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Economics of Wood Conversion Efficiency and Plank Yield Estimation among Different Wood Species

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Abstract: The conversion efficiency and the estimation of plank yield of three wood species (Danta, Alstonia and Obeche), were investigated using quantitative techniques. Ten logs of each of the three species, making a total of 30 logs were surveyed in ten sawmills in Delta State, Nigeria. Log length (m) lumber volume before miling (V_1) and after milling (V_2) were determined. Plank yield was determined to be (V_2), while, volume of residue (waste) was determine by subtracting V_2 from V_1. Data collected were analyzed using quantitative techniques. The findings showed that Danta has the highest conversion efficiency of 59.08%, while, Obeche was the least in conversion efficiency of 50.89%. The result also revealed that the estimation equation for the three timber species performed well based on the values of R^2 and R^2 (adj.) of the multiple regression model. The result further revealed that there is negative and significant relationship between plank yield per log and the residue (waste) generated in the three species of timber surveyed. The study showed that though there is positive relationship between log size and plank yield per log, such correlation is not significant in the three models. Hence, log size is not a reliable estimator of plank yield per log. This could be due to the possibility of log deformities. On the basis of the findings, it was recommended that the rate of residue generation and deformities which tend to reduce plank yield per log should be the major factors to be considered in determining the quality and prices of logs of Danta, Alstonia and Obeche.

Key words: Economics, efficiency, estimation, plank, wood, yield

INTRODUCTION

Before now, Nigeria was rich in forest resources. In terms of relative contributions, the forest share of the real GDP, declined steadily from 4.2% in 1960s, to about 1.87% in 1985, 1.30% in 1995 and stood at about 1.2% in 1998 (CBN, 1999). The observed trend in the performance of the forestry sector in Nigeria requires urgent attention especially that the sector is crucial to the supply of forest products related industries in Nigeria such as sawmills, plywood mills, paper mills etc. All these wood related-industries contribute immensely to the economy in Nigeria (Adewumi *et al*., 2004).

Hence the wood supply status of Nigeria becomes very crucial. According to Liiro (1993), the wood supply status of Nigeria has deteriorated greatly as a result of ineffective control of forest resource exploitation. Coupled with this, is the inefficient conversion of wood resources in many sawmills. The future of wood-based industries in Nigeria remains bleak unless deliberate attempts are made to enhance the economic value of wood.

In 1989, the total available volume of commercial trees above 30cm Diameter at Best Height (DBH) was estimated at 305 million cubic meters in Nigeria's 14.9 million cubic meters land. Hussain (1991) stated that "while over 140,000 ha of plantations have been established by the Federal and State government since 1940, the record of maintenance is poor". The demand for industrial wood exceeds the sustainable supply from existing plantations. Some of the desirable policy options will involve judicious forest exploitation, aggressive aforestation programme and improvement in wood yield/conversion efficiency per log (R.M.R.D.C, 1991).

There is evidence of huge wastage of wood resources during wood processing operations. This may be due to one or a combination of the following factors, viz; inefficient operators, crooked logs, pile of slabs, half processed materials, rejects and sawdust (R.M.R.D.C, 1991). During saw milling operations, slabs, edging, trims and sawdust are produced in extracting lumber from round logs. These are considered as unavoidable negative output of sawmilling, while the lumber or planks are

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considered as positive output. According to Warsta (1978), the amount of residue depends on the species of the log, the size and shape of the log, the condition of sawing machine the competence of the machine operator and the required conversion specification.

NISER (1974) defined wood residue as the pieces of materials that are lost from the process of harvesting up to when the final products (planks) have been taken. Hence, residue may be regarded as negative product of wood processing. That not withstanding, what is regarded as wood residue in the sawmill is an important raw material in other industries. Onosode (2006) reported that the presence of defects in logs greatly affects the quality, volume of plank yield and volume of residue. The various wood defects tend to influence lumber quality and output to varying degree. Hence, in assessing the monetary value (pricing) of logs, factors that negatively affect wood conversion need to be considered. Wood conversion in this study is defined as the percentage of positive output (plank yield) with respect to the total volume of the wood before milling. For instance, Guernsey (1996) observed that factors that negatively affect wood conversion include shape, size and infection of log. This has some economic implications in wood business that may warrant some investigation.

Objectives of the study: To determine wood conversion efficiency of some selected wood species and to estimate plank yield per log as influenced by wood residue and size among three species of timber (Danta, Alstonia and Obeche).

This study is deemed significant in that the findings will enable wood entrepreneurs to estimate with relative accuracy, the wood conversion efficiency and plank yield per log of Obeche, Alstonia and Danta. Such information can be useful for the purpose of pricing decision, planning and budgeting in wood business.

MATERIALS AND METHODS

This study was conducted in Delta State, Nigeria. It was chosen for the study due to its position as one of the major timber production areas in Nigeria. Hence many people in this area take timber (wood) marketing as means of livelihood. The area is located in the tropical rainforest region in Nigeria.

Data collection techniques: Three species of timber (Danta, Alstonia and Obeche) were surveyed in ten different sawmills in Delta State, Nigeria. Ten logs were selected from each of the species, giving a total of thirty logs that were studied. The parameters of interest included: Log length (m), average diameter and the average volume (cm^3) (V_1). All the measurements of all species of logs were determined without exclusion of the bark before milling. After milling, volume of lumber (yield) (V_2) was determined. Volume of residue (V_1 minus V_2), was also calculated.

Data analysis techniques: The data collected were analysed using mean, standard deviation and percentage wood conversion efficiency was determined by converting the volume of lumber (V_2) to percentage. This was done using the mathematical expression below:

$$\frac{\text{Final Volume of Lumber (V2)}}{\text{Initial Volume of Log (V1)}} \times \frac{100}{1}$$

The multiple regression model was used to estimate the functional relationship between plank yield per log and its determinants.

Model specification: The explicit form of the regression model adopted took the form:

$$Y = \alpha + \beta_2 RS + \beta_2 SZ + \mu$$

Where

Y	=	Plank yield
α	=	Int ercept term
R_s	=	Residue
SZ	=	Size of log
β_1 - β_2	=	Coefficients of regression
μ	=	Error term

RESULTS AND DISCUSSION

The wood conversion efficiency of Alstonia, Danta and Obeche is presented in Table 1. The finding of the study shows that Danta (Nesogordonia papavereria), has the highest wood conversion efficiency (59.86%) per log. This was followed by *Alstonia* sp. (52.86%) per log. Obeche (Triplochiton scleroxylon), has the lowest wood conversion efficiency (50.89%) per log.

The conversion efficiency of the three wood species takes the following order: Danta>Alstonia>Obeche. This result shows that wood conversion efficiency varies according to species. Thus some species of wood would have more economic valuable than others. This finding agrees with the earlier report of Guernsey (1996) that

Table 1:Wood conversion efficiency

S/No.	Wood types	Conversion efficiency%	Conversion inefficiency%
1.	Alstonia	52.86	47.14
2.	Danta	59.08	40.92
3.	Obeche	50.89	49.11

(Source: 2006 Survey data)

Table 2: Lead equations with respect to wood types

	Wood type	Intercept	Residue (Rs)	Log Size (Sz)	R^2	R^2 (adj.)	remark
1.	Danta	200.33	-37.77	3.25	99%	98%	Sig.
2.	Alstonia	99.951	-0.999	0.006	100%	99%	Sig.
3.	Obeche	260.85	-53.63	2.76	99%	98%	Sig.

(Source: 2006 Survey Data)

wood conversion efficiency would depend on the quality of the log, all other factors being equal.

Table 2 presents the lead estimation equations for the three species of wood. The detail interpretation of the estimation equation for Danta, Alstonia and Obeche is presented exhaustively below:

Estimation of Plank Yield of Danta with Respect to Log Size and Residue.

Hypothesis: H_{01}: There is no significant relationship between the plank yield of Danta and its log size and residue.

This hypothesis was tested by using the Ordinary Least Square (OLS) technique of multiple regression analysis. An evaluation of the Danta yield equation shows that the model performed relatively well based on the values of R^2 and R^2(adj.) of the semi-log equation. The R^2 is 99% and the R^2(adj.) is 98%. This implies that approximately 98% of the variation in the plank yield of Danta was due to the joint effect of residue (waste) and the size of the log. The estimated regression equation is presented below:

$$Y = 200.33 - 307.77Rs + 3.25\,Sz + \mu$$
$$(27.95)^{*} \quad (-19.88)^{*} \quad (1.47)^{Ns}$$

* = Significant at 1%

Ns = Not significant

The implication of this equation is that there is a negative and significant functional relationship between the plank yield of Danta and its residue (waste). That is, as the residue is increasing, the yield of Danta is decreasing.

The coefficient of residue (-37.77) in the equation, implies that a 1% increase in residue will lead to about 37.7% decrease in the plank yield of Danta per log. On the other hand, as the residue is decreasing the plank yield of Danta is increasing, all other things being equal. The result of the study also shows that there is a positive relationship between the plank yield of Danta and the size of its log. This shows that bigger logs of Danta are likely to have more yield than smaller logs, all thing being equal. The fact that the variable is not significant in the model, indicates that the size of log of Danta, however, does not always determine its yield, most especially when the log is deformed and the processing machine is inefficient. Under such condition it becomes difficult to accurately estimate the yield of Danta on the basis of its log size. This result agrees with the earlier reports of Guernsey (1996) and Onosode (2006) that log size can influence lumber yield.

Estimate of plank yield of alstonia with respect to log size and residue

Hypothesis: H_{02}: There is no significant relationship between the plank yield of Alstonia and its log size and residue.

This hypothesis was tested by using the Ordinary Least Square (OLS) technique of multiple regression analysis. An evaluation of Alstonia plank yield equation shows that the model performed relatively well, based on the values of R^2 and R^2 (adj.) of the linear equation. The R^2 is 100% and the R^2 (adj.) is 99%.

This implies that approximately 99% of variation in the plank of Alstonia was due to the joint effect of residue and size of the log.

The estimated regression equation is presented below:

$$Y = 99.951 - 0.999Rs + 0.006Sz + \mu$$
$$(1701.67)^{*} \quad (1131.24)^{*} \quad (0.04)^{Ns}$$

* = Significant at 1%

Ns = Not significant

The equation implies that there is a negative and significant relationship between the plank yield of Alstonia and its residue (waste). That is, as the residue is increasing, the yield of Alstonia per log, is decreasing. The coefficient of residue (waste) (-0.99) in the estimation equation, shows that a 1% increase in residue per log, will result in approximately 1% decrease in the plank yield of Alstonia per log. The result also shows that there is however, a positive relationship between the plank yield of Alstonia and its log size. Hence, the bigger the log of Alstonia the more the plank yield it is expected to generate. But this assumption does not always hold, especially when the log is deformed.

Estimation of obeche plank yield with respect to residue and log size

Hypothesis: H_{03}: There is no significant relationship between the plank yield of Obeche and its residue and log size.

Table 3: Summary statistics for all parameters

	Alstonia			Danta			Obeche		
Stat	Yield	Residue	Size	Yield	Residue	Size	Yield	Residue	Size
Count	10	10	10	10	10	10	10	10	10
Mean	52.86	47.13	0.48	59.08	40.92	0.46	50.89	49.13	0.49
Std. Dev.	14.99	14.98	0.09	12.2	12.2	0.13	9.83	9.80	0.09
Std. Error	4.74	4.70	0.03	3.80	3.80	0.40	3.11	3.10	0.04
Minimum	15.08	31.46	0.35	23.56	23.5	0.30	26.06	36.32	0.36
Maximum	68.44	84.92	0.66	60.91	60.90	0.72	63.68	73.94	0.60
Massing cases	0	0	0	0	0	0	0	0	0

(Source: 2006 Survey Data)

This hypothesis was tested by using the ordinary least square technique of multiple regression model. An evaluation of the Obeche plank yield equation shows that the model performed relatively well based on the value of R^2 and R^2 (adj.) of the semi-log equation. The R^2 is 99% and the R^2 (adj.) is 98%. This implies that approximately 98% of variation in the plank yield of Obeche was due to the joint effect of residue (waste) generated and the size of the log.

The estimated regression equation is presented below:

$$Y = 260.86 - 53.63Rs + 2.76Sz + \mu$$
$$(26.96)^{*} \quad (-221.34)^{*} \quad (1.13)^{Ns}$$

This estimated equation implies that there is a negative and significant relationship between the plank yield of Obeche and its residue (waste) generated. This means that the quantity of residue (waste) generated can negatively and significantly affect the plank yield of Obeche. That is, as the residue is increasing the plank yield of Obeche is decreasing.

The coefficient of residue is -53.63 in the estimation equation. This implies that a 1% increase in residue will lead to approximately 54% decrease in the plank yield of Obeche per log, all other things being constant. Also the coefficient of log size (1.76) in the estimation equation indicates that a 1% increase in the log size of Obeche will lead to about 1.76% increase in the plank yield of Obeche. This further implies that a bigger log of Obeche is likely to produce more planks than a smaller log. This does not however, significantly determine the plank yield of Obeche, hence the variable is not significant in the model (Table 3).

CONCLUSION AND RECOMMENDATIONS

From this study, the following conclusion can be drawn Danta has the highest conversion efficiency followed by Alstonia while Obeche was the least. Danta is therefore expected to posses higher Economic value than Alstonia and Obeche. The estimation equations revealed that out of the two variables captured in the models, residue (waste) significantly influenced plank yield in all the three wood species. The degree of negative influence of residue on plank yield in the three wood species is in the following order: Obeche > Alstonia > Danta. This result suggests that the effect of residue (waste) on the plank yield of Obeche (Triplochiton sleroxylon) was significantly evident when compared to Danta and Alstonia that have relatively lower quantity of residue. The result shows that Danta has highest resistance to milling machine. The high waste generated by Obeche could perhaps be due to its thicker bark and its soft nature. This physical property of Obeche reduced it plank yield significantly on economic ground. This because the bark is regarded as a residue (waste) in wood business.

In all the wood species captured in this study, the result indicated a positive relationship between log size and plank yield per log. In spite of this, the correlation is not significant. Hence, log size cannot be used to estimate plank yield of Danta, Alstonia and Obeche. This could be due to physical deformity such as hollow and curvature of logs.

We therefore, recommend that in determining the quality and price of logs, factors such as rate of waste production, hollow and curvature which tend to reduce plank yield per log should be considered.

REFERENCES

Adewumi, O.I., M.S. Adebayo, O.O. Abiodun and A.O. Caroline, 2004. Cost and returns structure of plank business in Ijebu division, Ogun State Nigeria. In The Ogun J. Agric. Sci., 3: 143-156.

CBN, 1999. Central Bank of Nigeria Statistical Bull. CBN; Abuja, pp: 10.

Guernsey, F.W., 1996. Utilization for Sawmill Residue in the Southern Cost Region of British Colombia, London: Oxford University Press.

Hussain, K., 1991. A Survey of aforestation programme in Nigeria (Unpublished).

Iwhiwhu, R.E., 2006. Survey of Sawmill Residue in Ethiope East L.G.A. of Delta State. (Unpublished) B. Agriculture, Department of Forestry and Wildlife, Delta State University, Asaba Campus.

Liiro, O., 1993. Scarcity of raw materials for wood-based Industry (Unpublished).

NISER, 1974. A Report on the state of the Sawmilling Industry in Nigeria. Prepared for ministry of Agriculture. Natural Resources.

Onosode, A.T., 2006. Wood Waste Utilization Potentials, Unpublished Lecturer Paper.

R.M.R.D.C Raw Materials Research and Development Council, 1991. An Update Task force for the Techno-Economic Survey of the Wood and the Products Sector.

Warsta, U., 1978. The Reduction of the Volume of Waste in the World.