NIGERIAN AGRICULTURAL JOURNAL
ISSN: 0300-368X
Volume 53 Number 1, April 2022 Pg. 23-31
Available online at: http://www.ajol.info/index.php/naj
https://www.naj.asn.org.ng

Trend in Land use, the Case of Forest Exploitation for Charcoal Production in Ido Local Government Area of Oyo State

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Abstract
Charcoal production; being one of the major drivers of forest degradation had resulted to an alarming impact on the forests and the socio-economic livelihood of the rural population. Hence, the need to investigate charcoal production and forest degradation. This research therefore focused on the trends in land use and forest exploitation for charcoal production in Ido Local Government Area, Oyo State with a view to encouraging sustainable forest management. Five villages (Akufo, Ilaju, Batake, Idiya and Alako) were randomly selected from 18 villages. Data were collected using a structured questionnaire and analyzed using descriptive statistics and Logit regression at p=0.05. Results showed that majority of the respondents were male (78.6%), between 51-60 years (39.3%), attained primary education (68.0%), married (77.7%), farmers (52.9%), had work experience between 6-10 years and indigenes (33.5%). Significant changes observed were the scarcity of wood for charcoal production (100.0%). Most exploitation for charcoal production was on a monthly and weekly basis with 37.4% and 32.5% respectively. Common plant species for charcoal were *Anogeissus Leiocarpus* (71.8%), *Erythophleum suaveoleris* (24.8%), and *Afzelia africana* (3.4%). Significant positive socio-economic impacts were high standard of living, higher patronage and higher income with odds-ratio of 13.50, 8.09, and 6.60, while negatively the impacts were pollution, scarcity of wood, low productivity, poverty, and the unconducive environment with odds-ratio of 11.60, 10.10, 4.69, 3.79, and 2.50 respectively. The interference of charcoal production in Ido Local Government has affected both forest and the environment. There is therefore need for an awareness workshop/programme for the charcoal producers in and around the study area to manage forest and forest products. Poverty alleviation programs should be organized for the rural dwellers to reduce their dependence on the forest reserve.

Keywords: Trend in Land use, Forest Exploitation, Charcoal Production

Introduction

Charcoal is the lightweight black carbon and ash residue hydrocarbon produced by removing water and other volatile constituents from animal and vegetation, especially trees. Emeodilichi (2018) gives a historical explanation of wood energy and household perspectives in the rural setting and the history behind the production of wood charcoal dates back to the ancient period, about 4000 BC, in China and West Asia. North and South America, Africans and Europeans also made use of charcoal. The timber extraction for wood fuels accounts for 61% of total wood removal from the forest (FAO, 2005). This fact highlights the importance of these fuels in the energy mix of many countries. Energy provision is a basic human need, and consumption is closely related to a country's development. In many sub-Saharan Africa and many other developing countries, there is low energy consumption among households; this has resulted to the heavy dependent on wood fuels for their energy requirements (Arnold *et al.,* 2006). The growing demand for charcoal in our country has resulted in localized deforestation in vulnerable areas.

In the last few years, economic hardship, poverty, unemployment, and an increase in the price of oil have necessitated the need for people to find alternative means of making a living in respect of domestic cooking energy in Nigeria. During the colonial periods, many people used firewood as domestic energy fuel, after the colonial era; there was a change in the *status quo*. People embarked more on using electricity, fossil fuels such as kerosene, and gas as cooking energy. At present, millions of households now use charcoal as domestic and outdoor recreational cooking energy due to epileptic power supply, scarcity and increase in the price of oil and gas (Tobias, 2007). The main energy source for cooking and heating used by most of the urban and suburban population in Africa is wood fuels (e.g., charcoal and firewood). These account for more than 80% of the primary energy supply in sub-Saharan Africa and this also forms an important source of household income. The production and utilization of these wood fuels have been growing in line with population growth, thus changing the pace of deforestation in sub-Saharan Africa (Bernes *et al*., 2002).The chain of charcoal production is linked to rural population growth and motivated by the urban consumption of charcoal. The consumption of charcoal is mainly motivated by the cultural behavior of people living in the cities using charcoal to cook their food.

It should be noted that the urban population is increasing on a daily basis and in order to meet the needs of this growing population, many have resulted to the use of charcoal. Charcoal is usually produced in rural areas and transported to urban areas for consumption. It has excellent cooking properties: it burns evenly, for a long time, and can be quickly extinguished and reheated. Even in developed countries, such as the US, charcoal is desired for the flavours it impact ongrilled food. Kalu and Izekor (2007) listed the main uses of charcoal to include; cooking, roasting, blacksmithing and bronze casting.

Charcoal is normally produced by applying a selective logging system based on preferred tree species or by a clear cut during the extension of agricultural land. It also targets a specific tree size using trees above a minimum cutting diameter of 15cm. The most common species used include; *Anogeissus Leiocarpus*, *Erythophleum suaveoleris*, *Cordyla africana*, and *Afzelia Africana* (Chavangi, 1984). Moreover, several fruit trees are used to produce charcoal in areas where the preferred trees are scarce. It is difficult for the forestry sector to generate data that capture production and consumption volumes of charcoal. The production of charcoal has far-reaching impacts on forest degradation and extends across a range of socio-economic and environmental issues of people. As African cities grow, the request for charcoal production has increased as well. The increase in the demand for charcoal always imply cutting down more trees to get wood for charcoal making, which may increase the rate of deforestation. Several studies have demonstrated the link between charcoal production and forest degradation since the early 90s and this linkage is due to the fact that deforestation frequently occurs in areas with intense charcoal production. Charcoal production can be considered as a by-product of the deforestation process. Deforestation and forest degradation are the principal causes of forest cover change and account for many global carbon emissions (Achard *et al.,* 2007). Deforestation of the forest occurs as the indiscriminate removal of timber from the forest, and this has resulted in terribly poor quality forest and the environment itself has been badly affected (Beyene, 2011)

Methodology

Study Area

The work was carried out in Ido Local Government Area (LGA), Oyo State, Nigeria. Its headquarters is in the town of Ido with an area of about 986km^2 and a population of 103,261 with the 2006 census. It lies between longitude 3° 47′34.99″E and latitude 7° 30′44.49″ N. Ido LGA was among the five in Ibadan district in 1956, It shares boundaries with Oluyole, Ibarapa, Akinyele, Ibadan Northwest, Ibadan Southwest Local government area of Oyo State and Odeda Local Government in Ogun State.

Sampling Procedure

A preliminary study was carried out for this research and in this, 18 major villages were identified in Ido, these include: Idiya, Alako, Akufo, Eleyele oko, Ilaju, Aba Emo, Onikannga, Elere, Onifunfun, Onisago, Aase, Batake, Akindele, Akinwanre, Ladunni Morakinyo, Morakinyo, and Agbun. Furthermore, purposive sampling was used to selected 5 out of the 18 villages identified, this was based on the fact that these villages were actively involved in charcoal production, and the villages were: Alako, Ilaju, Batake, Akufo, and Idiya. Meanwhile, a document indicating the population size of the selected villages for 1991 and 1996 was obtained from the National Population Commission of the State and from this the population of the selected villages were computed, i.e., Idiiya (1942), Alako (392), Batake (1793), Akufo (1877), and Ilaju (1197), using the population projection formula.

$$P_n = P_0 e^{rt} \ldots\ldots\ldots (1)$$

Where P_n = final population, P_0 = initial population, **e** = exponential, **r =** growth rate at 3.5%, and t= time that is (x- 1991) where x is the projection year.

Sampling intensity adopted by Diaw *et al*., (2002) was further used to select respondents for the study. This indicated that 10% sampling intensity be used for population below 500, 5% sampling intensity for population between 500 and 1000 and 2.5% sampling intensity for the population above 1000. In view of this, 48 questionnaires were administered in Idiya, 39 in Alako, 29 in Ilaju, 44 in Batake and 46 in Akufo, making a total of 206 respondents. In addition, the charcoal producers were interviewed using in-depth interviews to elicit comprehensive and detailed information regarding the villages for the purpose of impact of charcoal production on forest degradation in the study area.

Data Collection Methods

Both secondary and primary data were collected, and primary data collected with the aid of well-structured questionnaire, while secondary data were obtained from documents, journals, articles, etc. to provide useful information regarding the trend in land use in case of forest exploitation for charcoal production.

Data Analysis

Digital Image Processing: Optimum Index (OIF) was used to select the optimum combination of three bands (that is the one with the highest amount of information) out of all possible 3 band combinations in the satellite image using ILWIS. The bands of the landsat/imagery (1999-2019) was stacked, subject and processed into a colour composite using Arcmap Image Analysis tool. The composite for each year and a Vector shape file of the study area were clipped together using Arcmap Analysis tool (Extract- Clip) of Arcgis 10.1 to extract the area of interest (AOI). A supervised classification was then carried on the extracted AOI using Erdas Imagery to produce a land cover map (1999-2019) for the study area.

Image Pre-processing: The imagery was subjected to pre-processing operations which include; geometrical rectification and image registration, radiometric and atmospheric correction.

Change Detection Analysis: Supervised Image Classification was performed using Maximum Likelihood Classifier. Four (4) classes of Land Cover types (Table 1) were defined. Training set (A set of pixels/ samples and corresponding class labels) was collected using existing maps, higher resolution spectral images (Google Earth) and Visual interpretation as guide.

Accuracy Assessment: Validation was performed for the classified images using validation set (which was obtained from Fieldwork, existing maps, high resolution spectral images and Visual interpretation of the same image).

Results and Discussion

Table 1 shows the socio-economic characteristics of respondents in the study area. The sex distribution of respondents in the study area showed that majority were male (78.6%), while the female respondent had a lower percentage of 22.4%; indicating that more males engaged in charcoal production activities than the females (such degradation activities include; collection of timber and forest tree species etc.). This is due to the cultural element that charcoal production is a men's work but the trend and beliefs are changing so that many females have taken up charcoal production as a coping strategy. Taiwan (2009) noted that charcoal production was a man's job since he is the head of the household and has responsibility of feeding his household. The result on the age distribution revealed that respondents between the ages of 51 -60 years recorded the highest percentages (39.3%), while respondents between the ages of 30-41 years recorded the least percentage (12.6%). This showed that majority of people involved in charcoal production were still in their active age. It was further revealed that 77.7% were married, while the least number recorded those respondents that were divorced with 1.5%. This indicated that most people in the study area were married and saddled with the responsibility of catering for their families, as a result were more involved in charcoal production activities in the area. This, therefore, supported the findings of Nbasi *et al.* (2011) who stated that the married are more involved in farming and forest activities. It was further revealed that majority of the respondents were educated at the primary school level with 68.0%, while respondents with tertiary education recorded the least percentage with 2.9%. This is an indication that the educational level of the respondents were low as a result, they tend to source for easy ways to generate income to meet their family needs. Occupational status of respondents showed that most (52.6%) of charcoal producers and villagers were involved in farming activities, this was followed by those who trade and do business (18.4%), while students recorded the least percentage (11.2%). The work experience status showed that respondents with 6-10 years' experience recorded the highest percentage of 33.5%, followed by 16 years and above (31.6%), while those with 1-5 years recorded the least percentage (5.8%). This is an indication that most people in the study area have been involved in charcoal production for a long time. It was further revealed that majority of the respondents were indigenes with 70.4%, while the others were non-indigenes (29.6%). This is a clear indication that the indigenes were the ones involved in the charcoal production business and their activities on daily basis result in the degradation of the forest. This therefore supported the findings of Hosonuma (2012); Chidumayo and Gumbo (2013), who stated that farming and charcoal production activities substantially cause environmental change, particularly degradation.

Trend of Degradation in Ido Local Government

LULC (Land use and land cover) Change in Ido LGA of Ibadan from 1999 to 2019

Map A and B showed the land use and land cover classification of Ido LGA. It shows a significant change in the land cover as there was reduction in the area map of 2019 compared to that of 1999. It was also revealed in map A that there was increase in water bodies, Built-up Area and Open space. Map B however, showed that there was reduction in km^2 (land size) from $954.13km^2$ to $683.38\ km^2$.

Results in Table 3 revealed that the charcoal producers in the study area have specific wood species they are using with 90.8%, while those with no specific wood species were 9.2%. The highest percentage was recorded for Ayin (*Anogeissus Leiocarpus*) tree with 71.8%, followed by Obo (*Erythophleum suaveoleris*) with 24.8%, while the Apa (*Afzelia africana*) tree species had the least percentage of 3.4%. This implies that the producers around the study area are highly depended on the *Anogeissus Leiocarpus* (Ayin) as the best tree species used for charcoal, the more the felling of this preferred species, the more the species go into extinction. When the preferred species is no more available, the producers look for other alternative tree species for their production, thus, resulting to degradation. The aim of sustainable forest management is thereby negated through this means (Azeke *et al.,* 2001).

Results in Table 4 revealed that 31.1% of the respondents sourced their wood from forest, 28.2% sourced their charcoal from farmland, 22.8%, sourced their wood from the community, while 18% sourced their wood from private farmlands. Rate of exploitation was revealed to be 37.4% on monthly basis, 32.5% confirmed that exploitation took place weekly. About 17.0% of the respondents noted that exploitation of wood is carried out on a daily basis, while the least were those involved in yearly felling of wood for charcoal with 13.1%. This is line with the finding of Kissinger *et al*. (2012) which stated that the process of degradation is conventionally associated with the direct causes of factors such as farming, forest products consumption, and export. The results in Figure 2 confirmed that wood extraction from the forest has resulted in massive destruction of the forest by reducing ecosystem diversification, changing the structure of forest, loss of species diversity, etc. Figure 3 showed that 78.0% of the respondents confirmed that wood extraction from the forest has led to soil erosion, and 54% caused desertification of the forest. The chart also confirmed that 39% of the respondents were aware that wood extraction for charcoal production has led to decrease in tree species in the study area. Therefore, this supported the findings of Pelser and Kherehloa (2000), which stated that the process of degradation is conventionally associated with direct causes, such as decreased tree species, soil erosion, and desertification.

Positive and Negative Socio- Economic Impact

Logit regression model for positive socio economic in the study area

Equation 2 presents the logit regression model obtained for positive socio-economic impact observed in the study area.

PSEI = -74.64 +18.72 HL – 0.21 EM + 2.09 HI – 2.81 AP + 41.03 HP – 21.81 ID… (2)

N = 177, Final Loss = 84.47, Chi-Square (df, 6) = 70.10

Odds- Ratio (Unit Change): Constant (-74.64); HL (13.50); EM (0.81); HI (8.09); AP (0.06); HP (6.60); ID (0.00)

Where:

HSL- High Standard of Living
EM- Employment
HI- Higher Income
AP- Alleviation of Poverty
HP- High Patronage
HP- Higher Profit
ID- Infrastructural Development

The model presented (Table 5) showed the positive socio-economic impacts of charcoal production on rural dwellers which gave overall significant fit to the data judging from X^2 that was significant at P<0.05. High Standard of Living (HSL), Higher Income (HI), and High Patronage (HP) were significant with odds-ratio of 13.50, 8.09, and 6.60, respectively. vThe positive impact identified to be responsible for socio-economic impacts of charcoal production on rural dwellers were High Standard of Living (HSL), Higher Income (HI), and High Patronage (HP). There was sufficient evidence that the estimated coefficient for the positive impact were not zero. This implies that the regression parameters in the model were statistically significant. In other words, the higher the value of the odds-ratio, the more the likelihood, the more the positive impacts of charcoal production on rural dwellers in the study area. Hence, it indicated that variable(s) with positive impacts (factors) primarily influenced charcoal production on rural dwellers in the study area, thus this implication was corroborated by Deek (1996), Bland and Altman (2000) that the logistic model provides information on the consequences of one variable on the other.

Logit Regression Model for Negative Socio- Economic Impact

Equation 3 presents the Logit Regression Model Obtained for Negative Socio Economic Impact Observed in the Study Area.

NSEI = -5.01 +1.55 LP+33.79 SW – 0.37 LI – 0.97 LP – 1.19 HCP + 2.45 PSA + 18.43 PO + 38.08 PV – 37.16 MI -0.64 CC + 19.37 UE – 36.91 PWC ……… (3)

N = 177, Final Loss = 113.12, Chi-Square (df, 11) = 41.46

Odd Ratio (Unit Change): (-5.01); LP (4.69); SW (3.79) LI (0.69); LP (0.38); HCP (0.31); PSA (11.60); PO (10.10); PV (3.50); MI (0.00); CC (0.53); UE (2.50); PWC (0.00)

Where:

LP- Low Productivity
SW- Scarcity of Wood
LI- Low Income
LP - Low Patronage
HCP - High Cost of Production
PSA - Presence of Several other Alternatives
PO - Pollution
PV- Poverty
MI- Migration
CC- Climatic Condition
UE- Un-conducive Environment
PWC- Poor Working Condition

Logit Binary Nature of Challenges Involved in Plantation Development

The model presented in Table 6 on the negative socio-economic impacts of charcoal production on rural dwellers gave an overall significant fit to the data judging from X^2 that was significant at P<0.05. Low productivity (LP), Scarcity of wood (SW), Un-conductive Environment (UE), Poverty (PV), Pollution (PO), Presence of several other alternatives (PSA) were significant with odds-ratio of 4.69, 10.10, 2.50, 3.50, 11.60, and 3.50 respectively. The negative impact of charcoal production on rural dwellers where Low productivity (LP), Scarcity of wood (SW), Un-conducive Environment (UE), Poverty (PV), Pollution (PO), Present all other several alternative (PSV). Therefore, this implied that the negative factors with odds ratio have the highest negative influence on exploitation in the study area (Table 6). Thus, the higher the value of odds- ratio, the more negative impacts charcoal production exploitation will have on rural dwellers and the more the influence on reduction in forest covers in the study area. The implication was corroborated by Mainusch (2010) that the logistic model provides information on the consequences of one variable on the other.

Conclusion

The interference of charcoal producers had brought about changes in the forest, environment, and farmland and this had further resulted in scarcity of trees species, desertification, soil erosion, and decrease in forest product. It was revealed that the producers go a long way to look for preferred tree species for charcoal production. The results explain special and temporal dynamics of forest degradation associated with charcoal production. The findings indicated that charcoal production is a main contributor of forest product exploitation. In the charcoal producing districts, charcoal production was largely independent of agricultural expansion. Positive impact of charcoal production in the area include; high standard of living, higher income, and high patronage. This makes the producers of charcoal go extra mile to looked for preferred trees species to produce charcoal. Negatively, scarcity of wood, pollution, un-conducive environment, poverty, and low productivity were the identified impacts of charcoal production on the rural dwellers. Based on the outcome of this research, there is therefore need for an awareness workshop/programme for the charcoal producers in and around the study area to manage forest and forest products. Poverty alleviation programs should be organized for the rural dwellers to reduce their dependence on the forest reserve.

Table 1: Land Cover Classification Scheme and their General description

S/N	Classes	Description
1	Built up Area	Residential, Commercial, Industrial, Facilities and settlement
2	Vegetation	Evergreen forest and mixed forests with higher density of trees; including mangrove, sparse vegetation etc, and all types of agriculture crops.
3	Water Bodies	Areas covered by dam's water such as rivers, ponds, lagoons, dams and waterlogged areas.
4	Open Space	Open Land and Non- Vegetated land

Source: Anderson et al. (2001)

Table 1: Socio- economic characteristics of the respondents

Socio Economic Characteristics	Frequency N = 206	Percentage
Gender		
Female	44	21.4
Male	162	78.6
Age		
30-40	26	12.6
41-50	62	30.1
51-60	81	39.3
60 Above	37	18
Marital Status		
Married	160	77.7
Single	17	8.3
Divorced	3	1.5
Widowed	26	12.6
Education Status		
No Formal Education	10	4.9
Primary School Certificate	140	68
Secondary School Certificate	50	24.3
Tertiary Education	6	2.9
Occupation		
Civil Servant/Salary Earner	36	17.5
Student	23	11.2
Artisans	0	0
Trader/Business	38	18.4
Farming	109	52.9
Work Experience		
1-5	12	5.8
6-10	69	33.5
11-15	60	29.1
16 Above	65	31.6
Nativity		
Indigene	145	70.4
Non-Indigene	61	29.6

Source: Field Survey, 2021

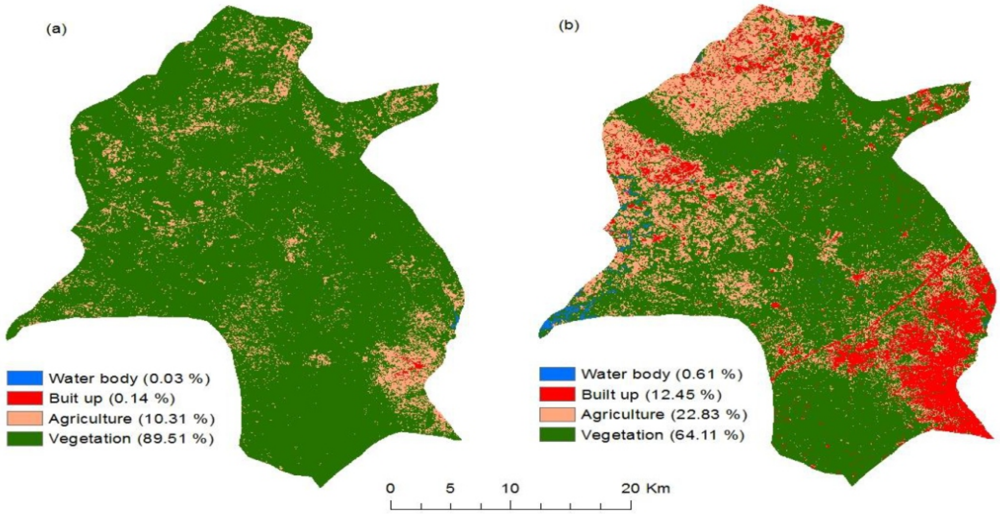

Figure 1: Spatial distribution of LULC in Ido LGA, Ibadan, Nigeria: (a) 1999 (b) 2019

Table 2: The Area of LULC Types in Ido Lga, Ibadan from 1999 to 2019

LULC Types	**1999**		**2019**		**1999-2019**		
	km^2	%	km^2	%	Changes Area (km^2)	Changes Rate (%)	Direction of change
Water body	0.36	0.03	6.49	0.61	6.13	+ 1710.55	↑
Built up	1.49	0.14	132.70	12.45	131.21	+ 8809.06	↑
Agriculture	109.94	10.31	243.35	22.83	133.41	+ 121.35	↑
Vegetation	954.13	89.51	683.38	64.11	-270.75	- 28.38	↓
	1065.92	**100**	**1065.92**	**100**			

KEY: Land use land cover (LULC) .Local government area (LGA)

Table 3: Assessments of the Plant Species for Charcoal Production

Assessment of Plant Species	**Frequency N206**	**Percentage**
Do you have a specific wood for charcoal?		
Yes	187	90.8
No	19	9.2
If yes, what type of wood		
Ayin (*Anogeissus Leiocarpus*)	148	71.8
Obo (*Erythophleum suaveoleris*)	51	24.8
Apa (*Afzelia africana*)	7	3.4
In case there is no more preferred species, what do you do?		
Change the wood	132	64.1
Change location to get the preferred wood	74	35.9
Is there any alternative species you use?		
Yes	142	68.9
No	64	31.1
In a situation where there is no alternative what do you do?		
Change the wood	132	64.1
Change location to get the preferred wood	74	35.9

Source: Field Survey, 2021

Table 4: Rate of Exploitation in the Study Area

Rate of Exploitation of Wood	Frequency N=206	Percentage
Where do you get the wood for charcoal production?		
Forest	64	31.1
Farmland	58	28.2
Private Farm Land	37	18
Within Community	47	22.8
Are these wood species always there for collection?		
Yes	106	51.5
No	100	48.5
If yes, do you get the quantity needed?		
Yes	138	67
No	68	33
If no, where else do you source for the wood?		
Forest	72	35
Farmland	81	39.3
Private Farm Land	37	18
Within Community	16	7.8

Source: Field Survey, 2021

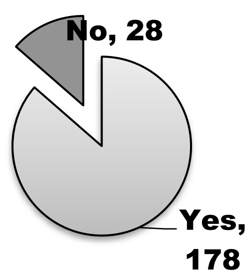

Figure 2: Decision if changes occurred during wood extraction

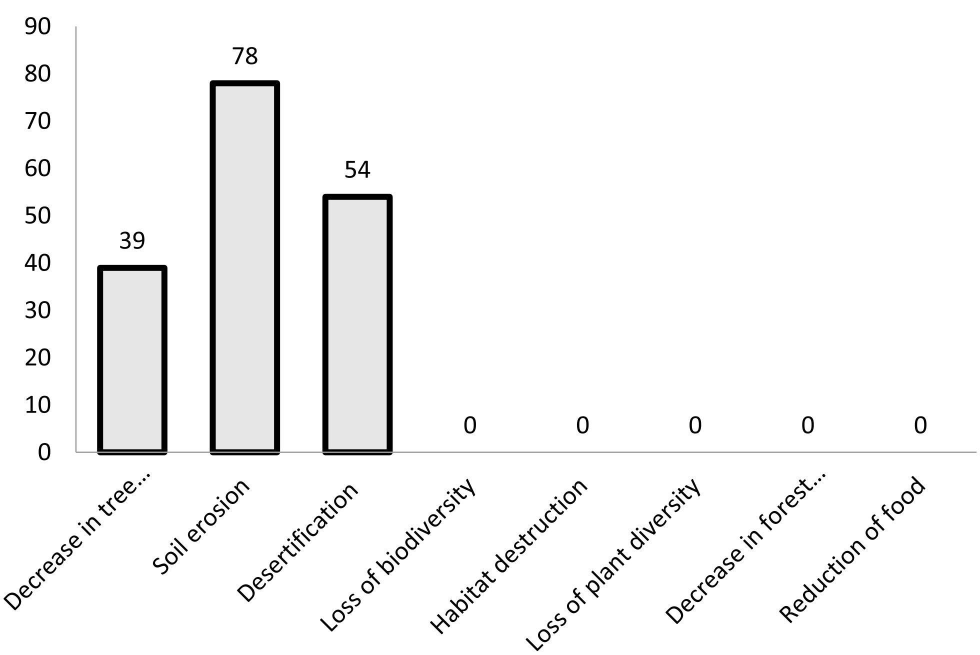

Figure 3: Perceived changes that occur during wood extraction

Table 5: Logit binary nature of challenges involved in plantation development

Dependable Variable: PSEI –Positive Socio-Economic Impact (Yes = 1; No = 2)

Independent Variable	Coefficient	Odd Ratio
High Standard of Living	18.72	13.50*
Employment	-0.21	0.81
Higher Income	2.09	8.09*
Alleviation of Poverty	-2.81	0.06
High Patronage	41.03	6.60*
Infrastructural Development	-21.81	0.00
Model X^2 (df = 6) 70.10, Final Loss = 84.47, P<0.00		

****= Significant at p< 0.05***

Table: 6: Dependable Variable: NSEI –Negative Socio-Economic Impact (Yes = 1; No = 2)

Independent Variable	Coefficient	Odd Ratio
Low Productivity	1.55	4.69*
Scarcity of wood	3.79	10.10*
Low Income	-0.37	0.69
Low Patronage	-0.97	0.38
High Cost of Production	-1.19	0.31
Presence of Several other Alternatives	2.45	3.50*
Pollution	18.43	11.60*
Poverty	38.08	3.79*
Migration	-37.16	0..00
Climatic Condition	-0.64	0.53
Un-conducive Environment	19.37	2.50*
Poor Working Condition	-36.91	0.00
Model X^2 (df = 11) 41.46, Final Loss = 113.12, P<0.00	-36.91	0.00

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