

## Sanitation Pilot: Briquetting of Faecal Sludge as Replacement to Charcoal



### Abstract

This Pilot was taken up to find a means of using faecal sludge usefully and in a profitable manner. The experiment was to carbonise the dry faecal sludge as pellets and then briquettes and see its usage in various industries. Various types and sizes of briquettes were made. These were then tested for their calorific value. Further the briquettes were used in the various local industries like in hatchery, tea boiler and ironing to know its usefulness. The results were encouraging as it was found that the dried faecal sludge can easily be made into pellets by using a pellet machine and it can be carbonised by subjecting it to heat. The briquette can then be replace ford charcoal in poultry or hatcheries. It can also be used for water boiling and hence was used for tea shops with boilers and with ironing of clothes. It was also used in agriculture and found it to be good for growing crops as good manure.

### Introduction

Under the Technical Assistance Program, the Mission Director, SBM(U), MoHUA has approved this pilot project for WASH Institute to undertake directly. Hence, WASH Institute aimed for the effective use of the sludge to convert the treated sludge into briquette.

A pilot briquette making unit has been established at WASH Institute training centre in Dindigul. The briquettes produced were subject to various experiments for it to be utilized as a replacement for charcoal. The results were very encouraging.

In India, over 1.2 billion people generates nearly 1.75 million tonnes of excreta daily, which when properly used can serve as a potential source of energy. Faecal sludge generally has high calorific value which can be attributed to the organic constituents present in it.

The human excreta is a rich source of biomass having a mixture of undigested fats, fatty acids bacterial biomass, polysaccharides (sugars), protein, completely undigested cellulose, dead cells gut secretions and other secondary organic matter derivatives etc. The human excreta rich in biomass and nutrients is treated as waste and generally not put to reuse.

Hence WASH Institute, initiated a research to develop briquettes from faecal sludge which can serve as a replacement to charcoal from wood and can be used in industrial applications. The project is piloted in Dindigul District which has a Sewage Treatment plant with the capacity of handling 13.65 MLD of sewage from which 4.5 tonnes of dewatered bio sludge is generated every day.

### Identification of Problem

As the population continues to be increasing and if wastewater and sludge which is hazardous material if not safely disposed will lead to damage to environment, pollution of water sources

and disease and death. Hence managing the waste by making a useful and recyclable material which is the briquette is one of the best solution.

Faecal waste which is human waste is hazardous material. The Faecal sludge coming after STP (Sludge treatment Process) are dumped . Some of these treated sludge is used for agriculture the rest remains unused. In urban areas tonnes of waste produced from STPs which can be utilised as a replacement to charcoal if it is proven as an easy and viable solution. The experiments were conducted WASH Institute indicates that the conversion of treated sludge is into briquette is a possible solution.

### **Purpose**

Experimenting the use of treated sludge from STPs as briquette in the various corporations and municipalities and it can be possible income generating option to operate the STPs/FSTPs.

### **Statement of the Hypothesis**

Faecal Sludge from STP is safe and good for use as a replacement for charcoal in small industries like hatcheries, tea shops, water boilers and ironing clothes, hence it can generate income.

### **Assumptions**

As the STP sample is treated there are no pathogenic organisms. As in briquetting they are further subjected to heat hence it is rendered safe. On burning it generates heat hence it can be used as replacement for charcoal.

### **Limitations**

The limitations of the study is due to varying briquette size showed slight variations in temperature. Preparing of briquette with and without binders to get pellets could be considerations from area and can give slightly varying results.

While making the briquette slight odour emanates which is more similar to smoke. Safety equipment and masks are required while doing the experimentations.

### **Objective**

The treated faecal sludge from the sewage treatment units are often dumped as land filling materials in many corporations/Municipalities, which is open for the farmers and public to use as fertilizers only. This was observed at the Dindigul corporation which triggered the thought of how to manage this huge quantum of treated sludge more effectively and gainfully

### **Design of the Study and Procedures Used:**

The Research process includes

1. Obtaining the treated Sludge from STP at Dindigul Corporation

2. Sludge Drying in the yard specially prepared for Briquette making.
3. Carbonizing the Faecal sludge by using a kiln (burning).
4. Hand Made Pellets
  - Pounding the sludge to get fine particles.
  - Making various combinations (mixing of various materials with treated sludge) with proposition to find optimum and right mix as well as combination.
  - Grinding or powdering of the faecal sludge and organic materials
  - Sieving the grinded materials to filler small particles for making pellets
  - Filtered and dried mixure is then added water to make a paste
  - Making pellet using pellet machine.
5. Heating of the various sludge combinations in a pot to make briquette.
6. Testing the faecal and organic combinations for calorific value.
7. Preparing of Faecal sludge pellet using pellet machine.
8. Using faecal sludge Briquette for various experiments as in hatchery, ironing and tea preparation and water boiling and room heating.

### Collection and Drying of Faecal sludge

The dewatered faecal sludge was obtained from Sewage Treatment Plant at Dindigul and the same was used for our research. The faecal sludge (FS) was dried in the briquette making shed for few days till it was almost free of moisture. A wooden stand with post was used for breaking down the dry sludge to fine particles. This was then sieved by using a similar sieve used for sand sifting in building constructions. The fine particles were then mixed with water for making pellets.

The Faecal sludge was mixed with other biomass materials for the given ratios. The table below shows the details of different combinations tried.

S.No	Biomass Materials used	Ratio
1	Faecal Sludge + Cow dung	50 : 50
2	Faecal Sludge + Saw Dust	50 : 50
3	Faecal Sludge + Coir dust	50 : 50
4	Faecal Sludge + Ground nut husk	50 : 50
5	Faecal sludge alone	100

### Carbonizing the Faecal sludge

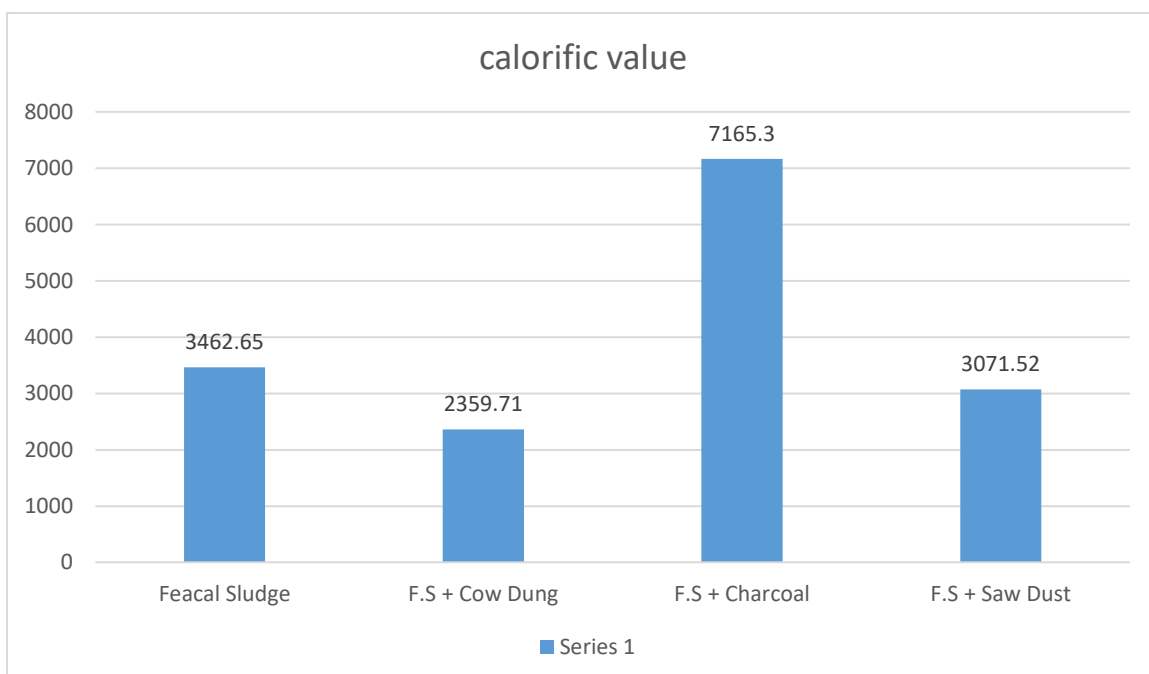
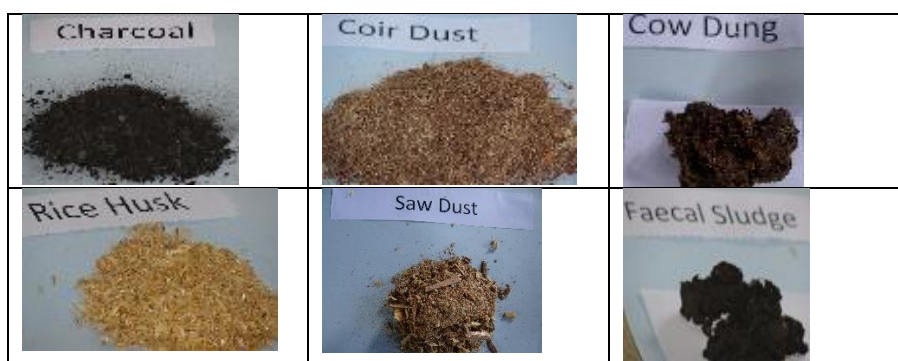
Carbonizing the Faecal sludge FS in a kiln to burn. First bricks were laid on the ground in a particular method to build a kiln. Three layers of bricks with space in between in three sides for air flow. A drum with faecal contents is placed with a lid on top. Heating is done to carbonize the contents 200 kg of FS burnt for 8 hours. The contents were left to cool. However the carbonized material did not cool for 6 days. The heat remained and charcoal turned to ashes at the bottom.



A similar experiment was done by taking less quantity of 15 kgs in a tin. This was heated for 1.30 hours and it was found to be perfectly converted to charcoal. It was understood that FS will burn and produce intense heat lasting for a long duration.

The above materials were found to burn and produce good heat. The same samples were also send to laboratory to test the calorific value.

	Calorific Values	
1	Faecal Sludge	3462.65 Cal/gm
2.	F.S + Cow Dung	2359.71 cal/gm
3.	F.S + Charcoal	7165.30 cal/gm
4.	F.S + Saw Dust	3071.52 cal/gm

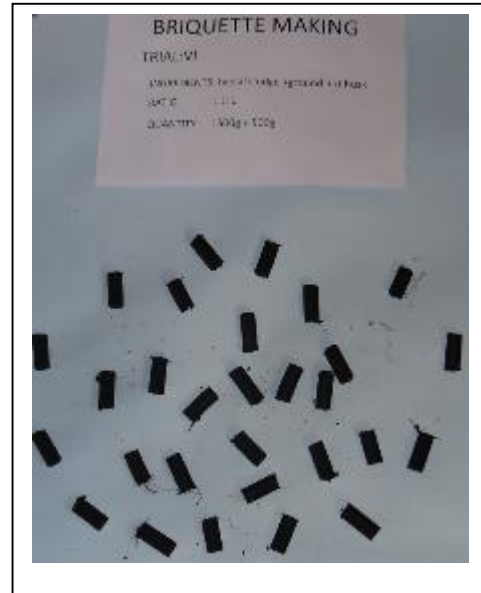


## Hand Pellet Making and Briquetting

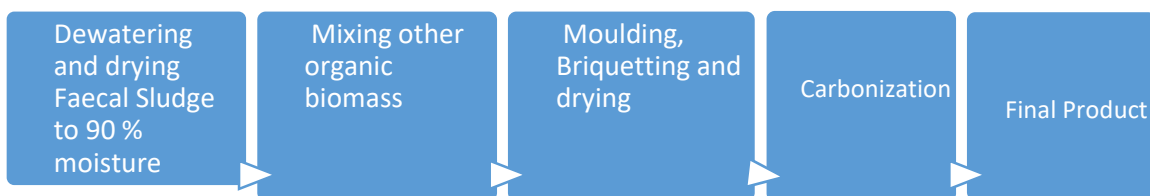
A standard size of pellet was made by use of hand pellet machine which gave briquettes of size is 2.5 cms. length width 1cm, and weight is 2.50gms. Pellets were made using above the combinations using a manual hand pelletizing machine and then dried for 3 days. The drying is subject to normal temperature of the day which was 34 degrees at noon. Later the dried pellets were subjected to carbonization process by heating them upto 150 degree centigrade by using firewood/Furness. Temperature was measured using a Thermometer. If the pellet size is more the heating needs to be increased.



Feecal Sludge alone without binder was used with water alone and made into pellets by using pellet machine and then converted to briquette. The mixing of dry sludge with water in the ratio of 80: 20%.



### Steps in Briquetting



### Boiler Tea Shop:

Cost of charcoal comes to Rs.50-80 per kg charcoal and not available regularly. In coming years, availability of charcoal in Tamil Nadu is going to be tough due to order from the Honorable Court

to seemai karuval (Prosopis Juliflora) plant and in most cases these plants were used as charcoal. If the Briquette is available as replacement in a lower price such as INR 10/- per kg, there will be huge market.

In order to test the real time, use of prepared pallets, 10 tea shops selected and 1 kg of briquette was distributed and advised them to use as replacement for Charcoal. The results are given below:

Size of briquette used: Thickness .8mm and Diameter 3.25 mm, weight 2.5gms

	Name	Boiler size	Timing	No of litres of water boiled per day	Time after boiling in minutes
	Vedasandur Gopal	5 litre	40	5 litres	65
	Thadikombu Murugan	5 litre	39	5 litres	70
	Metupatty Muthu	5litre	38	5 litres	68
	Dindigul Ramesh	5litre	42	5 litres	70
	Ottanchatram Govindan	5 litre	45	5 litres	68

Here the temperature after boiling was retained for one hour and more. It was found that 5 litres of water reaches boiling point for 1 kg use of briquette of the given size.

Size of briquette used: Briquette Size: Length: 2cm and diameter 0.5cm weight 7.5 gms.

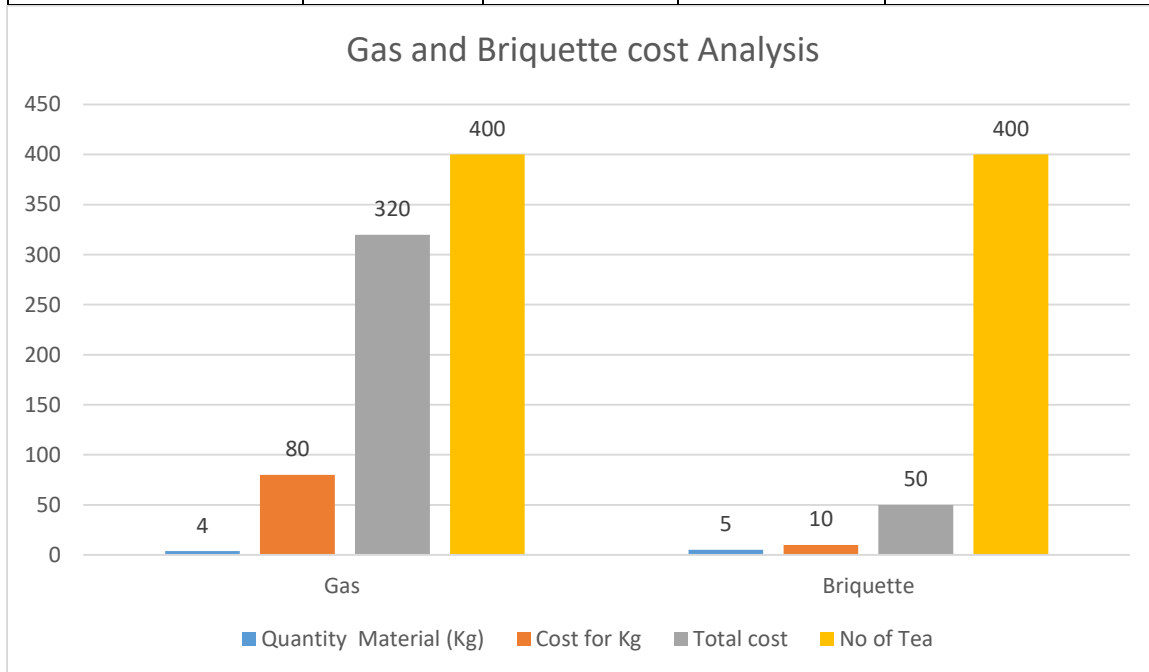
	Name	Boiler size	Timing for boiling in minutes	No of litres of water boiled per day	Time after boiling in minutes
	Vedasandur Gopal	5 litre	35	5 litres	35
	Thadikombu Murugan	5 litre	35	5 litres	38
	Metupatty Muthu	5litre	34	5 litres	40
	Dindigul Ramesh	5litre	35	5 litres	39
	Ottanchatram Govindan	5 litre	38	5 litres	40

Here the retention time of heat was found to be average 30 minutes. The subject trail with Tea shop found to be effective.

Compared to gas this is much cheaper. Gas Cylinder (Commercial) of 18kg costs Rs.1400/- So it costs almost Rs.80 per kg cylinder cost. In a day the tea shop owner uses about 4kg of gas for making 300 to 400 tea of 100 ml. Hence Re 1 spent for each tea. In case of using Faecal Sludge briquette the cost of fuel is only 10 paise for use of 5 kg briquette.

Comparing Briquette usage and Gas usage cost				
	Quantity Material (Kg)	Cost for Kg	Total cost	No of Tea

Gas	4	80	320	400
Briquette	5	10	50	400



Hence this is a viable economically. In case, all the tea shops in Dindigul District switch to use the briquette, It is estimated that around 3 to 4 tons of briquette needed per month.

### Sludge Charcoal in Hatcheries

In Dindigul district there 345 gram panchayats and on an average 2-3 hatchery unit exists in every gram Panchayat. There are 5-6 companies which produce hatched chicks. As Dindigul is a drought prone area, managing hatchery help the small farmers livelihood.



In each hatchery, if they hatch around 5000 chicks, it has to be kept in 10 days in warm

settings. The farmer is given one day old chicks the farmer has to grow the chicks and return the grown chicks to the hatchery. The casualty or mortality of the chicks is very high during the first 10 days. This is the time, they have use the charcoal to keep the warm ness and Briquettes can be better replacement. Getting charcoal is by purchase from outside, which is costly as per kg charcoal costs Rs.48- 60. We need 250 kg of charcoal to keep them warm for 10 days.

In Dindigul there are about 1000 hatcheries near by old market Nammakal which is the National market. Ordinary charcoal per kg burns at a temperature of 98 degrees Farenheit and the heat remains for 5 hrs. The FS briquette of size is 2.5 cms. length width 1cm, and weight is 2.50gms. gives heat which remains only for three hours. However when the size of briquette with 6 inch dia and 2 inch dia is used the heat is staying more than 5 hours. It is found that size of briquette need to be varied accordingly.

Hence it is found that the FS briquette cost is only that of transportation and labour which is about Rs.10/-

Now to prevent mortality of chicks by use of charcoal and FS briquette the result is found to be same. Hence, using the briquette is good and cheaper and viable option for the hatcheries.

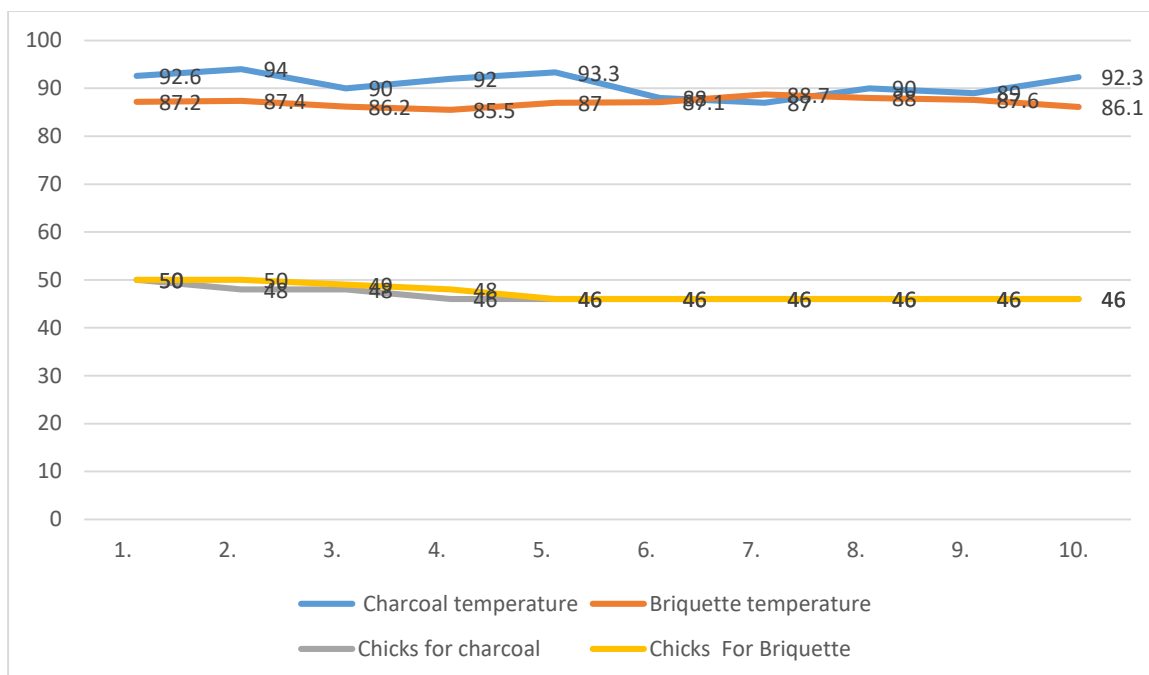
In the trail, 1 kg of briquette in a pot was used with similarly 1 kg. charcoal was used to compare the results. It is found that the temperature was 88.7 Fahrenheit and 92 degree Fahrenheit for Briquette and Charcoal respectively. Around 90 degree Fahrenheit is optimum and sufficient to keep the place warm. The trail helped to alter the size of briquette to reach the level of 90 degree temperature.



A 4/4 square feet of space was provided for each experiment. One mud pot size of five litre capacity is placed with the FS briquette which is heated and kept in the centre of the ground. The chicks move towards the pot and as they gain heat become active and move out. They are found sticking to each other to gain warmth and develop.

Temperature and Causality analysis				
Days	Charcoal temperature	Briquette temperature	Chicks for charcoal	Chicks For Briquette
1.	92.6	87.2	50	50
2.	94	87.4	48	50
3.	90	86.2	48	49
4.	92	85.5	46	48
5.	93.3	87	46	46
6.	88	87.1	46	46
7.	87	88.7	46	46
8.	90	88	46	46
9.	89	87.6	46	46
10.	92.3	86.1	46	46





## Ironing

A Metal Iron box of 3.3 kg. of only sludge briquette pellets were ignited. It took 10 minutes for the briquette to get heated. A little smoke came when it burned. We were able to iron 4 cotton shirts with the heat. If left without ironing the heat remained strong for 30 minutes and retained for 2 hours. In case of coal briquettes 300 gms. we can iron 10 shirts while in 300 gms of FS briquette we could iron only 6 shirts. The use of FS briquette is still cheaper than coal which costs ranging Rs.48-60 kg)

## Agriculture

Tamil Nadu Agriculture department test report for FS shows the Major and Micro nutrients analysis of Faecal Sludge

Major nutrients	Soil	Faecal Sludge
Nitrogen -N	60	154
Phosphorous-P	11	42
K- Potassium	210	500

### Micro Nutrients in Faecal sludge

FE	Mn	Cu	Zn
3.16	4.39	0.82	0.78

Different types of vegetables were grown using various combinations of organic material and Faecal sludge.

Material	Ranking-Growth number of leaves, branches flowers, fruits
Faecal sludge + Cowdung + Red soil	1
Faecal sludge + Soil	2
Soil+Cowdung	3
Faecal sludge only	4

When adding cow dung along with soil found better growth than other combinations in organic farming. The types of plant tested were greens, pumpkin, bitter gourd and ash gourd.



### Water heating

1 litre of water can be heated with 100 gms. of Briquette pellet in 20-30 minutes. To catch fire, it takes 15 minutes. It was found that 10 litres of water can be heated using 3 kg of briquette.

### Testing the efficiency of FS Briquette

The faecal sludge pellets after carbonization was lighted and burned to know whether how much heat they generate and how long the heat remains. Also they were used in iron box for ironing clothes and for warming chicken in hatcheries, instead of regular wood based charcoal. The faecal sludge pellet is found to be very effective for ironing purpose as the heat generated lasted for more than 2 hours.

### Methods and Instruments used for Data Gathering:

1. A bomb calorimeter used for determining heat of sample.
2. Pellet machine for making pellets.
3. Seive for fine particles
4. Thermometer for temperature check.
5. Tea boiler
6. Earthen pots
7. Chicks
8. Seeds
9. Iron box
10. Drums
11. Bricks
12. Firewood
13. Grinder

14. Pounding machine
15. Binder material
16. Grow bags

### Major Findings

- Converting treated faecal sludge into Briquette is possible
- All the trial / test conducted proved that faecal sludge can be better alternate for charcoal
- Cost benefit ratio is high for briquette then charcoal
- This is a viable market for hatcheries, ironing, tea shops and agriculture crops.

### Recommendations for Further Investigation:

- We can use this as an alternative of using Karvuvel (Prosopis Juliflora) weed for coal making.
- Need to find out ways to reduce odour. It should made as an attractive material to the public.
- Awareness to be created among public.

### Conclusion

This preliminary research showed that the faecal sludge biomass is rich in carbon and hence can be very well used as a replacement of conventional wood charcoal for various purposes. Further research is needed to make the process of briquetting from faecal sludge easier and simpler so that it can be produced in a large scale. Apart from meeting the energy needs, the reuse of faecal sludge as fuel, will largely eliminate the pollution caused by unused sludge to the environment. The potential uses and market places for the briquette has been identified. Briquette making is going to be a new approach adopted in India and will be a model for the entire sector players in the country.

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