CHARACTERIZATION AND PERFORMANCE ANALYSIS OF COW DUNG BASED FUELS FOR RURAL MASSES

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Abstract –
The energy derived from animal wastes, such as cow, donkey, and horse dung, provides an alternative source of energy to humanity. Anaerobic digestion of animal dung offers several benefits such as reduction of odors, pathogens, and production of renewable energy biogas. The aim of this work is to compare the amount of biogas produced from cow, horse, and donkey dung. This work used three 1 litre capacity plastic gallons as prototype biodigesters. The dung was collected and fed into the batch biogas digester. These biodigesters were operated and daily gas produced from the dung was observed for 37 days retention time. Gas production is measured by using the water displacement method. The digesters were fed with the same proportion of dung from each animal, and water. The experimental results show that 1 kg of cow dung can produce about 15 to 30 L of biogas per day. Hence, Cow dung is the best source of biogas production among horses, cows, and donkeys. The process of methane gas production, if extended to the commercial scale, would not only provide an alternative source of energy but would also be a means of environmental sanitation.
Keywords: Cow dung, Biogas, Energy management.
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1 INTRODUCTION

At a time when the viability and safety of energy alternatives is being debated, it is pertinent to look at one of the oldest renewable energy alternatives, Biogas. About 32% of the total primary energy use in the country is still derived from biomass and more than 70% of the country's population depends upon it for its energy needs. India can resolve its energy crisis, especially the shortage of electricity and gas by shifting towards renewable energy resources instead of using non-renewable resources like coal. This technology will be helpful in rural sites rich in animal and agricultural waste. As per a recent study sponsored by MNRE, the current availability of biomass in India is estimated at about 750 million metric tonnes per year. Biogas is defined as a "mixture of methane and carbon dioxide produced by feeding animal dung (especially the manure of buffaloes, cattle, and sheep) and water into an airtight underground tank, known as a digester and allowing it to decompose" (McKendry, 2002). Biogas is primarily Methane and Carbon dioxide. It may have small amounts of hydrogen sulphide moisture and siloxanes. The gases methane, hydrogen and carbon monoxide can be combusted or oxidized with oxygen.

This energy release allows biogas to be used as a fuel; it can be used for any heating purpose, such as cooking. It can also be used in a gas engine to convert the energy in the gas into electricity and heat. A family type biogas plant generates biogas from organic substances such as cattle –dung, and other bio-degradable materials such as biomass from farms, gardens, kitchens and night soil wastes etc. The process of biogas generation is called anaerobic digestion (AD). The following are the benefits of the Biogas technology

- It provides clean gaseous fuel for cooking and lighting.
- Chemical fertilizers can be done away with since the digested slurry obtained from the biogas plants can be used as enriched bio-manure.
- It is good for the climate and for sanitation problems since toilets can be linked directly with biogas plants.

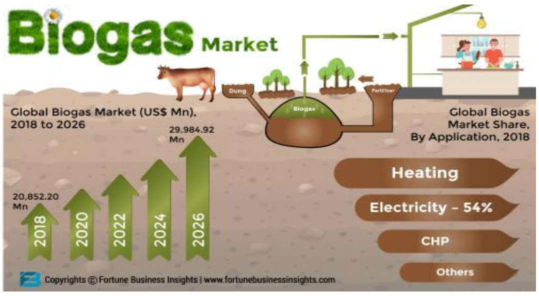

Figure 1

Five plants are coming up in Gujarat, Uttar Pradesh and Punjab that will use agricultural residues — currently being burnt by farmers, raising pollution levels cattle dung and municipal solid waste. Two CBG plants in Hyderabad and Punjab are operational, with state-run refiners opening CBG retail outlets in Hyderabad and Ludhiana in Punjab.

India's SATAT scheme, launched in October 2018, aims to set up CBG plants with a production target of 15mn t by 2023. But the government will miss the target by a mile, as it is impossible to add 4,998 plants in two years when it has taken nearly 2½ years to commission two projects. Production of biogas is a low-cost technology and economically feasible, as well as it is environmentally friendly. One of the benefits of biogas is that it does not produce air pollutants, such as CO, NOx, SO2, particulates, and volatile compounds.

1.1 Electricity Generation

Biogas is unique renewable energies, because of its characteristics of using, collecting and monitoring organic wastes, fertilizer production and slurry use in agricultural irrigation. Methane (77 to 90%) is present in natural gas. Some of its properties include colorless and odorless gas with a boiling point of -162°C and burns with a blue flame. The density of biogas is 1.15 kg/m3 and the upper calorific value is 39.8 MJ/m3 which equals 11.06 kWh/m3 in electricity units.

1.2 Multiple Usage of Biogas

Unlike other sources of renewable energy, the process of producing gas is natural and does not require energy. Furthermore, because trees and crops will continue to grow, the raw materials utilised in biogas generation are renewable. Manure, food scraps, and agricultural residue are all readily available raw materials, making it a very sustainable solution.

Overflowing landfills not only disperse bad odours but also allow poisonous liquids to leak into underground water supplies. As a result, another benefit of biogas is that it can help to enhance water quality. Anaerobic digestion also deactivates germs and parasites, making it an efficient way to reduce the spread of waterborne infections. Similarly, in places with biogas facilities, garbage collection and processing improve dramatically. As a result, the environment, cleanliness, and hygiene are all improved.

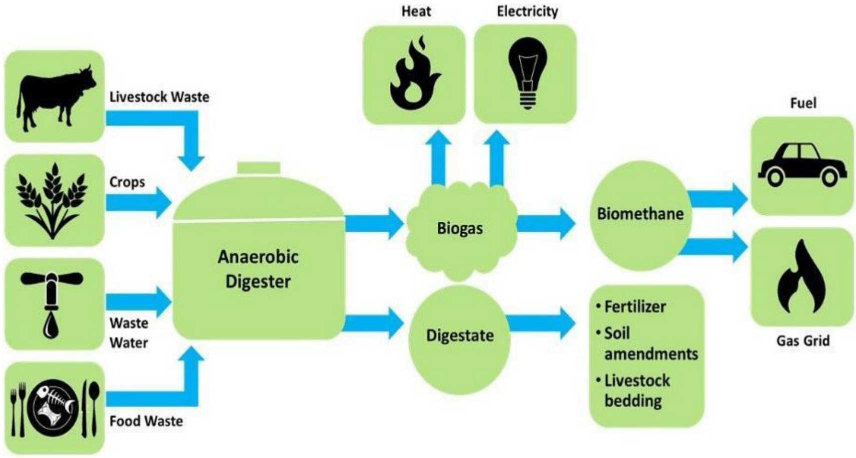

Figure 2

- **Battery Charging**

Biogas is converted to mechanical energy through an internal combustion engine. The mechanical energy rotates an electric generator which produces the electricity.

Biogas engine - uses the biogas to generate mechanical energy. Biogas is carefully mixed with the correct proportion of air and drawn into the biogas engine by the force of the engine pistons moving downwards, creating a vacuum.

The air and biogas mixture is then compressed as the piston moves up. Biogas is a slow burning fuel, and a higher compression ratio engine is essential for efficient combustion.

A high energy spark plug ignites the compressed air and biogas mixture. The burning biogas air mixture heats rapidly, expanding and then forces the piston down to create torque to rotate the engine.

The biogas engine exhaust valve opens, releasing the spent air and fuel mixture into a heat exchanger to extract remaining combustion energy.

Inoplex has carefully optimised this conventional four-stroke engine operation to suit a range of biogas, which burns very differently to petrol, gasoline or diesel.

Inoplex biogas engines include High compression ratios, high energy ignition sparks, swirling of air-fuel mixture and low exhaust temperatures.

Figure 3

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2 COMBUSTION ENGINE

- **Induce as Fertilizers (Organic Fertilizers)**

The by-product of a biogas plant that looks like mud, known as sludge, contains many nutrients. It can be used as fertilizer for plants. The quality of residual sludge from the biogas production process is better than the manure obtained directly from the cattle cage. It is because anaerobic digestion of organic material occurs in the fermentation process in the digester. It results in the increasing concentration of nitrogen, phosphorus and potassium. This condition makes the sludge ready to be used as organic fertilizer and it can be separated into the solid and the liquid one.

Different microbial systems participate in transforming organic residues in a number of reactions into biogas under anaerobic conditions, these include; hydrolysis-acidogenesis, acetogenesis and methanogenesis.

- **Biogas as a Fuel**

Switching to biogas as vehicle fuel can reduce greenhouse gas emissions in the transport sector between 60% and 80% compared to fossil-based fuels like gasoline and diesel.

When sufficiently purified, it can be used in place of fossil-based gas to drive natural gas vehicles (NGVs) or dual-fuel vehicles.

Countries have promoted biogas-driven cars, trucks and buses through a combination of tax exemptions, investment subsidies, and incentives for biogas injection into the natural-gas grid. China, France, the UK and Scandinavian countries, in particular, have strongly supported the transition to biogas in the transport sector.

Transport accounts for about 30% of global energy use, making renewable transport crucial for a sustainable energy future. Cost reduction remains the critical challenge. Yet increasing synergies with other power and transport technologies could further reduce biogas production costs.

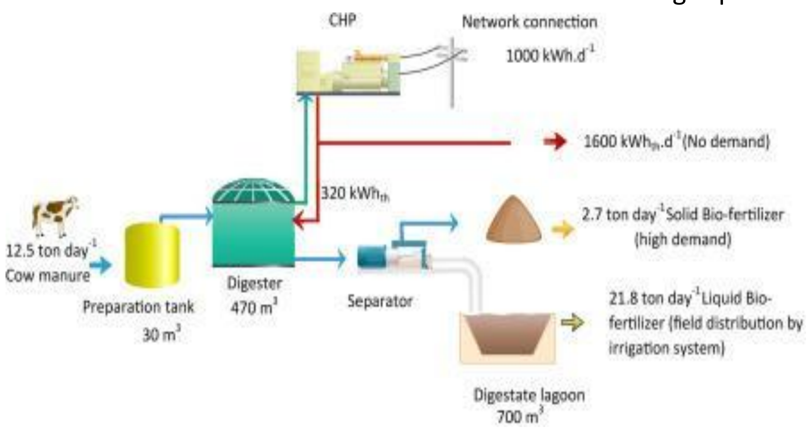

Figure 4

2.1 Hydraulic retention time (HRT)

For mesophilic digestion where temperature varies from 25 to 35°C, the HRT was greater than 20 days. In the thermophilic environment, HRT is usually less than 10 days. Shortening retention time can lead to increase in the volatile fatty acids (VFA), and this is why mesophilic digestion was considered. A surface cylindrical biogas digester was chosen because it was easy to feed, insulate, clean, and easy to construct and remove slurry after every hydraulic retention period. In addition, the batch digester was easy to agitate.

2.2 How Biogas controls Pollution

The biogas industry is uniquely positioned to help achieve reduced emissions and mitigate many of the impacts of poor air quality through providing renewable energy (in the form of heat, electricity, and vehicle fuel) and offering waste-management solutions. Biogas

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is generated through anaerobic digestion (AD), a natural process in which microbes digest organic material in sealed containers, producing biogas which can be used for cooking, heating, cooling, and electricity production or upgraded and used for vehicle fuel or gas-grid injection. This can be done on a micro scale (for buildings or small communities) and on a macro scale (for cities).

Biodegradable wastes are ubiquitous: they derive from multitudes of human social and economic activities. Such wastes can be found in: food waste from homes, restaurants, shops, and caterers; industrial production; agricultural wastes from animal husbandry, crop cultivation, and food production (such as dairy); and sewage sludge from wastewater treatment, both at city and local community level. All of these wastes emit methane but can be collected and taken to AD plants to produce renewable heat and energy, either for local use or for distribution into wider grids.

The main sources of greenhouse gas (GHG) emissions in cities are related to the consumption of fossil fuels in the form of electricity, transportation, energy use in commercial and residential buildings (for lighting, cooking, heating, and cooling), industrial production and waste (UN HABITAT, 2011). Traffic, domestic fuel burning, and industrial activities (15%) are among the leading sources of particulate emissions.

2.3 How Biogas is cost-effective

After selecting objectives and counter checking if biogas technology can fulfill the objectives at an acceptable cost-benefit ratio, it is still not certain that expenses are invested in the best possible way. For this, a comparison with other alternatives to biogas programs and biogas plants is necessary. The expected cost and benefits are to be shown in the form of suitable investment criteria to allow statements regarding the economic advantage of the project. Often, alternatives to biogas have only a 'benefit-overlap' with biogas and several alternatives have to be combined to 'produce' the same quantity and quality of benefits.

On the other hand, alternatives to biogas programs may have benefits that a biogas program cannot deliver. Afforestation programs, for example, deliver energy and soil protection, but also building material.

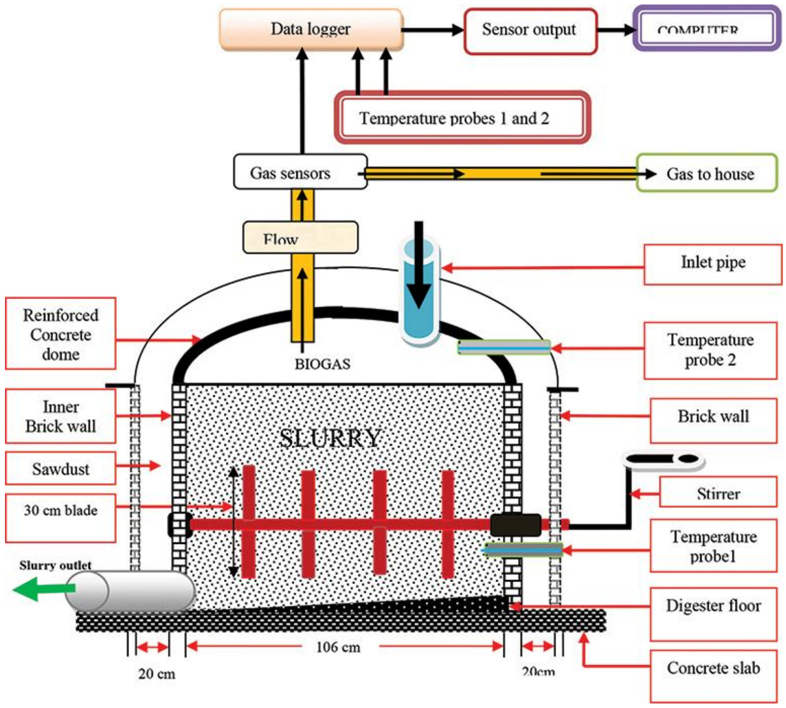

Figure 5 Detailed diagram of the designed batch biogas digester with various sensors positions.

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Apart from the viability of the project, its financial effects on the decision-makers and the parties it touches financially are important: are a certain group of farmers able to invest in a long-term project like biogas generation? The cost per m^3 of biogas and the cost for the same amount of alternative energy forms the basis for most economic comparisons.

3 PROPOSED METHODOLOGY

3.1 Primary Raw Material Details

Biomass and organic waste materials constitute the convenient and the most important components of the renewable energy source in rural areas. Biomass resources consist of agricultural, horticultural, semicultural, forest, animal and fish produce, and residues in the form of aquatic mass. algae, microorganisms and agricultural and industrial wastes and effluents. Photosynthesis is one of the most efficient natural processes for the production of plant biomass and conversion of abundant solar energy into biomass. Out of the total incidence of solar energy on earth only about 0.1% is converted into biomass through the process of photosynthesis.

Fossil fuels like petroleum products and natural gas have been used as energy resources by humankind and because of this a lot of environmental issues are arising. The extensive use of petroleum products has tremendously increased the cost and there is still a large difference in the demand and supply as wood is still being cheap and has resulted again for deforestation. A major part of agricultural residues is being consumed worldwide in traditional uses such as fodder for cattle, domestic fuel for cooking, industrial fuel for boilers, construction material for rural housing, etc. The burning of agricultural residues directly in industrial as well as domestic applications is highly inefficient. The process of compacting residues into a product of higher density than the original raw materials is called the densification of dung cakes. The properties of handling the material for wrapping, shipping and storage are also improved by giving a shape to the raw materials. If dung cakes are formed at low cost and made easily available to people it can readily serve as an alternative fuel for firewood and charcoal which people were used for both domestic and industrial operations for many decades, thereby decreasing the high demand for petroleum by-products. Besides this, dung cakes have higher heat intensity, cleanliness, convenience in use and handling and relatively occupy a smaller space for storage compared to fuel wood. The dung cakes are generally made in cylindrical or rectangular shapes as these shapes can be easily handled and transported. Several techniques are employed for making dung cakes, one of the methods is low-pressure compression with a binder which is being followed in making dung cakes. In high-pressure methods, a piston press and screw extrusion types are employed. In the dung cakes made using a piston press, the shape is totally solid while in dung cakes made using a screw press there is a concentric hole in the centre of the dung cakes that provides a more specific area and improves combustion properties. By employing piston press dung cakes having a 1200kg/m3 density can be produced compared to a loss biomass density of 100-200kg/m3. Because of more density, a higher heat value and combustion is being obtained.

The calorific value can still further be enhanced by adding coconut shell powder, since many years people in different parts of the world are using coconut shells as a fuel for water heating, firing ceramics and bricks. Dung cakes are employed in a number of areas both in domestic and small scale industries as a replacement for firewood and other solid fuels like charcoal. Due to the present fuel shortage and increasing prices for fuels, people are in search of alternate fuels and hence dung cakes can fill this gap for all domestic and industrial applications such as

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water heating, curing of tobacco, tea and fruits drying, and fuel for boilers respectively. There are many advantages of dung cakes being used as fuels which mainly improve the efficiency of agricultural residues. Since dung cakes are densified products they can be easily handled, stored and transported when compared to raw agriculture wastes. dung cakes also solve the problem of biomass disposal in a more efficient manner. A few disadvantages are also with dung cakes like they are strictly solid fuels and can not be used in IC engines, also they absorb moisture when not stored properly. The maximum temperature which is attainable by combustion of dung cakes is 1000 degrees which may not be suitable for high-temperature industrial applications as they have a low calorific value ratio due to low carbon content.

3.2 Methodology of Cow Dung Cake Making

A lot of investigations were done on rice husk which has been used as a major constituent with sawdust combined with binding agents such as cow dung, starch, and paper pulp. Along with these materials, some of the studies have also been done with coconut husk, and palm kernel shells. Already work has been carried out by using rice husk and sawdust along with the binders like cow dung, paper pulp and starch. Coconut shell is also considered to be one of the good sources of energy from ancient ages hence in our study rice husk, sawdust and coconut shell powder was also taken and combined with three binding agents cow dung, starch and paper pulp.

The rice husk, sawdust, and coconut shell powder, starch powder collected from local suppliers are shown in figure 5,6,7 respectively. Cow dung from local farming people and paper pulp were made in-house by soaking the waste paper in water for 72-80 hours. As particle size plays an important role in the combustion process a sieve size of 1700 microns was used to sieve all the materials and remove any foreign matter.

Figure 6 Rice husk

Figure 7 Saw dust

Figure 8 Coconut Shell Powder

3.3 Specimen Preparation

The materials were mixed in the required proportions using three different binders. The binders selected to give better results were cow dung, paper pulp, and starch. All the sieved raw materials and binders were carefully mixed one by one and compressed to a cylindrical shape of diameter of 50mm and length of 50 mm using a hand jolting machine. 10 gms of Rice husk, 10 gms sawdust and 10 gms of coconut shell powder were maintained in all the nine samples. Keeping rice husk powder, sawdust powder and coconut shell powder as common ingredients, the binder quantity was increased to 15gms, 25gms and 35gms. The combination quantity used is shown in Table 1.

Table 1 composition1 (Rice husk + saw dust + binder)

Composition 1	Weight of Rice husk (gms)	Weight of Sawdust (gms)	Weight of Binders used (gms)
1	15	15	15
2	15	15	25
3	15	15	30

Table 2 Composition2 (Rice husk + sawdust + Coconut shell powder + binder)

Composition 2	Weight of Rice husk (gms)	Weight of Sawdust (gms)	Weight of Coconut shell powder (gms)	Weight of Binders used (gms)
1	10	10	10	15
2	10	10	10	25
3	10	10	10	30

The calorific value:

- The calorific value of a specifically pressed fuel briquette is related with the amount of oxygen required for thorough combustion. Usually, with one gram of oxygen burnt, 14,022 J of energy can be released. It means the higher the oxidation of the fuel, the less oxygen is required for thorough combustions and the lower the heating value of the fuel. Meanwhile, when the fuel consists of compounds with a lower degree of oxidation, such as hydrocarbons, the heating value of the biomass will be higher.
- The calorific value of the pressed fuel briquettes is limited by fuel moisture content for the reason that the heat is used to vaporize the water, lowering the heat released.
- Furthermore, the calorific value of the fuel briquettes is also limited by the ash content. Approximately every 1% addition of ash translates to a 0.2 MG kg−1 decrease in the heating value.
- As for the calorific value of various fuel briquettes pressed from particular biomass are shown in the diagram below for your reference.

Table 3

Biomass materials	Calorific value of the briquettes Cal./kg	Ash Contents
Bagasse	4380 K.	1.80%
Bamboo dust	4160 k.	8.00%
Barks wood	1270 k	4.40%
Castor seed shells	3862 k.	8.00%
Cotton stalks/chips	4252 k.	3.00%
Coffee husk	4045 k.	5.30%
Coir pitch	4146 k.	9.10%
Forestry waste	3000 k.	7.00%
Jute waste	4428 k.	3.00%
Groundnut shell	4524 k.	3.80%
Mustard stalk	4200 k.	3.40%
Mustard shell	4300 k.	3.70%
Paper	4841 k.	1.5%
Papyrus	3965 k.	5.6%
Paddy straw	3469 k.	15.5%
Palm husk	3900 k.	4.90%
Rape seed waste	4403 k.	5.3%

Rice husks	3200 k.	19.20%
Sawdust	3898 k.	8.20%
Sunflower stalk	4300 k.	4.30%
Soya bean husk	4170 k.	4.10%
Sugarcane	3996 k.	10.00%
Tobacco waste	2910 k.	31.5%
Tea waste	4237 k.	3.80%
Wheat straw	4100 k	8.00%
Wood chips	4785 k.	1.20%

4 METHODS

- The three types of dung cakes made showed almost similar texture on the surface but the surface texture was good for starch with coconut shell powder of dung cakes when compared to cow dung and paper pulp.
- The colour of almost all the specimens was shades of brown depending on the amount and type of binder used are shown in figure 9, figure 10, and figure 11 respectively. To compare the calorific value of the dung cakes and to study the performance, a Calorific value test was conducted.

Figure 9 Cow Dung

Figure 10 Paper cake additives

Figure 11 Starch dung cakes

4.1 Determination of Moisture

- The briquettes were heated to a temperature of 1050C ± 50C for one hour in an air oven. The briquettes were then taken out from the oven and the materials were weighed.
- The percentage loss in weight was calculated which gives the percentage (%) moisture contains in the sample

5 RESULTS AND DISCUSSION

The calorific values of the each briquette is determined by using Bomb Calorimeter and the values from the results obtained. All the tests as stated earlier were conducted on the 9 samples made and the results noticed are shown in the figure 13, figure 14, figure 15, figure 16.

- C11 represents that the binder is cow dung, P11 represents that the binder is paper pulp and S11 represents that the binder is starch respectively for composition1 and C21, P21, S21 represent the composition 2 with the same binders with coconut shell powder respectively.

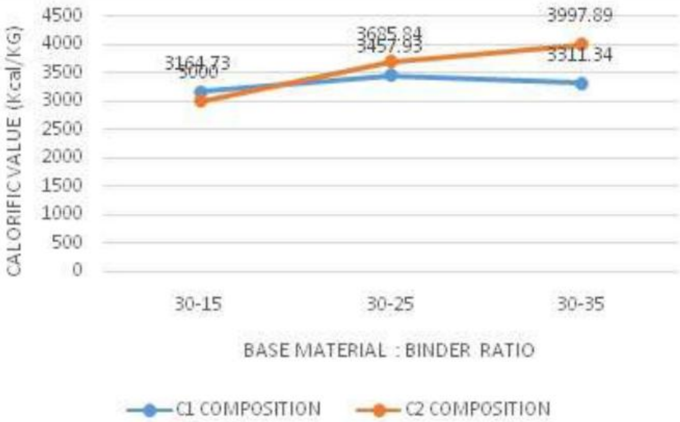

Figure 12 Calorific Value Analysis for Cow Dung cake

Table 4

Binder Ratio	Calorific Value (C1)	Calorific Value (C2)
30-15	3000	3164
30-25	3457	3685
30-35	3311	3997

Figure 13 Calorific Value Analysis for Paper Pulp dung cakes

Table 5

Binder Ratio	Calorific Value (P1)	Calorific Value (P2)
30-15	4105	4216
30-25	4063	4343
30-35	4004	4205

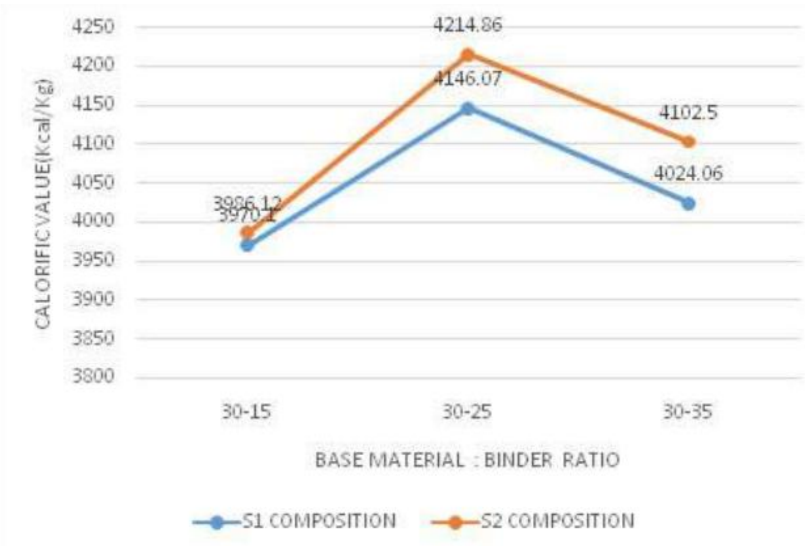

Figure 14 Calorific Value Analysis for Starch dung cakes

Table 6

Binder Ratio	Calorific Value (S1)	Calorific Value (S2)
30-15	3970	3986
30-25	4146	4214
30-35	4024	4102

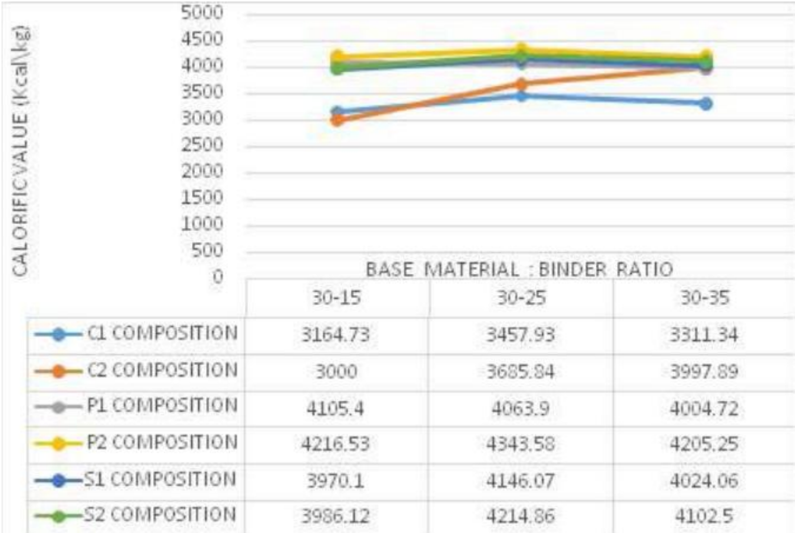

Figure 15 Calorific value comparison for cow dung, paper pulp and starch dung cakes Comparison Table

Table 7 Calorific value Range (0-5000Kcal/kg)

Binder Ratio	Calorific Value (C1)	Calorific Value (C2)	Calorific Value (P1)	Calorific Value (P2)	Calorific Value (S1)	Calorific Value (S2)
30-15	3000	3164	4105	4216	3970	3986
30-25	3457	3685	4063	4343	4146	4214
30-35	3311	3997	4004	4205	4024	4102

In five months' sugarcane bagasse seasons, just having large enough place you can effortlessly store masses of bagasse as raw material for pellet production in half-year or more. Moreover, there is abundant sawdust which is mainly from half-finished timber processing factories. You can easily collect 1000 tons every month. The timber factories are grouped near the town, so only two workers can finish sawdust collection. In sugarcane off-season, if the sawdust can not meet your requirements, there are still lots of wood chips from wood chip processing factories. Just a crusher machine can help you grind a large number of wood chips and twigs to produce raw material for pellet production. Most importantly, twigs are almost free and can be collected for thousands of tons in one month. The main costs you should pay are only personnel cost and electricity cost. Therefore with abundant raw materials and low-price bagasse efficiently convert to high-quality fuel pellets, you can make great profit and benefit to meet the growing demand for pellet fuel on the market!

The Calorific Value of Bagasse The gross calorific value (GCV) of dry bagasse has a mean value of 19605 kJ/kg. The gross calorific value (GCV) of wet bagasse is based on the composition of wet bagasse. Water has no calorific value and it also absorbs heat being vaporized during combustion. The net calorific value of bagasse, with around 48% moisture content is about 7670 KJ/kg. Less ash content.

Bagasse pellets Sugarcane bagasse has a high energy content and burning quality. The production procedure of sugarcane bagasse is drying materials, pelletizing and packaging. Bagassepellets with a high calorific value of 3400 to 4200 kilocalories.

Sawdust pellets The pellet production line of sawdust: purchasing raw materials, collecting materials, drying, pelletizing and packing. The moisture content of sawdust is around 30%-45% and the price is 21.05 to 24.29USD/ton. The calorific value can reach 4000-4500 kilocalories

In Soybean husks moisture content of the soybean samples average 18.88%, and those of cowpea husks average 21%. other results for soybeans gave 9.75%, 6.95%, 3.91%, 0.97%, 0.85%, 10.48%, 12.29% and 6.11% for contents of carbon, hydrogen, oxygen, nitrogen, sulphur, ash, crude fibre and crude protein respectively, in the sample.

The corresponding values for cowpea husk were 9.58%, 8.25%, 3.25%, 0.97%, 0.88%, 4.88%, 10.95% and 5.90% respectively. For cowpea husks, the higher heating value was calculated to be 14512.95 kJ/kg and for soybeans husks, 12593.17 kJ/kg while the corresponding lower heating values are 25.57 kJ/kg and 22.7 kJ/kg for cowpea and soy-beans husks respectively. Overall both agricultural wastes make good fuels. Soy-beans husk is found in this respect to be a little superior to the cowpea husk. They should be particularly applicable in the mills where these crops are processed.

Result in Discussion: The highest calorific values were observed for specimens made with paper pulp as binder second was for starch and the last was the cow dung. Adding coconut shell powder resulted in a significant increase in calorific value compared to compositions with rice husk powder and sawdust as base materials.

The calorific values of dung cakes made are comparable to the calorific values of traditional fuels that are used in boilers or firewood which is an indication that the dung cakes can be chosen to replace these traditional fuels. Finally, it can be concluded that the energy crisis which the people are facing can to some extent be addressed by these alternate fuels and also that the eco-friendly dung cakes made using rice husk, saw dust along with coconut shell powder with proper quantities of binders like paper pulp, starch and cow dung have the potential to be an efficient substitute for traditional fuels used in boilers and for domestic purposes.

Flue Gas Analysis: A flue gas analyser, IMR 1400 PL model was used for this study. The gas analyser used in this study. This analysis was carried out by first switching the analyser on in fresh, outdoor air to set its' zero value, following the manufacturer's instructions. It was then taken into the hood to be monitored. The equipment analysed and documented whether the flue gas limit values were being complied with or whether the system was running at the optimum settings. Two (2) gas sensors, which measure oxygen (O2) and carbon monoxide (CO) gases directly, formed the basis of the flue gas analysis. The analyser also enabled the measurement of CO2 concentration on the burner system. When the analyser measured CO levels above 9 ppm, an investigation was made. Also when the reading was over 35ppm for CO, prompt action was taken to release the openings around the hood.

The gas analyser was used to measure and calculate the following parameters from the flue gases:

i. Combustion efficiency
ii. Excess Air
iii. Carbon monoxide (CO)
iv. NOx
v. SO2
vi. Carbon dioxide (CO2).

Figure 16 IMR 1400 Gas Analyser PL model

Table 8 Percentage compositions of biogas produced using cow dung as biomass

Component	Cow dung %	Cow dung Rice husk %
Carbon Dioxide (CO2)	39.0	37.0
Hydrogen sulphide (H2S)	3.005	3.005
Methane (CH4)	58.01	59.5

It were observed from the study that Cow dung Rice husk shows a relatively higher methane and lower CO2 yield. This could be attributed to the quicker degradation of Cow dung Rice husk than the cow dung substrates within the period of experimentation. As a result, it could be inferred that there is an inverse relationship between methane and carbon dioxide production.

Table 9 Flue gas constituents for Cow dung cakes

Gas Constituent	1 st Reading (%)/ppm	2 nd Reading (%)/ppm	3 rd Reading (%)/ppm	4th Reading (%)/ppm	5 th Reading (%)/ppm	Average (%)/ppm
O2	20.90	20.90	20.90	20.90	20.90	20.90
CO	33.00	37.00	35.00	39.00	37.00	36.20
CO2	11.80	11.80	11.80	11.80	11.80	11.80
SO2	0	0	0	0	0	0
NO*X*	3.00	1.00	1.00	2.00	2.00	1.80
Excess air	1	1	1	1	1	1

Table 10 Flue gas constituents for paper pulp cake

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Gas Constituent	1st Reading (%)/ppm	2nd Reading (%)/ppm	3rd Reading (%)/ppm	4th Reading (%)/ppm	5th Reading (%)/ppm	Average (%)/ppm
O2	20.90	20.90	20.90	20.90	20.90	20.90
CO	4.00	6.00	5.00	6.00	4.00	5.00
CO2	11.80	11.80	11.80	11.80	11.80	11.80
SO2	0	0	0	0	0	0
NO*X*	2.00	1.00	3.00	1.00	3.00	2.00
Excess air	1.00	1.00	1.00	1.00	1.00	1.00

Table 11 Flue gas constituents for starch dung cakes

Gas Constituent	1st Reading (%)/ppm	2nd Reading (%)/ppm	3rd Reading (%)/ppm	4th Reading (%)/ppm	5th Reading (%)/ppm	Average (%)/ppm
O2	20.90	20.90	20.90	20.90	20.90	20.90
CO	8.00	10.00	11.00	10.00	9.00	9.60
CO2	0	0	0	0	0	0
SO2	0	0	0	0	0	0
NO*X*	1.00	1.00	1.00	1.00	1.00	1.00
Excess air	1.00	1.00	1.00	1.00	1.00	1.00

The laboratory analysis gave the following percentage of constituent compositions produced, assuming that water vapour and other trace gases were negligible. Gas produced from cow dung contained CH_4:58.0%, CO_2: 39.0%, and H_2S: 3.0%; The Gas produced from Cow dung Rice husk contained CH_4:59.5%, CO_2 37 % and H_2S: 3.0% (see Table 1). Cow dung Rice husk had a higher percentage of combustible compared to cow dung produced within the same fermentation period.

6 CONCLUSION

This work shows that biogas can be produced from animal dung through anaerobic digestion. Animal dung is continuously offered in our location and can be used as an alternative energy resource. The research exposed further that Animal dung has large possibilities for production of biogas. The application should be encouraged due to the high volume of biogas produced.

The study has shown that paper waste which abound everywhere including the immediate environment is a very good feedstock for biogas production. This waste

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can be utilized for energy generation instead of burning them up or having them littered around and invariably constituting a nuisance to the environment.

The study showed that the cow dung was most efficient in producing the Bigas yield (m^3) and m3 of biogas that can produce enough electricity to burn 1.6 units of electricity. So besides supplying methane to laboratories or departments, it can be potentially used for electricity generation. By this experiment, it is shown that co-combustion of crop residue and cow dung with the help of slurry from biogas digester is readily available.

7 FUTURE SCOPE

More investigation could be performed for biogas yield per day could be improved with the addition of crop residue like wheat straw and other available field residues, to get better and improved results.

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