing energy crisis due to various factors like over population, industrial development, booming of construction sector, etc., To solve the energy crisis the world is having paradigm shift towards renewable energy in recent years. Bio-gas plants will certainly plays an important role to develop the rural areas to the farmers to boost up their income. Some challenges like financing problem will persist over a foreseeable future but hopefully the joint effort of Government Organisations, Non-governmental Organisations and other stakeholders will help to realise the great potential of bio-gas.

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