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Survey and Ethnobotanical Investigations of Key Non-Timber Forest Products in Home Gardens and Sacred Forests in Cross River State, Nigeria

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Abstract A survey and ethnobotanical investigations were done in six Local Government Areas (LGAs), Cross River State, Nigeria, to examine the social and economic value and management practices of the primary Non-Timber Forest Products (NTFPs) in home gardens and sacred forests. The six LGAs were purposively selected based on the vegetation types. The vegetation types include tropical high forest/freshwater swamp mosaic as ecotype 1, tropical high forest as ecotype 2 and tropical high forest/savannah mosaic as ecotype 3 for Akpabuyo and Akamkpa, Ikom and Obubra, and Obudu and Boki. The study was conducted in 12 sacred forests and 60 home gardens in 30 randomly selected communities within the 11six LGAs. A stratified multi-stage random sampling was used with group interviews, personal observation and structured questionnaires as study tools. Also, a simple close traverse was adopted for area determination for home gardens and sacred forests, while the stock survey approach was used for identification, enumeration and measurements of NTFPs/ tree species in the study areas. One thousand and fifty questionnaires were administered to respondents randomly selected from 30 communities in the six LGAs to provide data on NTFPs. Results showed that 69.5% and 61.5% of the respondents were involved in home garden farming and sacred forest conservation, while 64.2% were farmers and only 21% were involved in NTFPs production to supplement farm income. The product contributed significantly to household food security, and the majority of the respondents (62.9%) were women. Volume production in ecotypes 1, 2 and 3 was 18.40, 14.00 and 13.18 m^3/ha, respectively. The analysis of variance showed that the number of stem/ha, the dbh (cm), the based area (m^2/ha) and the volume (m^3/ha) were not significantly different in the three ecotypes. The results also showed that ethnobotanical practices of NTFPs in home gardens and sacred forests have assisted in having proper methods of conservation and sustainable management of the existing forest products. Recommendations were proffered to eradicate or ameliorate the perceived problems. Finally, this study provides relevant information which would be inestimable in promoting and improving improper management of NTFPs in home gardens and sacred forests.

Keywords Non-Timber Forest Products, Ecotypes, Home Gardens, Sacred Forest

1. Introduction

Non-Timber Forest Products (NTFPs) were long dominated by timber products and had only recently gained significant governmental and scientific attention. Three prepositions were used to focus research and policy attention [1,2]. The first was NTFPs which have significantly aided the economy and the well-being of families within or/ and near the forested areas. Second, NTFP utilisation is less environmentally damaging than wood harvesting and other forestry uses, and third, NTFP development and production might minimise deforestation in the tropic. These prepositions motivated scholars to invest greater effort into identifying the monetary worth of NTFPs and their contribution to total livelihood. Several studies [1,2,3] found that NTFPs provided more than half of total livelihood income in certain places but less than 20% in others. NTFP exploitation, on the other hand, complements other livelihood activities [1,3].

It cannot be overstated that NTFPs are an incredibly diverse population since they are gathered for various causes by various persons. Some are ingested without additional processing and have no monetary value. Others pass via a lengthy network of merchants and processors before reaching a highly competitive worldwide market. Some NTFPs are found in the wild, while others have been cultivated in gardens and sacred forests. NTFPs include all-natural resources derived from the forest apart from wood [1,2,3]. They comprise mushrooms, edible nuts, herbs, fresh fruits and seeds, spices, fragrant plants, sports, gums, resins, plants, and animal products utilised for medical, cultural and cosmetic purposes [1,4]. NTFPs are gathered from various ecotypes, notably farm fallow and high forest; alternatively, they disrupt farmlands and forest and household gardens [2,3,4]. NTFPs, which have attracted the interest of many forest agencies in the last ten years, have been a means of livelihood for several rural areas that have lived in and out of the forest, using NTFPs for medicine, food, clothing shelter, home crafts, and variety of other necessities.

Thus, it is estimated that 80 per cent of individuals in emerging nations consume NTFPs to satisfy part of their nutritional and health requirements. As a result, billions of people, particularly those living in rural regions in developing nations, rely on NTFPs daily. Some are eaten inside the gatherers' households and are not marketed in marketplaces. As a result, the processing, extraction, and trade of NTFPs are sometimes seen as the only form of employment accessible to those living in isolated rural regions [1,2,3,4]. Again, NTFPs are also culturally significant, and their preservation in forests is critical to the preservation and continuance of several local traditions. Sacred forests are an excellent example of community-based environmental protection that receives no extra-moral funding [3,2,5]. The system's present revival is mostly owing to its vital contribution to biodiversity protection and critical environmental and ecosystem services. Harvesting from the sacred grove is banned or carefully controlled or regulated by elders and mostly only allowed to extract medicinal plants. This regulated access to the groves helps conserve many NTFPs for future use and as a source of germ-plasma for establishing useful NTFPs in gardens [1,4,5,6]. As a result, a framework for the ecological and sustainable use of NTFPs is developed, including basic baseline information of the species in question and an awareness of the marketing system that these products are marketed under proper regulations [1,3,6].

Such a system may serve as a vehicle for fair community engagement in resource management, benefit distribution, and income/revenue generation through NTFPs [2,4,6]. A literature survey regarding most of the NTFPs found in residential gardens, and sacred forests serve as food, fruits, vegetables, and medicine to supplement the existing NTFPs in the high forest. However, the significance of home gardens/sacred forests as dietary supplements has diminished considerably in the past decades [6,7]. Despite the huge contribution of NTFPs to home gardens and sacred forests, these sectors were taken for granted for a long time. [1,2,4,7] and have been subjected to neglect, misuse, overuse, and gross undervaluation because of a lack of adequate knowledge on their prevalence, occurrences, and expanding cultural and socioeconomic potentials in home gardens and sacred forest regions. Hence, many resources are becoming scarce, threatened, endangered and extinct in extreme cases [5,6,7]. As a result, as part of the national effort to gather appropriate information on NTFPs, and their importance in complementing the existing knowledge of NTFPs' potential, this study examines the social and economic value as well as various management practices of basic NTFPs in home gardens and sacred forests.

2. The Study Area

The study area, which is Cross River State, is located in the equatorial rainforest zone, between longitudes 7050' and 9028' east of the greenish meridian and latitudes 4028' and 6055 north of the equator. It is bounded in the south of Nigeria by Akwa Ibom State and the Atlantic Ocean and on the south-east Ebonyi State, Middle belt, Benue State and the united republic of Cameroon. It has a total landmass of about 23000sq km and a population size of 2,892,988 [8,9], with a density of 110 people per square kilometre. Six local Government Areas within the state were randomly selected. These include: Akamkpa, Akpabuyo, Obubra, Ikom, Boki and Obudu, respectively (see Fig. 1). These areas are within the tropical rainforest zones with annual rainfall ranging between 2000-3000mm. The rainy season spans from March to October, with high rainfall in July and in the month of August every year and temperatures between 250C-270C. In July, it has relatively higher humidity, which becomes drier towards the end of the year during the harmattan period [9]. Therefore, the study areas experienced the equatorial type of climate with two very distinct seasons, dry and rainy. These two seasons are almost evenly distributed. The dry season begins in November to April. The temperature during this season is very high, ranging between 300-320c. The mean annual temperature does not exceed 250c. The rainy season spans March through October, with high rainfall in July as well as in the month of August each year.

Thus, during the rainy season of each year, most of the dominant winds are the southern-western Monson Moisture bearing type which provokes heavy precipitation. The vegetation is dense equatorial forest undergrowth, with luxuriant species of trees of various heights and sizes. This results from the heavy downpour of rainfall, abundant sunshine, high temperatures and the availability of ferritic soils found in the area. The vegetation extends from Bakassi LGA with mangrove forest to the Cameroon boundaries, bounded by the rain forest from Akamkpa LGA to Boki LGA and derived savanna stretching from Ogoja and Obanliku/Obudu. In the east, it is bounded by the Mountain system and in the West, by the strip of a comparatively open country stretching Northward in the direction of Ogoja. A series drain the area of rivers flowing southwards towards the river Niger. The soils are derived from the pre-Cambrian basement complex rocks, exposed to some part of the study area. The ferruginous red and brown soils, rich in free iron and suitable for cocoa and banana production, are typical of this area [8,9, 10, 11,12].

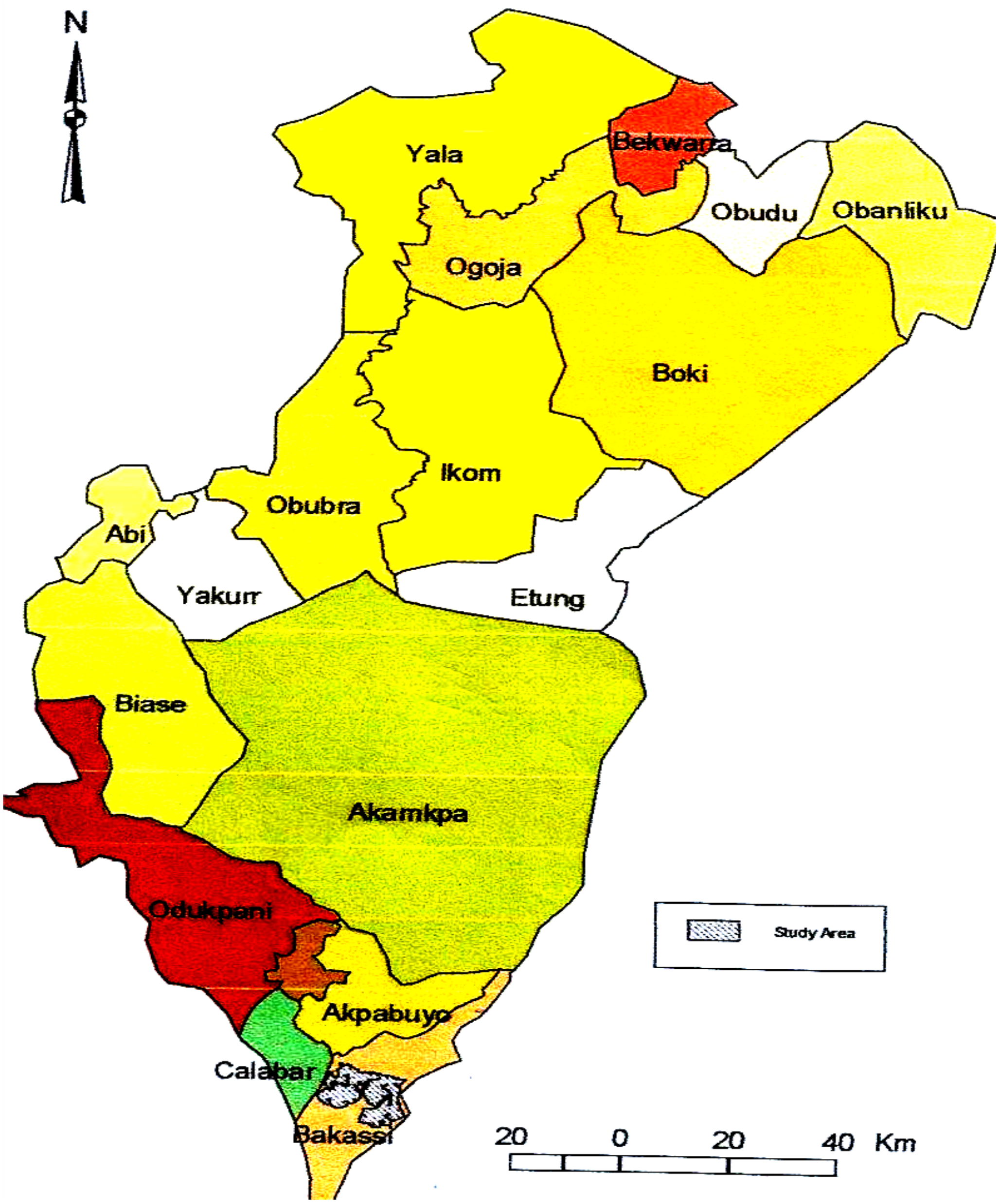

Figure 1. Map of the study area

3. Methodology

The eighteen LGAs in Cross River State were stratified into three ecological zones based on their vegetation. A stratified Multi-stage randomly sampling technique was used to ensure an equal chance of selecting each study site. This minimized bias in choosing the Six Local Government Areas out of 18 Local Government Areas which were purposively selected based on their vegetation types, namely: rainforest/freshwater swamp mosaic as ecotype 1 for Akamkpa and Akpabuyo, tropical high forest as ecotype2 for Ikom and Obubra, and rain forest/Savannah mosaic as ecotype 3 for Boki and Obudu LGAs respectively. Five communities in each LGA were also selected randomly in the second stage. The random selection was achieved by using a scientific calculator. Ten home gardens and two sacred forests were randomly selected as study blocks in each LGA at the third and final stages, as shown in Figs. 2 and 3.

Hence, two local government areas, ten communities, four sacred forests and twenty home gardens constituted a study block for each ecotype. Altogether, six (6) local government areas, thirty communities, twelve sacred forests and sixty home gardens made up the entire study site. Also, a reconnaissance survey of the sacred forest and home garden was undertaken to ascertain the survey stations for ground measurement. A simple close traverse technique was adopted to determine the area of each home garden and sacred forest in all randomly selected communities and households. Measurements of sacred forest and home garden boundaries were recorded for area determination (see Table 1).

The information included in this survey originated from both secondary and primary sources. Primary sources were based on the administration of 1050 structured questionnaires, oral interviews and personal observations. The secondary data sources are information from existing academic works/research related to library studies, textbooks, journals, and the internet. Multiple sources of evidence [10, 11, 13, 14, 15], including structured questionnaires and physical field enumeration surveys, were adopted for data collection. Multiple sources of evidence enable the same question to be investigated with different methods, both to cross-check and demonstrate a certain degree of consistency and collaboration of events. Structured questionnaires and semi-structured interviews (SSI) through PRA methods were used to obtain information from the field. In all, 1050 questionnaires were distributed.

Table 1. Techniques adopted for data collection

S/N	Techniques	Purpose
1.	Perimeter survey	(i)To ascertain the area coverage of home garden and sacred forest in the study areas and compare the results with what was reported in the questionnaires.
2.	Field enumeration of NTFPs richness, diversity and similarity	(i)Obtain information on various NTFPs in the areas. (ii) To cross check information supplied by respondents in questionnaires with what was actually on ground.
3.	GroupInterview/Personal Observation.	(i)To provide information on sacred forest and the related benefits derived from the forest. (ii)To highlight the type of NTFPs available/uses in the forest. To carry out the swot analysis of the sacred forest.
4.	Structured questionnaires	(i)To collect basic bio data on socio-economic and cultural information about respondents. (ii)To document the components of home garden and sacred forest practices (iii)To know what information the respondents have received about home garden and sacred forest, from whom and when it was received. (iv)To examine respondents' general impression about home gardens and sacred forest.

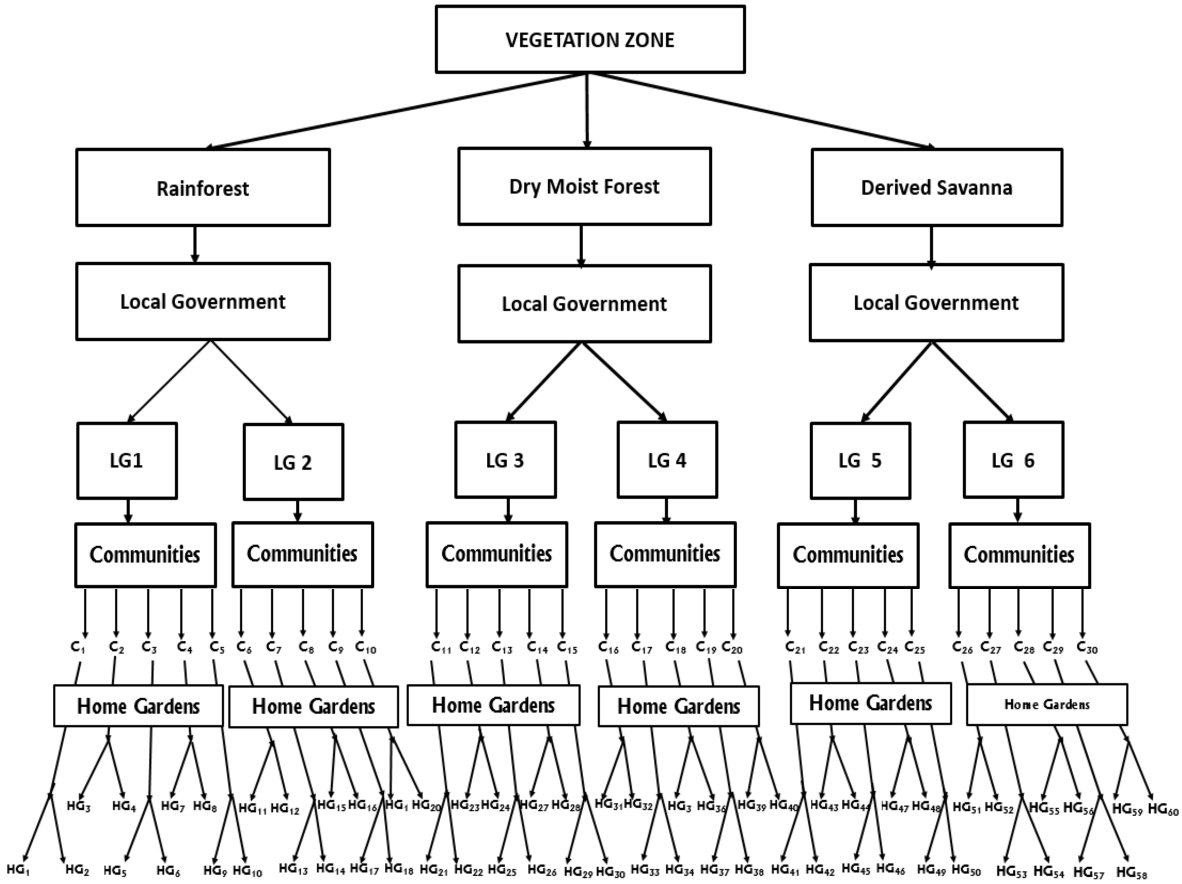

Figure 2. Selection of home garden in the area

Where:

LG 1, LG 2, LG 3, LG 4, LG 5, and LG 6 are respectively, Akpabuyo, Akamkpa, Ikom, Obubra, Boki, and Obudu Local Government Areas.

C_i, C_2, C_3, C_4, C_5, C_6, C_7, C_8, C_9, C_{10}, C_{11}, C_{12}, C_{13}, C_{14}, C_{15}, C_{16}, C_{17}, C_{18}, C_{19}, C_{20}, C_{21}, C_{22}, C_{23}, C_{24}, C_{25}, C_{26}, C_{27}, C_{28}, C_{29}, and C_{30} are Akamkpa, Ikot Edem Odo, Ikot Offiong Ambai, Esuk Mbat, Akwa Ikot Effanga, Neghe, Oban, Mbarakom, Awi, Ojor, Etayip, Bokomo, Enogni, Asenasan, Enini, Ochong, Edondin, Ohana, Isabang, Odonget, Ndemechang, Bunyia, Katchang, Wula, Bateriko, Kakum, Igwo, Ukwel Obudu, Utugwang, and Ukpe Communities).

The survey was split into four sections: A, B, C, and D, and the technique used/ adopted for data collection is shown in table 3.5. The sizes of home gardens were measured using 100m tape, 4m diameter tape, cutlass and range poles with four (4) research assistants. While in the sacred forest, a transcendent survey was carried out using the quadrant system. All of the existing trees in the study area with a diameter at breast height (dbh) of 10 centimetres or greater were located and counted to take a diameter at breast height measurement. The following five diameter classes were recorded: 0-10cm was for class 1, and 10-20cm was used for class 2, Class 3 had 20-30cm, 30-40cm was for class 4, while 40cm and more was for class 5. using stock survey method (SSM) for identification and enumeration of NTFPs/trees found in the study areas. Data on enumeration and measurement of trees were obtained from a temporary sample plot of 20m x 20m in size and randomly located in each of the selected sacred forests. Twelve sample plots were measured in ecotype 1 (Akamkpa and Akpabuyo), Fourteen for ecotype 2 (i.e. Ikom and Obubra LGAs), while eight sample plots were measured in ecotype 3 (Boki and Obudu LGAs). The variation in sample size was obtained as a result of the size of available sacred forests. In each sample plot, the following measurements were taken.

(i). Using girthing tape, measure the diameter at breast height of all standing trees in cm. All dbh values were obtained at 1.3 metres above ground and were adjusted based on stem anomalies. The total number of stems in each plot was recorded.

(ii). Total height in metres of all standing trees.

A questionnaire and checklist were used to collect/ confirm the cultural values and socio-economic importance of edible NTFPs and determine the medicinal values, management practice, and ethnobotanical values. After gathering the data from the field, it was processed, tabulated, and analyzed qualitatively and quantitatively. Data were processed using a more appropriate computer program, namely "Predictive analytical software (PASW) version" 18.0 and Microsoft Excel. Data were summarized and represented graphically using tables, histograms, and figures. The hypotheses were evaluated using inferential statistics like the chi-square test. Also, logic regression model was used for 1000 respondents in the study areas to evaluate the effects of important NTFPs in promoting the practice of sacred forests and home gardens. The explained or predicted variable has a dichotomous response in binary logic models. The two potential outcomes are usually given the numbers 0 or 1.

Respondents accepting NTFPs as a stimulus to the practice of sacred forests and home gardens were assigned the value of 1, while rejecting the concept attracts a value of 0. Models for testing were created by fitting all of the independent variables jointly. The optimal subset model was created via backward elimination: The variables investigated include a contribution to annual income (CAI), size of the forest/garden(SFG), the prevalence of illegal harvester (PIH); High dependence on NTFP (DIN), Lack of Information on NTFP (LIN); Increase Land used to pressure and population (ILP); Community involvement in sacred forest management (CIM), the existence of conflicts between community and NTFPs gathers (CCN), unsustainable harvesting of NTFPs (UHN), Fitting all the independent variables affecting the presence of important NTFPs in both the sacred forest and the home garden and then backward elimination yielded the best subset models, which were assessed and compared employing Chi-square goodness of fit statistical techniques, the coefficient of determination, the maximum likelihood technique for computing the last loss on validity, and the odds ratio [10,11].

Where C_i, C_2, C_3, C_4, C_5, C_6, C_7, C_8, C_9, C_{10}, C_{11}, and are Akansoko, Akwa Ikot Effanga, Mbarakom, Ojor, Etayip, Enini, Ochong, Odonget, Ndemechang, Bateriko, Kakum, Igwo, and Ukpe communities.

Binary logit models are often acceptable, especially in circumstances in which the response variable or the dependent variable is dichotomous or binary. This suggests that the response variable may have two possible outcomes or values: yes, and no, or the numbers one and zero. In addition to this, it illustrates how a categorical response variable and a set of explanatory variables interact with one another. It shows the characteristic that supports or determines the availability of key NTFPs in holy woods and home gardens. Following is the formula for calculating the logit of a response P that falls between 0 and 1:

$$\text{Logit (P)} = \log (p/1\text{-}p) \quad (1)$$

$$= \log p - \log (1\text{-}p) \quad (2)$$

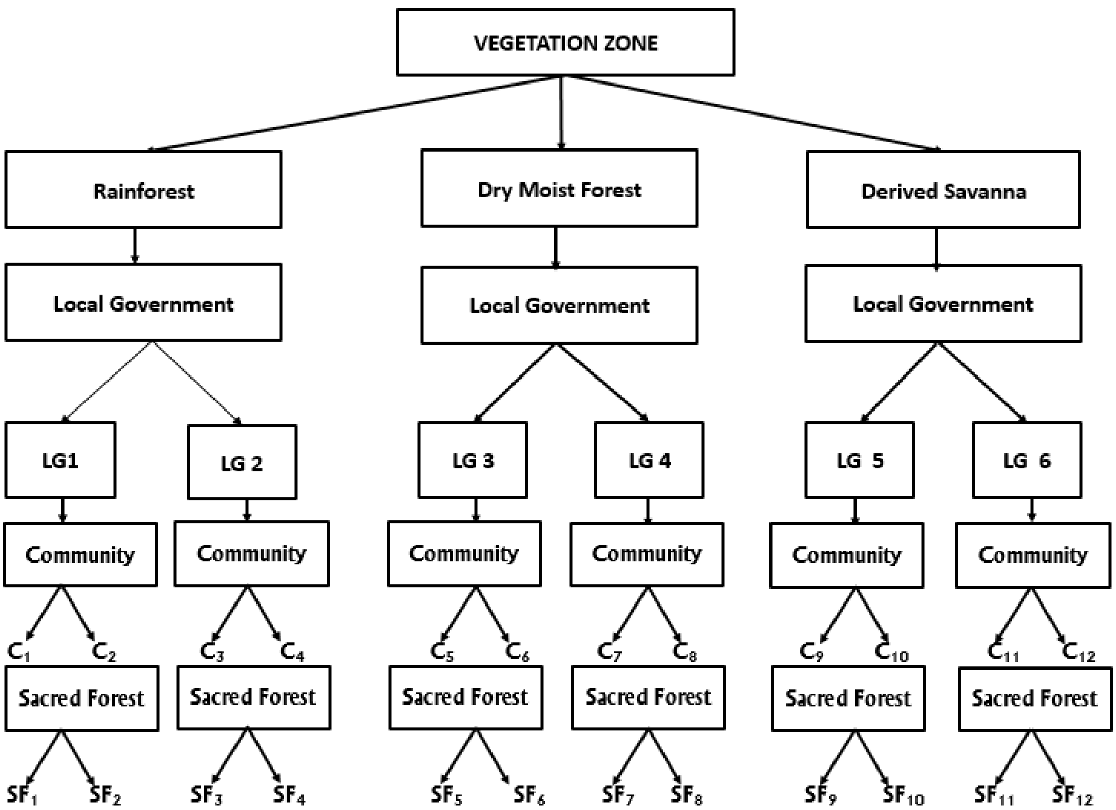

Figure 3. Flow chart showing selected sacred forest in Cross River State

Thus, the the simplest form of the logit model is depicted as shown in equation 3 as

$$\text{Logit}(P_i) = a + bx_i \quad (3)$$

where x represents the predictor or independent variables as a vector, P_i = likelihood of a response accepting a proposition, the regression parameters (a, b) represent the availability of significant NTFPs in sacred forests and home gardens. Another inferential statistics that was adopted was correlation analysis which determines the strength of association between dependent (AIN) and independent variables (x_1; x_2; x_3; x_4; x_5,; x_6,; x_7; $x_{8,\text{ and }}x_9$). Also, the chi-square test of independence was used to determine whether the response variable (AIN) is independent of x_1; x_2; x_3; x_4; x_5,; x_6,; x_7; $x_{8,\text{ and }}x_{9.}$

All the data generated for the study were processed using logistic regression (logit) option of predictive analytics software (PASW) ver. 18.0. The factors investigated were:

AIN = availability of important NTFPs (available = 1, not available = 0)

x_1 = size of the Forest/Garden (large 1, small = 0)

x_2 = prevalence of Illegal Harvesters (prevalence =1, not prevalence = 0)

x_3 = contribution to Annual Income (contribute = 1, not contribute = 0)

x_4 = high dependence on important NTFPs by rural communities (depend = 1, not depend = 0)

x_5 = information on NTFPs (available = 1; not available = 0)

x_6 = increase land use pressure and population density (increase = 1, no increase = 0)

x_7 = involvement of community in forest management (involvement = 1; no involvement =0)

x_8 = conflict between community and NTFPs investers (conflict = 1, no conflict = 0)

x_9 = unsustainable harvesting of NTFPs (sustainable =1, unsustainable = 0).

LGAs and communities involved in the study:

Six LGAs = location of respondents (Akpabuyo = 1, Akamkpa = 2, Obubra = 3, Ikom = 4; Boki = 5, and Obudu = 6) (4)

Akpabuyo = location of respondents (Akansoko = 1, Ikot Edem Odo =2; Ikot Offiong Mbai = 3; Esuk Mbat = 4, and Akwa Ikot Effanga = 5) (5)

Akamkpa = location of respondents (Neghe= 1, Oban = 2, Mbarakom = 3; Awi = 4; and Ojor = 5) (6)

Obubra = location of respondents (Ochon = 1, Edondon = 2; Ochana = 3 Isabang = 4; and Odonget = 5) (7)

Ikom = location of respondents (Etayip = 1, Bokomo = 2, Enoighi = 3, Assenasen = 4; and Enini = 5) (8)

Boki = location of respondents (Ndemechang = 1, Bunyia = 2, Katchan = 3 Wula = 4; Bateriko = 5) (9)

Obudu = location of respondents (Kakum = 1, Igwo = 2, Ukwel Obudu = 3; Utugwang = 4, and Ukpe = 5) (10)

4. Results

Results include a logistic regression analysis of the availability of NTFPs in home gardens and sacred forests depending on each LGA.

Pool Data for all the LGAS

$$AIN = -11.289 + 0.6x1 + 1.8896x2 + 1.931x3 + 1.469x4 - 1.117x5 + 0.956x6 - 0.792x7 - 1.25x8 - 1.864x9 \quad (11)$$

Odds ratio (unit change): constant (0.000), x_1 (1.823), x_2 (6.557), x_3 (6.889), x_4 (4.345), x_5 (0.327), x_6 (2.601), x_7 (0.453), x_8 (3. 49), x_9 (6.449).

Final loss = 384.19; chi-square (df,=9) = 825.443, p = 0.000.

Logistic Regression for Akpabuyo LGA

$$AIN = 13.062 + 5.306x_1 - 5.213x_2 + 1.822x_3 + 4.893x_4 + 6.168x_5 + 4.924x_6 - 8.555x_7 + 4.363x_8 + 4.804x_9 \quad (12)$$

Odds ratio (unit change): constant (0.000); x_1 (201.573); x_2 (0.005); x_3 (6.184); x_4 (133.371); x_5 (477.256); x_6 (13.584) x_7 (0.000), x_8 (78.481) x_9 (0.004).

Final loss = 34.293; chi-square (df=9) = 143.345; p = 0.000 (see Table 2)

Where;

AIN = Availability of Important NTFPs in sacred forest and home garden

X_1 =Size of the Forest/Garden (SA)

X_2 = Prevalence of Illegal Harvesters (PIH)

X_3 = Contribution to Annual Income (CAI)

X_4 = High dependence on important NTFPs by rural communities (DIN)

X_5= Lack of information on NTFPs (LIN)

X_6 = Increase land use pressure and population density (ILP)

X_7 = Involvement of community in forest management (CIM)

X_8 = Conflict between community and NTFPs investers (CCN)

X_9 = Unsustainable harvesting of NTFPs (UHN).

df = Degree of freedom

Logistic Regression Analysis Akamkpa LGA

$$AIN = -13.625 + 4.982x_1 + 2.718x_2 + 4.704x_3 - 5.053x_4 - 6.203x_5 - 2.472x_6 + 5.14x_7 - 3.628x_8 + 5.786x_9 \quad (13)$$

Odds ratio (unit change): constant (0.000); x_1 (145.765), x_2 (15.154), x_3 (110.377); x_4 (0.006); x_5 (0.084); x_6 (0.002); x_7 (170.793), x_8 (0.027); x_9 (325.774).

Final loss = 38.904; chi-square (df,=9) = 184.752; p = 0.000 (see Table 2).

Logistic Regression Analysis Obubra LGA

$$AIN = -13.762 + 4.485x_1 + 6.576x_2 - 3.244x_3 - 13.72x_4 - -3.261x_5 + 5.894x_6 + 5.023x_7; - 8.136x_8 + 5.224x_9 \quad (14)$$

Odds ratio (unit change): constant (0.000); x_1 (88.692), x_2 (717.832), x_3 (25.639); x_4 (0.000); x_5 (0.038); x_6 (362.752) x_7 (151.869), x_8 (0.000); x_9 (185.697) (4)

Final loss = 30.154; chi-square (df,=9) = 152.39, p = 0.000.

Logistic Regression Analysis Ikom LGA

$$AIN = -20.06 - 0.939x_1 - 5.17x_2 - 3.632x_3 - 7.377x_4 + 4.465x_5 + 5.366x_6 + 1.619x_7 + 3.805x_8 - 4.85x_9 \quad (15)$$

Odds ratio (unit change): constant (0.000); x_1 (0.391), x_2 (0.006), x_3 (0.006); x_4 (1598.524); x_5 (86.888); x_6 (213.932); x_7 (5.046); x_8 (44.938), x_9 (0.008).

Final loss = 23.308; chi-square (df,=9) = 175.67; p = 0.000.

Logistic Regression Analysis Boki LGA

$$AIN = -16.084 - 4.346x_1 + 6.273x_2 + 1.163x_3 + 6.183x_4 - 9.393x_5 + 4.045x_6 + 7.531x_7 - 4.87x_8 + 5.643x_9 \quad (16)$$

Odds ratio (unit change): constant (0.000); x_1 (0.013), x_2 (530.015), x_3 (3.201); x_4 (484.476); x_5 (0.000); x_6 (57.139); x_7 (1864.902) x_8 (0.008), x_9 (282.208).

Final loss = 28. 874; chi-square (df,=9) = 160.644 p = 0.000.

Logistic Regression Analysis Obudu LGA

$$AIN = -12.06588 + 5.662x_1 + 3.96x_2 + 2.677x_3 + 6.136x_4 - 10.134x_5 + 2.024x_6 - 4.658x_7 + 4.3225x_8 - 3.653x_9 \quad (17)$$

Odds ratio (unit change): constant (0.000); x_1 (261.446), x_2 (52.482), x_3 (14.536); x_4 (462.368); x_5 (0.000); x_6 (7.572); x_7 (0.009); x_8 (76.088), x_9 (38.755).

Final loss = 45.930; chi-square (df,=9) = 158.869; p = 0.000 (see Table 3).

A total of seven models were obtained for this study and presented as equations 1 to 7. According to the chi-square values, which were significant at the -level of 0.05, which is to say that $p < 0.05$, all seven models showed an overall significant fit to the data studied. Also, the majority of the estimated coefficients in equations 1-7 have p-values that are lower than 0.05, when a significance level of 0.05 is used for the test, this implies that the coefficients are not zero, since the significance threshold is being met. As regards the pooled data for the six LGAs the final loss was 384.19.

However, the remaining six models showed that the final loss in each of the six LGAs was 34.29, 38.90, 30.51, 23.31, 28.87 and 45.93 for Akpabuyo, Akamkpa, Obubra, Ikom, Boki and Obudu respectively (see Table 2 and 3). These values revealed that the important NTFPs in sacred forests and home garden were most abundant in Ikom, followed by Boki and least in Obudu.

The chi-square values that are significant at $p < 0.05$ indicate that the logit models that were produced from the combined data for all six LGAs as well as the data for each LGA on its own provided an overall significant fit to the data. The logit model provided the unique information on the availability of important NTFPs and variables used to determine it. Also, odds ratio is distinct information provided by the logit. It provides a ratio that compares the likelihood of an event occurring in one group to the likelihood of the event happening in another group. On the other hand, it seems to have highlighted the variable or variables that are primarily responsible for supporting or determining the availability of essential NTFPs.

Equally useful, is the final losses derived from the models which provided the information on the LGA with the most abundant important NTFPs. In this study, the LGA with the smallest final loss happened to be the one with the most abundant important NTFPs. Hence, the models showed that the important NTFPs were most abundant in Ikom with final loss 23.31, followed by Boki with the final loss of 28.87 while Obubra, Akpabuyo, Akamkpa and Obudu with the final loss of 30.15, 34.29 38.90 and 45.93 respectively indicating that important NTFPs continue to decrease as the value of the final loss increases (Table 4). The implication of the final loss was due to the uses and benefits derived from these NTFPs.

Also, the distances from the natural forest and the scarcity of the NTFPs probably may be the major reasons for the harvesting of NTFPs from the sacred forest and the cultivation of these NTFPs in the home gardens. This study supports several studies [13,16,17] that demonstrate how vital it is for rural residents, especially the poor, to cultivate and collect NTFPs from home gardens as an alternative source of revenue and subsistence. Additional research [14,18,19] revealed that the products support a variety of livelihoods and serve as a safety net, especially when agricultural production is inadequate to mitigate risk and fill the food shortfall gap in various areas.

Table 2. Stem diameter distribution of forest trees in Akamkpa and Akpabuyo Ecotype 1

Diameter classes						
Tree Species	0-10	10-20	20-30	30-40	40-50	>50
Brachystergia spp	5	3	1	0	1	1
Irvingia gabonensis	11	2	1	0	0	0
Canarium schwenfurthii	6	3	1	1	0	0
Poga oleosa	3	2	1	0	0	0
Pterocarpus spp	6	3	1	1	0	0
Ceiba pentondra	10	2	0	0	1	0
Alstonia booneii	5	4	0	0	0	0
Alfzelia africana	5	1	0	0	0	0
Ricinodendron heudelothii	8	4	0	0	1	1
Chrysophlum albidum	12	6	1	0	0	0
Cyanastrum cordifolium	10	3	2	0	0	0
Pentaclethra macrophylla	7	2	0	1	0	0
Pterocarpus mildbraedii	13	2	0	0	0	0
Total	101	37	8	3	3	2

Table 3. Stem diameter distribution of forest trees in Obubra and Ikom-Ecotype 2

Tree species		**Diameter classes**				
	0-10	10-20	20-30	30-40	40-50	>50
Brachystergia spp	6	4	2	1	0	0
Irvingia gabonensis	37	12	1	0	0	0
Canarium schwenfurthii	4	1	2	0	1	0
Poga oleosa	14	5	0	0	0	0
Pterocarpus spp	12	10	4	2	0	1
Ceiba pentondra	7	2	1	0	1	1
Pterocarpus mildbraedii	9	2	0	0	0	0
Alstonia booneii	4	1	2	0	0	0
Alfzelia africana	6	1	0	0	0	0
Ricinodendron heudelothi	5	2	1	0	0	0
Chrysophlum albidum	4	2	1	0	0	0
Cyanastrum cordifolium	10	5	1	1	0	0
Pentaclethra macrophylla	2	1	0	0	0	0
Total	120	48	15	4	2	2

Table 4. Stem diameter distribution of forest trees in Obudu and Boki- Ecotype 3

Diameter classes						
Tree Species	**0-10**	**10-20 20-30**	**20-30**	**30-40**	**40-50**	**>50**
Brachystergia spp	6	1	2	0	1	1
Irvingia gabonensis	10	4	1	0	0	0
Parkia spp	25	3	0	1	0	0
Poga oleosa	2	1	0	0	0	0
Pterocarpus spp	7	1	2	1	0	1
Ceiba pentandra	3	2	0	0	1	0
Alstonia booneii	4	1	0	1	0	0
Alfzelia africana	2	2	1	1	0	0
Autrenelia congolensis	6	2	0	0	0	0
Chrysophlum albidum	4	1	0	0	0	0
Cyanastrum cordifolium	6	3	1	0	0	0
Pentaclethra macrophylla	6	4	2	0	0	0
Pterocarpus mildbraedii	10	3	3	0	0	0
Total	91	28	12	4	2	2

Logistic Regression Analysis of Availability of NTFPs

The models obtained for this study were presented in equations 30, 31, 32, 33, 34, 35 and 36. The model aimed to describe the nature of association in terms of a parsimonious number of parameters and hypotheses concerning the model parameters. According to the chi-square values, which are significant at a level of 0.05(P < 0.05), all seven models that were presented offered a significant overall fit to the data. This was determined by the results of the analysis. The estimated coefficients in equations 30, 31, 32, 33, 34, and 25 and 36 all have p-values that are less than 0.05, which indicates that there is sufficient evidence that the coefficients are not zero. When the data from the six LGAs were pooled together, the final loss was 384.19. However, the models showed that the final loss in each LGAs was 34.29, 23.31, 28.87, 38.90, 30.15 and 45.93 for Ikom, Boki, Akamkpa, Akpabuyo, Obubra and Obudu. These values indicated that sacred forests and home gardens were best practised in Boki, followed by Obudu, while they are less noticed in Ikom.

Based on the X^2 - significant values at $P < 0.05$, it seems that the seventh logit models provided an overall significant fit to the data when applied to the pooled data from the six LGAs as well as the data from each LGA individually.

The logit model provided unique information on important NTFPs in sacred forests, home gardens, and variables used to determine the knowledge and use of these important resources. The odds ratio is the specific piece of information that is offered by logit. It compared the chances of something happening in one group to the chances of something else happening in another group. As a result, it pointed to the factors that most strongly support or are primarily responsible for determining the acceptability of the idea of holy woodlands and home gardens. The final loss derived from the models indicated that important NTFPs in sacred forests and home gardens were strongest in Obudu, followed by Boki and least in Ikom. The implication of these final losses was probably due to awareness of sacred forests and home gardens and outputs derivable from them. However, Obudu proved the communities' deep level of practising sacred forest, whereas, in Ikom, land hunger is a major obstacle.

5. Summary

NTFPs can benefit the local economy and enhance natural resource management, ultimately contributing to protecting an area's environment and biodiversity. NTFPs are important in Cross River State's subsistence farming and commercial sector. Individuals in this region have adopted the cultivation, gathering, and selling of NTFPs as a traditional way of life to suit their everyday requirements. However, the level to which NTFPs are employed varies greatly amongst families in the region, reflecting how they constitute a vital element of rural subsistence. These NTFPs are often grown in home gardens, which are not common in the research region. These gardens provide an acceptable answer to various difficulties, such as huge forest resource degradation and depletion, environmental improvement, and landscape enhancement. With its intense and diversified land uses in these locations, the home garden offers a safety net for homes when food goods are scarce. These gardens are essential sources of food, medicines, spices, herbs, and money. They are also critical for the long-term preservation of various distinct genetic resources. This strategy encourages whole–family and whole–community participation in food production by integrating infield agriculture with other home duties and scheduling.

As a result of the preceding, NTFPs play an important role in rural livelihood and gardening. Sacred woods are age-old customary nature convention procedures implemented by the selected Local Government areas; they were the first democratic method by the people to safeguard the environment from over-exploitation even before the word "democracy" was created. However, holy woods are conserved in this region for various reasons, including the fact that they house the gods or the spirits of the ancestors. They serve as places for religious activities and conserve culturally significant species (NTFPs) primarily for medicinal purposes. Despite shifting social and political conditions, religious beliefs that justify the survival of holy woods in the region have persisted. Thus, there is a necessity to raise awareness about the significance of holy forest protection and to include people in its conservation and management to explore the possibilities for livelihood development.

6. Conclusions

As an alternative source of income and livelihood, the cultivation and harvesting of NTFPs from home gardens are important sources of food and cash for rural people, especially the poor. These indigenous peoples in the study areas have been making use of NTFPs for a significant amount of time, maybe going back to the beginning of their settlement history. These goods contribute to a diverse livelihood base, functioning as a safety net, especially when agricultural output is insufficient to reduce risk and meet the food shortage gap. Likewise, families with home gardens gain more from NTFPs than those without. In general, inadequate market access and infrastructure are the key bottlenecks influencing the production of NTFPs in the region. As a result, fixing the current deficient market infrastructure will simultaneously alleviate associated difficulties restricting the study area's economic potential.

Sacred woods have been around for hundreds of years and are now a treasure trove of local wildlife. The forest structure is likewise distinctive, reflecting the least damaged old-growth regions.

1. They serve many purposes:
2. They aid in the preservation of vulnerable forest ecosystems.
3. They save many endemic or extinct plant and animal species.
4. They protect the local populations' culture and traditional beliefs.

The integrity of these pockets of the forest is jeopardised when traditional systems deteriorate for various reasons. It is worthwhile to attempt to implement the eco-tourism method in holy woods to create chances for alternative incomes for the local populations that live inside and around them while also conserving their biological resources, cultures, and traditions. The importance of educating the local people about eco-tourism cannot be overstated. Tourists should also be informed about the local cultures and traditional values of their towns. It should be underlined that all stakeholders, including local people, NGOs, and government organisations (Tourism, Forestry, Land, and Environment), must be included in the design of eco-tourism initiatives in holy woods. National forestry policy should be supportive of NTFP growth. The primary emphasis of the local community should be on wood and NTFP production, particularly in the home garden.

A strong local institution can help to create NTFPs. development agencies and (local) government should encourage the formation of a strong local institution. Rural people, especially the impoverished, are increasingly reliant on forest resources for a living since they have fewer other revenue streams. It is recommended that policies, strategies, and interventions aimed at reducing people's reliance on natural resources pay special attention to the poor by developing policies and strategies aimed at increasing the productivity and production of NTFPs home gardens per unit area through intensification of agricultural production, provision of improved technology, extension service, and design of income-generating activities such as the promotion of organic farming.

As pressure from growing populations, urbanisation, and globalisation increases, sacred groves will become more important as some of the last refuges of natural habitat and important links to traditional practices. Local markets are a sure way to reach some of the poorest people and play an important role in strengthening livelihoods and providing income opportunities. It is recommended that policies or strategies to improve marketing facilities for NTFPs be prioritised. Since they need to understand what customers want, local communities to have adequate access to information on the market. Domestication of economically valued items is becoming increasingly significant as NTFPs from natural forests dwindle. Domestication, such as home garden farming, may assure product sustainability. This dual method (natural and domesticated) is much superior to depending just on the natural environment.

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