



## Influence of log form on conversion efficiency of some sawmills in Oluyole local government of Oyo state, Nigeria

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### Abstract

Factors influencing lumber yield and value have been identified as the factor influencing the lumber recovery from logs during conversion in the mills. These include log shape (sweep, taper, crooked and straight), log size (girth, and the length) kinds of conversion and processing machine, machine maintenance culture, availability of machine part and experience of the operator. To improve on the lumber recovery, the conversion efficiency of the available functional sawmill must be assessed, hence the research. The study was carried out in selected sawmills in Oluyole local government area, Oyo state, Nigeria. Eight (8) sawmills, namely: Ore Ofe sawmill, Dicktard sawmill, Kolapo sawmill, Tiamiyu sawmill, Manshalau sawmill, Olaoluwa sawmill, Sumibare sawmill and Maleek sawmill all located at Alomoja area in Oluyole local government were sampled. Eighty (80) logs were sampled in all, ten (10) logs sampled randomly in each sawmill. The analysis of the data gathered revealed that Maleek has the highest percentage Lumber recovery of (88.2%) followed by Sumibare (86.4%), Manshalau (85.1%), Olaoluwa (83.7%), Tiamiyu (83.7%), Kolapo (81.7%), Dicktard (78.9%) and Ore-ofe had the lowest percentage Lumber recovery of (70.8%). This pattern variation may be due to log diameter classes, experience of the operator and their method of conversion. It is therefore concluded that the experience of the operator was the major determinant in sawmills and logs of large diameter and fairly straight log characteristics

**Keywords:** sawmill, log, form, straightness, taper

### Introduction

Sawmill is a factory where wood is cut into planks or boards in various sizes and shapes through the process of sawing by machine (Omobude-Idiado *et al.*, 2013) <sup>[13]</sup>. In Nigeria, sawmill size is distributed between small: medium: large scale in the percentile proportion (81%: 13%: 6%) respectively (RMRDC, 2003) <sup>[15]</sup>. Various machines used for conversion include; bandsaw (horizontal/vertical), mighty-mite, re-sawing machine (circular saw, planning machine) and many more.

Logs and sawn wood are marketed locally in designated plank markets and sawmills across the country (Aiyeloja *et al.*, 2013) <sup>[1]</sup>. Forest based industries, such as sawmills, constitute one of the largest in the Nigerian economy (Ogunsanwo *et al.*, 2005) <sup>[12]</sup>. As rightly opined by Ajibefun and Daramola (2004) <sup>[2]</sup>, the sawmilling industry, among other microenterprises is in the forefront of promoting the economic growth of Nigeria. Timber is by far the highest-valued forest product in most forests. In 2008, the export of industrial round wood, sawn wood and wood-based panels from developing countries accounted for US\$13.1 billion. In the last two decades, there has been a great concern as to whether the operational status of these industries is consistent with contemporary drive towards sustainable forest management and environmental control (ITTO, 2001; Akande *et al.*, 2006) <sup>[5, 3]</sup>.

In Nigeria, Sawmill generates various wastes such as; saw dusts, wood off cuts, wood barks, plain shavings and wood rejects (Dosunmu and Ajayi, 2002, Akinbode and Olujimi, 2014) <sup>[9, 4]</sup>. The activities of forest industry Vis - a - Vis tree harvesting, transportation, wood conversion and processing

have some negative impacts on the environment. Dumping of refuse (for example sawdust) into water bodies could block drainage and cause flooding during the rainy season, which can lead to lose of lives and properties (FAO, 1991) <sup>[10]</sup>.

Nigeria is currently experiencing scarcity and inadequate supply of round logs to the wood based Industries (Babatola *et al.*, 2011) <sup>[7]</sup>. Difficulty in getting the adequate amount of raw material inputs and species of wood has been the main obstacle of local wood products manufactures (Ametsistsi *et al.*, 2009) <sup>[5]</sup>. In recent times, the ever increasing demand for wood – based products and continuous harvesting of logs for various domestic and industrial applications has led to the reduction in forms and sizes of log available for conversion in forests, consequently leading to smaller sizes of marketable lumber generated from the sawmills (Omoniyi and Fatoki, 2013) <sup>[14]</sup>. Biodiversity is lost as a result of over – exploitation with little or no consideration for conservation and afforestation. This had threatened good choice of indigenous species. Izekor and Modugu (2011) <sup>[11]</sup> reported that about 50 – 55% of log input into the sawmill end as mill residue in the form of sawdust, slabs, off- cut and bark with only 45 – 50% lumber recovery. This had constituted a setback to sustainable management of the forest and the sustainability of the forest industries (Bhadmus *et al.*, 2013) <sup>[8]</sup>.

Supply of timber sustainably remain an issue begging for attention, therefore, there is need to conduct a research on the recovery ratio of the available sawmill and identify factors hindering adequate supply of wood for conversion and those that aid efficient conversion processes leading to minimum

wastage.

**Materials and Methods**

**Study Area**

Oluyole is a Local Government area in Ibadan, Oyo state, Nigeria. Oluyole is situated between latitude 7° 26'N and longitude 3°54'E and is located almost directly north of Lagos and it is about 200m above sea level which is typical or rain forest (low land) capable of supporting timber species. According to 2006 population census carried out by the Federal Republic of Nigeria, it was estimated that the total population of Oluyole local government was 202,725.

The annual rainfall of Oluyole local government is about (1800-2500mm) and the rain normally starts around March to October, the temperature is about 28-35°C. The humidity is usually about 80% in the morning and 50% in the afternoon. Its headquarters is in the town of Idi Ayunre and it has a land area of 629km<sup>2</sup>.

**Site Selection**

This project was carried out at sawmills in Oluyole local government.

**Table 1:** Names and Location of Sawmills Visited in Oluyole Local Government.

Sawmills	Location
Manshalau Sawmill	Alomoja
Tiamiyu Sawmill	Alomoja
Kolapo Sawmill	Alomoja
Ore-ofe Sawmill	Alomoja
Sumibare Sawmill	Alomoja
Olaoluwa Sawmill	Alomoja
Malud Sawmill	Alomoja
Dicktard Sawmill	Alomoja

Eight sawmills were visited and 10 logs were sampled/measured in each sawmill.

**Data Collection**

The following procedure was adopted for data collection on lumber recovery for the study; before conversion, the length of each log, top girth, basal girth were measured and recorded. The logs were found to be of different shaper, forms and diameter depending on the specie. The logs sawn via horizontal band saw machine, horizontal band saw travels in a rail. Saw blade was changed when necessary to ensure consistent timber sizes, the logs were firmly stationed on the rail while the horizontal band saw machine cut through the log. Slabs were cut off first by using quarter sawing method of conversion.

**Parameters Assessed**

**Determination of Log Volume**

Log input volume (v) = L/2 (Cb + Ct) (Smailianse formula)

Where,

V = Volume of log (M<sup>3</sup>)

L = Log length (M)

CB = Cross sectional area at base

Ct = Cross sectional area at top

**Determination of Lumber Recovery Ratio**

The percentage lumber recovered is the ratio of volume of lumber recovered from each processed log to that of log volume expressed in percentage (Lucas 1982, White 1983, Egbewole *et al*, 2006). This is expressed as:

$$V = \frac{W \times L \times T}{144} \times 0.0283$$

Where, T = thickness of lumber (inch), W = width of lumber (inch), L = lumber length (ft),

The percentage lumber recovered was estimated thus:

$$\%LV \times 100\%$$

Where, %LR = percentage Lumber recovered

ΣVL = (VL1 + VL2 + VL3 +----+ VLn) = total volume of lumber recovered (m<sup>3</sup>)

ΣVT = (VT1 + VT2 + VT3 +-----+ VT243) = total volume of all logs processed (m<sup>3</sup>)

**Data Analysis**

Correlation coefficient (r) was used to investigate the degree of association and the direction of relationship between the measured variable, while multiple linear regression analysis was carried out to determine the effects of the factors using the relationship described below. The coefficient of determination (R<sup>2</sup>) and standard error (SE) of estimation, mean square error (MSE) was also determined to know the proportion of variation explained by the regression equation.

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + \dots + b_nX_n + e$$

Where, X<sub>1</sub>---X<sub>n</sub> = independent variables (factors considered).

**Data Analysis of Variance (ANOVA)**

Analysis of variance (ANOVA) in complete random design (CRD) was used to test the variation that exists among the variables, considering the following factors: Input Volume, Output Volume, %Lumber recovery of log. Least Significant Difference (LSD) was used as follow up Test.

The mathematical model employed for (CRD) is:

$$Y_{ij} = U + T_i + E_{ij}$$

U = Overall mean

T<sub>i</sub> = Effect of the *i*th treatment

E<sub>ij</sub> = Random error

**Determination of Lumber Recovery Ratio**

The timber recovery ratio is the proportion of the volume acceptable, the quantity of timber produced (output), to the log input volume.

$$\text{Lumber recovery ratio} = \frac{\text{Volume of timber recovered (output) (m}^3\text{)}}{\text{Volume of log (input) (m}^3\text{)}}$$

**Wood Waste in the Selected Sawmills**

The wood waste generated are in the following forms;

- Waste due to slab

- Waste due to bark
- Waste due to sawdust

**Results and Discussion**

**Lumber Recovery on the Basis of Log Forms.**

Log form consists of geometry (log size) and log shapes. The geometry comprising log diameter class and length while log forms comprise of log shape which is categorized into: straight, sweep, tapered). This result below shows the wood conversion efficiency varying according to the form of the log.

**Table 2:** Variations in Log Forms From different Sawmills

Name of sawmill	Straight	Sweep	Taper
Ore Ofe	52.31	39.20	8.48
Dicktard	90.88	9.10	_____
Kolapo	72.33	9.35	18.31
Tiamiyu	72.24	18.80	8.94
Manshalau	61.08	31.10	8.78
Olaoluwa	82.05	8.83	9.10
Sumibare	82.44	17.55	_____
Maleek	72.44	25.78	_____

**Table 4:** Analysis of Variance (ANOVA) for Input Volume, Output Volume, and %Lumber Recovery

Source of Variance (SV)	Sums of Square (SS)	Degree of Freedom (DF)	Mean Square (MS)	F-cal F-tab
Sawmill	7	1673.81	239.12	9.38* 2.13
Error	72 1619.42 22.49			
Total	79 3293.23			

**Note:** \*= There is significant at 0.05 level of probability

At 0.05% level of probability there is significant difference between, the-sawmill selected and input and output.

**Table 5:** Follow-up Test (LSD)

Sawmill	Mean`
Sumibare	63.80a
Maleek	73.70b
Manshalau	74.00b
Olaoluwa	75.80bc
Kolapo	77.00bc
Tiamyu	77.10bc
Ore-ofe	77.80bc
Dicktard	81.30c

The mean with the same alphabet are not significantly different from one another.

**Table 6:** Years of Experience of Operator at the Selected Sawmills

Sawmill	Bandsaw	Sawdoctor
Dicktard	6- 10 yrs	12-19yrs
Kolapo	0-5 yrs	13-19yrs
Tiamiyu	11-15yrs	5-9 yrs
Manshalau	16-19 yrs	7-10 yrs
Olaoluwa	17-21 yrs	13- 16 yrs
Sumibare	6-10 yrs	11-14 yrs
Maleek	12-17 yrs	0-7 yrs
Oreofe	16-20 yrs	14-21 yrs

Thus some of the logs have higher recovery efficiency value than one another. This finding agrees with the earlier report of Guernsey (1996) that wood conversion efficiency would depend on the form of the log, all other factors being equal.

**Table 3:** Correlation Analysis of Lumber Recovery on the Basis of Diameter Class

	Base	Top	Log Length	Vol of Log	Vol. of Lumbr	EVT
Base	1					
Top	-0.032	1				
Log Length	0.360	-0.365	1			
Vol of log	0.890	-0.090	0.288	1		
vol. of lumber	0.803	-0.149	0.445	0.853	1	
EVT	0.33	0.182	0.461	0.317	0.763	1

The result of the correlation analysis indicated that there was a positive significant correlation between base diameter class and lumber recovery (0.33), between the top diameter class and lumber recovery (0.182), between the volume of log and lumber recovery (0.317), between the volume of lumber and lumber recovery (0.763).

**Maintenance of Machine**

Machines are maintained by the frequent supply of spare parts in which without this hinders the work output of the machine. It was observed during the research that machines are not properly attended to as in the general maintenance of the machine. Another method of maintaining the machine is lubricating and check-up of the machine part before use, and greasing it where it is supposed to be done. The user must equally consider the maintenance material piece of rules and requirements to keep the life span of the machine longer.

**Source of Raw Material**

The sawmillers obtained their raw material from the forest reserve either by government reserve free areas. Some saw millers obtain their logs from free areas as raw material are near to them, shorter distance covered during transportation. It could be that the logs from free areas are merchantable and sizeable coupled with the demand of their numerous customers. Hence, the saw millers that obtain theirs from government reserved areas do so as they are concessionaires and the availability of required growth logs coupled with nearness of construction works in their locations, which could be due to availability of trucks and falling equipment in their locations.

Sawmill industries in Oluyole local government area of Oyo state can be categorized into three categories namely the large scale, which are mostly integrated wood processing industries followed by the medium which are intermediary wood processing industries and the small scale which have the largest percentage in the metropolis than the others.

These sawmills are mostly involved in processing of round logs to lumber for local consumers. The result in this study is in agreement with the reports of many researchers (Alviar, 1983; Akindele and Fuwape, 1998; Onyekwelu, 2002) <sup>[18, 17, 22]</sup>.

Most of sawmills in Oluyole local government area use the CD-6 horizontal band saw machine for log conversion. The CD band saw machines are particularly suited for the conversion of large dimension logs (Onyekwelu, 2002). Thus, the use of “CD machines”, especially CD-6 for processing small dimension logs is associated with poor sawing efficiency, under-utilization of the machine as well as low log recovery rate (Onyekwelu, 2001) <sup>[23]</sup>. Consequently, the high percentage volume of wastes generated in sawmills investigated in this study could be attributed to the use of CD-6 machines. Since logs from the forests are increasingly becoming small dimension logs (Akindele and Fuwape, 1998) <sup>[17]</sup>, it follows that the current sawmill technology in Nigeria may not be appropriate for processing products from the forests (Onyekwelu, 2002) <sup>[22]</sup>. The implication of the results for log conversion in each of the selected sawmill is that the sawmill may not perform better than its present state, unless there are improvements on their operational procedures and change in type of conversion machines. Onyekwelu (2001) <sup>[23]</sup> suggested two approaches in addressing the problem of processing of logs from Nigeria forests, which are (i) managing the forests to produce logs of large dimensions suitable for the current wood processing technology and (ii) changing the processing technology to adapt to the small dimension logs from the forests

The efficiency and waste generation of any sawmills could be measured by the quantity of finished products from the log and the volume of waste generated. It could be observed that the waste generation from sawmills examined is almost the same. This could be as a result of size of logs and the machine type. The result from this study showed similarities with the study conducted by Olufemi *et al.*, (2012) <sup>[21]</sup>. The discovery from this work is higher than the work reported by Alviar (1983) <sup>[18]</sup> among sawmills in Ibadan, Lagos and Benin City. The result of this work is in agreement with the work of Egbewole *et al.*, (2011) <sup>[20]</sup> where it was reported that, the mean technical production efficiency (TPE) which is refer to as mill efficiency in this study for log conversion in the 9 selected small scale ( $\leq 10,000\text{m}^3$  log/year) sawmills was 53.41%. It was observed that small scale sawmills in Ondo State had the highest mean TPE of 58.07% - a similar trend reported in this study for small scale sawmill in this study was in accordance with the study carried by Egbewole *et al.*, (2011) <sup>[20]</sup> where it was reported that Lagos State has 55.97% and sawmills in Oyo State with 46.17%. According to Badejo (1990) <sup>[19]</sup> on utilization of wood in Nigeria sawmills, 45% of wood in sawmills end up as waste which eventually are either burnt or dispose improperly and this pose a great threat to environmental stability as observed in this present study.

## Conclusion and Recommendations

### Conclusion

The findings from the selected sawmills have revealed that, Maleek has the highest % Lumber recovery of (88.2%) followed by Sumibare (86.4%), Manshalau (85.1%), Olaoluwa (83.7%), Tiamiyu (83.7%), Kolapo (81.7%), Dicktard (78.9%) and ore-ofe had the lowest % Lumber recovery of (70.8%). This pattern variation may be due to log diameter classes, experience of the operator, method of their conversion and types of machine used for the conversion. From this study it can be concluded that the shape of log has significant effect on lumber recovery.

### Recommendation

Based on the study, in order to reduce the volume of (wood wastes) in the log conversion process to engender sustainable forest management and profitable production of the sawmills, experience of the operator should be a major determinant in the sawmill, logs of large diameter and fairly straight log characteristics and how to process it should also be taken into consideration.

Further investigation into other factor that may influence timber recovery is recommended.

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