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DETERMINANTS OF RURAL WOMEN'S WILLINGNESS TO USE BIO-CHARCOAL BRIQUETTE: LESSONS FROM KWARA STATE, NIGERIA

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ABSTRACT

The gradual degradation of forest, due to the increasing demand for wood fuels in rural and some urban areas of Nigeria, has posed the need for a transition to renewable energy sources from use of wood fuel to the use of biomass residue in form of briquettes. This study sought to investigate the determinants of rural women's willingness to use bio-charcoal briquette in Kwara State, Nigeria. A three-stage sampling procedure was used in selecting one hundred and sixty rural women for the study. Data were obtained using structured questionnaire and was analyzed by frequencies, percentages, means, standard deviation, and multiple regression. The result revealed that most (86.9%) of the rural women are married with an average age of 48.7 years and majority (43.1%) holds primary school certificates. A very significant proportion (91.9%) of the respondents indicated a willingness to use bio-briquette technology. Lack of awareness of briquette's technology ($\bar{x}$=2.41) and limited access to bio-briquettes due to poorly developed supply chains ($\bar{x}$ =2.30) were identified as the major constraints to the use of briquettes. Result also revealed that marital status (B=0.479) and educational attainment (B=0.091) were significant predictor of willingness to use briquettes at $p<0.05$ level of significance. The study concluded that more awareness in form of educational programmes should be deployed to rural areas to sensitize the populace on the need for renewable energy usage.

KEYWORDS

Agro-residue, biomass, briquette, cooking fuel, green energy

Introduction

The resultant effect of hike in cost of cooking gas and kerosene and the increasing demand for energy due to population growth has forced many households in Nigeria to use wood fuel which comprises charcoal and firewood for cooking. According to a World Health Organization's (WHO) report, about 52% of the world population relies on wood fuel as source of energy for heating and cooking (WHO, 2024).

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Wood fuel typically produce smoke which can cause diseases, contribute to climate change and generate greenhouse gases which are detrimental to human lives and public health (Niu et al., 2023). Amounting to 3-4 million premature deaths annually with a wide range of illnesses in developing countries (WHO, 2024).

The need to develop green sources that can minimize toxic emissions is crucial. One of such green sources is briquettes produced from biomass of forestry and agricultural residues. The development of this renewable energy source has the potential of decreasing the dependence on increasingly scarce energy sources and contribute to the protection of the environment (Zhao et al., 2022; Ibrahim et al., 2020).

Fuel briquettes made from forest and agricultural residues such as saw dust, paddy straw, rice husk, soya husk, coffee husk, weeds, sugarcane bagasse, groundnut shell, leaves etc are unique technology for green energy source (Ferronato et al., 2022; Ali et al., 2024). Effective use of these agro-forest residues can help energy conservation efforts.

Most rural communities in Nigeria are agrarian in nature with abundant amount of agricultural solid wastes. These offers tremendous opportunity for the production and use of biomass briquettes, offering a reliable and sustainable substitute for non-renewable energy resources. In most developing countries, households are making briquette fuel, saving time, energy, and environment and generating income since the global demand for energy is expected to increase due to the increasing world's population (Adeeyo et al., 2022; Yinusa et al., 2024).

Biomass briquetting is gradually gaining popularity in Nigeria as a means of sustainable, eco-friendly and cost-effective energy production. Aside the benefit of generating energy for the households, briquetting is also considered as a viable value-addition method for agricultural wastes that are abundantly produced in rural areas (Ibitoye et al., 2021; Suryani et al., 2022).

The daily quest for firewood which serves as a major source of cooking fuel in many rural households in Nigeria is becoming a difficult task. The use of firewood is not sustainable as its sources are becoming scarce. The limited supply of firewood has driven up the prices making it difficult for people to access wood fuel. While serving as a better alternative, the adoption of biomass briquettes' energy would help achieve clean and efficient household energy, and sustainable environments (Adeeyo et al., 2022).

Women form the cardinal group of people that rely on energy for cooking. As mothers, family caretakers and sometimes income earners, they serve as a critical link in achieving sustainable energy generation for households. In spite of the benefits of bio-briquettes, most households in Nigeria still rely heavily on traditional energy sources such as firewood and charcoal for cooking. Understanding the rationale behind this will help policy makers and extension service providers to design programmes that could assist household transition from use of traditional energy sources to renewal energy sources. It is against this background that the present study seeks to ascertain the factors influencing rural women's willingness to use Bio-Charcoal Briquette in Kwara State, Nigeria.

Objectives of the Study

The main objective of this study is to investigate the determinants of rural women's willingness to use Bio-Charcoal Briquette in Kwara State, Nigeria. The specific objectives of the study were to:

1. Determine the sociodemographic profile of the respondents,
2. Access the level of willingness to use bio-briquette as alternative to wood fuel,
3. Ascertain the determinants of the respondents' willingness to use bio-briquette,
4. Identify the possible constraints to bio-briquette utilization in the study area

Methodology

The study adopted the survey design methodology and was carried out in Kwara State, Nigeria. The state occupies about 36,825 square kilometres and is referred to as the gateway between the north and the south of Nigeria due to its unique geographical position. Kwara state lies between latitudes 8° 24' and 8° 36' North and longitudes 4° 10' and 4° 36' East with a humid tropical climate which is characterized by wet and dry seasons. The rainy season begins towards the end of March and ends around October with two peak periods in June and September. Temperature in the state is uniformly high throughout the year (Adedapo, 2020). Kwara state's vegetation consists mostly wooded savanna, though there are forested regions in the south. The state falls within the middle belt region of the country and has a strong agricultural base with majority of the people being small scale farmers. The population for the study comprises all rural households in the state. A three-stage sampling procedure was used in selecting respondents for the study. In the first stage, 50% of the four ADP zones in the state were randomly selected. These zones include; Zone C and D. In the second stage, four rural communities were purposively selected from each of these zones based on the density of forest area and tree rich savanna around them. These include Ahogbada, Panpo, Alapa and Afon in Zone C; Erinle, Igbonna, Odofin-Igbana and Owu Isin in Zone D. Lastly, twenty households were systematically selected in each of the communities. In all, one hundred and sixty respondents were selected for the study. Data were collected with the aid of structured interview schedule. The data collected were presented using percentages, and analyzed with mean, standard deviation and multiple regression. The sociodemographic profiles of the respondents were determined using frequency counts and percentages. The level of willingness to use briquettes was assessed using a three-point Likert type scale of Very willing (2), Willing (1), and not willing (0). The determinant of willingness to use bio-briquette was computed using multiple regression analysis. The possible constraints to bio-briquette utilization in the study area were identified using a four-point likert type scale of Very Severe Constraint (3), severe constraint (2), mild constraints (1) and not a constraint (0). The scale measured as $X = \Sigma x / n$ Where, X = likert value, Σ = summation, n = total respondents / sample size was used to form the basis for deciding the possible constraints for briquette's utilization. Thus, the decision rule holds that $X = (3 + 2 + 1 + 0) / 3 =$

2.0 so, constraints > 2.0 were considered major while those < 2.0 were considered not important constraint. For all purposes, p-value of 0.05 was considered as the level of significance.

Result and Discussion

Sociodemographic Profile of the Respondents

The data on Table 1 shows that a good proportion (38.1%) of the respondents falls between the age bracket 40-50years with an average age of 48.7 years. These age groups are likely ingrained in the habits and preferences for traditional fuel sources and may require behavioral change to adopt new technologies like bio-briquettes. Younger individuals tend to be more open to adopting innovative solutions. For instance, studies by Damette et. al (2018) and Pokubo et. al (2024) on clean cooking fuels in Sub-Saharan Africa found that younger households are more willing to transition to cleaner energy sources due to greater exposure to education and modern cooking technologies. It can also be deduced from the Table that most (86.9%) of the women are married. Married women, particularly in rural settings, are often primary caregivers and responsible for gathering fuel for household use. In addition, the Table illustrates the educational attainment of the respondents showing that primary school certificate is the highest educational attainment of most (43.1%) of the respondents. Higher education offers possibility of assessing information sources which could contribute to awareness and understanding of benefits of innovations. More than half of the respondents (69.4%) indicated farming as their primary occupation. Farmers may have easy access to bio-waste (raw materials for bio-briquettes) but may not be informed about processing and its use as fuel source. Nearly half (49.4%) of the respondents earn between ₦30,001 and ₦50,000 per month, with an average income of about ₦48,324 only. This amount falls below the poverty line threshold of 1 USD per day, based on the current exchange rate of ₦1,560 to 1 USD (CBN, 2024). As a result, respondents are likely to adopt alternative energy sources that offer reduced costs. Furthermore, a notable proportion of the respondents (63.8%) have households of 6-10 people, with an average household size of 6 persons. Larger households may have higher fuel needs, which could encourage the uptake of bio-briquettes due to its cost efficiency. bio-briquettes, being more efficient, could provide a viable alternative for large households seeking to save on fuel costs. Guta et al (2022) asserted that larger families often have higher fuel demands, which influences their choice of cooking fuel. Lastly, the Table revealed that majority (91.9%) of the respondents are unaware of bio-briquettes, while only 8.1% are aware. This very low level of awareness is a critical constraint to the uptake of the innovation. Information is a major resource that is needed in every sphere of life endeavor especially in relation to use of agricultural technologies (Olabanji et. al., 2021a).

Table 1: Distribution of respondents according to sociodemographic profiles

Sociodemographic Variables	Frequencies (N=160)	Percentages (%)	Mean
Age (in years)			
Below 20	10	6.3	
20-30	21	13.1	
31-40	32	20.0	48.7 years
41-50	61	38.1	
51 and above	36	22.5	
Marital Status			
Married	139	86.9	
Single	16	10.0	
Divorce/separated	02	1.2	
Widow	03	1.9	
Highest Educational Qualification			
No Formal Education	28	17.5	
Primary School Certificate	69	43.1	
Secondary School Certificate	58	36.3	
Post-Secondary Education	05	3.1	
Occupation			
Trading	28	17.5	
Civil Servant	04	2.5	
Artisanship	17	10.6	
Farming	111	69.4	
Household monthly income (₦)			
≤ 30,000	38	23.8	
30,001 – 50,000	79	49.4	
50,001 – 70,000	34	21.3	₦48, 324
70,001 – 90,000	05	3.1	
>90,001	04	2.5	
Household Size (persons)			
Less than 5	39	24.4	
6-10	102	63.8	6 Persons
11-15	11	6.8	
Above 16	08	5.0	
Awareness of Bio-Briquette			
Yes	13	8.1	
No	147	91.9	

Source: Field Survey, 2024

Level of Willingness to use Bio-Briquettes

Table 2 shows that about 30.6% of respondents are very willing to use bio-charcoal briquettes. This population are likely to be early adopters who recognize the benefits of the innovation. A significant proportion (61.3%) of the respondents indicated a second level of willingness to use bio-briquettes. However, about 8.1% indicated 'not willing' to use the technology. This group may be resistant due to their unfamiliarity with the innovation, cultural attachment to traditional fuels, or skepticism about the efficacy of bio-briquettes. A study by Piao and Managi (2023) shows that cost savings is one of the key motivators behind households' willingness to switch to alternative energy source.

Table 2: Distribution of respondents based on willingness to use bio-briquettes

Willingness Level	Frequencies (N = 160)	Percentages (%)
Very willing	49	30.6
Willing	98	61.3
Not willing	13	8.1

Source: Field Survey, 2024

Determinants of the Respondents' Willingness to use Bio-Briquette

Results in Table 3 indicate that among the eight variables entered into the model, two were found to be statistically significant predictors at 5% level of significance. These include marital status (B=0.479) and educational attainment (B=0.091). marital status being significant suggests that married individuals are more willing to adopt bio-briquettes. According to Thomas et al. (2017), married individuals may prioritize the well-being of their households and therefore may be more inclined to embrace affordable and eco-friendly energy solutions. The significance of education indicates that the higher the educational attainment of individuals the greater the environmental awareness and tendency to use sustainable eco-friendly technologies. The model explains approximately 61.9% of the variance in the willingness to use bio-charcoal briquettes, indicating a good fit. The adjusted R^2 value of 0.531 further supports the model's robustness. The significant F-value suggests that the overall model is statistically significant. The high R^2 value signifies a strong explanatory power of the socio-demographic factors in predicting the respondents' level of willingness to use the briquettes' technology.

Table 3: Determinants of willingness to use bio-briquettes

Variables	Coefficient (B)	SE	t-value
Age	-0.079	0.207	-0.380
Marital Status	0.479	0.075	6.269*
Educational Attainment	0.091	0.202	0.450*
Occupation	-0.107	0.262	-0.407
Household Monthly Income	-0.030	0.170	-0.176
Household Size	0.265	0.266	0.996
Awareness of Briquettes	0.103	0.160	0.645
Constraints to use of briquettes	-0.234	0.170	1.383

R^2= 0.619, Adjusted R^2 = 0.531, F = 8.237, p<0.05

Source: Data Computation, 2024

Possible Constraints to Bio-Briquette Utilization

Table 4 reveals that lack of awareness of briquette's technology ($\bar{x}$=2.41), poor awareness of the benefits of bio-briquette charcoal in terms of efficiency, health, and environmental impact ($\bar{x}$=2.40) and limited access to bio-briquettes due to poorly developed supply chains ($\bar{x}$ =2.30) were identified as the major constraints to the use of bio-charcoal briquettes. This is consistent with studies such as Olabanji et al. (2021b) and Rizzo et al (2024) that emphasized the role of awareness in the adoption of technologies, highlighting that awareness is often the first barrier to overcome in the diffusion of sustainable innovations. The Table further revealed that lack of necessary skills or training to use bio-briquettes effectively ($\bar{x}$=2.23) is another possible constraint that could limit the use of briquette's technology as a source of cooking fuel.

Table 4: Distribution of the respondents based on constraint to use briquettes

Availability of briquettes	VS	S	M	NC	WMS	Std. Dev
Lack of infrastructure to facilitate the processing and generation of briquettes.	56 (35.0)	44 (27.5)	35 (21.9)	25 (15.6)	1.82	1.08
Lack of awareness of the innovation.	109 (68.1)	20 (12.5)	18 (11.3)	13 (8.1)	2.41	0.979
Poor access to some required material.	30 (18.8)	18 (11.3)	32 (20.0)	80 (50.0)	0.99	1.171
The cost of sourcing some of the required material	35 (21.9)	20 (12.5)	45 (28.1)	60 (37.5)	1.19	1.161
Limited access to bio-briquettes due to poorly developed supply chains	96 (60.0)	30 (18.8)	20 (12.5)	14 (8.8)	2.30	0.996
Difficulty to obtain bio-briquettes regularly due to high transportation costs.	68 (42.5)	41 (25.6)	30 (18.8)	21 (13.1)	1.98	1.069
Resistance to switching to bio-briquettes due to accustomed nature to using firewood or traditional charcoal.	13 (8.1)	11 (6.9)	37 (23.1)	99 (61.9)	0.61	0.932
Poor awareness of the benefits of bio-briquette charcoal in terms of efficiency, health, and environmental impact.	107 (66.9)	23 (14.4)	18 (11.3)	12 (7.5)	2.40	0.960
Lack of necessary skills or training to use bio-briquettes effectively	73 (45.6)	61 (38.1)	16 (10.0)	10 (6.3)	2.23	0.870
Unsupportive cultural views	11 (6.9)	10 (6.3)	34 (21.3)	96 (65.6)	0.54	0.889

Source: Field Survey, 2024

Conclusion and Recommendations

The findings of the study indicated that majority of the respondents were willing to adopt bio-charcoal briquette technology, with marital status and educational attainment being significant predictors of willingness. The major barriers to the use of the technology are lack of awareness and inadequate supply of briquettes. It was concluded that while bio-briquettes offer a viable, eco-friendly alternative to traditional cooking fuels like firewood and charcoal, their widespread adoption in rural areas is dependent on awareness and educational programmes. Based on the findings, the study therefore recommends that for a sustainable supply of biomass briquettes, it is important to legislate policies prosecuting individuals and communities indiscriminately cutting down trees for wood fuel and charcoal production. More awareness on the benefits of using briquettes should be created. Government agencies and non-governmental organizations should collaborate to launch intensive awareness campaigns that educate rural women about the benefits of bio-briquettes, including their cost-efficiency, health benefits, and environmental advantages.

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