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GUDIYATTAM BLOCK ENERGY PLANNING - POTENTIAL OF BIOGAS FROM LIVESTOCK FOR HOUSEHOLD COOKING

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Abstract:

Among the renewable, Biogas (livestock dung) energy has good potential in rural areas of TamilNadu. A study to explore potential of Biogas for cooking in households of panchayat villages was conducted. Union of panchayat villages is a block and in this study defined as a region. Gudiyattam is a designated rural block in the state of TamilNadu and consists of 44 panchayat villages and 1 town. This study was conducted using available variety of Livestock in each panchayat village and aggregated to Block level. Among the 44 panchayat villages,it is observed that 5 having high potential, 18 having moderate and 22 with no potential. An analysis was carried out to identify potential biomass and forest land saved in panchayat villages of Gudiyattam block. Potential household beneficiary's panchayat village wise identified. This study has found Regional Energy planning through Biogas for household cooking is a reliable alternative and has potential for replication in other blocks.

Key words: Biogas,Panchayat village,Live stock,Forest land, households.

I Introduction:

1.1 Conventional fuel use for household cooking and its impact on Health

Ezzati M et al (2004) stated that in the year 2000 World Health Organization (WHO) estimated about 420 thousand premature deaths per year in India because of the household fuel air pollution. Smith KR(1993) stated that in rural India, due to use of fuel wood adverse health impacts on women are observed. According to Census of India 2011, 62.5% of Indian rural households still use firewood as a primary fuel for cooking with inefficient energy extraction and other health-environmental hazards. Bates et al (2005) confirmed that the use of solid fuel in indoor stoves is associated with an increased risk of cataracts in women. This conclusively proves that alternative fuels for household cooking that are pollution free, environmental friendly are desirable in rural households. Biogas is One of the renewable and is environmentally friendly fuel.

1.2 Potential environmental benefits of Biogas

Wise DL et al (1986) state that Out of world's total primary energy, renewable energy constitutes 13% and amongst bioenergy contribution is 77%. Bhattacharyya SC(2006) observed that Not only electricity but villages get minor supply of all energy sources as they are mainly dependent on kerosene, fire wood and dung etc for cooking and lighting. Borjesson P(2008) noted that Not only climate change but also biogas has the potential to combat environmental problems such as eutrophication, acidification and air pollution. Ansari(2012) highlighted the potential of Biogas as it solves major environmental problems such as soil degradation, deforestation, desertification, CO2 emission, indoor air pollution, organic pollution and social problems such as women occupation etc. by replacing wood and fossil fuels. Smith KR et al(2000) reported that a kg of Acacia wood burned in a traditional mud stove generates 318 gm of Carbon (g-C) equivalent of Carbon emission. Smith KR et al (2000) observed that for cooking efficiency of combustion is more in case of biogas stoves than the traditional biomass or fossil fuel stoves (kerosene / LPG stoves) and biogas stoves will contribute the lowest to GHGs. Slurry from 1 kg of digested dung can yield up to extra 0.5 kg Nitrogen compared to fresh manure [Sasse LV 1998]. It is estimated that the use of bio-slurry annually saves 39 kg of Nitrogen, 19 kg Phosphorus and 39 kg Potassium per household [East Consult,2004] Bioenergy can be a good and sustainable option to minimize greenhouse gases (GHGs) emissions.(Bilgen S et al,2008)

1.3 Current state of biogas energy in India

In India, the energy consumption patterns in rural areas have been largely towards using firewood and other traditional biomass fuels such as chips, charcoal and dung cake. (Husain, 2005).As per Ministry of New and Renewable Energy, Government of India, Among the Decentralized Energy Systems at national level, Family Type Biogas Plants accounts to 42.40 Lakh as on 31.03.2010.(MNRE,2011). According to TEDA (2009), Tamil Nadu ranks 1st in the country in the co-generation of power from sugar mills; 3 co-operative and 16 private sugar mills have installed the cogeneration plant. The total installed capacity under cogeneration is 446.10 MW which is 30 % of the installed capacity in the entire country and the exportable surplus is 256.11 MW as on 31.03.2008.In TamilNadu, community type bio-gas plants, and toilet linked bio-gas plants using Biodegradable waste, were installed during 2002-05 as shown in Table 1.0.

Table 1.0 Biogas plants installed in Tamil Nadu during 2002-05

Year	Plant type	Numbers installed
2002-03	Community type Biogas plants	129
	Toilet linked Biogas plants	2
2003-04	Toilet linked Biogas plants with integrated sanitary complexes	25
2004-05	integrated sanitary complexes Other institutions	16 2

(Source: TEDA 2009) http://www.teda.in/site/index/id/1T9t8D5n1t accessed on 9.9.2014

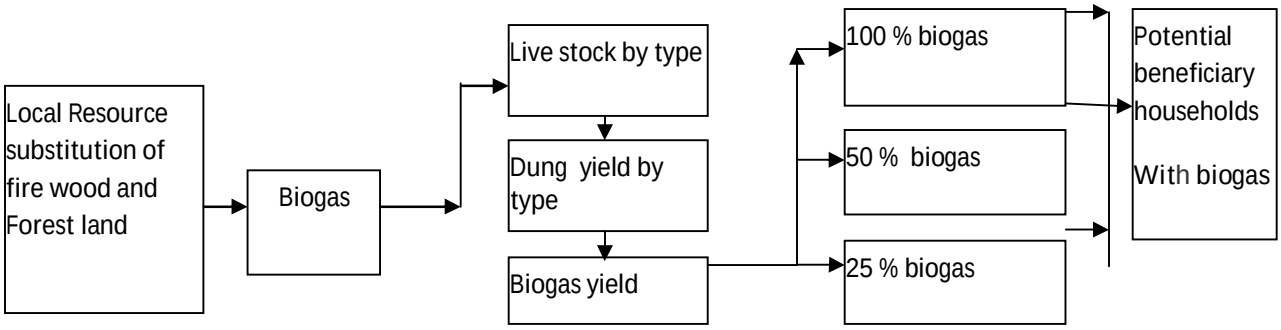

Fig 1.0 Flow chart of Energy planning with Biogas from Live stock Dung for household cooking.

The flowchart using Energy planning with Biogas for household cooking is shown in Figure 1.0.

1.2 Location of the Gudiyattam Block

Gudiyattam block is located in the northern part of the district of Vellore. It lies between 12° 15' 00" and 13° 15' 00" North latitudes and 78° 20' 00" and 79° 50' 00" East longitudes in TamilNadu state of India. It constitutes 44 panchayat villages and Gudiyattam town as illustrated in Figure 2.0. About 54% of the panchayat villages have populations between 1000 and 3000 persons (Census of India 2001).

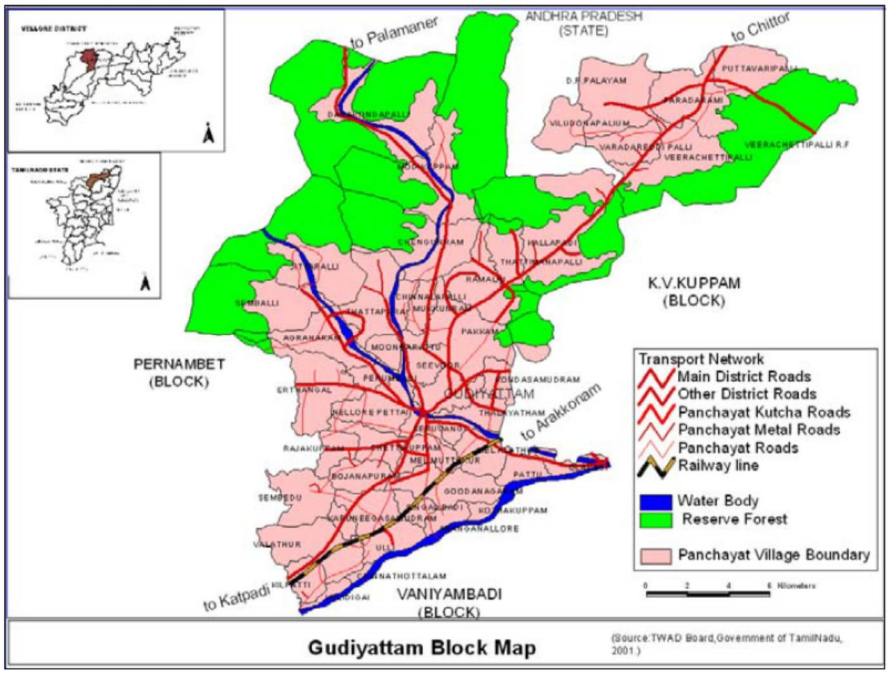

Fig 2.0 Gudiyattam block Map
(Source:TWAD Board 2001)

2.0 Methodology:

Gudiyattam Block as a case study:

The study area is primarily agriculture based and secondary activity is animal husbandry and has significant amount of different livestock as illustrated in Table 2.0. Currently, dung from the live stock is used inefficiently as dry dung cakes and manure. This paper attempts to study the potential of Biogas from live stock dung for Cooking in panchayat villages of Gudiyattam block.

Table 2.0 Number,type of live-stock and Biogas yield in panchayat villages, Gudiyattam block -2007.

Panchayat village name	Cow (Nos)	Buf Falo (Nos)	Goat (Nos)	Sheep (Nos)	Hen (Nos)	Pig (Nos)	Total (Nos)	Total annual biogas yield (cu.m)
i	ii	iii	iv	v	vi	viii	ix	x
Agraharam	465	70	197	266	342	166	1569	41389.03
Ananganallore	601	6	70	600	3115	0	4413	40146.64
Bojanapuram	502	7	405	1800	3150	0	5880	41046.08
Chengundram	480	5	510	417	490	6	1930	33425.27
Chettikuppam	406	0	112	600	3112	65	4317	28152.98
Chinnalapalli	284	10	277	295	264	0	1150	20953.44
Chinnathattalam	551	0	0	0	2010	54	2637	33350.11
Dakshina pathapalayam	742	10	589	672	984	10	3031	51288.97
Danakondapalli	512	10	420	342	515	9	1828	35396.53
Ertangal	435	16	285	217	225	96	1309	30955.61
Goodanagaram	216	19	167	276	265	25	1032	17877.89
Gudiyatham	0	0	0	0	0	0	0	0
Jittapalli	0	0	0	0	0	0	0	0
Kallapadi	568	15	305	365	355	22	1650	39080.07
Karuneeka samudram	421	10	55	265	1700	0	2465	28284.51
Kilpatti	923	11	420	1120	2620	12	5135	63694.57
Kondasamudram	696	30	266	175	265	23	1472	48016.45
Kothakuppam	632	0	101	401	1715	0	2868	39971.49
Kulidikai	702	6	155	80	3720	0	4694	44482.19
Melalathur	177	10	135	285	307	87	1093	14331.4
Melmuttukur	25	0	0	0	0	0	25	1478.25
Modikuppam	972	27	712	585	740	21	3075	67754.31
Moongapattu	387	6	85	120	370	5	983	24844.46
Mukkunram	240	2	100	80	380	4	821	15420.58
Nellorepettai	369	54	150	130	263	110	1107	32130.72
Olakasi	305	20	142	269	245	22	1038	23135.07
Pakkam	0	0	0	0	0	0	0	0

Paradarami	592	12	437	422	786	12	2288	40941.48
Pattu	252	7	147	205	286	14	941	17680.26
Perumpadi	296	35	256	300	267	106	1314	26003.8
Puttavaripalli	822	7	732	620	690	12	2897	55917.01
Raja Kuppam	657	0	120	1100	4430	0	6326	45189.77
Ramalai	545	10	259	498	305	14	1648	37167.94
Sempalli	342	89	365	478	395	88	1862	38441.46
Sempedu 897	897	237	1182	4120	32	32	6500	113320.9
Singalpadi	931	12	410	1155	3420	0	5959	64583.1
Thalayatham	307	15	110	100	190	30	803	21628.44
Thattaparai	941	22	760	620	732	10	3110	65449.55
Thattimanapalli	506	0	376	486	300	10	1697	33816.05
Ulli	820	4	80	310	3150	0	4400	51616.55
Valathur	621	0	0	252	2002	16	2911	38376.95
Varadha reddipalli	632	10	682	587	784	8	2723	44793.47
Veerichettipalli	318	12	520	430	524	8	1827	25068.49
Seevur	688	17	150	263	391	28	1567	45385.56
Cheruvanki	307	40	142	159	343	164	1244	26604.56
Viludonapaliam	0	0	0	0	0	0	0	0
Total	22060	873	12386	21465	46179	1289	105514	1608592

(Source: Veterinary clinic, Gudiyattam 2007 and primary survey 2006-07)

Ramachandra TV (2000) reported the production of dung per day in Kg on an average for cattle is 4.5, Buffalo is 12.Kishore et al (2000) reported the dung production per day in Kg for swine is 0.34, sheep is 0.32, Goat is 0.35 and Poultry is 0.02.This data was used to compute the potential livestock dung yield by live stock type in the study area.

In this study, the annual total dung produced by livestock was computed, based on the total number of livestock by type and dung production per live stock in a panchayat village. Then from the total annual dung production, the total annual biogas yield potential was computed as shown in table 2.0 using the formula in table 3.0.
Scenarios were generated based on variations in the availability of dung from live stock for the production of biogas. Three scenarios were generated based on the availability of 100 %, 50 % and 25 % Biogas on annual basis and the number of households that could be supported in each panchayat village.

Table 3.0 Total annual biogas production assessment

Live stock by type (nos)per Panchayat village	X average dung yield/day by live stock type	X 365 days	X dung to biogas conversion factor (Kg to Cu.m)	= total annual Biogas production (Cu.m /year)

(Source: Satyamoorty K 1999 ,p 59)

2.2 Cooking energy supply with 100 % Biogas availability assessment

The Biogas cooking energy supply was computed per panchayat village applying the formula as shown in Table 3.0. It is clear from Figure 3.0 that the cooking energy supply with 100% Biogas availability in percentage for the year 2007 varies primarily between 0 % and 50 %. Among the panchayat villages, five scored more than 50 %, seventeen scored in the intermediate range of 25 % - 50 %, and the remaining scored less than 25 %.

It is noted that panchayat villages with a high score are dispersed, one on the northern side along the Chittor road, one on the south-western side of Gudiyattam town, one in the middle of the Gudiyattam block and three on the southern side of Gudiyattam town. Panchayat villages with a moderate score are clustered and dispersed. One cluster is on the south-western side of Gudiyattam town, one on the northern side of Gudiyattam town along the Palamaner road. Among the dispersed, one is on the south-eastern side, two adjacent to Gudiyattam town, two on the northern side along the Chittor road, and one adjacent to the Kallapadi Reserve forest. Panchayat villages with a low score are predominant and concentrated in the middle of the Gudiyattam block, on the southern side and northern side of Gudiyattam town along the Chittor road.

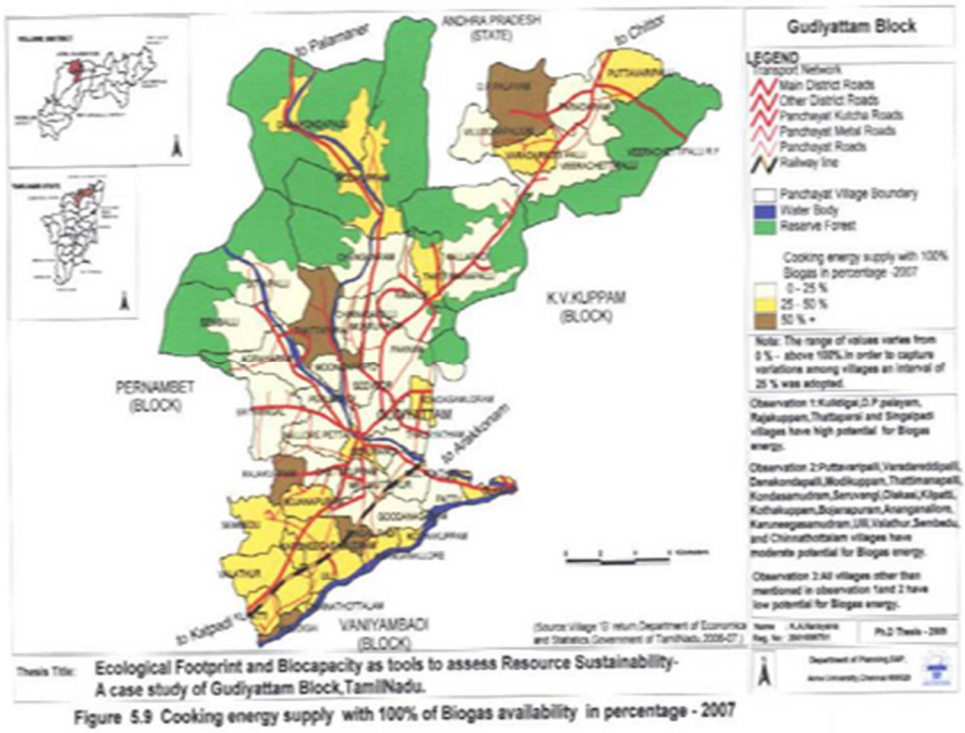

Fig 3.0 Cooking Energy supply with 100% Biogas availability in percentage -2007.

Table 4.0 Comparative assessment of scenarios of 100%,50% and 25%Biogas energy for cooking in the panchayat villages of the Gudiyattam block

Scenario	high	moderate	low	Percentage of the total

Biogas use				panchayat villages
100 %	5	18	22	11 % with high score 40 % with moderate score 49 % with low score
50 %	2	3	40	4 % with high score 7 % with moderate score 89 % with low score
25 %	0	2	43	0 % with high score 4 % with moderate score 96 % with low score

3.0 Scenario synthesis of biogas energy

A comparative assessment across scenarios using 100 %, 50 % and 25 % biogas cooking energy reveals a high score with a range of 0 % - 11 %, a moderate score with a range of 4 % - 40 %, and a low score with a range of 49 % - 96 % among the panchayat villages as shown in Table 4.0.

This assessment with 100% biogas energy among panchayat villages proves that 11 %(5) have high potential and 40 %(18) have moderate potential and the remaining with low to no potential in Gudiyattam block. The households benefitted by Biogas substitution for cooking panchayat village wise in percentage is shown in table 4.0.The assessment with biogas cooking household beneficiaries across panchayat villages varies between 0 - 31%. There are 5 villages less than 0, 24 villages in the range of 1 -10%, 11 villages in the range of 11%-20%, and the remaining 5 are above 30%.

4.0Forest land/Energy plantation – saving of Biogas equivalent fire wood

The equivalent fire wood saved annually by the substitution with 100% Biogas panchayat village wise is shown in table 5.0. Ramachandra TV (2000) used the value of 1 m3 biogas as equivalent to 3.5 kg of firewood in Kolar district energy study,Karnataka. Annually 20 tons per hectare for fire wood yield was assumed. The forest land/Enery plantation in hectares saved by the adoption of 100% Biogas for household cooking panchayat village wise and the number of household beneficiaries panchayat village wise in percentage was shown in table 5.0.

Table 5.0 Annual Biogas fire wood equivalent, forest land and potential household beneficiaries in percentage in panchayat villages, Gudiyattam block -2007.

Panchayat village name	Total annual biogas fire wood equivalent (tons)	Forest land (hectares)	% of households benefitted village wise
Agraharam	144.86	7.24	6

Ananganallore	140.51	7.03	12
Bojanapuram	143.66	7.18	13
Chengundram	116.99	5.85	5
Chettikuppam	98.54	4.93	5
Chinnalapalli	73.34	3.67	10
Chinnathattalam	116.73	5.84	19
Dakshinapathapalayam	179.51	8.98	10
Danakondapalli	123.89	6.19	8
Ertangal	108.34	5.42	4
Goodanagaram	62.57	3.13	3
Gudiyatham	0.00	0.00	0
Jittapalli	0.00	0.00	0
Kallapadi	136.78	6.84	4
Karuneekasamudram	99.00	4.95	21
Kilpatti	222.93	11.15	16
Kondasamudram	168.06	8.40	3
Kothakuppam	139.90	7.00	31
Kulidikai	155.69	7.78	18
Melalathur	50.16	2.51	4
Melmuttukur	5.17	0.26	0
Modikuppam	237.14	11.86	9
Moongapattu	86.96	4.35	7
Mukkunram	53.97	2.70	7
Nellorepettai	112.46	5.62	7

Olakasi	80.97	4.05	9
Pakkam	0.00	0.00	0
Paradarami	143.30	7.16	4
Pattu	61.88	3.09	10
Perumpadi	91.01	4.55	11
Puttavaripalli	195.71	9.79	16
Raja Kuppam	158.16	7.91	23
Ramalai	130.09	6.50	4
Sempalli	134.55	6.73	5
Sempedu	396.62	19.83	29
Singalpadi	226.04	11.30	29
Thalayatham	75.70	3.78	2
Thattaparai	229.07	11.45	11
Thattimanapalli	118.36	5.92	16
Ulli	180.66	9.03	12
Valathur	134.32	6.72	6
Varadhareddipalli	156.78	7.84	12
Veerichettipalli	87.74	4.39	4
Seevur	158.85	7.94	4
Cheruvanki	93.12	4.66	7
Viludonapaliam	0.00	0.00	0
Total	5630.07	281.50	

4.0 Conclusion:

In Rural areas, predominantly firewood is used for cooking. It is the cause of indoor air pollution and associated health hazards in rural households. A study was conducted to substitute firewood with biogas from livestock dung in the panchayat villages of Gudiyattam block. An analysis with different scenarios was generated and amongst, 100% biogas for cooking found to be effective with a total of 36% of the panchayat villages have good potential for substitution. A total of 281.50 hectares of forestland/Energy plantation in Gudiyattam block is saved by the use of biogas cooking.This land could be potentially used for agriculture. This study was conducted in year 2006-07 and Gudiyattam is a rural block and as per TamilNadu Government data for 2015,the spatial and temporal change for the period of 2007-14 in land use and population are very marginal. Hence, the data of 2006-07 was used for assessment of potential of Biogas for analysis.

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