

Impacts of Agriculture and Biomass Energy Production on Forest conversion: The Case of Igangan Forest Reserve of Ibarapa Region, South-West Nigeria

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Abstract

Energy and food security are vital needs for human existence. Growing global concerns on fuelwood production and subsistence agriculture are however rooted in the problem of forest degradation activities generally and massive tree felling in particular. The study assessed the relationship between farming and biomass energy activities in Ibarapa region of Oyo state against the environmental problems of deforestation and encroachment into the Igangan Forest Reserve (FR). Data from participatory rural appraisals through Focus Group Discussions, structured interviews and questionnaire administration involving thirty (30) charcoal producers and three hundred and sixty (360) household respondents, were analyzed in a Geographical Information System environment to assess the developments in and around the FR. The results indicate that subsistence agriculture is the most significant of the six major means of livelihood in the study area, while charcoal production, marketing and transportation are gaining prominence increasingly. The consequences of the threats by the land uses to the natural ecosystem and conservation, usually from slash/bush burning and tree felling in the area are established. The fate of the gazetted Igangan FR is also discussed. The study thus advocates the need for aggressive promotion of modern farming techniques while charcoal production activities are strictly monitored for environmental accountability.

Keywords: *Biomass, Energy, Agriculture, Forest Reserve, Nigeria.*

1.0 Introduction

Patterns of forest resource exploitation are underlain by the social, economic, and environmental factors that have instigated such human response. The sustenance of rural farmers in seemingly unfavourable climatic conditions cannot be neglected. These social, economic, and environmental characteristics account for the types and processes of human activities and management of endowed natural resources (Davies, 1987; Palaiologou *et al.*, 2010; Soneye, 2004). Regionally, they determine the apparent balance between the means of livelihood and level of development (Adeniyi, 1979; Omara-Ojungu, 1992; Sasaki *et al.*, 2011). In recent times, global attention on renewable and bio-energy as an alternative to fossil

fuels has been on the increase and with special attention to resources utilization, sustainability and impacts on the environment (Apak *et al.*, 2011; Palaiologou *et al.*, 2010). Tropical regions are spotlights for natural resources exploitation and food security due to the high dependencies on land resources, complexities in land uses and vulnerability to hazards; which arise from rapid population growth, resource and management conflicts (Soneye, 2004).

It is already established that biomass accounts for more than 70% of the energy sources in Africa, oil and gas is about 20%, hydro is about 5% and coal is just about 2% (Hall and Mao, 1994; Shittu *et al.*, 2004; Babanyara and Saleh, 2010; Oyekale and Aromolaran, 2012). Biomass as a source of energy in the dominantly rural areas of the continent is about 95% as reported by Shaad and Wilson (2009). Development of modern bio-fuel production technology remains nascent in Nigeria. Rather, it is based on cutting down of trees for logs in tracts of forests and thickets directly. Woods are also harvested while clearing farm plots in preparation for planting and also collection of crop residues after harvesting. Mueller *et al.*, (2007), Ogundele *et al.* (2012) and Steckel *et al.*, (2015) established some major social, economic and environmental effects of intensified bio-fuel production across the globe in recent times. The argument by Amezaga *et al.* (2010) nonetheless is that only unused marginal lands should be used for the feedstock production if the associated direct and indirect negative impacts are to be minimized.

Even though agriculture is the main employer of labour in Nigeria, it cannot guarantee food security in view of its rainfed, subsistence and small holding characteristics. As identified by Fasasi (2007), Orefi (2012) and Soneye (2014), the main produce which are mainly food crops of cassava, maize, yam, cowpea and sorghum hardly generate reasonable income to the farmers and also suffer from rainfall variability and cost of production inputs. With increasing cost of pertinent household needs and consumables without corresponding rise in the produce prices, the dwellers are bound to seek alternatives. They either migrate to urban areas in search of “greener pastures” or embark on feasible alternatives to their traditional means of livelihood.

Charcoal production around Ibarapa region is a fast growing business by active members of the communities especially the youths. As reviewed by Ajadi *et al.* (2012), it was initially designed to be a compliment to farming particularly in the dry season but has however grown to an all-year round activity due to increasing demand for the produce locally in urban areas and also for exportation. Studies in

various countries describe woodfuel production and marketing as a major forest-depleting business and that it is a principal facilitator of deforestation, and other rural agro-ecosystems maladies in sub-saharan Africa (NTL, 2002; Palmula & Beaudin, 2007; Uisso & Balama, 2011; Adedayo *et al.* 2013). Authors have described a new sequence in the sub-sahara Africa whereby rural dwellers now clear and burn lands for farming after the major trees have been felled and/or burnt for harvest of logs and firewoods (Arnold, 2003; Onuche, 2010; Mugo and Gathui, 2010). Further, many potential farmers are switching from searching for agricultural lands to that of woodlands and forests feedstock for biofuel for economic returns (Olusola and Adenegan, 2011).

Igangan Forest Reserve (FR) is one of the gazetted reserves in the Ibarapa region of South-West Nigeria. In view of the apparent increase in biomass energy production activities and the paucity of knowledge on the industry, the study was aimed at evaluating the relationship between agriculture and charcoal production in the area. To achieve this, few questions were raised;

- a. What is the contribution of farming and charcoal production to household income generation in Ibarapa region?
- b. How are forest plots managed in view of these two major activities in the region?
- c. What changes have been observed in settlement and accessibility in the region?

These questions were answered by following the study objectives which were to:

- a. Assess the significance of farming and charcoal production in Ibarapa region
- b. Evaluate feedstock supply for charcoal production in the region, and
- c. Examine changes in settlement and accessibility in the region over the last few decades.

2.0 The Study Area

Ibarapa region is in Oyo State, South-West Nigeria. The state spans longitudes 3⁰ to 5⁰E and latitudes 7⁰ to 9⁰N, covering a landmass of about 27,249 km² (**Fig. 1**). It enjoys an equatorial climate with mean annual rainfall of about 1,350 mm. Annual temperature is between 24.6°C and 31.5°C. Relative humidity is from 52% at the peak of dry season to 83% in the wet season (Erakhrumen, 2008). The topography is gentle lowland with few ranges (Agboola, 1995).

Ibarapa region has three Local Government Areas (**Table 1**). The major economic activity and means of livelihood is farming. The residents live in small settlements

ranging from farmsteads, hamlets and villages to a few towns. Settlement hierarchy within the region is determined by administrative, social and economic functions and services as well as population size and affluence. Some settlements in the part of state such as Iseyin, Saki, Okeho, Igbo-Ora, Igbeti, Ighoho, Kisi and Iganna Eruwa are gaining prominence through charcoal businesses either in terms of production, marketing and income generation.

Table 1: The LGAs of Ibarapa Region

	Ibarapa East	Ibarapa Central	Ibarapa North
Headquarters	Eruwa	Igbo Ora	Ayete
Population	118,226	102,979	101,092
Area Extent	838	440	1218
Population Density	141	234	83

The region is on the plains of Nigeria SW highland with elevation ranging between 100m and 150 m above mean sea level. The climate and vegetation of the region support the cultivation of food crops primarily as well as some tree crops such as cocoa, oil palm and cashew. These are supported by government farm settlements at Ipapo, Ilora, Sepeteri, Eruwa, Ogbomosho, Iresaadu, Ijaiye, Akufo and Lalupon. The originally rainforest vegetation is being transformed into derived savanna as a result of several centuries of subsistence farming involving bush burning. Ogundele *et al.* (2012) identified the key flora elements currently as savanna tree species of *Parkia biglobosa*, *Piliostigma reticulata* and *Vitellaria paradoxa*. The main grasses are *Panicum maximum*, *Imperata cylindrica* and *Andropogon tectorum*. It is well-drained.

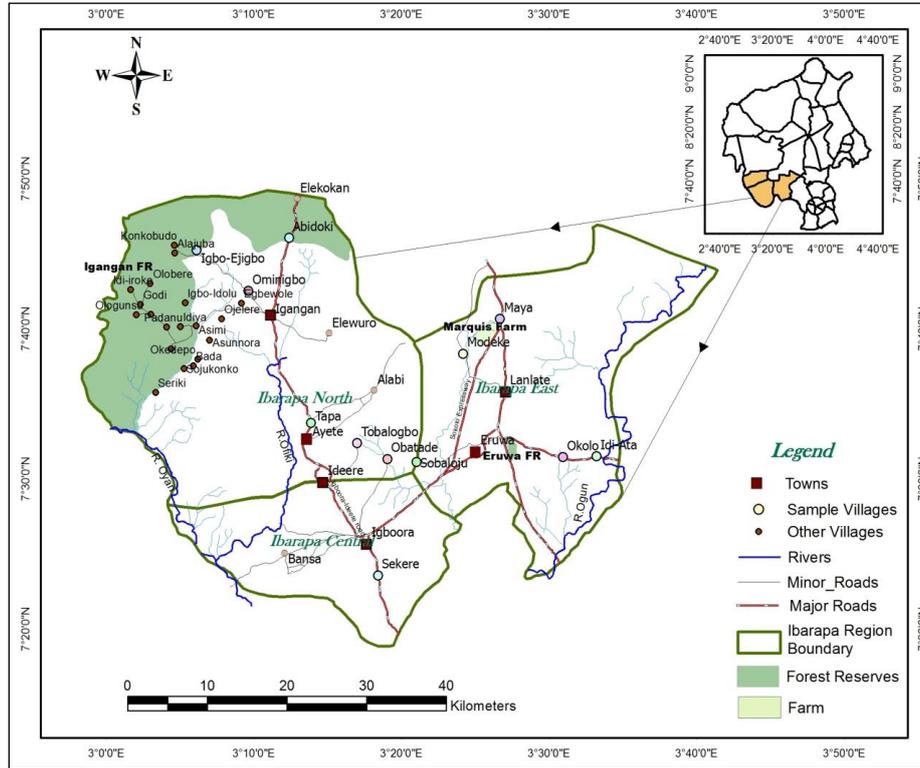


Fig 1: The Study Area

3.0 Materials and Methods

Data for the study were collected through a set of multiple sources (Table 2). The maps and satellite images of the area and administrative records were accessed and used as basis for the field activities. This was followed by community participatory appraisal involving Focus Group Discussion (FGD), structured interview and administration of different sets of questionnaires to the dwellers and identified stakeholders in the charcoal industry including the forests/feedstock owners and the charcoal producers.

Table 2: The Datasets used for the Study

Data	Coverage and Scale	Date Published	Source/Producer
Topographical maps	Sheet 240 (1:100,000) Igangan	1969	Federal Surveys, Nigeria
	Sheet 260 (1:100,000) Abeokuta	1968	Federal Surveys, Nigeria
Local Government maps	Ibarapa East LGA (1:100,000)	2001	Crown Tundak Consult Cartographers , Ibadan
	Ibarapa Central LGA (1:125,000)	2002	Duro-Kas Consultants, Ibadan
	Ibarapa North LGA (1:75,000)	2002	Ibadan
Images	Satellite Image	2013	www.google.com.ng/earth

Using the stratified sampling technique, a total of thirty (30) charcoal producers and 360 household respondents, the majority of who were also found to be either farmers and/or in the charcoal produce supply chain, were selected based on their places of abode, means of livelihood and a number of other socio-economic variables,. The data generated were on feedstock tree species, nature of removal and other production characteristics especially around the Igangan FR.

4.0. Results and Discussion

4.1. Household Income Generation in Ibarapa Region

The six (6) primary economic activities of the residents in the region are presented in **Table 3**. Farming ranked highest with 79.8% engaging in it, followed by trade and commerce (60.7%) and artisanship (27.4%). At the bottom are transportation and formal employment which included civil service and monthly paid jobs in the major towns.

Table 3: The Primary Occupation and Incomes of dwellers in the region

Activity	%age Engaged	Rank	Percentage within Income Ranges			
			<₦7,000	₦7,000-17,000	₦17,001-39,500	>₦39,500
Farming	79.8	1	98.03	81.58	63.15	73.80
Trade & Commerce	60.7	2	43.13	73.68	71.05	61.90
Artisanship	27.4	3	21.57	34.21	26.32	28.57
Charcoal Production	22.6	4	13.73	15.79	26.32	33.33
Transportation	16.8	5	1.97	21.05	18.42	28.57
Formal Employment	10.7	6	0.00	2.63	2.63	38.09

Source: Analysis of Field Survey (2013 - 2014)

**Note:* Percentages do not add up to 100 because of multiple household activities and income classes are quartile-based

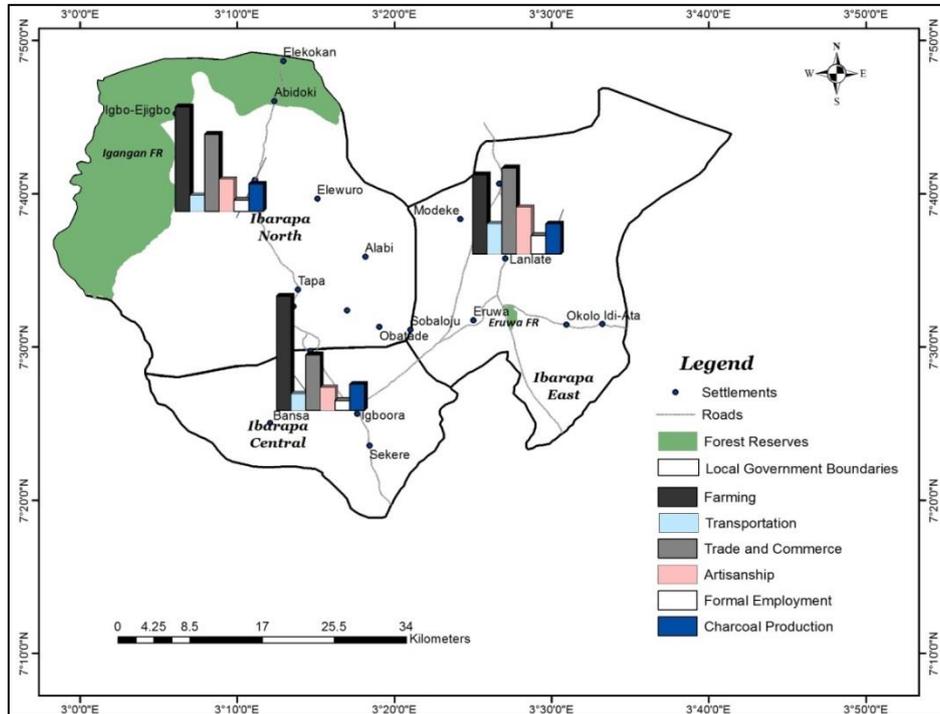


Fig 2: Occupational Distribution of the Households in the Region

Source: Computed from Field Survey (2013 - 2014)

The distribution on LGA basis is presented in **Fig. 2**. Charcoal production ranked 4th on the list with about 22.6% of the dwellers engaging in it. Whereas the proportion of dwellers engaged in charcoal production is almost uniform across the three LGAs, farming is very prominent in Ibarapa Central and North LGAs which also have wider expanse of potentially arable but forested lands for the activity (**Table 4**). The most developed Eruwa and Lanlate settlements in the region fall within Ibarapa East LGA. The LGA accommodates a number of tertiary institutions and government offices that aid the business.

Table 4: Occupational Distribution among Households in Ibarapa Region (%)

LGA	Farming	Transportation	Trade and Commerce	Artisanship	Formal Employment	Charcoal Production
Ibarapa North	84.42	12.98	62.34	25.97	9.09	22.08
Ibarapa Central	92.10	13.16	44.74	18.42	7.89	21.05
Ibarapa East	64.15	24.53	69.81	37.74	15.09	24.53

Source: Computed from Field Survey (2013 - 2014)

The records establish that farming remains a major employer of labour in the region but there are interests in the non-farm activities. A major characteristic of the farming technique is that of forests conversion through tree felling, followed by clearing and slash burning. Some 73% of the farmers reported that they engage in plot fallow with a view to allow cultivated plots regenerate naturally. Invariably, the system exerts greater pressure on cultivable land, more so with increasing population and cost of living. This accounts for why farmers will always venture into forested areas and reserves for agricultural endeavours.

4.2. Types of Feedstock for the Biomass Energy

A total of thirteen (13) available tree species were identified by the charcoal producers as preference for the sector in the area. Their local, common and species names as well as their average maturity ages are shown in **Table 5**. African birch, kosso wood, black false currant, iron wood, idi, iron tree and wild syringa, are preferred most because they produce high quality charcoal that burns longer. In the absence of these in a new plot or perhaps where cleared farmlands are bereft of them, monkey kola and balsam tree would come to rescue but they produce light-weight charcoal that burn out quickly. Though they produce high quality charcoal, the remaining species are seldom used either because they are prohibited by law or they command better economic returns more sustainably.

Table 5: The tree species in use for charcoal production in the region

Rank	Local Name	Common Name	Species Name	Maturity (yrs)
1	Ayin	African Birch	<i>Anogeissus leiocarpus</i>	5
2	Aipe	Kosso wood	<i>Nauclea diderrichii</i>	9
3	Odu-oko	Black False Currant	<i>Allophylus africanus</i>	6
4	Ayan	Iron Wood	<i>Distemonanthus benthamianus</i>	5
5	Idi	Idi	<i>Terminalia avicennioides</i>	6
6	Akufo	Iron Tree	<i>Laphira alata</i>	
7	Asapa	Wild syringa	<i>Burkea africana</i>	5
8	Ogugu	Monkey kola	<i>Cola cariccifolia</i>	7
9	Iya	Balsam tree	<i>Daniellia oliveri</i>	5
10	Emi	Shea Butter tree	<i>Vitellaria paracloxum</i>	7
11	Igba	African Locust Bean tree	<i>Perkia bigolobosa</i>	7
12	Iroko	African Teak	<i>Milicia excelsa</i>	8
13	Gedu	Teak	<i>Tectona grandis</i>	8

Source: Compiled from Field Surveys and Questionnaires (2013)

4.3. Biomass Feedstock Supply for the Charcoal Production

Natural forests are the major providers of biomass feedstock for charcoal production across the entire region, accounting for 31.78% on the overall average (**Table 6**). As shown in **Fig 3**, it accounts for about 32.12% in Ibarapa North

LGA, 31.88% in Ibarapa Central LGA and 30.95% in Ibarapa East LGA. The highest proportion in the former is as a result of the proximity to Igangan, the most expansive FR in the region. Farm clearing is second in that order with Ibarapa Central LGA having a highest proportion of 30.63%. This can be explained in terms of its highest farming population and density.

Table 6: Proportion of feedstock for charcoal production from different sources in the region

	Ibarapa Region	Ibarapa East	Ibarapa Central	Ibarapa North
Natural Forest	31.78	30.95	31.88	32.12
Farm Clearing	28.00	26.19	30.63	27.27
Salvage Harvesting	14.67	19.05	12.50	13.33
Logging Waste	18.89	16.67	18.75	20.61
Plantation	6.67	7.14	6.25	6.67

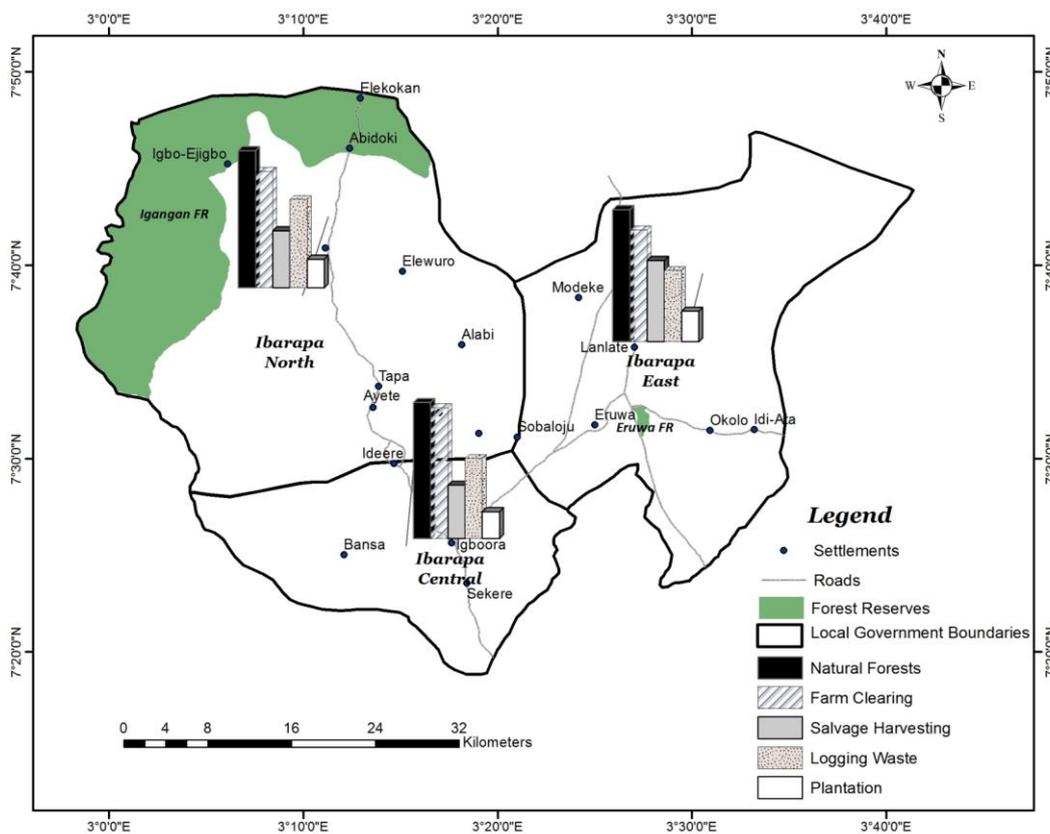


Fig. 3: Sources of Feedstock for Charcoal Production in Ibarapa Region

Source: Computed from surveys (2013-2014)

About 68% of the producers interviewed indicated that their production volume increases during the dry season and climaxes around April and May primarily because the feedstock are more accessible from the forests and farmlands being prepared around this period.

4.4 Changes in Accessibility and Settlement

The changes in types and distribution of transportation routes and number of settlements were analysed using the information from the topographical maps of the area for 1969 and the satellite imageries for 2013 (Fig 4).

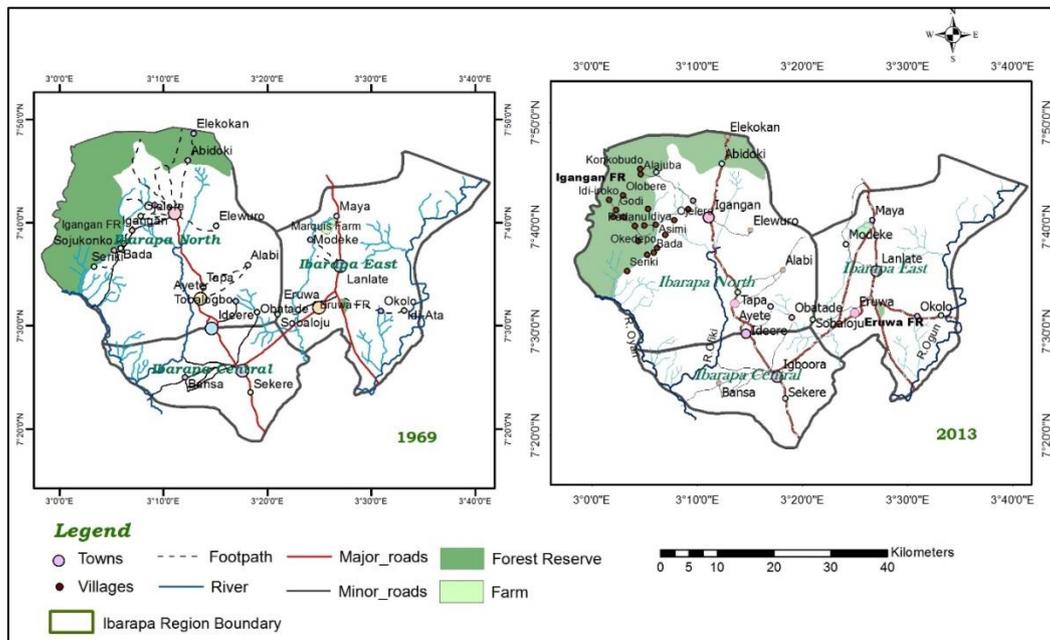


Fig. 4: Changes in the Distribution of Settlements and Transport routes the area, 1969 - 2013
 Source: Analysis of Data in a GIS environment (2013)

The analysis shows that many settlements have sprung up within the 44-year period. They were reported to have started as farmsteads within the FR to open up new tracts of farmlands and thereby reduce pressures on existing plots outside the reserve. These however, grew up to villages and larger settlements latter as charcoal businesses grew with felling of trees on the new lands (e.g. Idi-Iroko, Godi, Okedepo, etc). The prohibition to encroach into the FR is well understood by charcoal producers but some still harvest trees illegally primarily because of the inability of forestry officials to manage the resources adequately.

It is discovered that the communities from Igangan to Igbo-Ayin through Bada which were connected by footpaths as at 1969 and separated from Igangan FR by River Ayinsa had been connected by hurriedly constructed minor roads from different directions into the FR to facilitate access for encroachments

5.0. Conclusion

The study revealed that farming still remains the major occupation in the rural-dominated Ibarapa region, South-West Nigeria despite the growing interest in non-farm income generating activities. Its contribution to household income however varies from one LGA to the other. It is established that plot following, tree felling and slash bushing are the pre-dominant farming practices across the region. The degree of encroachment on Igangan FR is identified based on the analysis of the changes in the distribution of settlements and transportation routes around the forests over a 44-year period of 1969 - 2013.

The study is a potential contribution to the debate on the drivers of forests conversion and degradation in developing countries. The study suggests that agriculture requires appropriate strategies that can discourage bush fallowing and promote intensive farming using modern techniques and technologies. Also, there is need for agricultural services that would strengthen choice of produce, yield per hectare and the status and consumption power of the farmers intimately. The choice of alternative sources of energy supply such as wind and solar energy deserves equal attention and consideration if the nature of biomass feedstock is to be ameliorated and reserved areas are to be prevented from encroachment for means of livelihood.

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