

Awareness of the environmental implications of the unsustainable use of biomass energy sources among rural households in Jigawa State, Nigeria

Olusegun Martins ORIFAH,¹ Messiah Chijioke IJEOMA,²
Gloria Isi OMOKHUDU,³ Gabriel T. AHUNGWA,¹
Bashir Garba MUKTAR¹

¹ Department of Agricultural Economics and Extension, Federal University Dutse,
Dutse, Jigawa State, Nigeria. e-mail: martinsorifah@gmail.com

² Department of Agricultural Extension and Rural Development, University of Ibadan,
Ibadan, Oyo State, Nigeria

³ Department of Environmental Sciences and Toxicology Federal University Dutse,
Jigawa State, Nigeria

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Abstract. Use of biomass energy is on the increase in rural areas of Nigeria, and its use poses serious environmental challenges. The study assessed the awareness of the environmental implications associated with the unsustainable use of biomass energy sources among rural households in Jigawa State, Nigeria. Multistage sampling procedure was used to select 120 respondents for the study using structured questionnaire. Collected data were analysed using descriptive (frequency counts, percentage, mean, and rank) and inferential statistics (chi-squared test). The result revealed that the majority of the respondents were male (94.2%), married (90.8%), and between 31 to 40 years, with a mean age of 39.8 years. Results further revealed that the majority of the respondents were farmers (56.7%), had Qur'anic education (71.7%), and earned a monthly income of ₦10,000–₦20,999 (52.5%), with a mean monthly income of ₦13,816.67. Use of fuel wood (100%) and charcoal (100%) were the dominant biomass energy sources used. Results at the level of awareness revealed that the majority of the respondents (80.8%) had low awareness of the environmental implications associated with the unsustainable use of biomass energy sources. The respondents' main source of information on the environmental implications associated with the unsustainable use of biomass energy sources were radio (64.17%) and extension agents (54.2%). The high cost of other alternatives, scarcity of refilling stations, scarcity of the alternatives, and lack of funds to purchase other alternatives are some of the major constraint bedevilling the use of non-solid energy sources. Level of education ($\chi^2 = 6.584$; $p < 0.1$) and

average monthly income ($\chi^2 = 8.277$; $p < 0.1$) were significantly related to awareness of the environmental implication of the unsustainable use of biomass energy. It is therefore recommended that people should be enlightened on the environmental implications associated with the unsustainable use of biomass energy sources. Furthermore, policies favouring a switch of energy source should be considered.

Keywords: awareness, rural households, environmental implications, biomass energy, clean energy, Jigawa State

1. Introduction

Energy is essential for our very existence, with its use in diverse ways, such as cooking, heating, lighting, electrical appliances, and building insulations. Nigeria is blessed with rich and diverse renewable and non-renewable energy resources such as crude oil, natural gas, coal, solar energy, wind energy, biomass, biogas, etc. [1]. However, despite the abundance of various energy sources in the country, the issue of electricity and scarcity of alternate energy sources for households' utilization still looms, with millions of her inhabitants still lacking access to clean and affordable energy source. This development has forced many into seeking alternative energy sources. Bamiro and Ogunjobi (2015) [2] noted that household energy consumption accounts for 15–25% of the total primary energy use in developing countries. Gujba et al. (2015) [3] opined that the household cooking sector consumes the most energy in Nigeria, it accounts for about 80% of the total energy and 90% is from biomass energy alone. The use of biomass energy for cooking has led to environmental pollution and has increased greenhouse gases in the atmosphere due to the emission of CO₂ [4].

Biomass energy use involves the use of fuel wood, plant residue, animal dung, coal, etc. It is the major cooking energy source amongst rural household dwellers in Nigeria [2]. Biomass energy consumption constitutes about 90% of the rural household energy consumption in Nigeria [3]. Biomass is a renewable energy resource, but its unsustainable harvest and use (particularly trees) have grave consequences for the environment, trees are constantly felled without replacement, thereby contributing to the reduction of the carbon sink available to absorb the atmospheric carbon, which is a major component of greenhouse gasses [5]. It also leads to desertification, reduction in soil nutrient and soil microorganisms due to constant cultivation of the soil and the endangerment of some wildlife species whose place of natural habitat is destroyed [6, 7]. Bamiro and Ogunjobi (2015) [2] noted that the production and consumption of energy generally have environmental implications. Elijah (2012) [8] reported that the major cooking energy source in Nigeria is predominantly biomass with charcoal and wood biomass accounting for 31% and 50% respectively. Sambo (2009) [9] noted that Nigeria consumes more

than 50 million metric tonnes of fuel wood annually, and this leads to the constant felling of forest trees, thereby exposing the environment to harsh weather.

Use of biomass has been reported to emit toxic pollutants such as carbon monoxide, respirable particles, oxides of nitrogen and sulphur, which are dangerous to the environment and health [10]. Furthermore, desertification and forest degradation have been linked to the constant harvesting of wood for firewood or charcoal production [11]. There are various environmental implications associated with the use of biomass energy sources, but then statistical evidence shows that the usage is still on the high side and persists across the different geopolitical categorizations of Nigeria. The National Bureau of Statistics (NBS) (2012) [12] reported that in 2010 95% of the energy sources used for cooking in households in Jigawa State was fuel wood. Jigawa State Government (JSG) and Education Sector Support Programme in Nigeria (ESSPIN) (2014) also reported that both natural and human factors were responsible for forest cover depletion and thereby making the northern part of the State highly vulnerable to desert encroachment [13]. Furthermore, IEA (2007) reported that there will be a marked increase to the number of people relying on biomass energy source from 2.6 billion in 2015 to 2.7 billion by 2030 if mitigating policies are not explored [14]. Given the foregoing, it becomes necessary to ask if the rural households in Jigawa State have understanding of the environmental implications of the unsustainable use of biomass or not. Do they have access to information on the environmental implications associated with the unsustainable use of biomass? Other germane questions that readily come to mind include what the compelling drives encouraging the persistent use of this form of energy among the people in the area are. It is upon these premises that this study assessed the awareness of the environmental implications of the unsustainable use of biomass energy sources among rural households in Jigawa State, Nigeria. Specifically, the study:

- i. described selected personal characteristics of the respondents,
- ii. identified the types of biomass energy used by the respondents,
- iii. assessed the awareness of the environmental implications of the use of biomass fuel for cooking by the respondents,
- iv. identified respondents' sources of information on the environmental implications associated with the use of biomass, and
- v. investigated respondents' constraints to the use of non-solid energy source.

2. Methodology

The population for the study consisted of rural households in the northern fringes of Jigawa State, Nigeria. Jigawa State is predominantly an agrarian state with over 80% of the population involved in Agriculture [15]. The State is situated within

the Sudan savannah vegetation zone; however, there are traces of Guinea savannah in the southern part of the State. Its total forest cover is about 5% due to low-rainfall characteristics and deforestation primarily due to the use of wood for cooking, thereby making the northern part of the State highly vulnerable to desert encroachment (Jigawa State Government, 2017) [15]. A multi-stage sampling procedure was adopted for this study. The first stage involved the purposive selection of all the nine identified Local Government Areas in the northern fringes of the State. The northern fringes represent the area of intense deforestation both by natural and human activity. The next stage was the use of simple random sampling to select three (3) Local Government Area (Biriniwa, Sule Tankarkar and Babura) out of the nine Local Government Areas identified. Subsequently, two communities from each Local Government Area (Birniwa: Kukawa and Yusufari. Sule-Tankarkar: Jeke and Sule Tankarkar. Babura: Kanya Babba and Dorawa) were randomly selected to give a total of six (6) communities. The third stage involved the use of snowball sampling to generate a list of all households that use biomass energy sources. From the list generated, a total of 120 households were randomly selected proportionately and used for the study. Due to the role played by the heads of the households in decision-making at home, the heads of the households were purposively selected for the study. Structured questionnaire was used to obtain data on the respondents' socioeconomic characteristics, the type of biomass energy used, awareness of the environmental implications of the use of biomass fuel for cooking, sources of information on the environmental implication of the use of biomass, and constraints to the use of non-solid energy source. The obtained data were analysed using descriptive (frequency count, percentages, means, and ranks) and inferential statistics (chi-square).

3. Results and discussions

3.1. Respondents' personal characteristics

The results in *Table 1* show that the majority of the respondents are male (94.2%) and between 31 and 40 years (50%), with a mean age of 39.8 years. This implies that the majority of the respondents are males, in their middle and active age. This suggests that we have more male-headed households in Jigawa State, Nigeria, than female-headed households.

The results in *Table 1* further reveal that the majority of the respondents' have only Qur'anic education (71.7%), are married (90.8%), and have a household size between 6 and 10 persons (53.3%). This result supports the assertion of Antoninis (2014) [16] that the education pattern in Northern Nigeria is traditionally dominated by religious education, with Islam being the major religion, and that, instead of

improving the people's life, this has caused a decline in circular education in the area and resulted in so many of them being illiterate.

The results on occupation and average monthly income showed that a little above half of the respondents had farming as their occupation (56.7%) and more than half (52.5%) earned between ₦10,000 and ₦20,999 on a monthly basis with a mean income of ₦13,816.67. This implies that the respondents are small-scale farmers and may not have the wherewithal to adopt the use of cleaner energy sources.

Table 1. Selected personal characteristics of respondents

Variables	Frequency	Percentage	Mean
Age			
≤ 20	2	1.60	39.8
21–30	15	12.5	
31–40	60	50.0	
41–50	31	25.8	
51 and above	12	10	
Sex			
Female	7	5.8	
Male	113	94.2	
Religion			
Muslim	120	100	
Level of education			
Qur'anic	86	71.7	
Primary	19	15.8	
Secondary	13	10.8	
Tertiary	2	1.7	
Marital status			
Single	1	0.8	
Married	109	90.8	
Divorce	6	5.0	
Widow	4	3.3	
Household size			
1–5	26	21.7	9
6–10	64	53.3	
11–15	20	16.7	
16–20	10	8.3	
Occupation			
Civil servant	18	15.0	
Teaching	13	10.8	
Farming	68	56.7	
Trading	14	11.7	
Artisan	7	5.8	

Average monthly income (₦)			
≤ 9,999	41	34.2	13,816.67
10,000–20,999	63	52.5	
21,000–30,999	5	4.2	
31,000– 0,999	8	6.7	
41,000–50,999	3	2.5	

Source: Survey results, 2017

3.2. Types of biomass energy source used by respondents

Results in Table 2 show the types of biomass energy sources used by the respondents. The results indicate that all the respondents use firewood (100%) and charcoal (100%), with little above half of them using plant residue (53.3%). The result of this study is in consonance with the positions of Kayode et al. (2015) and Bamiro and Ogunjobi (2015) [17, 2], who separately found high usage of fuel wood, charcoal, and plant residue as energy source amongst rural households in Nigeria. These could be attributed to the high cost of cleaner energy sources like LPG, the family income, preferences, and habits [18, 2]. Adeyemi and Ibe (2014) [19] also found that there was a high use of firewood compared to other energy sources amongst households in Jigawa State, Nigeria. This trend, according to Zaku et al. (2013) [20], will still continue and may worsen if nothing is done to revive the economic situation in the country and as long as the energy crisis still looms in the country. Hence, there is need to revitalize the Nigerian energy sector and make it easily assessable for use by rural households in Nigeria.

Table 2. Type of biomass energy source used by respondents

Biomass energy source	Frequency	Percentage
Fuel wood	120	100
Charcoal	120	100
Animal dung	17	14.2
Saw dust	10	8.3
Coal	0	0.0
Plant residue	64	53.3

*Multiple responses

Source: survey results, 2017

3.3. Respondents' awareness of the environmental implications of the unsustainable use of biomass fuel for cooking

Results in *Table 3* revealed that the majority of the respondents (93.3%) are aware that the unsustainable use of biomass exposes the soil to erosion and that desertification is enhanced by the unsustainable harvest of trees for cooking (76.7%). The respondents further indicated that they were not aware that rainfall and temperature variability were environmental phenomena that are also influenced by the unsustainable use of biomass (95.8%), that environmental air is affected negatively by the unsustainable use of biomass (92.5%), and that soil microbes that enhance soil formation are destroyed by unsustainable use of biomass (93.3%). The finding implies that the majority of the respondents are not aware of the environmental implications associated with the unsustainable use of biomass fuel for cooking. These findings could be attributed to the low level of educational attainment amongst the respondents. The results of the categorization of the levels of awareness in *Table 4* show that 80.8% of the respondents have low awareness of the environmental implications associated with the unsustainable use of biomass fuel, while 19.2% of the respondents have high awareness of the environmental implications. This implies that the majority of the respondents are not fully aware of the environmental implications of unsustainable use of biomass fuel for cooking and thus suggest that a lot needs to be done to change people's perspectives. In a related study (Food versus Biomass Fuel: Socioeconomic and Environmental Impacts in the United States, Brazil, India, and Kenya), Pimentel et al. (1988) [21] argued that the removal of biomass from land for energy production increases the effects of wind and water degradation, flooding, and nutrient loss through topsoil erosion, it also affects wildlife communities by disrupting their natural ecosystems, and threatens the health of some human populations. WHO (2017) [22] opined that there are high emissions of carbon monoxides, hydrocarbon, and particulate matters from the combustion of fuel wood, roots, agricultural residue, and animal dung. These emissions are culpable for global warming. Some of the attendant effects of global warming are all over the literature, and these include flood, heat waves, unpredictable rainfall and temperature patterns, drought, desertification, and crop failure, to mention but a few. With a low awareness of the environmental implications of the unsustainable use of biomass and the increasing use of biomass energy in an unsustainable manner in Nigeria and other countries like South Africa [23] and the world at large [24], it can be inferred that danger looms on the face of the earth and thus calls for concerted efforts from all stakeholders and policy makers in figuring out ways to change the trend and correct the anomaly.

Table 3. Awareness of the environmental implications of unsustainable use of biomass fuel for cooking

Variables	Aware	Not aware
Unsustainable use of biomass exposes the soil to erosion.	112 (93.3)	8 (6.7)
Desertification is enhanced by unsustainable harvest of trees for cooking.	92 (76.7)	28 (23.3)
Soil nutrients are depleted faster when biomass are harvested on an unsustainable basis.	42 (35.0)	78 (65.0)
Environmental air is affected negatively by unsustainable use of biomass.	9 (7.5)	111 (92.5)
Rainfall and temperature variability are environmental phenomena that are also influenced by unsustainable use of biomass.	5 (4.2)	115 (95.8)
Soil microbes that enhance soil formation are destroyed by unsustainable use of biomass.	8 (6.7)	112 (93.3)
Forest wildlife becomes endangered when biomass is harvested on an unsustainable basis.	39 (32.5)	81 (67.5)
Biodiversity is lost.	21 (17.5)	99 (82.5)

Source: survey results, 2017

Table 4. The categorization of respondents' awareness of the environmental implications of the unsustainable use of biomass fuel for cooking

Awareness of environmental implications	Scores	Frequency	Percentage	Mean
High	12–13	23	19.2	10.75 ± 0.92
Low	9–11	97	80.8	

Source: survey results, 2017

3.4. Sources of information on environmental implication on the use of biomass energy

The results in *Table 5* indicate respondents' source(s) of information on environmental implications of the use of biomass energy sources. The results revealed that the majority of the respondents (64.17% and 54.2%) received the information on the environmental implication of the use of biomass energy from the radio and extension agents respectively. However, the majority of the respondents indicated that they did not get information on the environmental implications of the use of biomass from religious houses (100%), non-governmental organizations

(NGO) (99.2%), newspapers (98.33%), cooperative societies (94.2%), and television channels (86.67%). This implies that religious houses, NGOs, newspapers, and cooperative societies do not educate the people on the environmental implications associated with the use of biomass energy source but are only concerned with the mandates of which they are formed.

Table 5. Respondents' sources of information

Information Sources	Yes	No
Radio	77 (64.17)	43 (35.83)
Television	16 (13.33)	104 (86.67)
Newspapers	2 (1.67)	118 (98.33)
Extension agents	65 (54.2)	55 (45.8)
Cooperative society	7 (5.8)	113 (94.2)
Non-Governmental Organizations (NGO)	1 (0.8)	119 (99.2)
Religious bodies	0 (0.0)	120 (100.0)
Friends/neighbours	30 (25.0)	90 (75.0)

*Multiple responses

Source: survey results, 2017

3.5 Constraints of using non-solid energy sources for cooking

Table 6 shows the factors that restrain respondents from the use of non-solid energy sources. The results revealed that the high cost of other alternatives (91.7%), the scarcity of refilling stations (85.0%), the scarcity of the alternatives (80.0%), and lack of funds to purchase other alternatives (60.0%) are some of the major constraints around the use of non-solid energy sources amongst respondents. These results are in agreement with the findings of Hammeed et al. (2015) [18], who separately found lack of funds to purchase alternatives, scarcity of plants/refilling stations, and high cost of alternatives as the major constraints hindering rural households from choosing alternative and cleaner energy sources. These findings indicate that poverty is still prevalent in the area and corroborates the findings of Agbaeze and Onwuka (2015) [25], who noted that the majority of rural households are poor and live below the poverty line in Nigeria.

Table 6. Constraints of using non-solid energy source amongst respondents

Variables	Severe	Mild	Not a constraint	Remarks
High cost of other options	110 (91.7)	10 (8.3)	0 (0.0)	Severe
Lack of funds to purchase other options	72 (60.0)	38 (31.7)	10 (8.3)	Severe
Scarcity of the alternative	96 (80.0)	20 (16.7)	4 (3.3)	Severe
High risk involved in the usage of other materials	9 (7.5)	40 (33.3)	71 (59.2)	Not a constraint
Scarcity of refilling stations	102 (85.0)	17 (14.2)	1 (0.8)	Severe
Distance to refilling/selling points	57 (47.5)	30 (25.0)	33 (27.5)	Severe
Lack of technical know-how on the use of other materials	0 (0.0)	6 (5.0)	114 (95.0)	Not a constraint
Lack of preference for alternatives	0 (0.0)	2 (1.7)	118 (98.3)	Not a constraint

Source: survey results, 2017

3.6. Test of the relationship between respondents' socioeconomic characteristics and level of awareness of the environmental implications of the unsustainable use of biomass fuel

The results in *Table 7* show the summary of the chi-squared analysis of the relationship between selected socioeconomic characteristics of respondents and awareness of the environmental implications of the unsustainable use of biomass energy sources. The results revealed that level of education ($\chi^2 = 6.584$; $p = 0.086$) and average monthly income ($\chi^2 = 8.277$; $p = 0.082$) were significant to respondents' awareness of the environmental implications of the unsustainable use of biomass energy sources. However, their age ($\chi^2 = 5.549$; $p = 0.235$), marital status ($\chi^2 = 3.681$; $p = 0.298$), household size ($\chi^2 = 1.783$; $p = 0.619$), and occupation ($\chi^2 = 3.633$; $p = 0.458$) were not significant to respondents' awareness of the environmental implications on the unsustainable use of biomass energy sources. This implies that respondents' awareness of the environmental implications on the unsustainable use of biomass is a function of their level of education and income. This gives credence to the findings of Zaku et al. (2013) [20], who established that the use of biomass energy sources was more predominant with the poor and the less educated people; it also justifies the position of Uhunamure et al. (2017) [23], who noted that when there is an increase in income, people move away from the use of biomass energy to more cleaner energy sources such as LPG and electricity. This movement of people with higher education and income is deemed by and large to be associated with their

awareness of the environmental and health implications associated with the use of biomass energy. This assertion corroborates the statement of Hammed et al. (2016) [18], who posited that rural households with high income and a high level of education tend to opt rather for environmentally friendly cooking energy sources, such as LPG, than biomass energy sources. The findings here suggest that certain socioeconomic attributes are key in deciding the energy switch behaviour of rural people, but this in itself is not a sufficient condition as issues bordering around access, availability, preferences, etc. are also germane to this study. It is therefore important for policy-supporting decisions to consider an approach that is holistic.

Table 7. Chi-squared analysis showing the relationship between respondents' socio-economic characteristics and their level of awareness of the environmental implications on the unsustainable use of biomass fuel for cooking

Variables	χ^2 -value	Df	p-value
Age	5.549	4	0.235
Level of education	6.584*	3	0.086
Marital status	3.681	3	0.298
Household size	1.783	3	0.619
Occupation	3.633	4	0.458
Average monthly income	8.277*	4	0.082

χ^2 = chi-squared coefficient, df = degree of freedom, p-value = probability level of significance, * = significant at $p \leq 0.1$

4. Conclusion and recommendations

The findings revealed that the majority of the respondents are male, farmers, and married. Fuel wood, charcoal, and animal dung are the major biomass energy sources used by the respondents. The results further showed that the majority of the respondents are not aware of the environmental implications associated with the use of biomass energy sources for cooking. However, they are restrained from using cleaner alternative energy sources due to lack of funds, high costs of alternative energy sources, scarcity of cleaner alternative energy sources in their area, and the scarcity of refilling stations. The results of the test of the relationship between respondents selected based on socioeconomic characteristics and their level of awareness of the environmental implications on the use of biomass energy revealed that only the level of education and income were significantly related to their level of awareness of the environmental implications of the use of biomass energy. From the findings of this study, it is therefore recommended that people should be enlightened on the environmental implications associated with the use of biomass energy sources; NGOs, religious institutions, etc. should as a matter of urgency start

widespread campaigns to educate people on the environmental implications of using biomass energy sources in an unsustainable manner. Rural households should be encouraged to take to livelihood diversification through expositions and trainings to increase their income base, and the government should make efforts to bring development to the grassroots and have private partners engaged in the establishment of skid plants.

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