



# ASSESSMENT OF LUMBER RECOVERY EFFICIENCY AND WASTE GENERATED IN SOME SELECTED WOOD PROCESSING INDUSTRY IN SOUTH WESTERN NIGERIA

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## ABSTRACT

Lack of appropriate technologies in the wood processing industries in Nigeria has resulted in lower productivity and poor lumber recovery while in-situ primary processing of timber with appropriate technologies has not been well established to remedy this situation. This study assess the volume lumber recovery efficiency and waste generated in conventional, portable and artisanal sawmills in two selected locations within South-western Nigeria with a view to finding an alternative to this situation. Logs of about 11.34m<sup>3</sup> volume were randomly selected and data were collected on the output/volume recovery and waste generated in each of the processing method. Data collected on the waste generated was partitioned in to sawdust and slab. ANOVA was used to analyze the data and mean separation was done using Duncan post hoc test. The results of the study revealed that lumber recovery has an average percentage mean value of 53.298%, 57.741%, and 60.411% for Conventional, Portable and Artisanal sawmill respectively. The two partitions of the generated wastes (sawdust and slab) were significantly different ( $P < 0.05$ ) among the three sawmills examined. The portable sawmill recorded the highest mean (0.042m<sup>3</sup>, sawdust) and (0.402m<sup>3</sup>, slab), while artisanal had the least mean 0.002m<sup>3</sup> for sawdust and 0.083m<sup>3</sup> for slab. It is suggested that mechanical modifications and adequate training should be carried out to improve the skills and experience of the operators to reduce waste during conversion process as well improve their feed-work and set-work mechanisms

**Keywords:** Lumber recovery, Waste generated, Sawdust, Slabs, Sawmill.

## INTRODUCTION

The development in technology has changed the operations of the wood based industries significantly in recent years, emphasizing increase in profits through waste minimization and drastically increasing lumber recovery and energy efficiency as well as improving operator's safety and health (MPAC, 2015). The available records however, indicate that the supply of industrial sawn wood is far short of demand in Nigeria (Ogunwusi, 2012). Sawmill includes every compound and every breakdown saw or mill designed and used to break down and convert logs into boards, planks or scantlings or to re-saw the boards, planks or scantlings into boards, planks or scantlings of small dimensions (FAO, 1982). Owonubi and Badejo (2000) reported that sawmill industry is the most dominant and most active within the wood based industry as it accounts for 95% of the total wood input into the industry. There is evidence of huge wastage of wood resources during wood processing operations (RMRDC, 1991). Badejo (2001) noted that between 50-55% of the original wood brought to these mechanical processing industries end up as marketable portion while between 45-50% ends up as generated waste. This situation is unacceptable both from the efficient and sustainable utilization of resources' point of view. The downfall trend and the ever increasing demand for sawn wood have paved way for illegal activities such as in-situ conversion of lumber, so called artisanal sawmill 'chainsaw mill', to cushion the effect of inefficiencies in the sawmill industry (Ogunsanwo et al., 2011).

The obsolete machines and operators inefficiency affecting the optimum production of conventional sawmills coupled with the illegal and low quality output of artisanal sawing affects to large extent the conversion efficiency of round woods and consequently more wastes are generated (Ogunsanwo et al., 2005). FAO 2003, reported that the improvement of the Nigerian's wood processing industry which generates income, employ labour as well as provide raw materials for the wood based industries as one of the largest in the economy requires an urgent intervention. Investopedia 2017, reported that the breakthroughs in efficiency of sawmill systems have often coincided with the invention of new tools that contribute to the efficiency of labour, input materials, energy, efforts, money, and time employed during conversion of logs into lumber in the wood based industry. Therefore, there is a need for availability of more sophisticated machines or technology and skills, which can reduce or manage the effects observed in the aforementioned wood processing industry in Nigeria.

The aim of this research was to assess the volume of lumber recovery and waste generated during wood conversion in conventional, portable and artisanal sawmills, with a view to note the factors which could be manipulated to improved lumber recovery and

reduce waste generated during conversion, and thus enhancing efficiency in the entire Nigerian wood processing industry.

## MATERIALS AND METHODS

The study was carried out in Oyo and Ogun state in South-Western Nigeria. The area lies between longitude 2°3'11E and 4°6'01E and Latitude 6°2'11N and 8°3'71N with a total land area of 77,818 km<sup>2</sup> and a projected population of 28,767,752 in 2005 (world population review, 2019). The area which has 85 constituted forest reserves with a forest area cover of 842,499 hectares is endowed with natural forest resources and mineral deposits with extensive fertile soils (FORMECU, 1998).

The sites were selected purposively base on the availability, accessibility and functionality of the three sawmills chosen for the research. In University of Ibadan, Oyo State conventional and portable sawmills were selected while, Ayetoro, Ogun State was selected for Artisanal sawmill. The selection of timber species for the study was based on the available timber species currently working on in the selected sites and the most patronized timber species found in the selected site.

Seventy-eight logs of different species, sizes and shapes that amounted to 34.02 cubic meter were used. Each log was measured at butt, middle and top for its diameter as well as log length before conversion. Each of the three sawmill was then fed with equal logs in cubic meter volume for conversion, through and through technique was used to convert the logs into lumber; the numbers and dimension of the lumber pieces obtained were recorded and residues were examined in order to determine the percentage of lumber recovery.

Before each primary conversion, the top, middle and base diameters of the logs were measured using 50m measuring tape. The input log volume of each log was then calculated using Newton's formula below:

$$V = \frac{\pi h}{24} (D_b^2 + 4D_m^2 + D_t^2) \dots\dots\dots \text{(Equation 1)}$$

Where,

V = volume of log (m<sup>3</sup>)

D<sub>b</sub> = diameter at the base of the log

D<sub>m</sub> = diameter at midpoint of log

D<sub>t</sub> = diameter at the top of the log

h = Log length (m)

π = 3.142 or 22/7

At the end of every log processing, the number of planks produced from each log were enumerated. Width of the plank was taken at different points along the plank to cater for irregularities along the plank and the average was calculated. Digital vernier caliper and 50m measuring tape was used for measurement and parameters such as length, breadth and height of

the planks were obtained to determine the lumber recovered using the formula bellow:

$$V=W \times T \times L \dots\dots\dots \text{(Equation 2)}$$

Where,  
 V = Volume of lumber recovered  
 W = Width of the lumber  
 T = Thickness of the Lumber  
 L = Length of the lumber

The percent lumber recovery Factor is the proportion of the volume acceptable of the quantity of lumber produced (output), to the log input volume and was determined as follows:

$$\text{Lumber Recovery Factor} = \frac{\text{Volume of timber recovered (output) (m3)}}{\text{Volume of log (input) (m3)}} \times 100 \dots\dots\dots \text{(Equation 3)}$$

Wood waste in the selected sawmills which is the volume of waste produced at every conversion was determined. The wood waste generated was in the form of sawdust and slab.

$$\text{Volume of Waste} = \text{Volume of input} - \text{Volume of output} \dots\dots\dots \text{(Equation 4)}$$

In determining the volume of sawdust produced as a waste in the conversion process, the thickness of the saw kerf was determined using digital vernier caliper. The saw kerf is an important factor that defines the amount of waste produced in form of sawdust from a single conversion. Other factors considered include the cross sectional area of the log and saw passes.

$$\text{Volume of Sawdust} = \text{thickness of the blade} \times \text{C.S.A} \times \text{total number of passes} \dots\dots \text{(Equation 5)}$$

Cross Sectional Area (C.S.A) of log was determined by:

$$\text{C.S.A} = A_t + A_b \wedge 2 \ast \dots\dots\dots \text{(Equation 6)}$$

Where,

$$A_t = \text{Area at top} = \frac{\pi D_t^2}{4}$$

$$A_b = \text{Area at base} = \frac{\pi D_b^2}{4}$$

The Volume of waste due to slab was obtained by sawing from the log to attain rectangular shape and this was calculated using this formula:

$$\text{Volume of Waste due to slab} = \text{Volume of waste} - \text{Volume of sawdust} \dots \text{(Equation 7)}$$

Data generated was analyzed using analysis of variance (ANOVA) and mean differences were separated using Duncan post hoc test.

$$Y_{ij} = \mu + B_i + T_j + e_{ij} \dots\dots\dots \text{(Equation 8)}$$

Where,  
 $\mu$  = Overall mean  
 $B_i$  = effect of the block  
 $T_j$  = effect of jth treatment  
 $e_{ij}$  = random error term (Adesoye, 2004).

## RESULTS AND DISCUSSION

Lumber Recovery in the conventional, portable and artisanal sawmills

From the result in table 2 it is indicated that, artisanal sawmill had the highest lumber recovery percentage with a mean value of 60.41% followed by portable sawmill with a mean value of 57.74% and the least mean value of 53.30% was recorded in the conventional sawmill. The result of the ANOVA revealed that there was no significant difference in the percentage of the lumber recovered among the three sawmill at (P>0.05) but a remarkable difference was noticed in the lumber yield of the three sawmills considered. This is in line with the observation make by Kambugu et al., 2005 in their work Relative efficiency of sawmill types operating in Uganda's softwood plantations.

The highest mean value for lumber recovery recorded in artisanal sawmill was not farfetched from the fact that the chain saw operator had the opportunity of selecting trees with good form and moderate stem diameter for processing. Aside from this, the artisanal sawmill is not constrained by bench level as in the conventional and portable sawmilling, so the operator gets maximum lumber recovery from his logs.

### Waste Generation in the conventional, portable and artisanal sawmills

Contrary to the belief that, artisanal sawmill produces higher waste. Result of the ANOVA revealed that portable sawmill recorded the highest waste generated with a mean value of 0.042m3 and 0.402m3 for sawdust and slab respectively, while artisanal sawmill had the least mean value of 0.002m3 for sawdust and 0.083m3 for slab. The higher waste volume generated in the portable sawmill could be traced to limited skills/experience of the operator and the fact that the stem diameters of some of the logs supplied to the portable sawmill during the time that this research work is being conducted were higher than the headrig capacity of the available wood-mizer machine use. Therefore, part of the logs was trimmed off with cutlass and more saw dust was generated from some of the logs that were split with chain saw into two during processing.

This go in line with Garland and Jackson (1997), who observed that the waste in sawmilling result from crude method, felling and bucking technique. In the factories, wastes are generated

in the form of slabs; saw-dust and half-processed materials, the various stages of conversion of the wood from our forests are associated with the generation of substantial amount of waste as currently seen, as a problem which starts right from the forests (Onosode, 1988). No wonder there was high waste generation in the portable sawmilling system as a result of trimmings, half processed logs (having metals, barbed wires etc.) and slabs For instance, FAO (1990), observed that less than two-thirds of harvested trees are finally taken away from the forest for further processing. The mechanical processing of wood in sawmills and ply mills in this country has also been found to be associated with considerable amount of wood residue generation in form of trimmings, off- cuts, peelers, slabs and saw dust (Fabiya and Oyagade, 2003). Therefore, the high waste generation observed in portable sawmill is not an abnormality considering the fact that the researcher has no say in the model of the Wood Mizer, log diameter, form factor and experience of the operator. This only goes to prove what Badejo (2001) submitted that only 50-55% of the original wood brought to these mechanical processing industries end up as marketable portion while as much as 45-50% ends up as waste.

Table 1: ANOVA table for the lumber recovery and the waste generated in all the three sawmills.

Variables	Source of variation	Sum of square	df	Mean square	F	P- Value
Lumber recovery	Lumber Recovery%	19746.899	74	266.850	1.226	0.299
	Error	654.341	2	327.170		
	Total	20401.240	76			
Waste generated from sawdust	sawdust m3	0.017	74	0.000	24.989	0.000
	Error	0.011	2	0.006		
	Total	0.028	76			
Waste generated from slab	slab m3	0.932	74	0.013	43.050	0.000
	Error	1.084	2	0.542		
	Total	2.016	76			

Source: Fieldwork, 2018

Table 2: Duncan postmortem for percentage lumber recovery and waste generated in conventional, portable and artisanal sawmills

	Sawmills		
	Conventional	Portable	Artisanal
Lumber Recovery%	53.298a	57.741a	60.411a
SawdustWaste(m3)	0.012a	0.042b	0.002a
Slab Waste(m3)	0.295b	0.402c	0.083a

Means followed by the same letter(s) along the Column are not statistically different ( $p > 0.05$ ).

Source: Fieldwork, 2018

## CONCLUSION

The highest waste generated in potable sawmill is as result of trimming off the log for potable sawmill to accommodate them. Therefore, there is need for intervention to encourage more potential investors to create as many as possible potable sawmills with good model that can handle large logs as we have in southwester Nigeria.

There is also need for more technical and mechanical modification on both the skills and experience of the operators as well as their feed work mechanism to reduce much waste generated during conversion process.

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