Journal of Biology, Agriculture and Healthcare
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol.6, No.4, 2016

Fuelwood Depletion and Alternative Sources of Energy in the Guinea Savannah Ecosystem of Nigeria

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ABSTRACT

Population pressure and poverty are the main reasons of firewood depletion in the Guinea Savanna ecosystem of Nigeria. In the near future the fuelwood will be increasingly scarce and expensive. Currently, the acute scarcity and deficit in wood supply has resulted in enormous increase in price either by the way of monetary outlays on fuel for the urban or labour on the part of fuelwood collectors in the rural areas. Over 80% of Nigeria's population that depend on fuelwood is worsened by the widespread use of insufficient cooking methods, the most common of which is still an open fire. The open fire system has a very low terminal efficiency and the smoke is also harzadous to human health, especially to women and children who mostly do the cooking in homes. Equally, the biomass energy resources of the nation have been estimated to be significant, which can be used for the production of the briquette as an alternative cooking fuel. The contents of this work will provide better alternative on efficient use of biomass resources and other alternative renewable energy devices capable of revolutionizing the cooking systems particularly in the rural areas of Nigeria.

Key words: Fuelwood, Energy, Ecosystem

INTRODUCTION

Inspite of the rapid urbanization in developing countries like Nigeria, a very high percentage of the population (over 80%) has, however, continued to stay in villages. Due to high rate of population growth in general and much more so in villages and the increasing prices of alternative fuels and energy technologies, it is expected that the demand for wood will increase. Accompanying this, is pressure on land due to growing of human and livestock population, increasing industrialization, urbanization and rising standard of living. This situation if left unchecked or unmatched by any counter measures, it is bound to touch limits which may upset ecological balance. In Nigeria, the dependence on wood is more pronounced in rural settlement, which has no other available and affordable energy option. Hence, concerted efforts are required to change this trend and protect the environment with specific reference to desertification, soil erosion and pressure on already depleted forest by way of indiscriminate felling of trees without systematic replacement (ECN – UNIDO, 2007). With multiple pressure on forestwood, supplies and marketing, villagers spent greater amount of their time searching for fuelwood and more use is made to animal dung and crop residues to supply household energy. The reliance on dung and crop residues is disastrous, with its attendant effects on the soil fertility leading to considerable impoverished yields per unit land area and difficult question of dividing the land between the food and the firewood plantations (Ileoje, 2011).

Equally, other loose biomass resources, agricultural and wood waste are not properly managed to supplement the fuelwood for cooking. This called for the need to produce solid fuel briquettes for cooking and heating.

Factors such as alternative to fuelwood, (obtained by self-collection), accessibility and affordability to other commercial fuels and socio-economic inclination to traditional fuel will continual to stick Nigerians to fuelwood. The conservation and efficient use of wood is an urgent necessity. Cooking is done by burning of firewood and other biomass in the form of charcoal, cornstalks and crop residues, sawdust and other crop processing wastes in a system known as woodstove. Presently, attention is being drawn all over the world in improving these wood stoves in terms of convenience and efficiency. Equally, to make the best use of the industrial recycling and maximize raw materials utilization i.e. sawdust from wood work industries, molasses from sugar companies, agricultural products such as husks and shells from milling industries are waste and nuisance to environment, their disposal are tasks requiring additional cost. But these waste or loose biomass are potential input materials required for the briquettes industries. It is on this basis that, renewable energy systems such as biomass (fuelwood and other waste) be accessed and integrated into the nation's energy mix to provide direction for judicious use of fuelwood and other biomass resources (Anozie and Ejike, 2003). With multiple measures on already depleting forest, there is the urgent need to employ short and long term resources to arrest the situation or majority of the population of this country may have food without fuelwood for cooking by the next two decades. It is on this basis that, the long term plan in respect of fuelwood management becomes most urgent and necessary.

The biomass resources of Nigeria can be identified as wood, forage grasses, shrubs, animal wastes arising from forestry, agricultural, municipal and industrial activities as well as aquatic biomass (Danshehu, 2002). The primary way to utilize biomass is through direct combustion. Biomass is similar to fossil fuels as it is also made up of hydrocarbons that can burn to release heat (Voger, 1996). The biomass energy resources of the nation have been estimated to be 244 million tones/year. Nigeria is presently consuming about 143.4 x 10^9kg of fuelwood annually. The average daily consumption is about 1.5 to 2.0kg of dry fuel wood per person (Forestry Dept, 2010).

Table 1: Nigeria's Production of major crops (Million tones)

SNO	CROP	2009	2010	2011	2012	2013
1	Maize	22.9	24.2	23.8	24.6	25.5
2	Tubers	56.8	57.9	58.6	58.4	59.1
3	Pulses	2.2	3.4	3.1	3.6	3.5
4	Plantain	1.8	1.9	2.2	2.1	2.3
5	Vegetables	3.6	3.8	3.7	3.9	3.9
6	Industrial crops	6.8	7.1	7.6	7.7	7.9
	Total	**94.1**	**98.3**	**99.0**	**100.3**	**102.2**

Source: Federal Ministry of Agriculture, 2014.

Nigeria recorded an aggregate crop production of 102.2 million tones for the major crops in 2013 (Table 1). This quantity refers to the harvested useful parts of the plants. The discarded parts consisting of roots, leaves, stalks, straws, chaff and other parts of plant shoot (Otherwise called crop biomass) would be far in excess of the figures shown. It can be deduced therefore that Nigeria's annual production of agricultural biomass is enormous. The study shows the potentials for deriving energy from this enormous biomass production.

The supply possibility of fuelwood for 2004 was estimated at 131.7 million m^3 (Table 2). Fuelwood production takes place in all parts of Nigeria. Although, the available volume is much higher in the high forest zone, but intensity of fuelwood extraction appears much greater in the Northern states.

Table 2: Estimated Nigeria's wood requirements in ('000m^3)

SNO	ITEMS	2003	2007	2011	2013
1	Fuelwood	121,102	138,996	146,267	149,792
2	Utility wood	4,432	4,912	5,223	5,634
3	Sawlogs	13,651	14,810	15,789	16,467
4	Veneer logs	2,967	4,298	5,865	6,691
5	Particle board	361	548	817	1,279
6	Pulpwood	1,723	2,364	2,919	3,478
	Total	144,236	165,928	171,015	183,341

Source: Federal Ministry of Environment, 2014.

In Nigeria, as a result of increasing price of commercial fuels, kerosene, coal etc. over the past ten years, explains the persistent use of fuelwood for cooking not only to the rural but even urban poor.

2.0 ALTERNATIVES TO FUELWOOD (RENEWABLE ENERGY SYSTEM)

The development of renewable energy sources is not only on the fear of exhaustion of fossil fuels but also the need to protect our living environment and equally future occupations in providing goods and services that are more durable and reusable. The opportunity for suitable development calls for the need to consider the renewable energy sector. This is so because, the markets for renewable energy technology in developing countries like Nigeria are likely to increase dramatically in the next decade to come. The mentioned renewable energy systems below are good alternatives to fuelwood substitutions.

2.1 BIOMASS

Biomass as it stands in the field or collected as waste, often an unsuitable fuel since it has high moisture content and a low physical and energy density and thus it can not be used as fuel for most conventional prime movers which are designed to operate on liquid or gaseous fuel (Anozie and Ejike, 2003). However, technology for conversion of biomass into high quality gaseous, liquid and solid fuels; mechanical and electrical power exists. Established conversion technology can be divided into thermal and biological routes (Bala *et al.,* 2010).

Biomass may be converted by anaerobic digestion processes or by fermentation into methane and ethanol respectively. At present the established technologies are the anaerobic digestion of cellulosic wastes to form biogas (methanol or fermentation of simple sugar) to form ethanol. Technology exists for the production of heat, steam, electricity and gaseous and liquid fuels from biomass through the thermal routes.

2.2 IMPROVED WOODSTOVES (Efficient Woodstoves)

To enable multiple cooking at a time with more efficiency and less time consumption, the use of the improved (efficient) wood burning stoves cannot be over-emphasized. The development and active utilization of efficient woodstoves such as improved clay, metallic and ceramic – coaled wood burning stoves will certainly be the right steps in the direction. These stoves will serve as appropriate alternative for judicious use of fuelwood, agricultural and forest residues. The stoves are listed below:

i. Single – hole metallic woodstove (Two versions). This was developed at Sokoto Energy Research Centre, and Energy Research and Development Centre, Nsukka. These were constructed from the galvanized medium and high grade sheet metal with provisions of intake air and firewood at the inlet of the stoves. These stoves have efficiency of over 17% as against the traditional tripot metallic stove with efficiency below 10% (Fig. 3).

ii. Single – Hole clay woodstove: In a similar way the stove was constructed from clay which was prepared with binding materials such as grog, millet/rice husk and allowed to dry. The stove was later fired to make it water and fire resistant. Three types of improved wood stove depending on the family sizes and dishes to be cooked were designed and developed with three principal features.

(a) A close – health (Fire box) where combustion of the wood takes place thus protecting the fire from the effects of the wind to reduce heat loss mostly by convection and radiation.

(b) Multi-pot design, capable of carrying out more than one pot at a time permitting heat recovery from hot gases that otherwise have gone to waste

(c) A chimney to provide the necessary draft for bringing in air for combustion and removing smoke from the kitchen environment, thereby making it convenient to users.

(d) Double – hole woodstove: The design was obtained after modifying a similar type of wood stove fabricated and tested in Nepal. A chimney was integrated in this design as shown in Fig. 4. This type of stove is mainly for the medium size families of 6 to 10 sizes, with efficiency of over 42% as against the most commonly used traditional stoves.

2.3 BIOMASS BRIQUETTING

Biomass in the form of fuelwood, charcoal, corn-stalks and crop residues, dried solid animal waste, sawdust, millet / rice husk, kernel shells and other crop processing wastes constitute virtually 100% of the traditional cooking and heating fuel in the West African sub-region (Ileoje, 2011). Traditionally, various attempts have been made to device methods by which people in rural areas can use wastes to make briquettes. The simplest idea for areas where animal dung is shaped by hand, sun dried for use as fuel, is that, the dung cakes will burn longer if wood ash is added. Developing countries like India and China are shaping cow dung manually to produce dung cake while in Northern Nigeria, the people make use of cow dung cakes for cooking and heating for many decades. However, most efforts have been devoted in making a simple machine for the production of briquettes. The identified fuels produced from wood residues and other agricultural waste products are appealing because the fuel is dry and uniform in size, thus easier to store and ship. The uniform and increased heating value per unit volume also provides better combustion control and overall combustion efficiency.

The briquette has the following benefits:

i. By reducing biomass materials to bulk and increase the density of the materials to make transportation easier and cheaper.
ii. Increase the energy constant per unit volume of materials by ducking the moisture content during compaction processes.
iii. Obtain a homogenous product having the same physical characteristics (density particle size and moisture content) from highly heterogeneous group of materials.
iv. Having uniform quality of energy per unit feed stock.
v. Obtain a highly cohesive fuel product from particular materials that were difficult to process.

Besides the normal domestic cooking, briquettes are used for rural industries such as small – scale foundries, bricks, kilns and bakeries. Briquette industries Ltd at Ota, Ogun State is involved in briquetting of sawdust as alternative to cooking fuel (Fig. 5). But based on currents heating value of the locally produced briquette, it has 6 to 7 times more energy content than those loose biomass not briquette. Equally the heating flame and temperature obtained in cooking process are better when compared with other renewable energy fuels. The briquettes with about 16.6MJ calorific value and about 70% burning efficiency in comparison with other solid cooking fuels proved to be cost effective based on various cooking performances conducted (Danshehu and Sambo, 1997).

2.4 SOLAR ENERGY

The annual average solar intensity in Nigeria is 6898.5MJ/m^2 per year or 1934.5KWh/m2 per year, a value that can be used to calculate the available solar energy. Thus, over a whole year, an average of 6,372,613 PJ/ year (2^2≈1,770 thousand Twh/year) of solar energy falls on the entire land area of Nigeria. This is about 120 thousand times the total electrical energy generated by the Power Holding Companies for the whole country for the year 2002 (Bala et al, 2010).

Sources of solar energy are:

i. Solar Thermal

The National Energy Policy document specifically acknowledge that solar thermal technologies have tremendous potentials to make significant contribution to the national energy mix, especially to the rural energy supply strategy. Its specific policy statements include aggressively pursuing the integration of solar energy into the nation's energy mix and keeping abreast with worldwide developments in solar energy technology. Current development envisages varying levels of penetration of solar energy into thermal use in the domestic, commercial, agricultural and industrial sectors of the economy. Those solar technologies relevant to Nigeria in the short, medium and long terms have been identified. Solar thermal technologies that are available in the International market today are efficient and highly reliable, providing solar energy for a wide range of applications that are currently provided by fuel wood energy supply. These include domestic hot water and space heating in residential and commercial buildings, solar cooking, solar dessilation and solar drying for agricultural products and timbers.

ii. SOLAR PHOTOVOLTAIC

Nigeria is endowed with abundant solar radiation, which is well distributed throughout the country all the year round. This radiation can be converted to electrical energy and used to provide power in:

(a) Lighting
(b) Water pumping for domestic and agricultural uses
(c) Refrigeration particularly for vaccine in the health sector,
(d) Communication system, telephones, television, radio
(e) Remote sensing,
(f) Corrosion protection of oil and water pipelines
(g) Rural electrification for domestic and industrial uses, etc.

There are enormous potentials for the utilization of solar – electricity to realize, the rural development policies and initiatives of the federal government. It hoped that the Federal Government of Nigeria and the private sector will invest in solar electricity which contributes a reasonable proportion of the electricity supply for domestic and industrial sectors of the economy.

CONCLUSION

In the light of firewood scarcity and its present inefficient use in cooking, improved wood stoves need to be urgently developed to reduce the rate of combustion of wood. The use of these improved wood stoves will revolutionize the cooking systems particularly in the rural areas of Nigeria, thereby reducing the quantity of fuelwood wasted daily during the cooking activities as a result of heat loss. In addition, the use of alternative sources of energy such as briquettes from wood and agricultural waste. Biogas are therefore a step in the right direction in mitigating hazards to our environment and in reducing over dependence on depletable fuels for cooking. Hence, concerted efforts are required to change the existing trend of efficient firewood utilization and employ the services of alternative energy sources or the majority of the population of the country (particularly the rural dwellers) may have food, without fuelwood for cooking by the next two or three decades to come.

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ANNEX

Fig.1: Artist View of three stone type woodstove

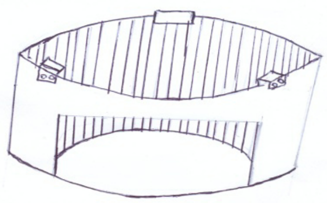

Fig. 2. Metal Woodstove.

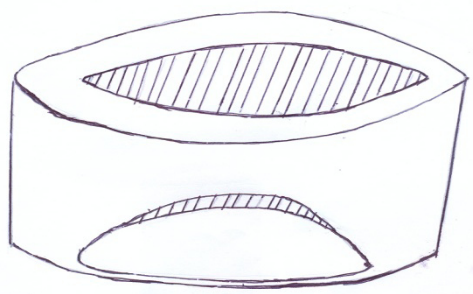

Fig. 3. Single-Hole clay Woodstove.

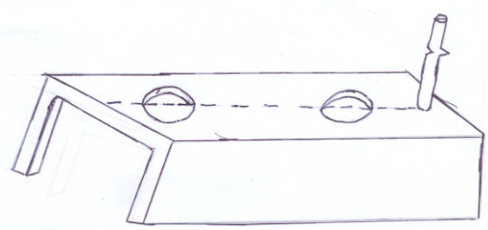

Fig. 4 Double Hole-clay Woodstove.

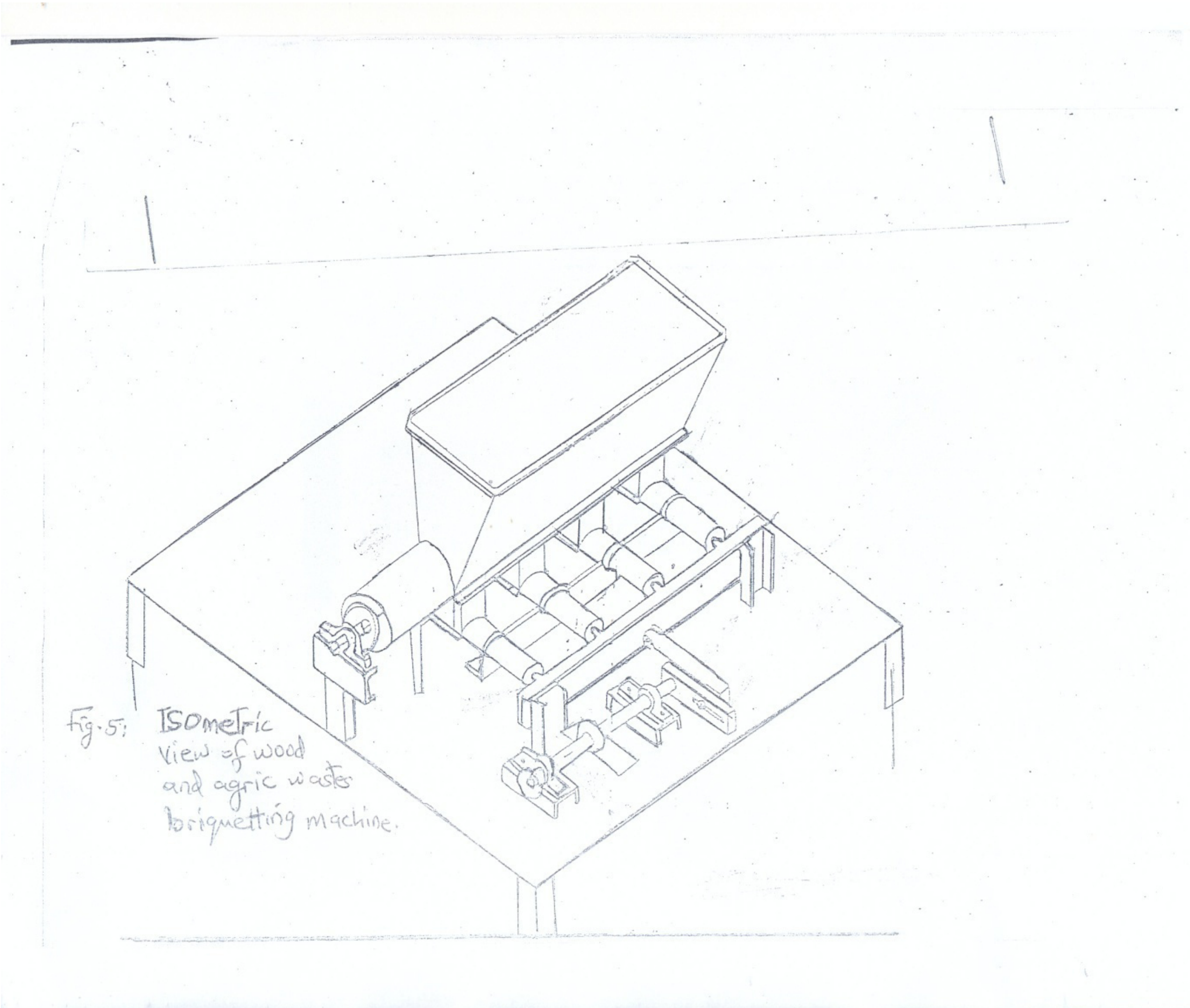

Fig.5: Isometric view of wood and agric wastes briquetting machine.