Babatola Olufemi, Joseph Olalekan Akindeni, Samuel Oluyinka Olaniran

Lumber Recovery Efficiency among Selected Sawmills in Akure, Nigeria

Iskorištenje drvne sirovine u promatranim pilanama područja Akure u Nigeriji

Original scientific paper • Izvorni znanstveni rad
Received – prispjelo: 8. 3. 2011.
Accepted – prihvaćeno: 9. 2. 2012.
*UDK: 630*832.15*
doi:10.5552/drind.2012.1111

ABSTRACT • *This study was carried out to investigate the efficiency of lumber recovery among selected sawmills in Akure metropolis. Measurements were carried out before and after log conversion to estimate the volume of sawn timber and wood residues generated from the selected sawmills. The outcome of the research revealed that 56.08 % of the log input was recovered as sawn timber while 43.92 % was left as wood residues. From the 43.92 % of wood residue, 34.39 % was left as slab while 9.53 % was left as saw dust. This finding showed that the efficiency of these mills was comparably higher than the results from earlier studies. It is believed that the yield could still be improved by channeling the residues in the form of slabs to other valuable products.*

Keywords: *sawmills, lumber recovery, wood residue, logs*

SAŽETAK • *Istraživanje je provedeno s ciljem da se ustanovi iskorištenje drvne sirovine u odabranim pilanama u području Akure. Mjerenja su provedena prije i nakon obrade trupaca kako bi se utvrdio obujam proizvedenih piljenica i drvnih ostataka u promatranim pilanama. Rezultati istraživanja pokazali su da je iskorištenje trupaca u obliku piljenica 56,08 %, dok je udio drvnih ostataka bio 43,92 %. Od 43,92 % drvnih ostataka 34,39 % su okorci, a 9,53 % je piljevina. Istraživanja su pokazala da je učinkovitost istraživanih pilana veća od rezultata prethodnih studija. Pretpostavlja se da iskorištenje trupaca može biti i veće ako se drvni ostaci u obliku okoraka prerade u određene drvne proizvode koji imaju tržišnu vrijednost.*

Ključne riječi*: pilane, iskorištenje drvne sirovine, drvni ostaci, trupci*

1 INTRODUCTION
1. UVOD

The sawmilling industry in Nigeria is dominated by small scale and privately owned establishments. They are mostly concentrated in the city usually regarded as the centre of activity. Alviar (1993) reported that these sawmills have individual production capacities of about 500 cubic meters of lumber per year while they number well over 1500 across the country. A record by Ondo State Department of Forestry (2007) revealed that there are 311 registered sawmill complexes across the state with more than 50 % concentrated in the state capital. The first sawmill in the state was established in 1909 (Adewale, 1988) and since then the form and sizes of the available logs have reduced considerably (Lucas, 1990). While the form is poorer, the sizes are smaller and the population of merchantable timber in the country-owned forest has started declining in recent times (Malami, 2010). This is due to the growing demand for sawn timber in the furniture and building industries. To meet this demand, an appropriate sawmilling practice that encourages high lumber recovery rate is required. This situation demands con-

[1] Authors are professor and assistants at Department of Forestry and Wood Technology, Federal University of Technology, Akure, Nigeria.
[1] Autori su profesor i asistenti Odsjeka za šumarstvo i drvnu tehnologiju Federalnoga tehnološkog sveučilišta, Akure, Nigerija.

stant review of the efficiency of conversion, which is the objective of this study.

The efficiency rate of lumber recovery ranges between 40 and 50 % as reported by Alviar (1993). This implies that 50 – 60 % of the log volume ends up as waste usually in the form of slabs, sawdust, edges and shavings. Lumber recovery efficiency is widely used as a measure of assessing the performance of any sawmill. The mode of estimation is by dividing the total lumber product in cubic meters by total input volume. However, this does not take into account the size, quality or grade of the log in question. Log size, quality or grade and length are also important factors to be considered in lumber recovery efficiency. The lumber recovery factor is the percentage of sound lumber produced from a log. According to Badejo (1980) 75 small sized sawmills operating around Lagos State generate about 21,000 m^3 of residue every year. Further study by Alviar (1993) on 17 CD horizontal band saw headrigs sawing 84 m^3 in Lagos, Ibadan and Benin City found that 47 % of the product (sawn timber) was recovered while other residues such as slabs, sawdust and bark were 38.6 %, 8.1 % and 6.3 %, respectively. All these studies did not separate the quantity of saw dust from slabs. The present study has gone a step further to do the separation by taking into consideration the dimension of the saw kerf. The low product volume recovered in these sawmills was a result of adherence of mill operators to traditional practice, poor saw fitting and maintenance, lack of secondary processing machines to salvage the proportion of slab going to waste, poor sawing methods and inadequate training of sawyers. The sawmill practice has considerably improved in terms of equipment and personnel. This study has, therefore, been designed to investigate the lumber recovery efficiency of selected sawmills in Akure metropolis.

2 MATERIALS AND METHODS
2. MATERIJALI I METODE

This research was carried out in the metropolitan city of Akure, Ondo State, Nigeria, which is the administrative capital of Ondo State with its headquarters at Akure South Local Government. The town hosts more than 50 % of the saw mills in the whole state. Ten sawmills were randomly selected within Akure metropolis and each of these mills uses CD horizontal band saw with the following parameters; wheel diameter (1600 mm), blade width (200 mm), and power of 125 kW. Other operations such as ripping, crosscutting, edging and trimming are carried out on the circular sawing machine.

Data was collected based on production and working conditions of the selected sawmills. For primary conversion of logs, a sawing method was used called “sawing around”. Ten wood species sawn predominantly and common to these sawmills were selected (see Table 1). The standard length of logs processed in these sawmills is 3.6 m (12 ft). The diameter at the top and bottom of each log varies with the taper levels. Before primary conversion in each of the mills, the top and bottom diameter of the logs were measured and the volume of each log was estimated using Smalian equation below:

$$V_{\log} = \frac{l \cdot \pi \cdot (D_b^2 + D_t^2)}{8} \quad (1)$$

$V_{\log}$ – volume of the log before conversion, m^3
D_b – diameter at the base of the log, m
D_t – diameter at the top of the log, m
l – length of the log, m

The volume of sawdust from each log was estimated from equation 2:

$$V_{sd} = b \cdot l \int_1^n w \quad (2)$$

V_{sd} – volume turned to dust, m^3
b – kerf of the saw blade
l – length of the log, m
w – width of each plank at the point of cut, m

The volume of sawn timber (plank) was estimated from the nominal sizes (1’ x 12’ x 12’’) of individual planks from each of the logs, after calculating edging and trimming on the circular sawing machine, from equation 3:

$$V_{st} = \Sigma\, n \cdot (l \cdot b \cdot h) \quad (3)$$

V_{st} – volume of sawn timber, m^3
l – length of the plank, m
b – breadth, m
h – thickness, m
n – number of planks from each sawn log

The volume of slab produced during the conversion process was then estimated using equation 4:

$$V_{slab} = V_{\log} - (V_{sd} + V_{st}) \quad (4)$$

3 RESULTS
3. REZULTATI

The results in Table 1 show the log volume of wood species sampled from the selected sawmills and their recovery volumes of lumber and wood residues. Lumber recovery is low with most wood species as a result of higher volume of slabs generated from their wood logs.

The overall lumber recovery in the sampled sawmills was 56.08 % of the total log input. The remaining 43.92 % was the wood residue, out of which 34.39 % was the solid waste in the form of slabs and off-cuts, while 9.53 % was turned to saw dust during the conversion process. The volume of saw dust generated depends on saw parameters and the number of times the blade goes through the logs for sawing. The overall recovery rate in the selected sawmills is shown in Table 2. The result of the analysis of variance testing for the significance of the finished product (sawn timber) from the selected mills showed that there was no significant difference (p>0.05) in the recovery of the finished product (Table 3). Furthermore, the analysis of variance in Table 4 and 5 revealed that there was no significant difference (p>0.05) in the quantity of sawdust and slabs produced among the selected sawmills in Akure metropolis.

Table 1 Species names, trade names and mean volumes of round logs and lumber recovery after processing
Tablica 1. Vrste drva, trgovački nazivi, srednji obujam trupaca i količina piljenih proizvoda

Specie names *Vrsta drva*	**Trade name** *Trgovački naziv*	**Log** *Trupci* m^3	**Planks** *Piljenice* m^3	**Sawdust** *Piljevina* m^3	**Slabs** *Okorci* m^3
Khaya ivorensis	Mahogany	9.44	5.23	0.96	3.26
Mansonia altissima	Mansonia	2.32	1.14	0.16	1.07
Milicia excelsa	Iroko	11.07	7.05	1.24	2.78
Celtis zenkeri	Ita	10.94	6.24	1.25	3.48
Triplochyton scleroxylon	Obeche	5.99	3.32	0.43	2.25
Cordia milenii	Omo	8.12	4.59	0.71	2.79
Nelsogodonia papaverifera	Danta	7.68	4.34	0.62	2.72
Alstonia boonei	Ahun	8.28	4.28	0.77	3.34
Entandrophragma cylindricum	Ijebu	11.37	5.67	1.11	4.00
Terminalia superba	Afara	6.10	3.12	0.58	2.36

Table 2 Percentage of finished products and waste from selected sawmills
Tablica 2. Postotak gotovih proizvoda i drvnog ostatka u promatranim pilanama

Sawmills / *Pilane*	**Slabs, %** *Okorci, %*	**Sawdust, %** *Piljevina, %*	**Finished products, %** *Gotovi proizvodi, %*
YABSOL	33.77	9.79	56.44
GUANCO	33.55	9.56	56.89
OLUKAYODE	35.03	9.35	55.62
AYENI	34.55	9.78	55.67
EMINISA	34.29	9.50	56.21
ANIFOWOSE	34.91	9.45	55.64
AGBEDE	34.93	9.29	55.78
HOUSING	33.94	9.27	56.79
ISEOLUWA	36.19	9.57	54.24
ALAWIYE	32.74	9.73	57.53
Mean value / *srednja vrijednost*	34.39	9.53	56.08

Table 3 Analysis of variance (ANOVA) for finished products among the selected sawmills
Tablica 3. Analiza varijance (ANOVA) gotovih proizvoda u promatranim pilanama

SV	*SS*	*df*	*MS*	*F*-value	Sig.
Selected mills	23.444	9	2.605	0.425	0.918^{ns}
Error	555.035	90	6.123		
Total	574.479	99			

(ns = not significant at p>0.05 / *ns – nije signifikantno na razini p>0,05*)

Table 4 Analysis of variance (ANOVA) for waste (slabs) among the selected sawmills
Tablica 4. Analiza varijance (ANOVA) krupnoga pilanskog ostatka u promatranim pilanama

SV	*SS*	*df*	*MS*	*F*-value	Sig.
Selected mills	123.091	9	1.455	0.822	0.598^{ns}
Error	159.3115	90	1.770		
Total	172.406	99			

(ns = not significant at p>0.05 / *ns – nije signifikantno na razini p>0,05*)

Table 5 Analysis of variance (ANOVA) for waste (sawdust) among the selected sawmills
Tablica 5. Analiza varijance (ANOVA) količine piljevine u promatranim pilanama

SV	*SS*	*df*	*MS*	*F*-value	Sig.
Selected mills	0.760	9	0.084	0.202	0.993^{ns}
Error	37.630	90	0.418		
Total	38.390	99			

(ns = not significant at p>0.05 / *ns – nije signifikantno na razini p>0,05*)

4 DISCUSSION
4. RASPRAVA

The efficiency of any sawmill could be measured by the quantity of finished product recovered from a log compared to those resulting into residue. It could be observed that in all sawmills examined the recovery rate is almost the same. This is because there is no significant difference in the volume of sawn timber and residue produced from each of the selected sawmills. The efficiency of lumber recovery among these sawmills is a little higher than what was observed by Alviar (1993) among sawmills in Lagos, Ibadan and Benin City. He observed that in these cities, 47.0 % was recovered as sawn-timer (product), 44.9 % as slabs and 8.1 % as sawdust. Badejo (1980) asserted to the fact that the proportion of wood waste due to slab might be reduced with improved conversion methods. A review of level of wood conversion and utilization in Nigeria by Thorpe (1983) showed that 45 % of log input into the sawmill industry ended up as mill residues. Today this may be higher due to better training of personnel, newer equipment and higher consciousness for better performance. This assumption has been confirmed in the selected sawmills in Akure as it could be noted that the percentage of log input accounted as waste is about 43.91 %. As a result of variation in shape and form of logs, it is very important to position them properly for sawing so as to reduce waste and derive maximum volume of sawn timber (Fuwape and Sobanke, 1998). Optimum utilization of round logs is obtainable if the log is properly positioned during conversion and turned frequently for efficient recovery of sawn timber. Efficiency of wood conversion in sawmills implies that wood residue generated during conversion is reduced to the barest minimum. Efficiency of log conversion can be further improved in these mills by ensuring that logs are converted on time to reduce the harmful effect caused by bio-deteriorating agents. Sawmill equipments should be adequately maintained and the level of accuracy of sawyers would also improve the efficiency of wood conversion.

5 CONCLUSION
5. ZAKLJUČAK

There is some increase in the conversion efficiency. It was observed that the efficiency of different species is comparable among them. However, there are variations that are mainly due to different sizes and forms of individual production logs. As a result of variations in log forms, greater volumes of wastes in the form of slabs are generated. Higher efficiency in the utilization of wastes after sawmilling processes could, however, be enhanced through development of new production lines, whereby waste in the form of slab and sawdust can be re-processed to products such as wood parquets, tools handles, production of panel doors and briquettes for energy production.

6 REFERENCES
6. LITERATURA

1. Adewale, O. J., 1988: A study of wood processing in some sawmills in Ondo State. An unpublished B. Agric. Tech Dissertation in the department of Forestry and Wood Technology. Federal University of Technology Akure, Ondo State, Nigeria.
2. Alviar, G. O., 1993: Sawmilling industry in Nigeria. Field documents No. 17. Food and Agricultural Organization (FAO) Rome.
3. Badejo, S. O. O., 1980: Efficiency and growth potential of Nigerian sawmills. From review (Draft FORMECU) Federal Department of Forestry Nigeria, 1998.
4. Fuwape, J. A.; Sobanke, A.O., 1998: Combustion characteristics of wood briquettes produced from sawdust. National Conference of Nigerian Society of Agricultural Engineering, pp. 1- 11, 8 - 11th September, 1998.
5. Lucas, E. B., 1990: Wasted tree products in Nigeria and their potentials as industrial raw materials; in: Proceedings of the National Conference of the Forestry Association of Nigeria, Hosted by FRIN, Ibadan. pp. 13.
6. Malami, A. A., 2010: Physical and mechanical properties of *Eucalyptus camaldulensis* (Dehnh) grown in northwestern Nigeria in relation to utilization as timber. Ph. D. Thesis. Usmanu Danfodiyo University, Sokoto, 200 p.
7. Thorpe, E., 1983: Nigeria Forestry sub-sector. Review report submitted to Forestry Project Monitor and Evaluation Unit (FORMECU), Federal Department of Forestry Nigeria.

Corresponding address:

Prof. OLUFEMI BABATOLA, Ph.D.

Department of Forestry and Wood Technology
Federal University of Technology
Akure, NIGERIA
e-mail: olufemibabatola@yahoo.com