



**BRIQUETTING A BETTER ALTERNATIVE TECHNOLOGY FOR DISPOSING GUINEA CORN STRAW (AGRO RESIDUE) IN ENUGU STATE**

**Anthony A.A<sup>1</sup>; Abu F.M<sup>2</sup>; Egbe M.E<sup>3</sup>**

<sup>1</sup> Department of Electrical Electronics Engineering, Federal Polytechnic Ohodo Enugu State

<sup>2</sup> School of General Studies, Federal Polytechnic Ohodo Enugu State

<sup>3</sup> Faculty of Mechanical Engineering Joseph Sarwuam Univerty Makurdi

\*[anthonyamehsmart@gmail.com](mailto:anthonyamehsmart@gmail.com)

**Abstract**

In Enugu state, the predominant population in the rural area are involved in subsistence farming were reasonable Large quantity of guinea corn straw is generated that are either left to rot on farmlands or disposed of by burning in open air. In many rural areas, the residues are also used in their raw form for cooking purposes which is inefficient. The disposal and use of the residues cause pollution in the environment which affects human health. Guinea corn straw can provide a source of clean and renewable energy in the form of solid biofuel called briquettes through densification. Briquetting is a densification technology that converts residues with a low heating value per unit volume into high density and energy concentrated fuels. This paper offers a perspective on the potentials of guinea corn straw in Enugu state to produce briquettes as an alternative clean and sustainable domestic cooking fuel. The paper concludes that briquettes could be economically and environmentally friendly alternative to fuelwood.

**Keywords:** Energy, Biomass, Briquettes, Sustainability, Pollution.

**Introduction.**

Agricultural residue handling is a very big challenge in our society especially in Africa at large and Nigeria in particular, and also they is need to address energy scarcity by adopting an affordable, sustainable and renewable with low emission. Due to the scarcity and cost of fossil fuels and the effects of climate change, there is a growing demand for renewable energy today (Wang *et al.*, 2019).

Sequel to the increasing adverse environmental impacts related to the use of conventional fossil fuels, there is strong interest worldwide in the development of technologies that exploit renewable energy sources; and also, new measures to limit greenhouse gas emissions are continuously sought (briquettes). The availability of energy is essential for the development of any country.

Biomass is considered one of the most available energy source and is applicable in numerous energy conversion systems. Biomass energy refer to energy generated from the use of materials resulting from existing organisms or newly reproduced living organisms of plant and animal origin (Sugathapala and Chandak, 2013). It is known to be the third most utilized energy resources in the world while coal and oil are the first and second respectively (Tumuluru *et al.*, 2010a). It would have been the largest but as the result of oil boom in the nineteenth century, it made nations to divert to fuel produced from decay of plant and animal origins as their major source of energy. The use of fossil, firewood for energy has negative effect on both human health and the ecosystem by causing deforestation which results to soil erosion, desert encroachment, atmospheric pollution and global warming

(Elinge *et al.*, 2011). Nigeria has abundant supply of agro- residues which are used inefficiently, causing extensive pollution to the environment. Every year, Nigeria produces over a million tonnes of guinea corn straw residues. This residues are either immediately burned for energy production in combustion systems or eliminated by burning in the field after harvest, just like in other parts of the world. Burning wastes in fields damages the ecosystem and habitat of rural areas. Finding uses for this agro waste is thus important, if not absolutely necessary, given that they can actually worsen environmental issues (Zhang *et al.*, 2005). Briquette fuel is more advantageous than raw materials in general because it is renewable, has a higher calorific value than other solid fuel sources, has less ash than coal (2-10% vs. 20-40%), and burns more effectively than coal (Ifa *et al.*, 2020). Briquettes are used in both rural and urban settings for domestic and commercial purposes, including cooking, steam production, oil grinding, and tile manufacturing (Kpalo *et al.*, 2020). The moisture and ash concentrations, flow properties, and particle size are the key determinants of raw material selection. Because high moisture content materials are difficult to grind and take more energy to dry. Moisture content in the range of 10% to 15% is desirable (Abdoli *et al.*, 2018). The physical, chemical, and energetic characteristics of biomass briquettes have been determined by several studies that have appeared in the literature on the conversion of biomass into briquettes in Nigeria and throughout the world (Bot *et al.*, 2021, 2022 and Kapen *et al.*, 2021). In order to improve the qualities, other studies looked at the physico-chemical and mechanical characterization of mixed briquettes made from various agricultural biomass and binders. The factors determining briquette strength and durability have been examined in a several of research (Adu-Poku *et al.*, 2022 and Akolgo *et al.*, 2021). The calorific value, and ultimate characteristics (C, H, O, S, and N) as well as density are the factors that allow the evaluation of a biomass for energy utilization (Torquato *et al.*, 2017).

The use of briquetting for conversion of these agricultural residues is one of the means of realizing these goal for cheaper, and cleaner energy source to fill up the gap.

It's a known fact that the major waste generated at the rural areas of Enugu State is mainly guinea corn straw (agricultural residue) which can be processed into briquettes to generate energy for domestic and industrial use. Despite this level of waste generation, they is still high gap and need for fuel for heating, cooking, and other purposes. Most of the rural settlement rely on wood fuel and charcoal to close this gap which often result to environmental problem like deforestation and even health hazard due to smoke therefore they is need for alternative means that are cleaner, cheaper and more sustainable.

Since its known that biomass fuel (briquettes) does not pose risk, hence they is need to adopt this system or technology and even improve on the technology by making hybrid briquettes which is an improved of the normal briquettes.

The aims of this research are:

- i) To convert guinea corn straw to briquette thereby reducing open burning that pose risk to environment.
- ii) To produce a more cost effective and reliable means of domestic energy source.
- iii) To increase revenue for farmer since they will sell residue which will be use as raw materials for briquettes.

In Enugu State, the huge volume of guinea corn straw (agricultural waste) generated annually, coupled with the decreasing availability of wood fuel has necessitated concerted effort to look for efficient ways of harnessing these waste for energy generation. Direct combustion of raw agricultural waste as fuel feedstock has some obvious disadvantages including difficulty in controlling the burning rate of the biomass, difficulty in mechanized feeding supply, low heat density, difficulty in stock handling and transportation as well as large storage requirements.

Most of these problems are associated with the low bulk density of the agricultural waste. One approach to

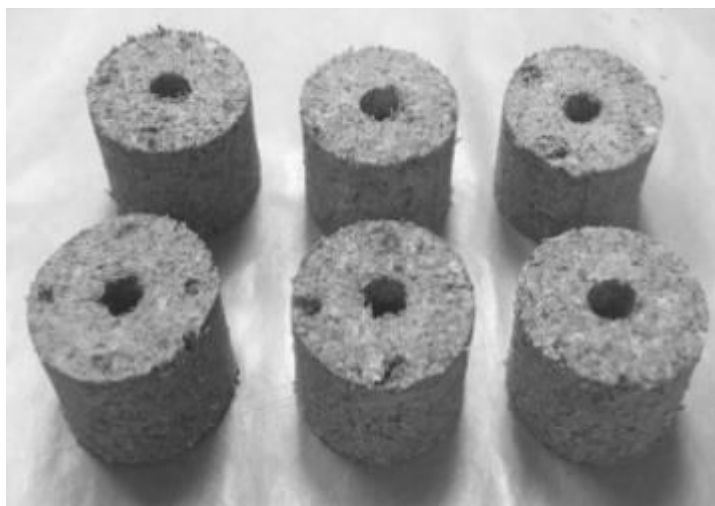
checkmate these setbacks and efficiently utilize agricultural wastes as fuel is by their densification to produce charcoal briquettes.

This research work shall be limited to means guinea corn straw can be of more importance to produce briquette that will give high calorific value, low carbon emission and low volatile matter with very low emission than the old conventional fuel wood method.

## Literature Review

### ***Briquettes and Briquette Technology***

Briquettes are a form of solid biofuel that can be burned for energy made from biomass resources including agricultural residues. The technology use in making the briquette is briquetting. They are made of different qualities and dimensions depending on the raw materials, mold and technologies applied during production (Oladeji J. 2025)



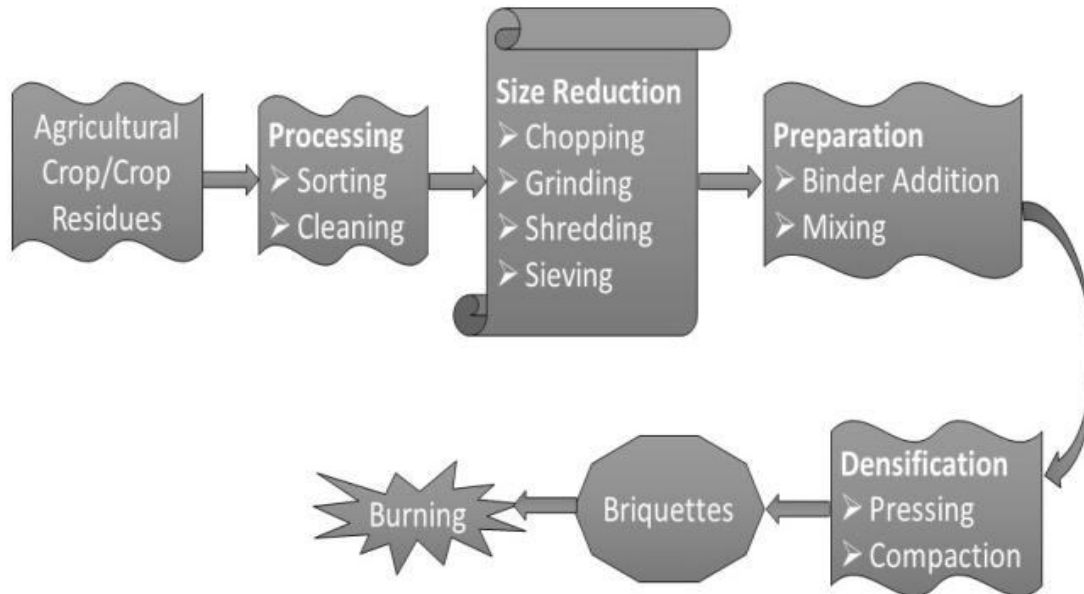
**Source:** Shuma R, *et al.* 2017 **Fig 1** briquettes

The use of agricultural residues to produce briquettes can reduce waste of resources and consumption of fossil fuels [Wang Z, *et al* 2017]. Production of briquette helps to solve the problem of residue disposal and deforestation which eases the pressure on the forest reserve. [Bhattacharya SC, *et al* 2020]. The advantages briquettes have over conventional fuelwood include higher heat content, ease of use, cleanliness and compact size [Dinesha P, *et al* 2018]. Briquettes are products of briquetting technology which is the densification or compaction of residues into a product of higher density than the raw materials [Kaur A, *et al* 2017]. The process.

converts low bulk density biomass into high density and energy-concentrated fuel and it involves basically drying, grinding, sieving, compacting and cooling operations [Tripathi AK, *et al* 2019]. Briquetting machines used for densification of agricultural residues are of various types. They include the roller press, screw press extruder, the piston press which can either be mechanical or hydraulic [Chen L, 2009]. These machines can either be operated manually or with high energy depending on whether it is low compaction pressure or high compaction pressure technology. Additionally, the manual press is another type of briquetting machine which can be made from either wood or metal. The locally available raw material determines the type of briquette machine to be used and the type of fuel briquette produced [Pallavi H V, *et al* 2013]. Briquettes can be produced with or without a binder. According to Pallavi *et al.* 2013, briquette production may require binders such as starch or clay soil to bind the matter together depending on the material, the pressure and the speed of compaction. Briquetting technology is yet to get a strong foothold in many developing countries, including Nigeria, because of the technical constraints involved and the lack of knowledge to adapt the technology to suit local condition [Sunday Y.K *et al* 2021].

**Steps involve in briquetting**

- a) Getting the agro waste waste
- b) Sieving the waste to remove impurity and sun drying
- c) Grinding or shredding
- d) Mixing the agro waste with binders
- e) Densification or Briquette production
- f) Drying in an oven.



**Fig 2. Source Sunday Y.K et al 2020**

**Characteristics of Briquettes**

The characteristics of briquettes are categorized in terms of physical, mechanical, and thermal properties, depending on the measured parameters.

- a) Physical characteristics: this include the moisture content, density, and water resistance.
- b) Mechanical characteristics: this include shatter index, durability and comprehensive strength.
- c) Thermal properties: this include the proximate composition (volatile matter, ash content and fixed carbon) and Ultimate composition ( carbon, hydrogen, nitrogen, oxygen and sulphure),

**Utilization of Briquettes**

Briquettes can be utilized in several applications ranging from residential cookstoves to large scale industrial power plants. They can be easily adopted in any biomass-based energy conversion devices, such as residential boilers, residential stoves, gasifiers, industrial boilers. Briquettes are good alternatives because the contemporary domestic fuels (fuelwood, kerosene and gas) are getting scarce and expensive

**Materials and Methods**

The biomass wastes used for the briquette production is the agro waste under study (guinea corn straw and cassava starch or Okoho as binder) which all are readily available In the area on the farm usually after harvesting crops.

The collected agro waste sun-dried and sieved with a mesh to remove impurities and kept in a polythene bag to avoid absorption of moisture until required for preparation of briquettes. In preparation of binders, boiling water mixed with the respective percentage of starch binder to make it in gelly form.

The made briquettes will be dried, and taken to laboratory at National Centre for energy research and Development, University of Nigeria Nsukka for proximate and ultimate analysis of the briquettes. Determining the material composition of the materials used for the study is important in other to evaluate the behavior of the material during the validation of the models and also to determine how the different compositions of the material and binder react to different input variables that affect the height, ash content, volatile matter, calorific values, bulk density and compression ratio on the briquettes produced from the materials.

At the end of this work, a more reliable and sustainable means of generating energy for cooking and heating with higher calorific value compare to the conventional means was generated. Also a means of reducing pollution of excessive burning of guinea corn straw and also means of making extra income for the farmer was generated.

### Conclusions

Agricultural resources are diverse and their distribution cuts across the entire state. The residues are produced in large quantities evidenced from the estimates of crop production and yield in the state. A lot of the residues are discarded by burning in the open or are left to rot on farmlands thereby causing environmental pollution. The use of these residues for cooking purposes in their raw form encourages indoor air pollution resulting in respiratory diseases leading to deaths. The large volume of agricultural residues available in Enugu state can be utilized efficiently when they get converted into briquettes. Briquetting at low pressure could provide a means for people With limited equipment and resources to upgrade residues that could have been wastefully discarded. Because they can be produced at low cost, other domestic cooking fuels can be complimented and reduce their high demand. This will provide clean and sustainable energy for rural areas and reduce the risk of environmental pollution which leads to climate change, thereby meeting the goal of affordable and clean energy championed by the United Nation's SDG.

### Recommendations

Affordable and Clean Energy (SDG 7) is the 7th goal of the United Nation's Sustainable Development Goals. Briquetting of agricultural residues presents a sustainable means of achieving that goal in Enugu state and thus agricultural waste which does not pose threats to food shortage rather provide cleaner, cheaper and sustainable energy means be adopt so as to mitigate the possible health hazard pose by the old and predominant system.

### Reference

- Ajieh MU, Igboanugo AC, Audu TOK. Design of grass briquette machine. Niger J Technol. 2016; 35(3): 527–530.
- Chen L, Xing L, Han L. Renewable energy from agro-residues in China: Solid biofuels and biomass briquetting technology. Renew Sustain Energy Rev. 2009;13(9): 2689–2695.
- Dairo OU, Adeleke AE, Shittu T, Ibrahim NA. Development and Performance Evaluation of a Low-Cost Hydraulic-Operated Biomass Briquetting Machine 1\*. FUYOYE J Eng Technol. 2018; 3(1): 1–6.
- Legacy Foundation. Fuel Briquette Press Kit – A Construction Manual. 2003.
- Obi, O.F, Akubuo, C.O, Nwankwo V. Development of an Appropriate Briquetting Machine for Use in Rural Communities. Int J Eng Adv Technol. 2013; 2(4): 578–582.
- Olorunnisola A. Production of Fuel Briquettes from Wastepaper and Coconut Husk Admixtures. CIGR Ejournal.2007; IX: 1–11.
- Pallavi H V, Srikantaswamy S, Kiran BM, Vyshnavi DR, Ashwin CA. Briquetting Agricultural Waste as an Energy Source. J Environ Sci Comput Sci Eng Technol. 2013; 2(1): 160–172.
- Rousset P, Caldeira-Pires A, Sablowski A, Rodrigues T. LCA of eucalyptus wood charcoal briquettes. J Clean Prod. 2011;19(14): 1647–1653.
- Tumuluru SJ, Christopher WT, Kenny KL, Hess JR. A Review on Biomass Densification Technologies for Energy