www.jard.edu.pl http://dx.doi.org/10.17306/J.JARD.2023.01658

Journal of Agribusiness and Rural Development

pISSN 1899-5241
eISSN 1899-5772

4(70) 2023, 411–419
Accepted for print: 30.10.2023

AN INVESTIGATION INTO THE SOCIO-DEMOGRAPHIC DETERMINANTS OF CHARCOAL PRODUCTION IN OYO STATE AND THE NEED FOR ITS DISCONTINUATION

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Abstract. Charcoal is used all over the world. Although its contribution to household income has made it popular in most rural areas, its production aggravates forest cover depletion and degradation. In Oyo State, Nigeria, Charcoal production has continued despite government efforts to reduce or eradicate charcoal production in the state. This study therefore attempted to assess the reasons for this and what should be done to ameliorate it. Those who engage in full-time and part-time charcoal production were investigated. Data were obtained from 350 respondents with the aid of a well-structured questionnaire using a multistage sampling technique, and 304 copies of the questionnaire were analyzed using descriptive statistics and a Logit regression model. The results revealed that the mean age of charcoal producers was 48.86 ±0.06 years and that they were predominantly (97.7%) males. A large proportion of the respondents (76%) had obtained either a West African School Certificate or a Senior Secondary Certificate, while the mean experience in charcoal production was 15.33 ±0.30 years and most (63.8%) of the individuals involved in the industry were migrants. The majority (71.7%) of them lived in mud houses and had little or no access to basic amenities such as good roads, electricity or pipe-borne water. The logit results indicate that age and owning a private plantation encourage continuous charcoal production (at the 5% significance level) on a full-time basis, thereby encouraging constant production. However, being an indigene of the state, having other income sources and educational attainment at tertiary level reduced the probability of being a full-time charcoal producer, hence reducing charcoal production. To stem continuing forest resource depletion through charcoal production, it is imperative that factors such as the provision of basic amenities, the promotion of alternative sources of income, and access to tertiary education coupled with the availability of short-term loans with a grace period for loan repayment as well as participation in tree planting by charcoal producers be prioritized by policy makers and other stakeholders in the industry.

Keywords: amenities, charcoal, full-time, livelihood, part-time, producers, socioeconomics

INTRODUCTION

The struggle to survive has forced man to develop skills to explore and utilize the available resources within and beyond his immediate environment. This has led to the development of numerous activities, one of which is charcoal production (Obadimu et al., 2018). Charcoal is used all over the world and its production contributes substantially to rural employment, providing a quick return on investments (Obadimu et al., 2018). Its prodigious contribution to household income has made it a popular means of securing a livelihood in most rural areas. Household dependence on charcoal in Sub-Saharan countries has been described by SEI (2001),

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while Kalu and Izekor (2007) have posited that charcoal will continue to be produced because it helps households meet certain socio-economic needs. Socio-economic studies reveal the dynamics of production, socio-cultural values and processes of any society at a given point in time. Their analyses are instrumental for understanding socio-economic development and its realities at any given time (Iyayi, 2006). Socio-economic characteristics have been found by Hassan (2008) to influence the way of thinking, attitudes, perceptions and behavior of people toward the adoption of agricultural innovations, while socio-economic indices have been employed in the analysis of the forestry sector by a myriad of authors (FAO, 2010; Vedeld et al, 2004).

Some of the studies conducted on charcoal production have revealed that it is practiced on a part-time basis (Ajadi et al., 2012), whereas SEI (2001) submitted that there are three main types of charcoal producers: full time, seasonal and occasional producers. Charcoal and wood biomass have previously been found to account for 31% and 50% of cooking energy in urban and rural areas in Nigeria (Elijah, 2012), while production output has been reported to vary with kiln design and size, tree species, log arrangement and experience (SEI, 2001). Charcoal production is basically a rural enterprise, and the processes involved are essentially the same wherever it takes place. The problems posed by charcoal production are numerous. It contributes to the degradation of woodland and is one of the activities contributing to the destruction of forest cover in Nigeria (Olori, 2009), a situation aggravated by illegal commercial logging (Olori, 2009), since mature, nearly mature and immature trees are used in its production. A study on the choice of energy sources in Nigeria pointed to poverty as the major factor leading to overdependence on fuel-wood by most households (Nnaji et al., 2012; Taru et al., 2011). Most studies (such as Nnaji et al., 2012; Olori, 2009) on charcoal have investigated the factors affecting its usage, but there remains insufficient empirical data regarding the choice to engage in charcoal production. This problem is further exacerbated by inadequate reliable data and empirical evidence related to interacting indices, which has increased the abuse of forest resources and compounded the barriers to socio-economic development. Knowledge of people's usage of forest resources and the interacting factors leading them to start or stop producing charcoal is extremely important in order to stem its production. Hence, this study examines the socio-economic factors underlying the discontinuation of charcoal production.

MATERIALS AND METHODS

Oyo State is located between latitudes of 7°51′N and 9°25′N and longitudes of 3°55′E and 52°50′E. The State consists of 33 Local Government Areas. It has an estimated total population of 7,840,864 as of 2016 (NBS, 2017). The State covers 28,454 km^2 and is bounded to the south by Ogun State, to the north by Kwara State, to the west partly by Ogun State and partly by the Republic of Benin, and to the East by Osun State.

The state has an equatorial climate with dry and wet seasons and relatively high humidity. The annual rainfall is between 1,000 and 3,000 mm. The dry season lasts from November to March, while the wet season starts in April and ends in October. The average daily temperature ranges between 25°C (77.0°F) and 35°C

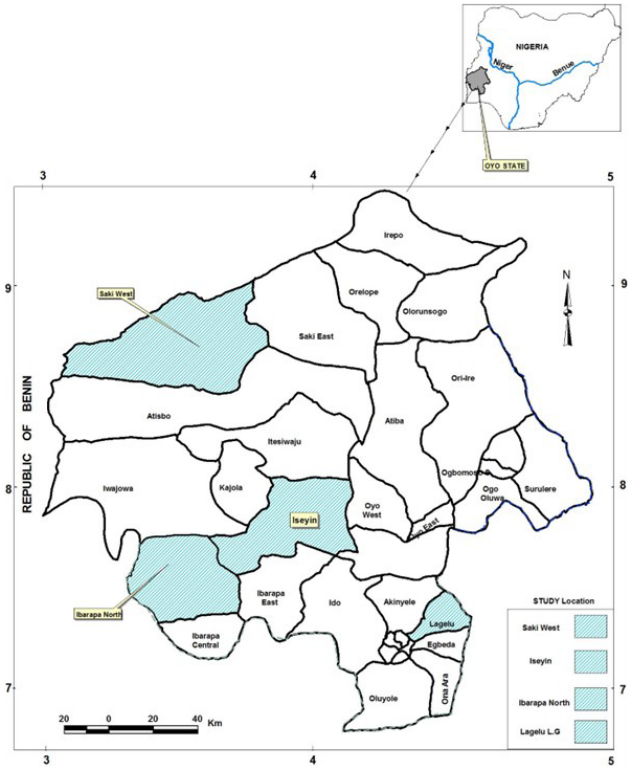

Fig. 1. Map of Oyo State showing the study area
Source: Mapping Laboratory, Department of Geography, University of Ibadan, Nigeria.

(95.0°F) almost throughout the year. The vegetation pattern is rainforest in the south and guinea savannah in the north (thick forest in the south gives way to grassland interspersed with trees in the north). The climate favours the cultivation of crops like Maize, Yam, Cassava, Millet, Rice, Plantain, Cocoa tree, Palm tree and Cashew (OYG, 2016).

Data collection and sampling technique

A well-structured questionnaire comprising open and closed questions with oral interviews was used to elicit information from the charcoal producers using a multistage sampling technique. In the first stage, the state was stratified based on its 33 Local Government Areas (LGAs), while the second stage involved the purposive selection of four LGAs notable for charcoal production: Ibarapa North, Lagelu, Iseyin and Saki West. In the third stage, a systematic sampling procedure was employed to select respondents from the sampled LGAs; after determining the number of respondents to be selected and randomly selecting the ith respondent from the first K sampling intervals, the $(I + K)^{th}$, $(I + 2K)^{th}$, and $(i + 3K)^{th}$ were taken, and so on. The systematic random sampling was determined with probability proportionate to size (PPS) based on the population distribution of the targeted respondents in the strata. Out of 350 copies of the questionnaire that were administered, a total of 304 (86.9%) were retrieved and analyzed. Descriptive statistics such as frequency, percentages, means, and standard errors of means and Logit regression were used.

Empirical model specification and estimation

A Logit model was used to investigate the socio-economic factors that might contribute to a reduction in charcoal production (Gujarati, 2004; Bland and Altman, 2000). The models tested were obtained by fitting all the independent variables together, and backward elimination was performed to obtain the best model.

The linear probability model is expressed as:

$$P_i = E(Y = 1/X_i) = \beta_1 + \beta_2 X_i \quad (1)$$

$$P_i = E(Y = 1/X_i) = \frac{1}{1 + \exp^{[-(\beta_1 + \beta_2 X_i)]}} = \frac{1}{1 + \exp^{(-Z_i)}} \quad (2)$$

where: $Z_i = \beta_1 + \beta_2 X_i$.

Equation 2 is the cumulative logistic distribution function. Z_i ranges from $-\infty$ to $+\infty$, and P_i ranges between 0 and 1.

The probability of producers engaging in charcoal production only is specified as follow $1/(1 + \exp^{(-Zi)})$ while $1 - P_i$ is the probability of producers engaging in charcoal production and other businesses. This can be expressed as $1/(1 + \exp^{(Zi)})$. Therefore, it can be said that

$$\frac{P_i}{1 - P_i} = \frac{1 + \exp^{(-Z_i)}}{1 + \exp^{(-Z_i)}} \quad (3)$$

where $P_i/(1 - P_i)$ is the odds ratio in favour of producers engaging in charcoal production only to the probability of producers engaging in charcoal production and other businesses. Taking the natural log of equation 3, we obtain:

$$L_i = \ln\left[\left(\frac{P_i}{1 - P_i}\right)\right] = Z_i = \beta_1 + \beta_2 X_i + U_i \quad (4)$$

where:

L_i – log of odds ratio (Logit)
P_i – producers who engaged in charcoal production only (full time)
$1 - P_i$ – producers who did not engage in charcoal production only (part time)
β_1 – intercept
β_2 – slope (coefficient)
X_i – X_1, X_2, X_3 ……
X_n – independent variables
u_i – error term.

The independent variables X_i – in this model can be described as follows: X_1 – age of charcoal producer (years), X_2 – sex of charcoal producer (male = 1, 0 = if otherwise), X_3 – marital status (married = 1, 0 = otherwise), X_4 – spouse's level of education, X_5 – respondent engages in tree planting, X_6 – respondent owns a plantation, X_7 – number of years outside state of origin, X_8 – respondent has other sources of income, X_9 – income per annum from other sources, X_{10} – years of experience in production, X_{11} – has access to credit, X_{12} – state of origin, X_{13} – level of education of the charcoal producer, X_{14} – household size, X_{15} – number of children in school, X_{16} – income from charcoal production.

RESULTS AND DISCUSSION

Socio-economic characteristics of charcoal producers

Table 1 reveals that a large proportion (72%) of the respondents were in the age group 40–59 years, while the mean age of 46.86 ±0.06 indicates that they were in their

Table 1. Socioeconomic characteristics of respondents

Variables	Category	Frequency (%)
Age	20–29	15 (4.9)
	30–39	47 (15.5)
	40–49	121 (39.8)
	50–59	98 (32.2)
	60–69	23 (7.6)
	Total	304 (100)
	Mean ± SE	46.86 ±0.06
Sex	Male	294 (96.7)
	Female	10 (3.3)
	Total	304 (100)
Educational status	No formal education	21 (6.9)
	Primary six school leaving certificate	28 (9.2)
	Modern school	7 (2.3)
	Junior secondary school	2 (7)
	West African school certificate	13 (45.1)
	Senior secondary certificate examination	94 (30.9)
	Tertiary education	12 (3.9)
	Others	3 (1)
	Total	304 (100)
Marital status	Married	292 (96.1)
	Single	8 (2.6)
	Divorced	3 (1)
	Widow	1 (0.3)
	Total	304 (100)
Family type	Monogamy	284 (95.4)
	Polygamy	14 (4.6)
	Total	304 (100)
Years of Experience	1–5	5 (1.6)
	6–10	49 (16.1)
	11–15	113 (37.2)
	16–20	95 (31.3)
	21–25	26 (8.6)
	26–30	15 (4.9)
	31–35	1 (0.3)
	Total	304 (100)
	Mean ± SE	15.33 ±0.30
Years of residency outside home state	0	110 (36.2)
	1–5	28 (9.2)
	6–10	115 (37.8)
	11–15	48 (15.8)
	16–20	3 (1)
	Total	304 (100)
	Mean ± SE	5.66 ±0.28
County/State of origin	Oyo (Study Area)	111 (36.5)
	Kwara	25 (8.2)
	Benue	127 (41.8)
	Niger	9 (3.0)
	Benin Republic	32 (10.5)
	Total	304 (100)

economically productive period. They were predominantly (96.7%) males, implying that charcoal production is a male-dominated business. 76% of the respondents had obtained either a West African School Certificate or a Senior Secondary School Certificate, implying that an average charcoal producer in the study area had at least a secondary education and was educated. This could be attributed to the level of importance attached to education coupled with access to free education at primary and secondary levels, which was made available by the government in the 1980s and the early 1990s in western Nigeria. Most (96.1%) of the charcoal producers were married and practiced monogamy (95.4%), with a relatively large family size of six persons. This would have increased their propensity to seek a sustainable livelihood as charcoal producers. The mean years of experience (15.33 ±0.30) indicates that the charcoal producers had acquired enough experience to persistently engage in the business. Charcoal production is encouraged by movement of labour and capital, because only 36.2% of the producers had not resided outside their state of origin. Some 37% of the respondents were indigenes of the locality, most (41.8%) were migrants from Benue State, and 8.2% and 3% were migrants from Kwara and Niger States respectively. Trans-border movement also boosted charcoal production since 10.5% of the migrants were from the Republic of Benin, a neighbouring country. These findings are similar to the findings of Yusuf (2008) on charcoal production and sustainable rural development. The data collected on building type (Fig. 2) indicated that most (71.7%) of the respondents lived in mud houses. The majority (98%) of the houses were not painted and 66.8% had a thatched roof. Most (85.9%) of the respondents rented their apartments and the common method of faecal disposal was through the use of surrounding bushes or bare ground. A large proportion of the respondents used lanterns (40.8%) and locally made lamps (43.1%). Only a few (14.1%) had access to electricity. The main sources of domestic water were streams (42.1%) and rivers (40.5%). There was inadequate access to good roads, as most (86.2%) of the respondents moved from place to place along the footpaths. The results further show that only 7.6%, 6.2% and 1.3% had a motorcycle, car or bicycle respectively (Fig. 3). The lack of access to basic amenities among charcoal producers found in this study agrees with information from the IFAD (2001) indicating that the rural population in Nigeria has limited access to

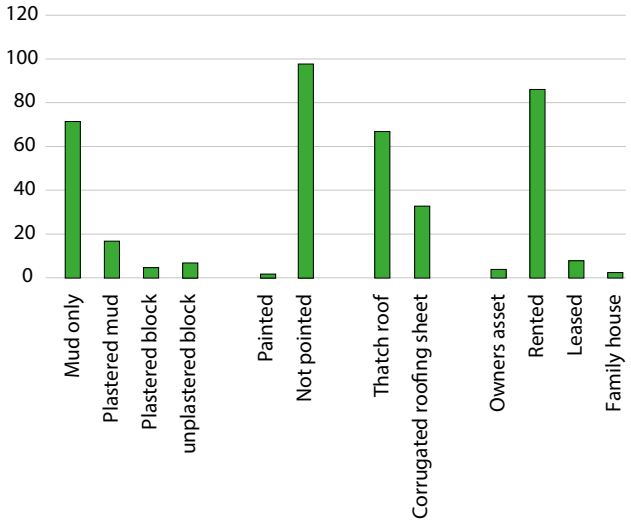

Fig. 2. Distribution of respondents according to building type
Source: field survey, 2021.

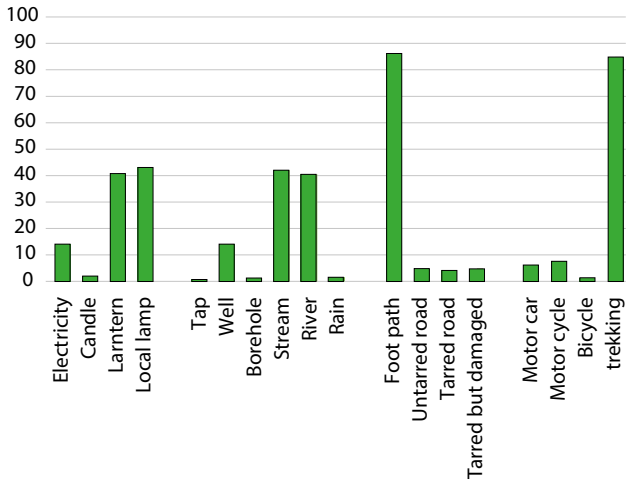

Fig. 3. Distribution of respondents based on amenities accessed
Source: field survey, 2021.

basic amenities. Furthermore, charcoal production usually takes place very close to sources of raw materials which are located very deep in the forest. The majority (69.08%) of the respondents did not have other source of income, which implies that their basic means of survival and income generation was charcoal production (Fig. 4). However, among those with other sources of income (30.92%), almost 46% were farmers, some were

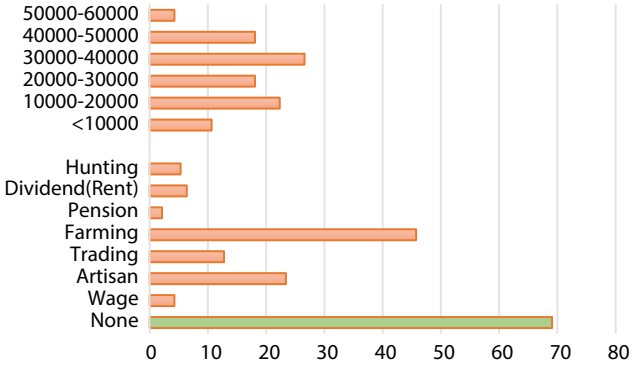

Fig. 4. Respondents' other sources of income and income levels (N)
Source: field survey, 2021.

artisans (23.4%) and traders (12.77%), some received rent/dividends (6.38%) a few were hunters (5.32%) and others received wages (4.26%) or a pension (2.13%).

The odds ratio and marginal effect results for charcoal production are presented in Tables 2 and 3 using 16 explanatory variables. Five variables were statistically significant at various levels while the likelihood ratio chi^2 (304.00) and the p-value (0.0000) indicate that the model is a good fit to the data.

Age ($p < 0.01$) and owning a plantation ($p < 0.10$) were significantly and positively related to being a full time charcoal producer, with odds ratios of 1.26704 and 13.13885 respectively. This means that as age increases, so does the likelihood of engaging in charcoal production on a full-time basis. This could result from the fact that there is tendency for the demand for livelihood sustainability to increase as one advances in age, especially with an increase in household size, due to the need to take responsibility for a large family (Table 1). Furthermore, when a private plantation is established, it can easily be converted to charcoal, perhaps as a result of factors such as the long rotation period required for trees to reach maturity (especially if the objective is to produce timber), the urgency of meeting certain immediate needs, a sense of ownership and also government requirements for plantation owners to make payments of a certain amount before the trees planted

Table 2. Odds ratio result for mode of operation in charcoal production

Variables	Odds Ratio	Standard Error	Z	P>|z|
Age	1.26704	0.0810279	15.637	0.000***
Marital status	0.3665327	0.2409168	–1.53	0.127
Educational level (Spouse)	1.159442	0.2366575	0.72	0.469
Do you engage in tree planting	0.3255594	0.30550887	–1.20	0.232
Do you own a plantation	13.13885	17.31313	1.95	0.051*
Number of years spent outside State of origin	0.9684513	0.0896565	–0.35	0.729
Do you have other sources of income	1.121026	0.2784031	0.46	0.646
Income per annum from other sources	0.9999246	0.0000278	–2.72	0.007***
Years of experience	0.9369174	0.0546987	–1.12	0.264
Do you have access to credit	0.3460683	0.3658686	–1.00	0.316
Being an indigene	0.4499802	0.1615696	–2.22	0.026**
Respondent educational level	0.3240135	0.0581046	–6.28	0.000***
Total household size	1.328094	0.3183221	1.18	0.236
Number of children in school	1.383671	0.2862638	1.57	0.116
Revenue from charcoal production	1.000032	0.0000298	1.08	0.278
Constant	0.1319561	0.3583344	–0.75	0.456

Table 3. Marginal effect of mode of operation in charcoal production

Variables	dy/dx	Standard Error	Z	P>|z|
Age	0.0588881	0.01598	3.69	0.000***
Marital status	–0.2497182	0.16339	–1.53	0.126
Educational level (Spouse)	0.0368081	0.0508	0.72	0.469
Do you engage in tree planting	–0.2732096	0.21564	–1.27	0.205
Do you own a plantation	0.4177079	0.10662	3.92	0.000***
Number of years spent outside state of origin	0.007976	0.02305	–0.35	0.729
Do you have other sources of income	0.0284274	0.06175	0.46	0.645
Income per annum from other sources	–0.0000188	0.00001	–2.72	0.007***
Years of experience	–0.0162122	0.01451	–1.12	0.264
Do you have access to credit	–0.2537702	0.23563	–1.08	0.281
Being an indigene	–0.1986842	0.08972	–2.21	0.027**
Respondent educational level	–0.2803966	0.04539	–6.18	0.000***
Total household size	0.0705973	0.05971	1.18	0.237
Number of children in school	0.0807971	0.05169	1.56	0.118
Revenue from charcoal production	8.05e–06	0.00001	1.09	0.278

***1% significance level, **5% significance level, *10% significance level.
Source: field survey, 2021.

can be harvested as timber, which are not applicable to agricultural farmers. Being an indigene ($p < 0.05$), income from other sources ($p < 0.01$) and the educational level of the producer ($p < 0.01$) significantly reduced the chance of a respondent being a full-time charcoal producer, with odds ratios of 0.4499802, 0.9999246 and 0.3240135 respectively. A unit increase in age and owning a plantation increased the probability of being a full-time charcoal producer by 0.06 units and 0.42 units respectively, whereas a unit increase in cash income from other sources per annum, higher educational attainment or less migration reduced the probability of being a full time charcoal producer by 0.2 $x10^{-4}$ units, 0.28 units and 0.20 units respectively (Table 3). A reduction in the influx of migrants with expertise in charcoal production from neighbouring states and countries would therefore likely reduce the level of forest exploitation for charcoal production. Income from other sources also reduces dependency on the forest for charcoal production and helps sustain forest cover. Higher educational attainment reduces the likelihood of an individual being a full-time charcoal producer. This could be because it increases their chance of obtaining an alternative, better, more decent and less risky job.

CONCLUSION AND RECOMMENDATIONS

In conclusion, charcoal production is an active industry that individuals engage in on a full-time or part-time basis in the study area. The people in this industry lack sufficient access to basic amenities and migrants contribute significantly to the extent of charcoal production. Charcoal producers venture into the available natural forest and engage in indiscriminate felling of myriad tree species with the sole objective of maintaining their livelihood, without consideration for its consequences. In order to prevent widespread forest reduction and excessive degradation of forest resources due to charcoal production and realize some environmental conservation objectives, policymakers in the forestry sector and other stakeholders should use factors such as the provision of

basic amenities and tree planting programs targeted at charcoal producers and the communities where charcoal production takes place. Income diversification, the provision of alternative jobs and access to tertiary education should be promoted with the aid of target funds and soft loans provision by both private financial institutions and government agencies. These will stem charcoal production activities and reduce wanton destruction of the limited forest areas.

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