

MINIMIZING FUELWOOD CONSUMPTION THROUGH THE EVOLUTION OF HOT STONE COOKER AS AN ALTERNATIVE DOMESTIC ENERGY SUPPLY

M. A. C. A. Odii and J. N. Mokuwunye

ABSTRACT

The central objective of this paper is to minimize fuelwood consumption through evolving alternative domestic energy. Data on alternative domestic energy sources, and use fuel wood consumption during scarcity of petroleum were collected using structured questionnaires. Data on time spent to cook yam, rice and beans with hot stone were also collected. The hot stone cooker design was observed to cook food faster. The application of hot stone cooker during the period of scarcity of petroleum products would minimize the use of fuelwood as a source of domestic energy supply. This would lead to a sustainable environment. The study recommended the adoption of the hot stone cooker so as to ensure sustainable environmental protection through minimizing the use of fuelwood.

INTRODUCTION

Energy is indispensable to socio-economic and industrial development of any nation. Yet the strategic role energy and energy policy play in the economic development has not been appreciated in Nigeria. (Iwu, 1993). All forms of life including that of man are

dependent on energy and its level of industrial development.

Energy consumption pattern in the world today shows that Nigeria and indeed African countries have the lowest. Nevertheless, Nigeria suffers from inadequate supply of usable energy due to rapidly increasing demand, which is typical of a developing economy. Paradoxically the country is potentially endowed with sustainable energy resources. Nigeria is rich in conventional energy resource, which include Oil, natural gas, lignite, and coal. It is also well endowed with renewable energy source like wood, solar, hydropower and wind.

Rather than harness these abundant energy resources, fuelwood constitute the major source of household fuel. For instance about 80% of the country's populace that dwell in the rural areas use firewood as energy sources (Baliya 1991). The inability to harness cost effective alternative fuel for both industrial and household usage in the various part of the country have resulted in the nation wide domestic energy crisis and a consequent deterioration of the industrial and economic sectors. Situation has therefore created an upsurge in the exploitation and utilization of fuelwood, which has resulted in serious ecological problem of deforestation, desertification, erosion, loss of topsoil, infertility, and poor crop yields in most part of the country. Furthermore, many years of sustained degradation of the environment and worsening desertification as a result of heavy

dependence on fuelwood have given rise to increased cost of food production and compounded the problem of limited resources.

The concept of environmental disruption may be regarded as an outcome of the misuse and depletion of social head capital (regarded as natural and artificial resource) which cannot be privately appreciated from either technological or an institutional point of view. Many environmental problems arise as a result of poor resource management or inadequate planning and utilization of the available resource (Nwabue 1993, Odii et al 1999).

Desertification and deforestation are the major problems of the forest resource. Odii et al. (1999) maintained that human actions which head to desertification include, overgrazing, poor cultural practice and collection of vegetation for fuel. In attempt to solve this energy crisis, several efforts are made to develop alternative domestic energy supply that would minimize the general dependence on fuelwood among others for increased environmental protection.

This paper examines the domestic energy situation and development in Nigeria. It also suggests a way of accelerated development in domestic energy generation and distribution at affordable cost as well as environmental protection.

The specific objective of the study include to

- i. Identify the sources of domestic energy supply.
- ii. Develop an alternative energy supply.

METHODOLOGY

Both field and laboratory experiments were conducted. The laboratory experiment was carried out in the Food Science and Technology laboratory located in the Federal University of Technology Owerri. The objective of the experiment is to evolve an alternative domestic energy supply.

The experimental materials include stone, heat source, basket, jute bag, rice thrash and/or saw dust. Stone has low heat conductivity and high specific heat capacity. The thickness of the stone and the high specific heat capacity makes it to absorb a large quantity of calories of energy which can be released gradually over a long period of time even when the heat source has been withdrawn. Food is cooked by the stored heat by radiation and conduction. Sources such as stove, hot plate and gas cooker were used as primary heat sources to heat the stone to 100⁰C. The type of stone used was igneous rock.

Basket is made up of high quality insulator preventing heat losses by conduction or convection because the fibers used in making it cannot conduct heat. Other experimental materials include stopwatch, water, pot, measuring cylinder and food materials (yam, rice and beans). These food materials were cooked using hot stone, initially heated with stove, Gas cooker, and electricity (hot plate).

The experimental design is shown in the figure below:

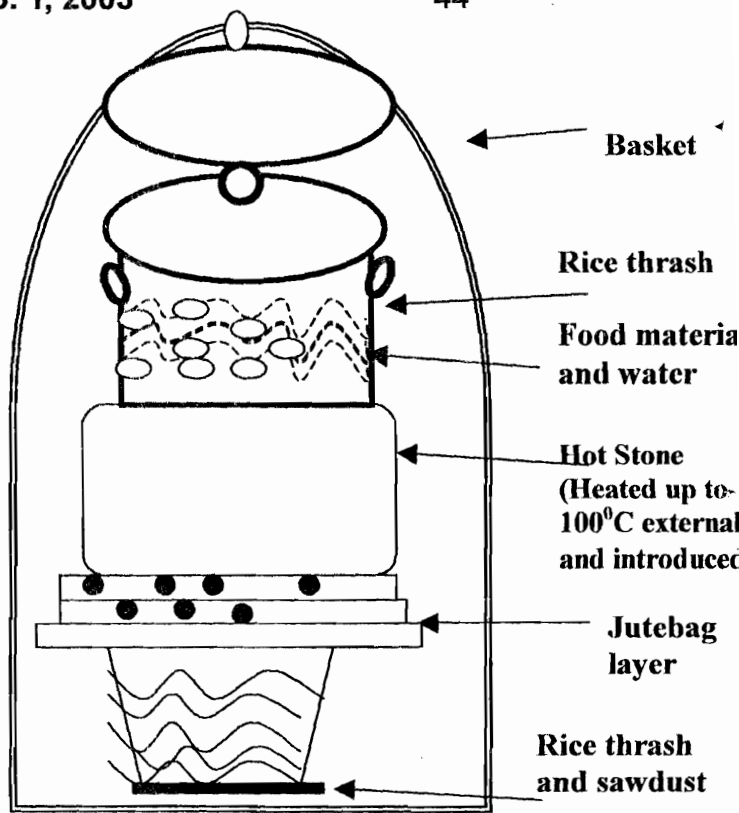


Figure 1: Hot Stone Cooker Experimental Design.

The food material intended for cooking was added to the water and the pot placed on top of the hot stone.

This was placed inside the basket as set up. It was covered with the basket cover and allowed to cook. The cooking time for each food material under different source of heat was recorded.

The field experiment was carried out in Delta State, which is one of the energy production and consumption nerve centers of the nation. This was done to ascertain the economics of fuel wood consumption. Stratified random sampling technique was used for the purpose of selecting the respondent for the field experiment. A total of sixty, randomly selected respondents in the semi – urban centers in Aniocha L. G. A. of Delta State were studied. Primary data were collected through the use of structured questionnaire, personal interviews and physical inspection of households domestic energy facilities of the respondents. Data on the various domestic energy sources, cost of various domestic energy, consumption of fuelwood as domestic energy were collected.

The data collected were analyzed using a combination of statistical such as percentages, means and frequency distribution.

RESULTS AND DISCUSSION

The tables below present the experimental results of the alternative domestic energy sources.

TABLE 1: Various Energy Sources and their Cooking Time for Rice

Energy Source	Time taken to heat stone(mns)	Time taken to heat water(mns)	Time taken to cook Rice (mns)
Stove (Kerosene)	90	15	15
Gas Cooker (Natural Gas)	30	10	5
Hot Plate (electricity)	20	6	4

Source: Computed from experimental data: 2000

NB: Volume of water used: ¼ liter; food material cooked: ½ cup of rice.

The table shows that the time taken to heat stone to red hot using stove as heat sources is 90 minutes while 15 minutes was used to heat water to 100^{0C} and 15 minutes to cook ½ cup of rice. The table also indicate that in using gas cooker as a heat source, it took 30 minutes to heat the stone to red-hot, 10 minutes to heat water to 100^{0C} and 5 minutes to cook the rice.

The result also show that in using hot plates as heat source, it took 20 minutes to heat the stone to red-hot, 6 minutes to heat water to 100^{0C} and 4 minutes to cook the rice. Cooking was therefore fastest using electricity as a heat source in conducting the experiment for rice. Thus rice could be cooked with hot stone initially heated with electricity supply through the means of hot plate.

TABLE 2: Various Energy Sources and their Cooking Time for Yam

Energy Source	Time taken to heat stone(mns)	Time taken to heat water(mns)	Time taken to cook yam (mns)
Stove (Kerosene)	90	15	20
Gas Cooker (Natural Gas)	30	10	15
Hot Plate (electricity)	20	6	10

Source: Computed from experimental data: 2000.

- The quantity of yam cooked was 5 slices.

From the table above, the time taken for the various heat source to heat stone and water remains the same as earlier described in the case of rice. However, the time to cook the yam using stove as heat source was 20 minutes while using gas cooker as heat source took 15 minutes to cook the yam and 10 minutes was used to cook with electricity as heat source. Again heating the stone using electricity proved to be the fastest means of cooking yam by means of hot stone cooker

TABLE 3: Various Energy Sources and their Cooking Time for Beans

Energy Source	Time taken to Heat stone(mns)	Time taken to heat water(mns)	Time taken to cook beans (mns)
Stove (Kerosene)	105	15	60
Gas Cooker (Natural Gas)	36	10	45
Hot Plate (electricity)	40	6	35

Source: Computed from experimental data: 2000.

Table 3 shows that it took stove 105 minutes to heat stone red-hot, 15 minutes to heat water to 100^{0C} and it took 60 minutes for the beans to cook.

The table also indicates that it took gas cooker 36 minutes to heat stone to red hot, 10 minutes to heat water to 100^{0C} and 45 minutes to cook the beans. It also took hot plate (electricity) 40 minutes to heat the stone to red-hot, 6 minutes to heat water to 100^{0C} and 35 minutes for the beans to cook. The time for heating stone changed here because a bigger stone was used to accommodate the longer cooking time associated with beans. However, cooking of beans using hot stone could be more efficient if the stone was initially heated using electricity.

The indications from the above results shows that stove has lower heating capacity, hence more time is spent during heating and more volume of kerosene is used up during cooking period. This is an uneconomical heat source during energy scarcity. There is also an indication that lesser time is spent during the cooking using gas cooker in comparison with stove as heat source.

Finally, least time is spent using hot plate (electricity) in cooking the food materials when compared with kerosene and gas cooker as heat source. Electricity is therefore more economical as energy source and when available could be used to heat stone which could be used to cook food materials at the least cost.

Table 4 below presents the frequency distribution of the various types of domestic energy sources consumed by household under normal supply of petroleum products.

TABLE 4: Frequency Distribution of Household Consumption of Domestic Energy During Abundant Supplies

<i>Sources</i>	<i>No. of Respondents</i>	<i>Percentage</i>
Kerosene	25	41.67
Natural gas	20	33.33
Fuel wood	14	23.33
Electricity	1	1.67
Coal	0	0
<i>Total</i>	<i>60</i>	<i>100</i>

Source: Field survey data, 2000.

Table 4 shows that about 41.67 percent use kerosene as their primary source of domestic energy indicating that majority of the household would depend on the use of kerosene during period of abundant supply of petroleum products as their main source of domestic energy.

About 33.33 percent would use natural gas while 23.33 percent would depend on fuelwood during peak period of abundant supply of petroleum products. Less than 2 percent use electricity as energy source while non of the respondents use coal as domestic energy source for cooking. The non use of coal may be attributed to the non availability of coal in the area while the epileptic nature of electricity supply may have resulted in its low level of use among the respondents.

The pattern of domestic energy supply was significantly different under period of scarcity of these domestic products. The frequency distribution of their consumption pattern is reported on table 5

TABLE 5: Frequency Distribution of Domestic Energy Consumption During Scarcity of Petroleum Products

<i>Sources</i>	<i>No. of Respondents</i>	<i>Percentage</i>
Fuel wood	51	85
Electricity	9	15
Natural Gas	0	0
Kerosene	0	0
Coal	0	0
<i>Total</i>	<i>60</i>	<i>100</i>

Source: Field survey data, 2000.

The above table shows that 51 respondents representing 85% resorted to the exploitation and utilization of fuelwood as their source of energy during scarcity of petroleum products. About 15 percent representing 9 respondents resorted to the use of electricity as their source of domestic energy.

It could be observed that none of the respondents use natural gas, kerosene and coal due to their very high cost arising from scarcity of these products. Thus periods of scarcity of petroleum products put pressure on environment through increased consumption of firewood. When respondents were asked how they replenish the trees the fetch in the form of firewood, only 13

respondents, representing 21.67 percent replanted trees after fetching for fuel wood. The remaining 47 respondents representing 78.38 percent do not replant trees when they fetch firewood for fuel. This reveals that massive tree planting, as a means of conserving the environment has not been adopted by many Nigerians, particularly within the Delta State of Nigeria.

POLICY IMPLICATION AND CONCLUSIONS

The major aim of this study is to minimize fuelwood consumption through the adoption of hot stone cooker as alternative domestic energy supply. This was designed using locally sourced materials such as stone, basket, jute-bag and sawdust.

The design was tested and observed to cook food faster particularly when combined with electricity as a heat source for heating the stone. It is appropriate and effective in terms of cooking. Since lesser time was spent heating stone to red-hot using electricity, this technology could be useful in cooking especially during peak periods of scarcity of petroleum products. Also lesser time was spent to cook rice, yam and beans using electricity when compared with kerosene and gas cooker as heat sources for heating the stone.

The study revealed that during scarcity many household resorted to the exploitation and utilization of fuel wood as source of domestic energy due to the scarcity of petroleum products. Thus hot stone cooker and electricity could be used to cope with this situation.

The study reveals that most of the trees fetched for firewood were not replanted. This reveals that massive tree planting and proper management of wood resource has not been in practice at grassroot level. Proper enlightenment campaign is therefore suggested for household to plant trees.

The findings of the study have a number of implications for practical purposes. They study reveals that there is over dependence on fuelwood as a domestic energy source during scarcity. This may have led to environmental degradation.

It is therefore necessary to adopt the use of hot stone cooker as an alternative domestic energy supply. This is because more resources could be saved cooking with hot stone. Moreover, the technology is cheaper to acquire. However this technology is a complement to other domestic energy supplies and never a substitute since it depends on other heat sources to initially heat the stone.

Electricity has proved to be the energy source that has lesser time for heating the stone used for the experiment. There is therefore the need for the efficient generation, transmission and distribution of electricity for the smooth operation and adoption of the Hot Stone Cooker as alternative domestic energy supply. Hot stone technology is environmentally friendly, affordable and easy since all the materials could be sourced locally. It is the ability of this technology to retain

and gradually release heat for cooking that makes it cheaper and appropriate.

REFERENCES

Ayodele, A. (1991), An Overview of Energy Development in Nigeria: *Journal of Energy and Natural Resource Management*, 1 (1).

A.D.F. (1991); TOR for Africa Energy Programme ADB Report, Abidjan.

Baliya, H. H. (1991): Fuelwood Consumption: A constraint to Rural Development in Boronu state, in *Population and Development in Boronu State*, edited by Engham E.V.T.

Badamose, F. (1991); Prospect for the Development and Utilization of Gas in the 1990's and Beyond; *Journal of energy and Natural Resource Management*, 1 (1).

Central Bank of Nigeria, (1998): Persistent Shortage of Petroleum Product in Nigeria. A Reappraisal of Cases Effects and Remedies, May, 1998.

C. A. D, (1984); "Wood for Energy in Nigeria" Final Report and Proposals to the Federal Department of Forestry Centre for Agricultural Development (Nigeria).

Eboh, C. (1984); "Managing Natural Resource: The Control of Energy Consumption" *Nigeria Journal of Administrative Science*, 1, January 22-38.

Iwu, G. O. (1993); Development: of Alternative

Energy Resource in Nigeria: A Reappraisal; Nigeria Metallurgical Society 11th Annual Conference Port Harcourt, Nigeria.

Nwabue, F. K. (1993); Smokeless Coal Briquette as a viable alternative to Fuelwood and Deforestation; International Conference on industrial Utilization of Tropical plant and conservation of Biodiversity. Enugu.

Odi, M.A.C.A., Asiabaka C. C. and Ugochukwu, A. I. (1999); "Determinants of Women Mobilization for Efficient Resource Management Environmental Sustainability" *Journal of Erosion and Environmental Degradation* 118 – 127.

Onu, P. (1993) The Threat of Global Atmospheric Pollution: *Journal of Environmental Review*, 2 (2)