

Analysis of sales, costs and demands for timber species in selected timber markets of Plateau State, Nigeria

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ABSTRACT

In this study, analysis of sales, costs and demands for timber species was carried out in selected timber markets of Plateau State, Nigeria. Association as well as relationship between factors influencing timber sales, costs and demands were investigated, and the dependency of timber sales on factors affecting it was ascertained. Data obtained through administration of 400 structured questionnaires were analysed. Results from the use of descriptive statistics showed that *Khaya senegalensis* (mahogany) was the mostly demanded timber species by consumers, and that the cost per timber species for most of the sawn woods ranged between N1001 and N1500, which was equivalent to US \$2.42–\$3.63 using the current conversion rate of Nigerian Naira 413.83 to 1US dollar. Pairwise use of Pearson product moment correlation (PPMC) indicated positive correlation between timber sales and variables representing costs, demands, stored timber and spoiled timber species. F-test statistics showed that timber sales were significantly affected, and *t*-test aided identification of the extent to which timber sales were affected by costs, demands, stored timber and spoiled timber species. Further analysis of results using multiple linear regression (MLR) gave a model representing dependence of timber sales on factors affecting them. With a positive correlation and relationship between variables, possibility of future increase in timber sales may be experienced due to increase in demand coupled with other factors. Therefore, timber regulatory agencies have to put in place measures to encourage planting of trees such as *Khaya senegalensis* (mahogany), whose timber species are mainly demanded by consumers of wood products, and curb excessive overexploitation of forests in Plateau State, Nigeria.

KEY WORDS

cost, demand, plateau, sales, timber

INTRODUCTION

Timber is one of many forest products usually obtained from trees that have been sawn into logs of wood made ready for use in construction of bridges, buildings and carpentry. Some commonly demanded timber species of trees are not readily available in Plateau State, Nigeria. Sometimes, the cost of some highly desired timber species is not within affordable range for some users, which often leads to choice of alternative species, which are often brought from other states of Nigerian federation outside the Plateau State. Some timber species found in the timber markets of Plateau State at the time of this study are *Khaya senegalensis* (mahogany), *Triplochiton scleroxylon* (obeche), *Milicia excelsa* (iroko), *Prunus avium* (cherry), *Quercus robur* (oak), *Betula pendula* (birch), *Juglans regia* (walnut) and *Cedrus deodara* (cedar), among other available timber species.

Ajewole et al. (2016) considered 27 sawn wood species in the capital city of Oyo State in Nigeria, and results from their study showed *Gmelina arborea* as the most preferred wood species among users in Ibadan, which is the capital city of Oyo State. Their study was centred on users' preferences; they did not consider analysis of costs of sawn wood in their study area. While studying variations in prices for sawn wood in three cities of Nigeria, namely, Benin, Ibadan and Lagos, Arowosoge et al. (2011) considered four commonly used wood species among furniture makers and their results indicated significant variation in the mean annual price of wood species. However, their research was restricted to furniture industry in the southern part of Nigeria, which is known as the wood-producing area of Nigeria.

Awe et al. (2019) studied availability of timber species among timber traders in selected markets using structured questionnaires in Kogi State located in the north-central part of Nigeria. Their research showed that *Terminalia* sp., *Milicia excelsa* and *Nauclea diderichii* were not readily available in their study area as such trees have become endangered species due to over-exploitation. While analysing timber marketing in one of the cities in the southern part of Nigeria, Okeleke (2020) reported in his results that marketing of timber indicated a market structure that tended towards monopoly with indication of high profitability for those in the business. However, his study did not consider northern part of Nigeria since the focus was on sales

and profitability of timber in the southern part of Nigeria. The research of Adegbenjo et al. (2021) considered wood species mainly sold in some markets of Alimosho Local Government Area of Lagos State located also in the southern part of Nigeria from an economic perspective. They also indicated that commonly traded wood species in their study area were profitable, especially with an emphasis on 2×6 inch plank size. Ariwoola et al. (2020) also investigated wood species with respect to demand and listed that *Terminalia superb* (afara), *Tectona grandis* (teak), *Milicia excelsa* (iroko), *Mansonia altissima*, *Gmelina arborea* (gmelina), *Cordia millienii* (omo), *Ceiba pentandra* (araba) and *Nauclea diderichii* (opepe) were preferred in that order based on price, hardness and durability of the wood species; but the focus of their study was on demand preference in a city also located in the southern part of Nigeria.

While investigating accessibility of timber species in some timber markets of Oyo State, Famuyide et al. (2012) discovered that *Tectona grandis*, *Nauclea diderichii*, *Terminalia* spp., *Khaya senegalensis* and *Milicia excelsa* have become scarce due to over-exploitation. Their study further showed that timber species of low quality were more available in the study markets, and the study recommended planting of trees which are fast growing, so as to meet the rising demands for good-quality timber species in six geopolitical zones of Nigeria. From the foregoing researches in literature, there has not been a research which considered analysis of sales, costs and demands for timber species in the main timber markets of Plateau State located in the north-central region of Nigeria. Most of the existing studies (Adedokun et al. 2017; Babalola et al. 2018; Faleyimu 2014; Bello and Mijinyawa 2010) have focused on timber species commonly found in the southern part of Nigeria. Only a few works whose objectives are different from those of this study have considered other regions of Nigeria.

Motivation to embark on this research centres on investigating timber species mostly demanded by consumers of wood products in markets of one of the north-central states of Nigeria. This includes determination of sales and cost per timber species of mostly demanded timber in two main timber markets of Plateau State, Nigeria. It also involves a model of monthly sales of timber species, which had not been previously found in literature for the study area.

In this study, we aim to determine sales, costs and demands for timber species in selected timber markets of Plateau State, Nigeria. The specific objectives of this study are to determine mostly demanded timber species by consumers of wood products, cost per timber species and dependence of timber sales on factors influencing it. The remaining part of this study is organised as follows: section 2 is materials and methods, section 3 is results and discussion and section 4 concludes.

MATERIAL AND METHODS

Study area

Plateau State is situated in the north-central geopolitical zone of Nigeria on coordinates 9°34’N and 9°04’E. This study focused on Plateau Timber Market Katakò and Railway Timber Market in Plateau State. The timber market in Katakò is divided mainly into two sections: the first section is called timber A and the second section of Katakò market is known as timber B. The market first existed in the area called Kwararafa in Jos city of Plateau State. Majority of the traders in the market stated that some timbers were from forests within Plateau State and others from some neighbouring states. However, some of the traders acknowledged that their wood products were from the southern part of Nigeria. The Railway Timber Market was founded in 1952 under Nigeria Railway Corporation in Jos, Plateau State. It is located close to British and American roads in proximity to Murtala Muhammad road in Jos.

Design Framework

This study is designed to measure the effect of factors affecting timber sales in some timber markets of Plateau State. The response of timber sales to factors affecting it is shown in Figure 1.

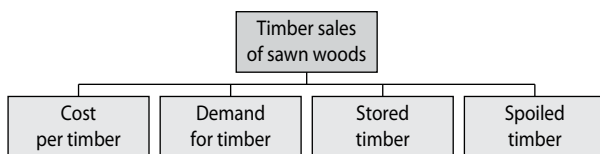


Figure 1. Schematic representation of design framework

Figure 1 shows the design framework for this study which investigates the impact of cost per timber spe-

cies, demand for timber by consumers of wood products, stored timber and spoiled timber species on timber sales of sawn woods in some timber markets of Plateau State.

Data Collection and Sampling Techniques

Data for this study were collected from 400 respondents. Structured questionnaires were administered to timber traders in Plateau Timber Market Katakò and Railway Timber Market in Plateau State. Purposive sampling technique was adopted in the choice of the market, and simple random sampling technique was used for administration of the questionnaires to timber traders.

Data Analysis

Descriptive statistics, F-test statistics, *t*-test and multiple linear regression (MLR) analyses were used to perform statistical analysis of the data collected in this study, using Statistical Package for Social Sciences (SPSS) version 23.

Model Specification

Let X_i ($i = 1, 2, 3, 4$) represent independent variables which are predictors of a model, such that $i \in \mathbb{N}$ is an index. Let X_1, X_2, X_3 and X_4 be cost per timber, demand for timber species by consumers of wood products, quantity of timber stored by sellers and quantity of timber spoiled, respectively, in selected markets of Plateau State. Let b_i ($i = 0, 1, 2, 3, 4$) be some unknown constants and some parameters associated with independent variables. Let Y represent timber sales in selected timber markets of Plateau State. Then, MLR is defined by the equation

$$Y = f(X_i, b_i) + \epsilon \tag{1}$$

where:

- $f(X_i, b_i)$ – a function representing cost per timber species, demand for timber species by consumers of wood products, quantity of timber stored by sellers and quantity of timber spoiled in selected markets of Plateau State,
- ϵ – the associated functional error.

For the four independent variables, equation (1) gives MLR analyses for X_i ($i = 0, 1, 2, 3, 4$) as follows:

$$Y = b_4X_4 + b_3X_3 + b_2X_2 + b_1X_1 + b_0 + \epsilon \tag{2}$$

The pairwise use of Pearson product moment correlation (PPMC) is given by the equation

$$r = \frac{N\sum X_i F - (\sum X_i) - (\sum F)}{\sqrt{[N\sum X_i^2 - (\sum X_i)^2] [N\sum F^2 - (\sum F)^2]}} \quad (3)$$

where:

r – the correlation coefficient, such that $-1 \leq r \leq 1$.

RESULTS AND DISCUSSION

The timber demanded by species and the number of pieces of sawn wood demanded are shown in Table 1 based on data obtained from 400 respondents in selected timber markets of Plateau State.

Table 1. Demand for timber species by pieces demanded monthly in selected timber markets of Plateau State

| Timber species | 1–100 pieces | 101–200 pieces | 201–300 pieces | 301–400 pieces | 401–500 pieces | Above 500 pieces | Total | % demands from consumers |
|--|--------------|----------------|----------------|----------------|----------------|------------------|-------|--------------------------|
| <i>Khaya senegalensis</i> (mahogany) | 35 | 52 | 43 | 7 | 13 | 29 | 179 | 44.8 |
| <i>Triplochiton scleroxylon</i> (obeche) | 12 | 24 | 15 | 10 | 0 | 9 | 70 | 17.5 |
| <i>Prunus avium</i> (cherry) | 3 | 5 | 3 | 0 | 0 | 1 | 12 | 3.0 |
| <i>Milicia excels</i> (iroko) | 5 | 7 | 4 | 1 | 2 | 5 | 24 | 6.0 |
| <i>Betula pendula</i> (birch) | 0 | 1 | 0 | 0 | 1 | 2 | 4 | 1.0 |
| <i>Quercus robur</i> (oak) | 2 | 0 | 0 | 0 | 0 | 4 | 6 | 1.5 |
| <i>Juglans regia</i> (walnut) | 0 | 1 | 0 | 0 | 0 | 1 | 2 | 0.5 |
| <i>Cedrus deodara</i> (cedar) | 0 | 1 | 0 | 0 | 0 | 0 | 1 | 0.3 |
| Others | 5 | 14 | 37 | 11 | 3 | 32 | 102 | 25.5 |
| Total | 62 | 105 | 102 | 29 | 19 | 83 | 400 | 100.0 |

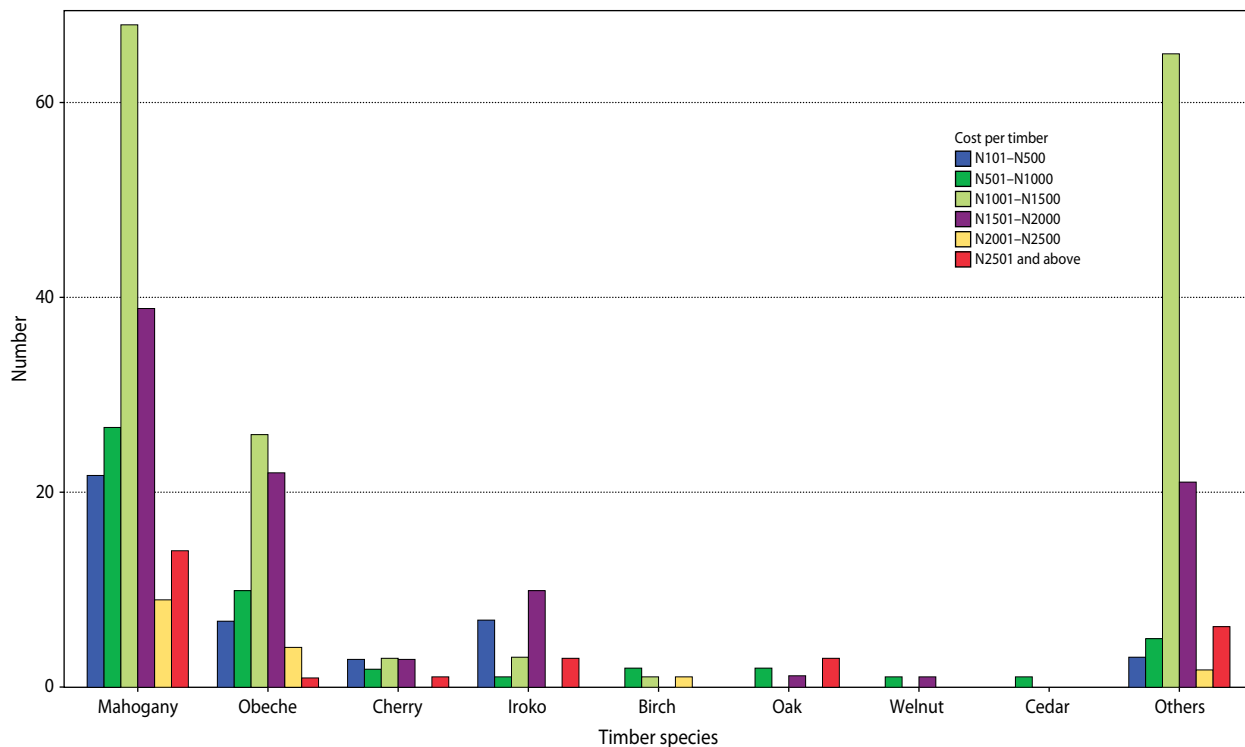


Figure 2. Cost per timber species in surveyed markets of Plateau state, Nigeria

Using descriptive statistics as shown in Table 1, about 44.8% of the timber traders reported mahogany as the mostly demanded timber species in Plateau Timber Market, Katako and Railway Timber Market in Plateau State. Timber species categorised as ‘Others’ constitute about 25.5% of timber species demanded monthly in selected markets of Plateau State. However, timber species classified as ‘Others’ in this study included *Gmelina arborea* (gmelina), *Tectona grandis* (teak), *Mansonia altissima* (mansonia) and *Terminalia ivorensis* (black afara). Those in the ‘Others’ category are the second mostly demanded set of timbers by consumers of wood products in the survey of timber markets of Plateau State. Results shown in Figure 2 indicate cost per timber of available timber species.

It can be seen in Figure 2 that sawn wood with cost per timber in the price range of N 1001–N 1500 (US dollar \$2.42–\$3.63) at the exchange rate of 1dollar = 413.83 Nigerian Naira is more readily available for sale in the surveyed timber markets of Plateau State. There are exceptions such as oak, walnut and cedar, which are not so common in the markets. However, sawn wood from iroko timber species has a higher price range than other timber species and it is in the price range of N 1501–N 2000 (US \$3.63–\$4.83) at the exchange rate of 1dollar = 413.83 Nigerian Naira.

The results presented in Table 2 show PPMC of cost per timber species, demand for timber by consumers of wood products, quantity of timber stored and quantity of timber spoiled with timber sales.

Table 2. Pairwise PPMC of cost per timber, demand, quantity of timber stored and quantity spoiled with timber sales in selected timber markets of Plateau State

| PPMC | Cost per timber | Demand for timber | Stored timber species | Spoiled timber species |
|--------------|-----------------|-------------------|-----------------------|------------------------|
| Timber sales | 0.381 | 0.634 | 0.592 | 0.265 |

A positive correlation was obtained in a pairwise comparison of timber sales with cost per timber species, demand by consumers for wood products, stored quantity and spoiled quantity of timber species. This suggests that there exists some degree of pairwise relationships between timber sales and other factors such as cost, demand, stored quantity and spoiled quantity.

Demand for timber species by consumers with PPMC value of 0.634 indicated a factor with strongest strength among the factors correlated with timber sales in Plateau Timber Market, Katako and Railway Timber market in Plateau State.

About 50.5% variation occurs in timber sales in response to the factors affecting it, as shown in Table 3.

Table 3. Response of timber sales to demand, cost, stored quantity and spoiled quantity of timber in selected timber markets of Plateau State

| Model ^a | R | R ² | Adjusted R ² | Std error of the estimate |
|--------------------|--------------------|----------------|-------------------------|---------------------------|
| 1 | 0.710 ^b | 0.505 | 0.500 | 1.237 |

^a dependent variable: timber sales (monthly); ^b predictor: (constant), cost per timber, demand for timber, stored timber and spoiled timber species.

To investigate the possibility of $R = 0.710$ occurring by chance or otherwise as shown in Table 3, F-test statistics was carried out on the timber sales and other associated variables. The results of the F-test statistics are shown in Table 4.

Table 4. F-test statistics for timber sales and associated variables at $\alpha = 5\%$ level of significance

| Model ^a | Sum of squares | df | Mean square | F | p-value |
|--------------------|----------------|-----|-------------|---------|------------------------|
| Regression | 612.182 | 4 | 153.045 | 100.072 | 0.000 ^{(b)++} |
| Residual | 601.037 | 393 | 1.529 | | |
| Total | 1213.219 | 397 | | | |

^a dependent variable: timber sales (monthly); ^b predictor: (constant), cost per timber, demand for timber, stored timber and spoiled timber species.

Results presented in Table 4 with p -value < 0.05 indicate significant effect of predictor variables on dependent variable at 95% confidence bound. This suggests that timber sales are significantly affected by factors such as cost per timber, demand for timber by consumers of wood products, quantity stored which represents availability of wood products and quantity spoiled during the period of sales of the timber species in the markets. It should be noted that F-test statistics could not, however, pinpoint which or how many of the predictor variables are mainly influencing the dependent variable of the study. To determine how the predictor variables are affecting the dependent variable, t -test is employed as shown in Table 5.

Table 5. *t*-test statistics of timber sales when associated with predictor variables

| Model ^a | B | Std error | Beta | t | <i>p</i> -value | Lower bound | Upper bound |
|--------------------|-------|-----------|-------|-------|---------------------|-------------|-------------|
| (constant) | 0.346 | 0.193 | | 1.788 | 0.074 ⁺⁺ | 0.034 | 0.725 |
| Cost per timber | 0.160 | 0.055 | 0.114 | 2.898 | 0.004 ⁺⁺ | 0.051 | 0.268 |
| Demand for timber | 0.413 | 0.044 | 0.407 | 9.322 | 0.000 ⁺⁺ | 0.326 | 0.500 |
| Stored timber | 0.287 | 0.042 | 0.307 | 6.895 | 0.000 ⁺⁺ | 0.205 | 0.369 |
| Spoiledtimber | 0.087 | 0.040 | 0.081 | 2.177 | 0.030 ⁺⁺ | 0.008 | 0.165 |

^a dependent variable: timber sales (monthly); ⁺⁺ significant at $\alpha = 5\%$ level of significance.

Results presented in Table 5 as obtained by *t*-test statistics show that all predictor variables except the constant term are statistically significant ($p < 0.05$). This suggests that sales of timber species are significantly affected by cost per timber species, quantity of timber demanded by consumers of wood products, quantity of timber stored and quantity of timber spoiled during the period of sales of the sawn woods in the study areas of Plateau State. This means that at 95% confidence bound, timber sales are affected by the aforementioned predictor variables.

To determine the dependence of timber sales on cost per timber, demand for timber species by consumers of wood products, quantity of timber stored and quantity of spoiled timber, this study used MLR model. While the MLR model considered the constant of the relationship, cost per timber species, demand for timber species by consumers of wood products, quantity of timber stored and quantity of timber spoiled as independent variables, the dependent variable was timber sales of sawn wood. Hence, using Table 5 with the aid of equation (2) gives the following MLR model equation:

$$Y = 0.160 X_4 + 0.413 X_3 + 0.287 X_2 + 0.087 X_1 + 0.346 \tag{4}$$

which is the equation for timber sales in selected timber markets of Plateau State.

The dependent variable *Y* represents the timber sales and X_1, X_2, X_3, X_4 are predictor variables affecting timber sales as defined in equation (2).

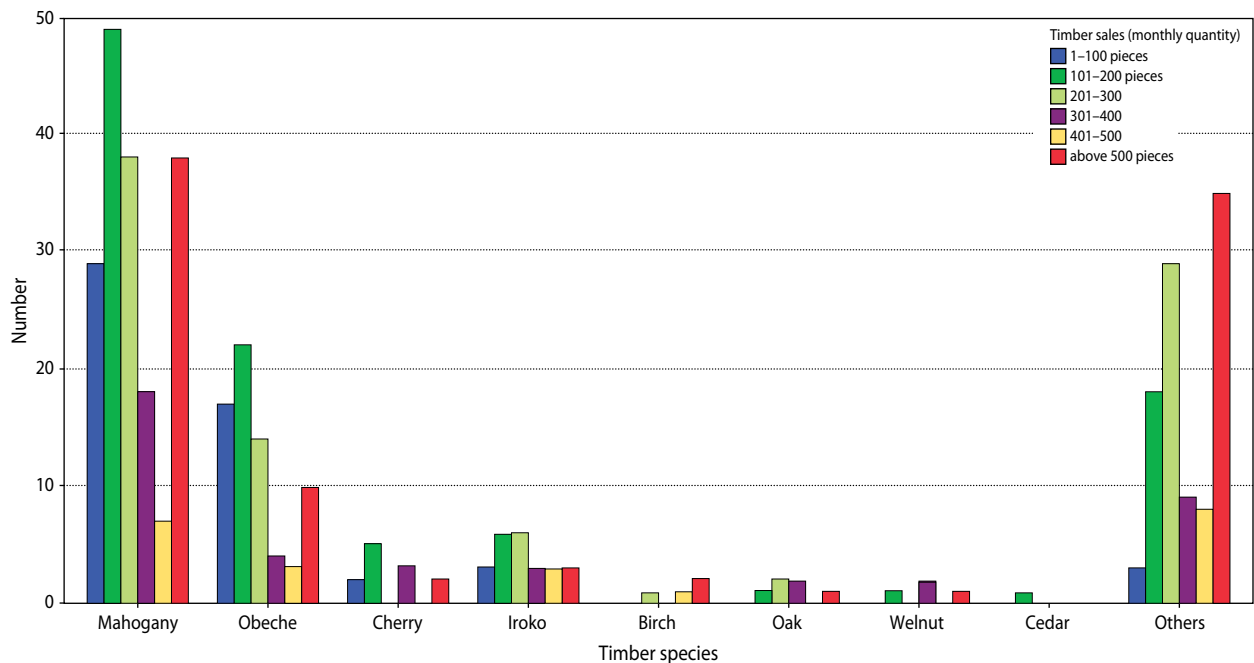


Figure 3. Timber sales of surveyed timber markets of Plateau State, Nigeria

Figure 3 shows the timber sales of sawn wood by available timber species in selected markets of Plateau State. It shows that *Khaya senegalensis* (mahogany) constitutes the major timber species most commonly sold in the surveyed markets of Plateau State.

While this study is in agreement with the research of Francis et al. (2017) and Chaskda et al. (2021) that forests of Plateau State are highly exploited leading to devastating effects on the ecosystem, there are differences in the type of wood exploited for different purposes. If over-exploitation of forests is not controlled in Plateau State, more forests will disappear in future. Although there are forest areas such as Amurum Forest Reserve (Abiem et al. 2017; Agaldo 2019), Jos Wildlife Park (Chaskda 2017) and Pandam Game Reserve (Turshak et al. 2021), among others, which are reserved in Plateau State, Nigeria, there are others such as Shere Hills (Francis et al. 2017) which should also be conserved to increase the number and types of different timber species. There is a need to create more reserved forests to protect endangered species of trees that may be cut down for sales in the markets of Plateau State, as such reservation of forests can help to reduce unhealthy anthropogenic activities which include logging, grazing, hunting, bush burning, collection of fuel wood and non-timber products.

Results of over-exploitation of forests are obvious as discussed in the study by Sambe et al. (2022). Their study pointed out that limited wood supply was the biggest challenge to furniture production in Plateau State. This study also agreed with the study of Sambe et al. (2022) that *Milicia excelsa* is highly demanded by consumers of wood products, hence its price was significantly higher than others in the selected markets of Plateau State. Also, some researchers have shown that forests have positive effects on economic growth of Nigeria, but the findings of Oyetunji (2019) indicated that such effects are not statistically significant.

CONCLUSIONS

In this research, analysis of the effect of cost per timber species, demand for timber species by consumers of wood products, quantity of stored timber and quantity of spoiled timber species on timber sales of sawn wood in selected markets of Plateau State was carried

out. It was found from the study that *Khaya senegalensis* (mahogany) was the mostly demanded timber species by consumers of wood products. Furthermore, cost per timber species of majority of sawn woods had an average price range of N1001–N1500 (US \$2.42–\$3.63) at a rate of 1dollar = 413.83 Nigerian Naira, with the exception of *Milicia excelsa* (iroko), whose average price range was slightly higher than that of other sawn woods from different timber species.

Analysis of data using PPMC indicated positive correlation when pairwise comparison was made for timber sales with other variables. Further analysis using other statistical tools confirmed prediction of timber sales from the effects of factors such as costs, demands by consumers for wood products, stored quantity and spoiled quantity of timber species in the surveyed markets of Plateau State. However, future upward surge in timber sales may be experienced when demand for timber species by consumers of wood products soars higher, which may put pressure on existing forest trees. Further studies on forest stands around the surveyed markets would be necessary to comprehensively get composition of forest trees in the regions around the markets. In this study, since *Khaya senegalensis* (mahogany) was the mostly demanded timber species by consumers of wood products and *Milicia excelsa* (iroko) had an average price range slightly more than that of other sawn woods from different types of timber species, this study recommends planting more of *Khaya senegalensis* and *Milicia excelsa* to cushion the effects of anthropogenic activities on the ecosystem and, at the same time, boost the economic activities of timber sellers in the markets of Plateau State.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interests.

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