



Women and Biomass for a Sustainable Energy Development in Rural Regions: Socioeconomic Discussion

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Abstract

A variety of fuel sources like coal, kerosene, cooking gas, electricity, firewood, dung cakes and agricultural wastes are used for cooking purposes. But due to rising costs and short supplies of gas, kerosene and electricity, women resort to greater use of biomass sources – that is, firewood, coal, dung cakes and agricultural wastes - for cooking. Thus, women have the assurance and dependence on biomass fuels as sustainable energy that do not fail them when other sources of energy fail. The aim of this paper is to examine the level of reliability of biomass fuels as sustainable energy. The objectives employed include detail analysis of various biomass fuels and their sustainability factors. Thirty women each, in three typical Nigeria states were approached and the strength of their dependence were evaluated via a questionnaire survey. The findings of the study reveal that reliance on biomass fuels is high because of their affordability, availability and efficiency.

Keywords: Biomass; Sustainable energy; Rural regions; Socioeconomic situation; Women

1. Introduction

Energy is a primary input for almost all economic activities and is, therefore vital for improvement in quality of life [1-4]. The demand for energy is increasing; on the other hand, the energy resources are becoming scarce and costlier. Energy is derived from non-renewable and renewable resources and the former are in the process of depletion. The world is plagued by severe energy crisis which derail the global economy and disrupt the environmental support system [5-8]. It is beyond the capacity of the global biosphere to absorb the emissions of a fossil fuel based energy system [9]. Concentration of carbon dioxide-a greenhouse gas, is gradually increasing in the atmosphere and is likely to result in abrupt and catastrophic climatic disruptions by increasing the global temperature [10]. A reduction in the carbon dioxide concentration can be achieved by limited use of fossil fuels [11, 12].

Reduced availability of fossil fuels, especially the most economical and versatile petroleum, and the limited capacity of the world to cope with the overwhelming pollution caused by fossil fuels are the two major considerations that have forced the world to seek an energy system hot based on fuels [8, 9]. This has prompted the new introduction of a sustainable energy

system based on renewable, clean and non-polluting energy resources. For example, from solar energy resources, from wind energy resources, from bio-energy resources etc [1-12].

In addition, increase in the price of fossil fuels, growing environmental concerns regarding their use and impacts including climate change and considerations regarding the security and diversification of energy supply have driven the increased use of biomass worldwide [4]. The growing use and production of biomass as a renewable energy source has created an international biomass market and leads to increasing trade in biomass resources also the rising cost of gas and electricity for domestic use encourages greater use of biomass sources by the low income group [5-8]. The rural population especially the women are more dependent on biomass such as charcoal and wood, as a household fuel than their urban counterparts. This is because much of the biomass are collected rather than bought. Against this backdrop this paper highlights the sustainability factors of women dependence on biomass energy.

2. Methodology

This paper makes use of multi-stage sampling using the following steps in selecting the sample frame.

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- List of all the western states in Nigeria and three randomly selected.
- List of the towns in the three randomly selected states and one town randomly selected from each state, having a total of three towns.
- List of the villages within the three randomly selected towns and one village randomly selected from each, having three villages.
- List of communities in each of the three randomly selected villages, one community randomly selected from each, having three communities.
- List of the three randomly selected communities and thirty women randomly selected from each community having a total of ninety women as a sample size.

Equally an in-depth interview was conducted with those women selling firewood and charcoal in order to know the rate at which women patronizes their products for a good understanding of their reliability on the fuels.

2.1. Discussion

The study area comprises of three rural areas in the western states of Nigeria and the questionnaires were administered by the rural women. From the survey conducted, in summary of the three areas, 60% of the rural women have no formal education, 30% have semi-education (i.e drop out from school) and 10% have formal education. Their major occupations are farming, trading and only few are civil servants at the local government and health centers. Thus, from the survey conducted, here are the forms of energy available in these areas, fuel wood, charcoal, agricultural waste and animal wastes.

2.1.1. Forms of Biomass Energy

Renewable energy is energy which comes from natural resources such as sunlight wind, rain which are naturally replenished. It plays an increasingly important role in energy supplies in our developing and developed societies. Biomass is a regenerative organic material that produces energy. This energy accounts for about 15% of the world's primary energy consumption and about 38% of the primary energy consumption in developing countries [2-4]. Biomass fuel releases carbon dioxide that was recently captured during photosynthesis and it tends to equal itself out thereby greatly reducing the green house gas effect on the ozone layer. Also increase in efficiency from biomass use will reduce emission from biomass use. The amount of

biomass saved through increase in biomass use efficiency can reduce green house gas emission further through substitution of fossil fuels [5-8].



Figure 1. Showing the Fuelwood shopping between two womens

2.1.1.1. Fuel Wood

This is the main household cooking fuel in Nigeria and mostly in other developing countries. From the survey conducted, 40 respondents highly depended on the use of firewood and 10 respondents' uses firewood along with agricultural wastes while the remaining 35 respondents depended on either charcoal or animal wastes. On the other hand, affordability, accessibility and availability are the man reasons why women still have a high dependence in using fuel wood regularly. Some of the respondents even noted that it is the most type of energy source that has never fail them even when other source of energy failed through high in price, scarcity and unavailability when they are needed. In addition, the rural women equally get sawdust extracted from the wood at the saw mills as another means in cooking. Furthermore, the interview conducted with the fuel wood sellers indicated that 75% of the women weekly patronizes and purchased the fuel wood this shows high dependence of the women on the fuel wood as a mean of sustainable energy for them (see Figure 1).

2.1.1.2. Charcoal

Charcoal is another biomass fuel used by women for cooking and by people as a secondary use to heat the smoothing iron. Some of the women noted that any food cooked with charcoal tasted of distinguished flavor to other some of the foods cooked by another source of energy. From the survey conducted, out of the 90 women respondents interviewed ,35 are highly depended on charcoal as their sustainable energy mainly

because it is affordable to get in terms of cost and is very easier to purchased, while the remaining 55 women stated that they make use of either charcoal, firewood agricultural waste or animal wastes(see table 2.1). In addition, an interview conducted by the charcoal seller indicated that the rate at which people purchased their products is between 60-70% in sales rating now; it shows that people are now shifting to the use of charcoal than any other fossil fuel, energy (Figure 2).



Figure 2. Showing charcoal for shopping.

This might also be as a result that at the time this survey has conducted the cost of kerosene in Nigeria was five times increase to its present price. This has really prompted the rural and even some urban women in Nigeria who cannot afford the high price of kerosene to result to the use of charcoal. But in order to get the good outcome for the conclusion of this research, the researcher asked the seller for the past sales account of the charcoal before the kerosene scarcity. It was then noted that ideally the rural women and some of the urban patronizes are their stable customers for so long and their sales percentage just increased by 5% during the scarcity period. With this result the conclusion was that the rural women highly depended on charcoal for their sustainable energy.

2.1.1.3. Agricultural Waste

It represents a primary energy source in most rural areas in the developing countries. The main production comes from agricultural and farming activities in the fields. In Nigeria, the type of agricultural waste used in cooking was being extracted from the shafts of palm kernel

called 'Oguso' and from the break off of the kernel called 'Esan' (Figure 3). From the survey conducted 10 rural women respondents used agricultural waste along with wood, while the remaining 80 rural women respondents make use of charcoal, firewood or agricultural waste.

2.1.1.4. Animal Wastes

Animal wastes come mainly from medium large scale animal farms. This animal waste need to be treated with special care because of its odour omissions. Only 5 of the respondents make use of it. However, from the summary of the rural women respondents here are the reasons for their dependence on biomass fuels as their sustainable energy. These are:

- Biomass fuels are the cheapest fuel that is affordable.
- Biomass ensures a better life standard for them.
- The output from biomass combustion (ash) can be used for other thing e.g is applicable as fertilizer in their farms.
- It provides a cleaner and renewable source of energy.
- It is safer alternative fuel.
- Is a source of an employment for the women as a sustainable income in meeting their needs.
- The biomass fuels have never failed them always available at anytime.
- The reliability of biomass fuel is very high; reported by the rural women.



Figure 3. Showing agricultural waste called as "Esan"

3. Conclusions

Wood is a renewable raw material that can be used not only for making timber-based products, pulp and paper but also as a source of energy. In traditional professionally-managed forests, the normal life cycle of the tree includes plantation, a stage of rapid height growth followed by a stage of steady growth in

diameter, height and volume. The point of harvesting depends on the species but it is generally reached after 30-80 years. Twenty-five to forty-five percent of the wood harvested each year is in the form of residues, i.e. the wood from forestry thinning and the residues from felling.

Therefore, most of the woody biomass resource available from forests and woodlands for energy production consists of residues. The key to creating an economic energy-from-woody-biomass scheme is to establish effective logistical systems for harvesting, recovering, compacting, transporting, upgrading and storing the wood. Harvesting and transport, in particular, can have significant impacts on energy balance and costs. The trend is to move towards greater mechanisation of harvesting for reasons of economy and safety. Because firewood and forest residues are low-value commodities, transport costs constitute the most important part of total production costs. Care must be taken, therefore, to choose an appropriate method of transport and locate the conversion plant as near as possible to the woody biomass source. It is observed that rural women will need to be participant in renewable energy efficiency and programs in conserving the energy and in fighting against releases of gases from fossil fuels which resulted to climate change.

Acknowledgement

The authors acknowledged Turkish Academy of Sciences (TUBA) for financial support of this study.

References

- [1] REN 21, Renewable Energy Network. Renewables Global Status Report 2022. REN21.
- [2] IEA, International Energy Agency. World Energy Outlook 2022. IEA, Paris, 2022.
- [3] Bhattacharya, S.C., Salam, P.A. Low greenhouse gas biomass options for cooking in the developing countries. *Biomass and Bio energy* 2002; 22: 305-312.
- [4] Koulou, V.S., Zabaniotou, A. Investigation of agricultural and animal wastes in Greece and their allocation to potential. *Renew Sustain Energy Reviews* 2007; 11: 1698-1719.
- [5] Beck R.W. Review of Biomass Fuels and Technologies. Yakima County Public Works Solid Waste Division. 2003. 47 pp.
- [6] Buragohain B, Mahanta P, Mohalkar V.S. Biomass gasification for decentralized power generation: The Indian perspective. *Renew Sustain Energy Reviews*. 2010; 14: 73-92.
- [7] FAO, Food and Agriculture Organization of the United Nations, Fuelwood and women. FAO Forestry Paper 84. 126 pp., Rome, 2008.
- [8] Kaygusuz K. Energy services and energy poverty for sustainable rural development. *Renewable and Sustainable Energy Reviews*. 2011; 15: 936-947.
- [9] Kishore V.N., Bhandari P.M., Gupta P. Biomass energy technologies for rural infrastructure and village power-opportunities and challenges in the context of global climate change concerns. *Energy Policy*. 2004; 32: 801-810.
- [10] Kaygusuz, K. Energy for sustainable development: A case of developing countries *Renewable and Sustainable Energy Reviews* 2012; 16: 1116-1126.
- [11] Kaygusuz, K., Keles, S. Sustainable bioenergy policies in Turkey. *J. of Engineering Research Applied Science* 2012; 1(1): 34-43.
- [12] Keles, S., Bilgen, S., Kaygusuz, K. Biomass energy source in developing countries *J. of Engineering Research Applied Science* 2017; 6(1): 566-576.