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# Contribution of Charcoal Production to Deforestation in Selected Farming Communities in Oyo State

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## ABSTRACT

Deforestation has been recognized as a key driver of climate change and has attracted increasing attention in recent decades. However, charcoal production is one major threat to the forest cover in Saki and Ibarapa North Local Government Area of Oyo State. This study therefore assessed the impact of charcoal production on forest cover in selected farming communities in Oyo state between 1984 and 2016.Simple random sampling procedure was used to select 160 respondents from a sample frame of 320 charcoal producers in Saki West and Ibarapa North Local Government Areas. Interview guide was used during the Focus Group Discussions and semi-structured questionnaire was used to elicit information on the types of trees used, their socio-economic characteristics and Land-Use and Land-Cover change (LULC) was determined using Landsat 8 imageries for three periods at 16 years intervals from 1984, 2000 and 2016. Primary data were analysed using frequency counts and percentages while remote sensing data were analysed using GIS (Arc GIS 10.1 and Idrisi). Findings revealed that 57.5% of the respondents were male, 32.5% were within the age group of 40-49 years, while 45.0% and 42.5% had primary and secondary school education, respectively. Also, 32.5% of the respondents had 16-20 years' experience in charcoal production, while 58.8% and 40.2% were native and non-native of the study areas, respectively. Most of the respondents use *Vitellaria paradoxa* (Shea tree, 76.9%), *Anogeissus leiocarpus* (Axle wood, 71.9%) and *Bridelia ferruginea* (Guinea, 61.9%) for charcoal production in the study areas. Result of the LULC for Saki West indicated a reduction of forest land area trees from 29.2% to 52.3% grassland and 18.5% bare land in 1984; 19.1% to 57.4% grassland and 23.5% bare land in 2000 and 18.0% to 57.8% grassland and 24.2% bare land in 2016. Also, the LULC for Ibarapa North revealed a reduction of forest area trees from 64.2% to 29.3% grassland and 6.5% bare land in 1984; 31.1% to 51.3% grassland and 17.6% bare land in 2000 and 29.4% to 56.6% grassland and 14.0% bare land in 2016. It is therefore concluded that forest cover in the study area is lost due to some human activities and charcoal production is a big factor.

**Keywords:** Deforestation, Farming communities, Charcoal production, Forest cover

## Introduction

Deforestation is considered as a major menace that affects economic activity and threatens the livelihood and cultural integrity of forest dependent people by reducing the supply of forest products (Annan, 2013).It causes erosion, desertification, drought and flooding. There is enormous evidence on the devastating effect of deforestation and charcoal production on the environment (Vanguard,2018).The most commonly cited impact of charcoal production is deforestation, that is, the clearance of forest or woodland. Although charcoal is one of the oldest sources of energy and a means of livelihood in both rural and urban centers in developing nations. .It is primarily produced in forested areas surrounding urban centers. It serves as a main source of energy for cooking in African urban centers where nearly 80% percent of the populations use it(Zulu and Richardson, 2013).The energy based demand of charcoal has been identified as a mechanism of forest cover change in Africa (Hosonuma*et al.*, 2012, Sitoe*et al.*, 2016). The consumption pattern of charcoal is growing faster than firewood consumption and its use is becoming a much larger part of the wood energy's total in Africa and South America (Chidumayo and Gumbo, 2013).During the production of charcoal, several problems like; deforestation, greenhouse gas emission, soil impact, and degraded ecosystem are contributed to the environment. For example, during agriculture expansion a farmer might pay charcoal producers to clear the land and to produce charcoal from the cleared wood to offset the cost of land-clearing. In this case, the charcoal production facilitated the conversion of land to non-forest land, but the cause of the deforestation was agriculture expansion. The processes involved in the production of charcoal include; felling trees and burning them in a poor oxygen environment which results in formation of incomplete combustion products like methane, also produces emission of greenhouse gas such as carbon dioxide ($CO_2$) and Methane ($CH_4$). Emission from charcoal production in tropical region was estimated at 71.2million t for carbon and 1.3million t for methane in 2009 (Chidumayo and Gumbo, 2013). As charcoal production continues, much debate has been generated as whether the economic benefits of charcoal production worth the environmental consequences that trail its production, which include deforestation, accumulation of greenhouse gases and its consequential effects on global energy balance and climate variation/change (Ogundele *et al.*,2011).Since the study area is known for charcoal production which is one of the drivers of deforestation, there is need to examine the socio-economic characteristics of the charcoal producers in the study area; assess the contribution of charcoal production to forest cover change between 1984-2016 using GIS, and determine the endangered tree species.

## Methodology

### Area of Study

Saki- West Local Government Area of Oke - Ogun in Oyo State is located in the Western part of Nigeria (Fig. 1). The vegetation within the study area can be described as typical Guinea savannah vegetation zone with favourable rainfall and adequate soils. It has an annual rainfall of about 900-1000mm in the wet days with an average of 72.7% relative humidity and temperature range of 21.8$^o$C - 31.2$^o$C in 5 selected meteorological stations (OYSADEP, 2001). Also, Ibarapa North is a rural Local Government Area located in the Northern west of Oyo State Nigeria , about 134km from Ibadan the State capital. It has an area of 1,218km2 and a population of 101,092 at the 2006 census, Ibarapa North has longitude of 7.6833$^o$ North and 3.1833$^o$ East. Majority of the inhabitants of Ibarapa North Local Government area are professionally farmers with little numbers of civil servants. Ibarapa North local government area is one of the Agricultural producing area in Oyo State; some of the products are yam, cassava, maize, vegetables like cucumber, carrot, efosoko and eweduetc.It has its headquarter in Ayete, other notable towns in the local government are Tapa and Igangan. Each of the towns has quite a number of villages. The major markets within the local government include Ajise, Obada, Alaagbaa, Atabi, Konko, Oja-Isale (Oyegbami,2019).

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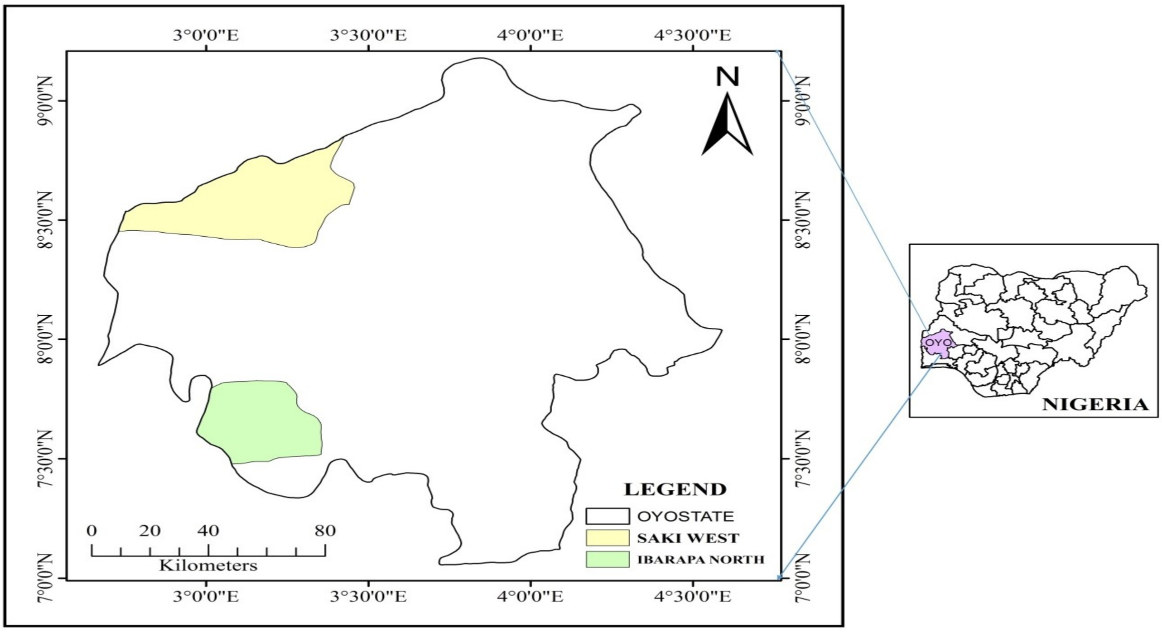


**Figure 1: Map of the Saki West and Ibarapa North Local Government Areas (Source: Ministry of Land and Survey Ibadan, Oyo State)**

**Sampling Procedure and Sample Sizes:**

The respondents were selected through a multi-stage sampling technique. At first, the study adopted purposive sampling technique in the choice of the studying area based on the concentration of charcoal production in the study area in the Oyo state. Secondly, two agricultural zones (Ibadan/Ibarapa and Saki zones) were also selected purposively based on presence of charcoal producers. One block from each of the zones was selected (Ibarapa North and Saki West). Thirdly, from each of the blocks, four cells were purposively selected making a total of eight cells. Lastly, fifty percent from the sampling frame of 320 registered charcoal producers were randomly selected to have a total number of 160 charcoal producers for the study areas.

**Data Collection:**

Primary data was collected using semi-structured questionnaire and Focus Group Discussion was held during their meeting to elicit information. The secondary data was raw remote sensing data have digital numbers which corresponds to a raw measure acquired by the sensor. To derive Forest cover changes from these images, the digital numbers were converted to reflectance values. The images in their reflectance values were combined to give false composites that were classified into three different land cover types. The land cover types were first identified on the field using coordinates received with Global Positioning System (Agbor *et al.*,2018). Extent of deforestation in the two study area was measured using Remote Sensing and Geographic Information System (GIS). A land use map of Landsat 8 imageries was acquired for three periods (16 years interval) from 1984, 2000 and 2016, and a change detection analysis was performed on the land use land cover types. The interval in years was based on the accessibility of the imageries. Arc GIS 10.1 and Idrisi Imagine software systems were used for all the analysis. The supervised image classification method was applied, using Maximum Likelihood Algorithm. This was used to determine the level of deforestation by calculating the percentage of the land use. The images were classified into bare land, grass land and forest land. The rate of change was determined using dynamic weight model. The land use/cover changes between 1984 and 2016) were determined by simple percentage (equation 1) with data derived from image classification (Liu and Zhang, 2011).

$$S = \left(\sum_{IJ}^{N} (\Delta S_{I-J}/S_I\right) \times \left(\frac{1}{T}\right) \times 100 \text{------------}1$$

where $S_I$ is the area of land type *i* in the beginning of the period, $\Delta S_{I-J}$is the total area of land cover type *I* converted into other types. *T* is the study period; and *S* is the land cover dynamic To derive LULC, the Landsat images were classified in Idrisi software using Supervised Classification Method. Maximum Likelihood algorithm was used to group pixels of similar value together into a class or land cover type. The land cover types were first identified on the field using Geographical Positioning System coordinates which were over laid on the images. The produced Land Use Land Cover images show the extent of deforestation in the study areas. To analyze the changes that have occurred over the years, the statistics of classified images were extracted in Idrisi environment. The statistics include areas in kilometers and percentages. The summary of software and their uses (Agbor *et al*, 2018Mas *et al.*, 2014 and Pijanowski *et al*.,2000). Arc GIS: for image delineation and scaling of final image output. Idrisi: for image processing and extraction of statistics tables.

## Results and Discussion

### Socio-economic characteristics of Respondents

Results on Table 1 shows that more (57.5%) males were involved in charcoal production, majority (83.8%) of the respondent's falls within the active and agile age group of 20-49 years with the mean age of 43 years. This gives an indication that they are within their productive stage and will be in the business for a long period; this will in turn enhance more deforestation in the study area. It was observed that about half (58.8%) of the respondents were native of the study area which imply that they have easy access to forest areas. It shows that respondents are familiar with the terrain of the area, which wi ll also expose the study area to deforestation. Also, majority (87.50%) of the respondents w ere secondary and primary school leavers, res pondents' years of experience falls between 16-20 years with the mean of 13years.The charcoal producers have low level of education which will make them more experienced in the enterprise, also little skill is required for producing charcoal. About half (56.3%) of the respondents are primarily into farming, while others were traders (41.9%), civil servants (5.6%) and artisans (2.5%). This shows that being an agrarian community, more forest areas will be opened for agriculture and farmers will produce charcoal during their off- farming season period.

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**Table 1: Distribution based on the socio-economic characteristics of the respondents (n=160).**

| Variables | Classes | Frequency | Percentage [%] | Mean |
|---|---|---|---|---|
| **Sex** | Male | 92 | 57.5 | |
| | Female | 68 | 42.5 | |
| **Age** | 20-29 | 23 | 14.4 | |
| | 30-39 | 34 | 21.3 | |
| | 40-49 | 52 | 32.5 | 42.9 |
| | 50-59 | 48 | 30.0 | |
| | Above 60 | 3 | 1.9 | |
| **Ancestry** | Native | 94 | 58.8 | |
| | Non-Native | 66 | 40.2 | |
| **Educational Level** | Non Formal | 13 | 8.1 | |
| | Primary | 68 | 42.5 | |
| | Secondary | 72 | 45.0 | |
| | Tertiary | 7 | 4.4 | |
| **Occupation** | Farmers | 90 | 56.3 | |
| | Traders | 67 | 41.9 | |
| | Civil Servants | 9 | 5.6 | |
| | Artisans | 4 | 2.5 | |
| **Years of Experience** | 1-5 | 25 | 15.6 | |
| | 6-10 | 40 | 25.0 | |
| | 11-15 | 26 | 16.3 | 12.8 |
| | 16-20 | 52 | 32.5 | |
| | Above 20 | 17 | 10.6 | |

**Source: Field survey, 2016**

**Endangered tree species being used for charcoal production in the study area**

In Table 2, the study shows that majority (76.9%) of the respondents use *Vitellaria paradoxa*(Shea butter), *Anogeissus leiocarpus* (71.9%) and *Bridelia ferruginea* (61.9%) This is because these trees species are mainly economic trees, with quality wood features and are therefore particularly vulnerable to overexploitation. This study affirms with Tunde*et al*, (2013) that trees such as Axle wood (*Anogeissus leiocarpus*), Burkea (*Burkea africana*), Shea butter (*Vitellaria paradoxa*), Hymenocardia (*Hymenocardia acida*) and Pericopsis (*Pericopsis laxiflora*) were good and strong wood that will give good quality of charcoal. During focus group discussion, one of the respondents gave the following statement:

*"I prefer to use Emi (Shea tree) to produce charcoal, and that most of the charcoal producers in the community prefer to use Shea tree. This is because it has good quality of wood that will produce a good quality of charcoal, which will be marketable. Also, this tree species has other features, like the fruit is edible and the seed is used for making Shea butter"(Azeez Idowu, 2016, Aba- Adenye Village, Saki West)*

**Table 2: Distribution based endangered species used for charcoal production**

| Variables (Type of tree used) Scientific name | Vernacular | Common name | Frequency | Percentage(%) |
|---|---|---|---|---|
| *Vitellariaparadoxa* | Emi | Shea tree | 123* | 76.9 |
| *Pericopsislaxiflora* | Ayan /Ayanre | Pericopsis | 57* | 35.6 |
| *Anogeissusleiocarpus* | Ayin | Axle wood | 115* | 71.9 |
| *Brideliaferruginea* | Ira | Guinea | 99* | 61.9 |
| *Terminaliaspp* | Idi | Tropical almond tree | 78* | 48.8 |
| *Harunganamadagascariensis* | Adin | Dragon's blood tree | 23* | 14.4 |

Source: Field survey, 2016 *= multiple response

**Land Cover Changes between 1984 and 2016**

From the Tables 3 and 4, it was observed that, forest land had reduced drastically based on several human activities from 1984 to 2016. Changes in the Land Use Land Cover (LULC) of Saki West reduced gradually from 29.2 percent (1984), to 19.1 percent (2000) and to 18 percent (2016) while that of Ibarapa North gave a sharp difference within the interval of sixteen years having reduced from 64.2 percent (1984), to 31.1 percent (2000) and to 29.4 percent (2016). This indicates that the rates of deforestation in the study areas are becoming very alarming. Figures 1-6 shows how forest cover had been degenerated to grassland and bare land between 1984,2000 and 2016. The Figures shows that there is drastic reduction in the forest cover of the two study areas. The study corroborates with Muhammad and Riffat (2015) that when an area is being deforested, the temperature increases and more climatic changes will start to occur. Also, Inyang and Esohe (2014) explained in Ojekunle (2014) that increase in the rate of deforestation correlates with increase in desertification that gradually leads to intense heat on the environment, however forest is one of the factors that regulates the temperature of an area. Temperatures of forested areas are very cool and trees in the forest give out more oxygen which is a cool air that contributes to cooling the area (Muhammad and Riffat, 2015). Removal of forests and replacing them by crops, grassland or bare soil will continue to have a large impact on the climate and land terrain of the deforested area. After deforestation, evaporation will be reduced, meaning more energy is emitted from the ground as sensible heat instead of latent heat, which acts to warm the surface. The reduced flux of moisture to the atmosphere means humidity levels and precipitation are likely to be reduced (Betts, 2006).This study is in line with Msuya *et al.*(2011) who explained that increased charcoal production has encouraged felling of trees, and has led to clean land with less tree density, causing reduction in the amount of rain. In support of the above, one of the respondents said:

*"We agree that the weather has changed compared to 10 to 30 years ago. Most times we enjoy going to farm and even sleeping in the hut on our farms. Nowadays, the weather condition in the farms is not bearable because*

*of numerous activities going on. In those days, charcoal producers produce charcoal and the impact is not felt at all but now the impact is felt on everywhere. Also, we discover that bird like Lonchura bicolor (Elulu) that cause rain to fall are no more found in the forest. This is caused as a result of deforestation". (Adeyemi, 2016, Sannisala Village,Saki West).*

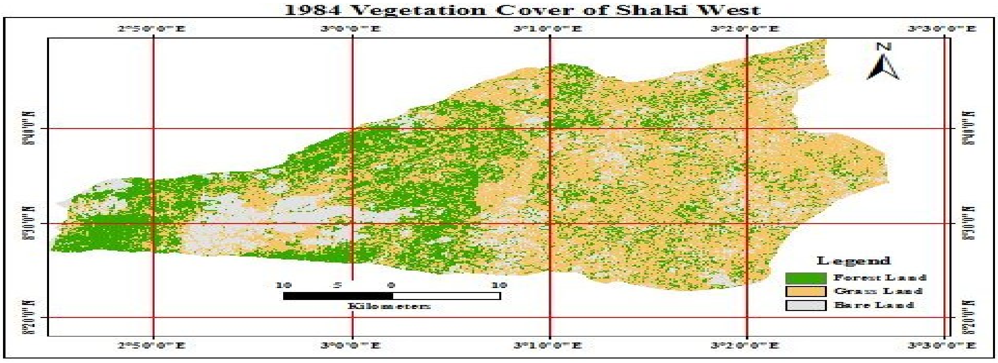


Figure 1: 1984 Vegetation Cover Map of Saki West LGA

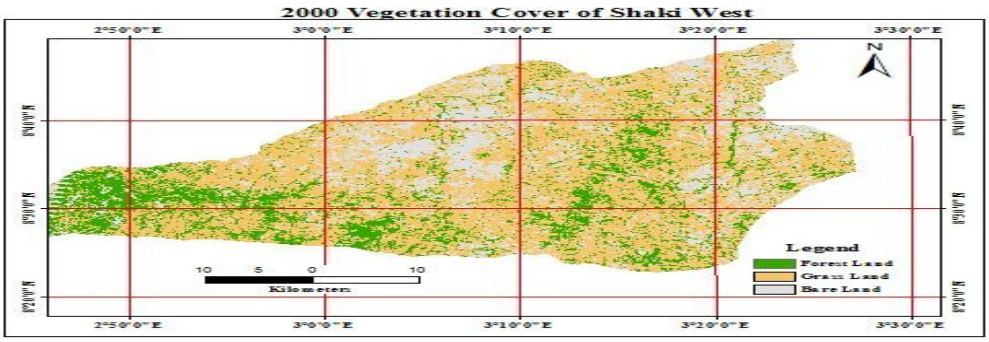


Figure 2: 2000 Vegetation Cover Map of Saki West LGA

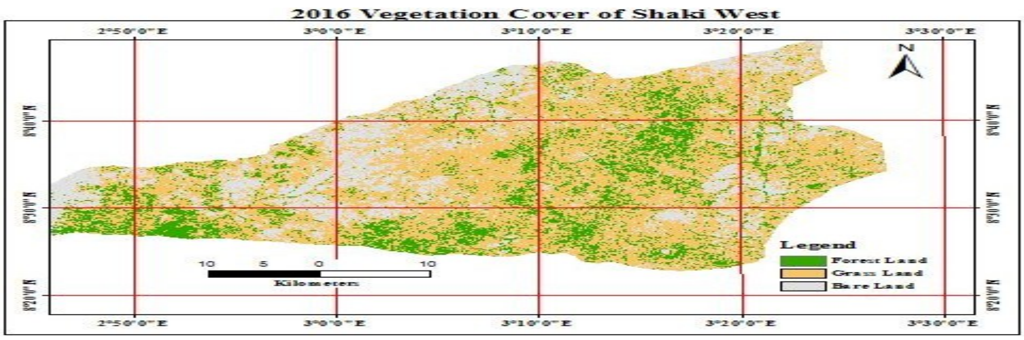


Figure 3:2016 Vegetation Cover Map ofSaki West LGA

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**Table 3: Land Cover Types Dynamics in Saki West between 1984 and 2016**

| | 1984 | | 2000 | | 2016 | |
|---|---|---|---|---|---|---|
| Land Cover Categories | **Area (Km²)** | **Area (%)** | **Area (Km²)** | **Area (%)** | **Area (Km²)** | **Area (%)** |
| Forest Land | 628.5 | 29.2 | 413.0 | 19.1 | 389.9 | 18 |
| Grass Land | 1132.6 | 52.3 | 1243.9 | 57.4 | 1250.4 | 57.8 |
| Bare Land | 401 | 18.5 | 505.2 | 23.5 | 521.8 | 24.2` |
| TOTAL | 2162.10 | 100 | 2162.15 | 100 | 2162.15 | 100 |

Source: Field survey, 2016

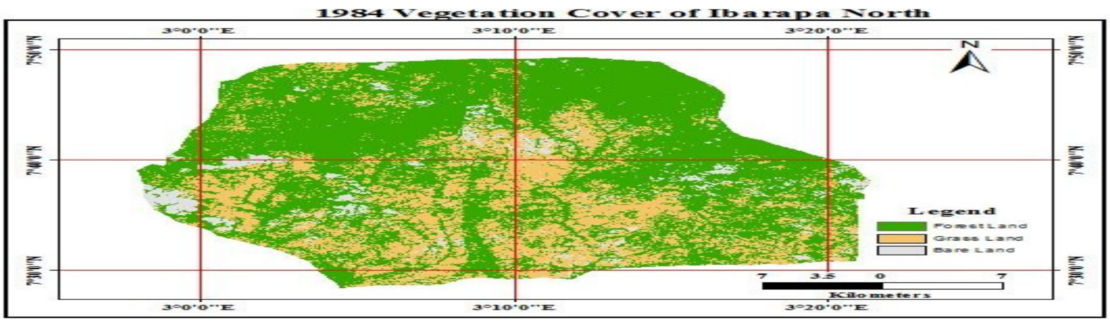


Figure 4: 1984 Vegetation Cover Map of Ibarapa North LGA

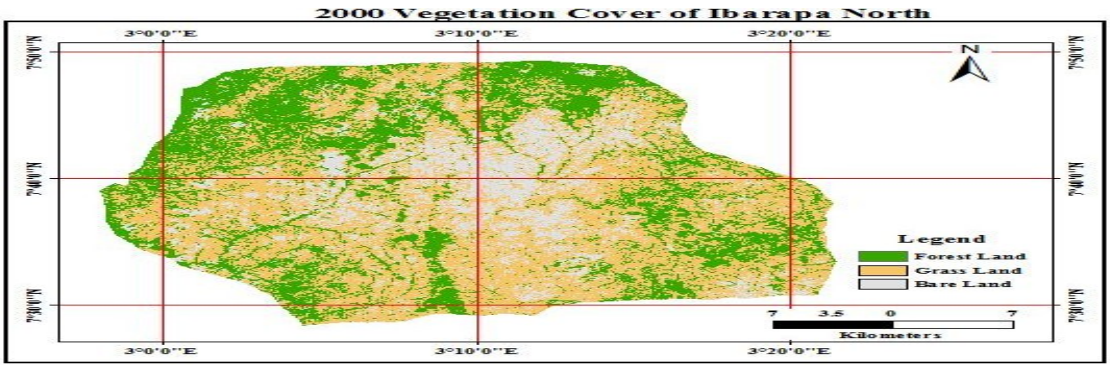


Figure 5: 2000 Vegetation Cover Mapof Ibarapa North LGA

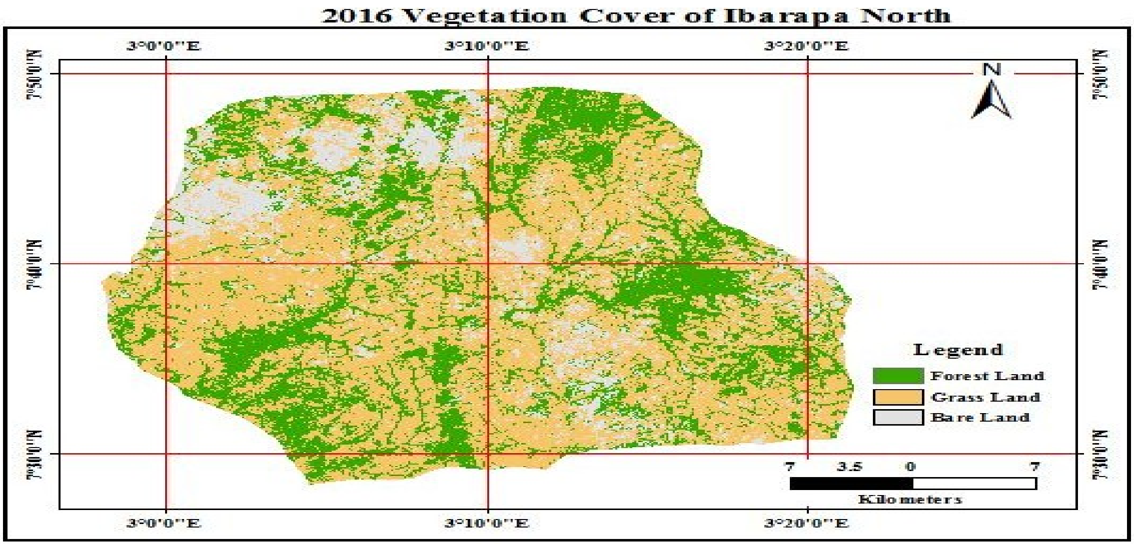


Figure 6: 2016 Vegetation Cover Map of Ibarapa North LGA

**Table 4: Land Cover Types Dynamics in Ibarapa North between 1984 and 2016**

| | 1984 | | 2000 | | 2016 | |
|---|---|---|---|---|---|---|
| Land Cover Categorie | | | | | | |
| | **Area ($Km^2$)** | **Area (%)** | **Area ($Km^2$)** | **Area (%)** | **Area ($Km^2$)** | **Area (%)** |
| Forest Land | 797.5 | 64.2 | 385.7 | 31.1 | 365.9 | 29.4 |
| Grass Land | 362.7 | 29.3 | 637.70 | 51.3 | 694.4 | 56.6 |
| Bare Land | 80.7 | 6.5 | 212.6 | 17.6 | 180.7 | 14 |
| TOTAL | 1241 | 100 | 1241 | 100 | 1241 | 100 |

Source: Field survey, 2016

## Conclusion and Recommendation

The study concluded that more males were involved in producing charcoal due to the energy exertion involved. The mean age and years of experience of respondents is 43 years and 13years respectively. Respondents have low level of education and are primarily involved in farming activities. Most of the respondents are native of the study areas, this make them conversant with the terrain of the area. This encourages easy access and sourcing of trees for charcoal production. Respondents in the study area affrimed that they use more of *Vitellaria paradoxa*, *Anogeissus leiocarpus* and *Bridelia ferrugnea* for production of charcoal because they are hard wood that gives good quality of charcoal. The Land Use Land Cover for Saki West and Ibarapa North between 1984, 2000 and 2016 revealed that forest cover is lost to bare land and grassland, showing that forest cover is under serious threat to deforestation. From the findings of the study, it is recommended that Charcoal producers/association should be encouraged to practice sustainable forest management in other to build the forest cover in the study areas.

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