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ASSESSMENT OF WOOD WASTE GENERATED IN SELECTED SAWMILLS IN KAJOLA LOCAL GOVERNMENT AREA OF OYO STATE

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ABSTRACT

This study was carried out in selected sawmills in Kajola Local Government Area of Oyo State to assess the volume of wood waste generated in their various forms during log conversion into sawn timber. Ten (10) sawmills were randomly selected in the area for the study and in each sawmill, ten (10) logs were sampled for conversion making a total of one hundred (100) logs. Some of the logs sampled included Melicia exceisa, Terminalia superba, Ceiba petandenra, Annogeisus leiocarpus and Danieila oliverii. Through and through sawing method was used for the logs conversion. Before conversion, input volume was determined while volume of lumber recovered, percentage of lumber recovery, volume of sawdust, slabs and bark were also determined. The result showed that Temidire sawmill had 80.23% which revealed the highest percentage of lumber recovery while Babameta sawmill had 70.09%, with least percentage of lumber recovery. Correlation analysis revealed that there was high positive significant relationship between top girth, basal girth and input volume of logs while others have no significant relationship among the factors considered. If the volume of wood waste generated in different forms can be reduced at any particular time, sawn board available for household use and construction industries will increase, hence, minimize the rate of exploitation of the forest.

Keywords: Wood waste, Sawmills, Kerf, Conversion, Lumber recovery, Timber species

INTRODUCTION

A sawmill can be defined as a wood processing industry equipped with various wood processing machines. These machines include band saw and circular saws. In sawmill industry, the wood has to be converted into various sizes that will maximize profit and also satisfy the demand of the people. Sawmilling industry originated in Nigeria with the establishment of the first pit-sawing facility in 1782 at Oyo State (Awe, 2000, Mohd, 1997). Since then, more sawmills have been established as the demand for lumber (sawn wood) continues to increase. As at 1991, there were about one thousand six hundred and seventeen (1617) sawmills in Nigeria, majority of which are located in the forest-rich areas including the Western part of the country (FAO, 2003, Akindele, 2003, Anonymous, 1993). Sawmill industry in Nigeria is largely characterized by small size operators who usually process timber with the CD series of sawing machine (i.e. CD4, CD5, CD10, machines among others). Large quantities of waste in form of slabs, sawdust and bark are regularly generated in sawmills. Lumber recovery factor has been defined as the percentage or a ratio of volume of sawn wood output to that of the volume input of logs processed in the sawmill, regardless of the types and kind of processing equipment adopted and species of wood involved (Kayode, 2005, Badejo, 1990). It is a measure of sawmill efficiency. Lumber recovery factor is an indication of the efficiency with which sawmill is being run. Lumber recovery is determined by many factors. These factors include: Log diameter, length, taper and quality; Kerf width of the sawing machines; Sawing variation, rough green-lumber size, and size of dry dressed lumber; Product mix; Decision making by sawmill personnel; Condition and maintenance of sawmill equipment; Sawing method.

Wood waste generated in sawmills cannot however be completely eliminated but can be significantly reduced by improving the processing techniques in the sawmill (Olatunji, 2006, Oluoje and Ogedengbe, 2006, Badejo, 1990). A number of factors have been identified as the influencing the lumber recovery ratio from logs during conversion in sawmills. These include log shape (crooked, taper, forked and straight), log sizes (girth and length), machine maintenance culture and availability of machine parts and experience of the operator (Badejo, 1990). Badejo (1990) is of the opinion that, the sizes of log being processed, regardless of the species, have important influence on lumber recovery.

Realizing the economic potential of these wood wastes, there is needed to conduct a concomitant study to determine the ratio of waste generated in different techniques of processing these logs in order to obtain expected monetary returns from them (NISER, 2004, Steel, 2006, Jamieson 1977). This invariably means that waste should be reduced as much as possible to enhance lumber recovery. Wood industries produce large volume of residues which must be utilized, marketed or disposed off. Heaps of wood residues are common features in the saw mill throughout the year, and to be precise in Nigeria as a whole, it is generally regarded as waste and this has led to open burning practices as a method of residue disposal. There are two categories of wood wastes, these are: those generated in the forest during logging process and those generated within the wood based plants during conversion processes. There are several causes of wood wastes. Most of these depend on factors such as the logging methods employed during timber extraction, the debarking process employed; type of sawing machinery used during timber conversion and the skill of the band saw operators. As a result of these factors, quantities of wood residues generated at any particular time vary from sawmill to sawmill (Smith and Joe, 2006, Hindle, 2009, Ayarkwa J.A and Addae – Menash A., 1999). Realizing the extent of exploitation of forest land, there is need to conduct a study to determine the ratio of lumber recovery with respect to factor influencing it, so as to be able to identify the factors that affect the recovery ratio of these logs. This study therefore focused on the assessment of machines used in the conversion of logs, experience of operators, number of machines involved in the operation, number of personnel; log input volume and the lumber recovery that impact on the conversion efficiency obtained during log processing.

MATERIALS AND METHODS

Study area

Kajola is a Local Government Area (LGA) in Oyo State, Nigeria. Its headquarters is Okeho, with Latitude 6^{o} 43’ 0’’N, longitude 4^{o} 31’0’’E. It has a land area of 609Km^2. The LGA has a population of 200,997. The annual rainfall is about (1300mm - 1600mm) and the rain normally starts around March to October, the temperature is about 21°C to 33°C. The humidity is usually very high (about 75 percent). The LGA has a total number of 16 sawmills in its environment (Kajola Local Government Office).

Selection of study locations

This study was carried out in selected sawmills in Kajola Local Government Area of Oyo State and it covers all the processes involved in the conversion of logs to lumber. The names of selected sawmills are listed below:

Table 1: The names of selected sawmills

S/No.	Name of Sawmill	Location
1	Oladokun	Okeho
2	Ajose	Okeho
3	Ojolowo	Okeho
4	Jayeola	Ilero
5	Makojami	Ilero
6	Ogo-Oluwa	Ilua
7	Oladejo	Okeho
8	Babameta	Ilero
9	Oluwanisola	Isemi-Ile
10	Temidire	Ilero

Experimental Design

Selection of sawmills depended ultimately on the availability of logs in their log yard. In the sawmills the process of log conversion into lumber and residues were examined in order to determine the percentage of lumber recovery while watching the workers and machines closely in operation, necessary data were collected. The residues were in form of slabs, bark and sawdust. In addition to the actual practical assessment of lumber recovery from sample of logs selected, ten (10) sawmills were randomly selected in the area and in each sawmill, ten (10) logs were sampled for conversion making a total of one hundred (100) logs. Ten (10) questionnaires were administered to respondents in each sawmills in order to acquire necessary information to enhance the accuracy of result for this study.

Procedure of Data Collection for Lumber Recovery

Before conversion, the length of each log, top girth, middle girth, basal girth and bark thickness of each log were measured and recorded. Diameters (under bark and over bark) at both ends of logs were also measured and recorded. The logs were sawn via conventional band saw machine and horizontal band saw travels in a rail. During sawing, 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 through and through method of conversion. Then the dimension of slabs and number of planks recovered were recorded in prepared field notebook.

Determination of log volume

Determination of Log input volume;

$Volume(V) = \pi L(A_b + 4A_m + A_t)/24$... (*eqn. 1*)

Where,

π = 3.142

L = length of log

Ab = Cross sectional area of basal

Am = Cross sectional of area middle

At = Cross sectional area of top

Determination of timber recovered

V = W x L x T ……………….(*eqn. 2*)

Where,

V = Volume of lumber recovered

W = Width of the lumber

T = Thickness of the lumber

L = Length of the lumber

Determination of lumber Recovery Ratio

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

$LRR = VTR/VLI$ ……………(*eqn. 3*)

Where:

LRR = Lumber Recovery Ratio

VTR = Volume of timber recovered (output) (m^3)

VLI = Volume of log (input) (m^3)

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

Estimation of Waste Due To the Volume of Slab

The waste due to the slab is the being sawn from log to attain rectangular shape and it can be calculated as follow;

1. (½ B x T x L) ……………(*eqn. 4*)
2. L x B x T ………..….(*eqn. 5*)

Where,
B = Base of the slab
T = Thickness of the slab
L = Length of the slab

Estimation of Waste Due To Sawdust

This can be calculated as follows;

Wd = V – (Tr + Ws + Wb) ……….(eqn. 6)

Where,
V = Volume of timber recovered (m^3)
Tr = thickness of timber recovered (m^3)
Ws = Waste due to slab (m^3)
Ws = Waste due to the bark volume (m^3)

Data Analysis

Data obtained were analysed using analysis of variance (ANOVA), correlation analysis, and Duncan Test.

RESULTS

Temidire sawmill had the highest lumber recovery percentage with value of 80.23%, followed by Ojolowo, Ogo-Oluwa and Oluwanisola sawmills with percentage lumber recovering of 78%. This is due to the fact that most of the selected logs are fairly large in girth and straight while Babameta sawmill had the least percentage lumber recovery of 70.09% and this due to the fact that most of selected logs are fairly small in girth and of different forms. Babameta and Makojami sawmills had the highest slab volume of 0.15m^3 and 0.14m^3 while Temidire sawmill had the least value (0.04) of volume of slab. There was a little variation in bark volume and sawdust volume amongst all sawmills. The highest total volume of waste was recorded in Makojami and Babameta sawmills with value of 0.2m^3 while Temidire sawmill recorded the least total volume of waste with value of 0.09m^3 as presented in Table 2.The result obtained agrees with (Kayode, 2005, Wilston, 1981) reported that logs size and shape have direct impact on lumber recovery.

Table 2: Mean value of the parameters determine on converted Logs on the basis of sawmill.

Name of sawmill	Input volume of log (m^3)	Lumber recovery vol. (m^3)	% of lumber recovery	Volume of slab (m^3)	Volume Bark volume (m^3)	Sawdust volume (m^3)	Total volume of wastes (m^3)
Oladokun	0.525	0.415	76.34	0.056	0.022	0.032	0.110
Ajose	0.525	0.384	71.87	0.063	0.016	0.034	0.113
Ojolowo	0.525	0.415	78.57	0.063	0.018	0.028	0.109
Jayeola	0.525	0.403	75.53	0.067	0.020	0.043	0.130
Makojami	0.525	0.392	72.81	0.145	0.020	0.043	0.208
Ogo-Oluwa	0.525	0.414	78.58	0.052	0.021	0.037	0.110
Oladejo	0.525	0.334	70.70	0.070	0.023	0.041	0.134
Babameta	0.525	0.362	70.09	0.152	0.020	0.034	0.206
Oluwanisola	0.525	0.414	78.50	0.053	0.022	0.037	0.112
Temidire	0.525	0.427	80.23	0.049	0.020	0.030	0.099

Table 3: Analysis of variance for slab, bark and sawdust volume

SV	SS	DT	MS	V.R	SIG.
Slab vol.	0.059410	9	0.006601	2.65	0.432[NS]
Bark vol.	0.0004302	9	0.0000478	0.02	0.000*
Sawdust vol.	0.0077784	9	0.0008643	0.35	0.437[NS]
Error	0.224474	90	0.002494		
Total	0.247014				
Grand mean	0.0201				
•/o CV	59.6				
S.E	0.0292				
L.S.D	0.0260				

Note: *NS = Not Significant at P<0.05; * = Significant at P< 0.05*

Table 4: Duncan multiple range test for the assessed parameters on the basis of sawmills

Sawmill	Input Vol.	% Lumber recovery	Slab vol. (m^3)	Sawdust vol.(m^3)	Bark vol. (m^3)
Oladokun	0.525[a]	76.34[a]	0.05[b]	0.032[b]	0.022[b]
Ajose	0.525[a]	71.87[a]	0.063[b]	0.034[b]	0.016[b]
Ojolowo	0.525[a]	78.57[a]	0.063[b]	0.028[b]	0.018[b]
Jayeola	0.525[a]	75.53[a]	0.067[b]	0.043[b]	0.020[b]
Makojami	0.525[a]	72.81[a]	0.071[b]	0.043[b]	0.020[b]
Ogo-Oluwa	0.525[a]	78.58[a]	0.052[b]	0.037[b]	0.021[b]
Oladejo	0.525[a]	70.70[a]	0.069[b]	0.04I[b]	0.023[b]
Babameta	0.525[a]	70.09[a]	0.180[a]	0.034[b]	0.020[b]
Oluwanisola	0.525[a]	78.50[a]	0.052[b]	0.037[b]	0.022[b]
Temidire	0.525[a]	80.23[a]	0.044[b]	0.030[b]	0.020[b]

Note: *Mean values with the same alphabet are not significantly different 5% at probability level.*

Table 5: Matrix correlation analysis

Variable	Basal girth	Total girth	Length of log	Input of logs	Vol. of lumber recovery	Vol. of sawdust	Vol. of Bark	Vol. of slab
Basal girth	1							
Total girth	0.497**	1						
Length of log	0.074**	0.164*	1					
Input of logs	0.481**	0.587**	0.206*	I				
Vol. of lumber recovery	0.137[NS]	0.098[NS]	0.063[NS]	0.156[NS]	1			
Vol. of sawdust	0.066 [NS]	0.094 [NS]	0.004[NS]	0.140[NS]	0.014 [NS]	1		
Vol. of Bark	0.108[NS]	0.240*	0.017[NS]	0.172[NS]	0.096 [NS]	0.161[NS]	1	
Vol. of slab	0.119[NS]	0.146[NS]	0.036[NS]	0.039 [NS]	0.023 [NS]	0.23 [NS]	0.064 NS	0.139 [NS]

Note: *** = Significant at a level of 1% of probability [P<0.01] * = Significant at a level of 5% of probability [P<0.05] NS = Non significant a level of 5% of probability [P>0.05]*

Table 6: Years of experience of Operators at the selected sawmills

Sawmill	Band saw	Circular saw	Saw doctor
Oladokun	11-15 yrs	16-20 yrs	6- 10 yrs
Ajose	6- 10 yrs	0-5 yrs	16-20 yrs
Ojolowo	0-5 yrs	6-10 yrs	11-15 yrs
Jayeola	11-15yrs	0-5 yrs	6- 10 yrs
Makojami	6-10 yrs	6-10 yrs	0-5 yrs
Ogo-oluwa	16-20 yrs	6-10 yrs	6-10 yrs
Oladejo	16-20 yrs	6- 10 yrs	11-1 5 yrs
Babameta	6-10 yrs	11-15 yrs	6- 10 yrs
Oluwanisola	11-15 yrs	0-5 yrs	0-5 yrs
Temidire	16-20 yrs	16-20 yrs	11-15 yrs

DISCUSSION

There is no significant difference between volume of slab and sawdust irrespective of sawmills and tree species sampled. There was also significant difference between volume of sawdust and tree species sampled with coefficient of variation of 60% and a very low standard error of 3% as revealed in Table 3. Temidire sawmill had the highest mean percentage of lumber recovery of 80.23%, followed by Ogo-Oluwa sawmill with lumber recovery of 78.58%, while Babameta sawmill had the least mean value of 70.09%. Babameta sawmill had the highest mean value of slab volume with a value of 0.180m^3, followed by Oladejo sawmill with slab volume of 0.069m^3 and Temidire sawmill had the least mean value with 0.044 m^3. Jayeola sawmill produced the highest waste with 0.043m^3 in sawdust volume and it was not significantly different from Makojami, Ogo-Oluwa, Oluwanisola and Oladejo sawmills, respectively. Oladejo sawmill produced the highest waste in bark volume with value of 0.023m^3 and it was not significantly different from other sawmill as presented in Table 4. Table 5 shows that there was high positive significant relationship between top girth and basal girth (0.497**), length log and Basal girth (0.074**) input of volume of logs, Basal girth and top girth (0.481** and 0.587**), respectively. There was also a positive significant relationship between length of log and top girth, input of volume of logs and length of with 0.206* while others have no significant relationship. Among the factors considered in this study, top girth, length of log and input of volume of logs had high positive significant relationship. Table 6 revealed that the years of experience of the operators vary from one sawmill to other. Ogo-oluwa, Oladejo and Temidire sawmills had the most skillful band saw operators with 16-20 years of experience while Ajose, Ojolowo, Makojami and Babameta sawmills had the least band saw operators with 0-10 years of experience. Oladokun and Temidire sawmills had the most qualified circular saw operators with 16-20 years of experience while Ajose, Jayeola and Oluwanisola sawmills had the least qualified circular saw operators with 0-5 years of experience. Ajose sawmill had the most seasoned saw doctor with 16-20 years of experience while Makojami and Oluwanisola sawmills had the least experienced saw doctor with only 0-5 years. Skill and experience of the machine operators can significantly contribute to the lumber recovery from the log. The result obtained from this study conforms to (Smith and Joe, 2006) reported that skill and years of experience of machine operators play a major role in deciding what the lumber recovery factor (LRF) from a given log will be.

CONCLUSION

It was observed that the major effect of wood waste are economic loss, environmental pollution, fire hazard, delay of work and harboring of dangerous animals. Disposal of sawdust is the major residue management problems. Bark are sold sometimes to traditional healer or given away free of charge while slabs are disposed by selling them as firewood in local market. In many cases however, it was found that most of the waste found in selected sawmills in Kajola Local Government Area of Oyo State were due to old age machine used in operation, form and shape of the wood.

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