TECHNICAL EFFICIENCY OF LUMBER RECOVERY FROM HIGH FOREST TREE SPECIES IN SELECTED SAWMILLS OF SOUTHWESTERN NIGERIA

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ABSTRACT

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*This study investigates the technical performance efficiency (TPE) of twenty seven sawmills purposely selected and grouped into three classes :small<500ft^3/day, medium 501-1000ft^3/day and large scale >1001ft^3/day based on their production capacities. 243 logs obtained from 20 species of wood sourced from Southwestern Nigeria were examined in 27 selected sawmills using the variables such as wood species, log sizes, shapes and sawkerf, which have direct impact on waste generated from sawn logs and log conversion efficiency. Whereas 135 structured questionnaire was used to obtain information relating to experience of headrig operators, age of machine, number of machine used for sawing operation, hands involved in operation and effective duration of operation while a model multiple factor equation was adopted to determine the over all performance efficiency of the assessed sawmills. The average TPE in the small scale sawmills was 53.41%, medium scale sawmills with 58.79% had the highest performance efficiency while large scale sawmills with 41.94% had the least TPE. The average lumber recovery (%LR) was 53.69%, large-sized diameter logs had the highest %LR of 56.48 and small sized logs had 51.77%. Ondo State had the highest mean %LR of 56.15 followed by Lagos (53.09%) and lastly by Oyo State (51.71%). Variations in log diameter classes had significant influence on %LR, slab volume and dust volume at ($p<0.05$). Significant correlation also exist between log diameter class and LR (0.853**). Noticeable variation in %LR was observed among the various wood species, Ceiba pentandra had the highest mean lumber recovery %LR value of 58.21% while Nauclea diderichii had the least (47.89%). For appreciable reduction of wood-wastes generated in sawmills, greater use should be made of large sized logs, routine maintenance of machines especially the saw blades is necessary, effort should be made towards inclusion of wood mizer headrig that handles smaller sized los with minimal wastages and obsolete headrig need to be replaced promptly while cognate experience should be a major determinant in the appointment of headrig operators. To avoid genetic erosion, choice of species was left to saw millers' discretion.*
Keywords: LRF: Lumber recovery factor, Headrig: Band saw machine, TPE: Technical performance efficiency, WWG: wood waste generated

INTRODUCTION

Sawmilling has been defined severally, as a system and as an industry (Bennett, 1974) and as a process (Lucas, 1982). As a process it involves converting log into lumber using different methods such as live sawing (sawing around the log), slash cutting, and cant sawing facility (Okigbo, 1964).

Factors influencing lumber yield and value have been identified as the factor influencing the timber recovery from logs during conversion in the mills. These include: log shape (sweep, tape crooked and straight), log sizes (girth and the length). Kinds of conversion and processing machine, machine maintenance culture, availability of machine parts and experience of the operators (Badejo, 1990). According to Zobel and Talbert (1991), log straightness improves both yield and quality of timber. In order to reduce the volume of wood wastes in the log conversion process and sustain the sawmills and corresponding profit margin, there should be an intensive research focus on efficient conversion of log so as to stem down the percentage of waste in Nigeria sawmills (Badejo, 1990).

Technical Performance Efficiency of a sawmill (TPE) is the state of being competent in performance or the ability to produce a desired effect with a minimum effort, cost, expenditure of time and waste. For example, efficiency of a machine is determined by the ratio of work done (output) to the energy that supplied (input) the work (Encarta Dictionary, 2009). Williston, (1981) defined efficiency in terms of sufficient volume and appropriate diameter classes of log supply to the mill to keep it operating at the planned rate. As such, there should be an adequate inventory of raw materials to keep the mill operating at maximum efficiency over time. The factors that contribute to changes in efficiency include technological innovation, installed capacity and capacity utilization, change in scale of output, capacity investment per worker and entrepreneurial skills (Kaise, 1971). Badejo and Onilude, (1987), observed a variation in percentage LR in their appraisal of small size sawmilling operations in Nigeria. They attributed the variation to the variations in the years of experience of the headrig operators, kinds of headrig

used, sawkerf, log sizes, and log form but reported percentage LR without quantifying the effect of these identified factors as they affect overall percentage TPE of sawmills in the study area. Fuwape, (1985) reported mean percentage LR of 56%, time efficiency as idle working time ranging between 12.79-76.43%, effective working time ranging between 23.6-87.21% on separate notes without considering the cumulative effects of these factors on percentage TPE of the sawmills, though acknowledged their individual influences on percentage LR. Hence the need for an approach that can bring together some identified quantifiable factors which commonly affect the percentage TPE of sawmills in Nigeria. However, much attention had been on investigating the Lumber Recovery Factor (LRF) which Dobie, (1972) and Badejo and Giwa, (1985) defined as the ratio of the volume of sawn wood output to that of the volume input of logs processed in the mill, regardless of the types of processing equipment used and the species of wood involved. Lumber recovery factor cannot solely determine TPE of a sawmill but depends on the entire mill operational system. It is therefore an indication of the efficiency of how a sawmill is being run. When the ratio is high, the volume of wood waste generated is low.
This study therefore examines the technical performance efficiency (TPE) of 27 selected sawmills using 243 logs obtained from 20 species of wood sourced from Southwestern Nigeria based on the variables such as wood species, log sizes, shapes, saw geometry, experience of headrig operators, age of machine, number of machine used for sawing operation, hands involved in operation and effective duration of operation which have direct impact on waste generated from sawn logs and lumber recovery factor and consequently on the technical performance efficiency (TPE) of any given sawmill. The study aimed at providing information that could bring about a more efficient log-processing technique that would enhance optimum income to sawmill owners through reduction in wood waste generation.

MATERIALS AND METHODS

Study area

The three states of Lagos, Oyo and Ondo states in the south western Nigeria were purposely selected based on preponderance use of various types of headrig machines of the CD4, CD5 and CD6 categories. These machines are mostly horizontal band saw and the only variation apart from the maintenance status of the machine which depends on its maintenance status is the size of log they can saw. South-Western Nigeria lies between longitude 2^0 12^1E and 6^0E and between latitude 6^0 21^1N and 8^0 37^1N (Agboola, 1979) with a total land area of 77,818km^2 and a projected population of 135,031,160 million in 2007 (FAOSTAT, 2007). The predominant vegetation in Southwestern Nigeria ranges from Coastal belt of mangrove swamp forest especially Ogun water-side area, Igbokoda, Ilaje and Ijaw in Ondo State and Epe area in Lagos State through tropical rainforest that spread across southern part of Ogun, Oyo, Ondo and Ekiti states and covered by savanna in the northern parts of Oyo, Osun and Ekiti States. 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).

Log dimension and volume estimation

A total of 243 logs of varying sizes and shapes was sourced from 20 timber species that are usually sought after in the study area were selected for the study (Table 1). Twenty seven sawmills out of 641 in the study area were purposively selected in each of the selected states based on observed preponderance of horizontal band saws in operation and scale of output. Rate of log conversion and different form of waste generated in the process of log conversion were also examined. One hundred and thirty five (135) copies of structured questionnaire were administered in the 27 selected sawmills while 5 respondents comprising 1 sawmill manager, 2 headrig operators, 1 mill technician and 1 timber contractor were selected per sawmill, the questionnaire were used to obtain information relating to the experience of headrig operator, age of machines, numbers of machine used in operation, machine maintenance culture in practice, number of people involved in log conversion operations, effective duration of operation (hrs) and total idle time (hrs) using stop watch while saw geometry (kerf, gullet depth, saw pitch, hook angle and cutting angle) were measured using veneer caliper and compass (Fuwape 1985).

Determination of percentage Lumber recovered

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:

$$LR = \frac{T \times W \times L}{144} \times \frac{0.0283}{1} \quad \ldots\ldots 1$$

where

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

The percentage lumber recovered was estimated thus:

$$\%LR = \frac{\sum V_L}{\sum V_T} = \frac{(V_{L1} + V_{L2} + V_{L3} + \text{---} + V_{Ln})}{(V_{T1} + V_{T2} + V_{T3} + \text{-----} + V_{T243})}$$

$$\%LR = \frac{\sum VL}{\sum VT} \times 100\ \% \quad ---2$$

Where, %LR = percentage Lumber recovered

$\sum V_L = (V_{L1} + V_{L2} + V_{L3} + \text{-----} + V_{Ln})$ = total volume of lumber recovered (m^3)

$\sum V_T = (V_{T1} + V_{T2} + V_{T3} + \text{-----} + V_{T243})$ = total volume of all logs processed (m^3)

Determination of effective duration of log conversion

While determination of effective duration of log conversion in selected sawmills was by measuring the time taken in conversion of logs and the down time in each sawmill using stop watch as follows;

i time taken in converting each of the 9 logs = effective working time(X hrs)
ii down time = idle working time (Y hrs)
iii reasons for idle working time were noted

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^2) and standard error (SE) of estimation, mean square error (MSE) was also determined to know the proportion of variation explained by the regression equation.

$Y = a + b_1X_1 + b_1X_2 + b_3X_3 + b_4X_4 + \ldots\ldots + b_nX_n + e$……………..………………....3

Where, X_1---Xn = independent variables (factors considered)

Analysis of time, human and material efficiency

Time efficiency is an important component of the over-all efficiency of a sawmill, other components include efficiency of labor, managerial and conversion efficiency of machines.

The time efficiency was determined by measuring the total sawing time (T_t) known as effective sawing period (T_e) and the down time, known as the idle time (T_i) for each log converted. The equation developed by Fuwape (1985) and used by Egbewole *et al* (2005) was adopted to calculate performance efficiency of the mills. The equation is expressed as:

$$Y = \frac{aX1}{eX1} \times \frac{1}{n}\left\{\left(\frac{aX2}{eX2}\right) + \left(\frac{aX3}{eX3}\right) + \left(\frac{aX4}{eX4}\right) + \text{-----} + \left(\frac{aXn}{eXn}\right)\right\} \times 100 \quad ---4$$

Where: Y = Performance efficiency of the mill (%)

n = number of factors considered (5)

X_1 = duration of log conversion operation of a chosen sawmill (0-9hr)

X_2 = numbers of machine involved in log conversion

X_3 = numbers of hands actively involved in log conversion

X_4 = level of experience of hands actively involved in log conversion (5---10yrs)

X_5 = volume of log input/ lumber recovered (m^3)

a = actual, e = expected, 0hrs = zero efficiency, 9hrs = 100% time efficiency

The assumption of equation 4 are that a typical sawmill has the following

i 1 headrig machine, 1 rip saw machine, 1 saw doctoring machine
ii Average of 2 operators for the headrig machine, 1 operator for the rip saw machine, 1 saw doctors machine operator.
iii the headrig machine has a capacity to convert about 650ft^3 (18.39m^3) of log within 9hrs of uninterrupted operation
iv the logs to be processed are readily available (about 18.39m^3) in required quantity and log geometry (shapes and dimension)
v that lumber recovery factor (LRF) ranges from (0--1).
vi that the model is flexible enough to accommodate other quantifiable factors ($X_{a\ ---}\ X_n$)

The limitations of equation 4 for a typical sawmill are

i if the actual duration of log conversion operation of a chosen sawmill is zero (aX_1 = 0 hrs), then the performance efficiency will be zero (Y = 0 %)
ii that any efficiency rating depends on 'actual duration of log conversion operation (0-9hr)'
iii that a sawmill with zero efficiency (Y = 0 %) at a given time can be put back to produce at its installed capacity (highest efficiency level) if the limiting factors are controlled.

RESULTS AND DISCUSSION

Out of the 243 sampled logs, 29 representing about (11.9%) of total logs were of large diameter class (>55.01cm), 115 (47.3%) medium diameter class (40.01--55cm) and 99 (40.7%) were chosen from small diameter class logs (≤ 40cm). The results of the study indicated that large diameter logs had the highest mean LR of 54.48%, closely

followed by the medium sized logs with 54.18% and lastly by small sized logs with 51.77%. Analysis of Variance (ANOVA) indicated that the influence of log diameter classes is significant on the % LR , wood waste due to slab and wood saw dust at ($p \leq 0.05$). The results of 2-way interactions among the log-diameter-classes and log shape was significant on the % LR while 2-way interactions on log-diameter-class and years of experience of headrig operators was not significant on the % LR ($p \leq 0.05$). However, The results of 3-way interactions among the log-diameter-class, log shape and the level of experience of headrig operators was significant on the % LR at $p \leq 0.05$. There was no significant difference in the diameter classes of the logs being processed both within and between the selected sawmills. The result of Duncan Multiple Range Test (DMRT) showed that there was no significant difference in the 53.74% LR obtained in the large diameter class logs and that of the 54.18% from medium diameter class logs but the two classes are significantly different from the 51.77% lumber recovered from small diameter class. The result of correlation analysis indicated that there was a strong positive significant correlation between log diameter class and total log input (0.904**), between log diameter class and lumber recovery (0.853**), between log diameter class and slab volume (0.878**) and also between log diameter class and volume of waste due to saw dust (0.438**) between log shape and slab volume (0.427**) while there was no significant correlation between log shape and lumber recovery (0.029) and also between log shape and waste due to dust volume (0.074) .
The prediction equation used for lumber recovery (LR) is therefore stated thus:

$$LR = 0.015 + 0.0053(Ls) - 0.002(LL) + 0.496(Tv) - 0.002(Dcl) + 0.0011(Ex) - 0.003(Kf) + e \quad \ldots\ldots\ldots\ldots 19$$

Where : LR = lumber recovered (variable predicted), the predictors are Dc = diameter class, Ls = log shape, LL = log length, Ex = experience of the headrig operators (yrs), Kf = saw kerf (mm), Tv= total volume, R^2 = (0.897) coefficient of determination, SE = 0.1217. (Table 3)
The implication of this is that at any given log diameter class of known log shape, log length, experience of headrig operator, known saw kerf , the average lumber recovery can be estimated. The results of regression analysis however showed that the effects of saw kerf will only contribute about 7.8 lumber recovery efficiency and this effect was not significant on the wood waste generation at $p \leq 0.05$. This trend is in agreement with Fuwape, (1985); Lucas (1983); Sanwo, (1982); Egbewole *et al*, (2006) and Williston (1981). The mean technical performance efficiency (TPE) for log conversion in the 9 selected small scale (≤ 10,000m3 log/year) sawmills was 53.41%. It was observed that small scale sawmills in Ondo State had the highest mean TPE of 58.07% followed by Lagos State with 55.97% and lastly by the small scale sawmills in Oyo State with 46.17%. For the medium scale sawmills, the mean TPE for log conversion in the 9 selected medium scale (10,001—20,000m3 log/year) sawmills was 58.79%. It was observed that medium scale sawmills in Lagos State had the highest mean technical TPE of 63.47% followed by Ondo State with 56.81% and lastly by the medium scale sawmills in Oyo State with 56.10% (TPE). While, the trend was different for the large scale sawmills,. The result showed that, the mean technical performance efficiency (%TPE) for log conversion in the 9 selected large scale (≥ 20,000m3 log/year) sawmills was 41.54%. It was also observed that large scale sawmills in Ondo State had the highest mean TPE of 47.25% followed by Oyo State with 43.42% and Lagos State with 35.15%. The implication of the results of the mean TPE for log conversion in the each of the selected sawmill is that the sawmill will not to performance better than its present TPE unless there are improvements on their operational procedures (Table 4).
In term of time efficiency, the percentage effective working time (EWT)for log conversion operations ranged between 46.67-70% with a minimum of 46.67% observed in the small scale sawmill in Oyo State followed by 53.33% in the Large scale sawmills in Lagos State while the maximum effective working time of 70% was observed in the large scale sawmills in Ondo State. The result of percentage idle working time (IWT) was a reverse of the trend above with a range ranged between 30-53.33% with a minimum of 307% observed in the medium scale sawmill in Ondo State followed by 31.11% in the medium scale sawmills in Lagos State while the maximum idle working time of 53.33% was observed in the small scale sawmills in Oyo State. (Table 4)
However, the results of analysis of variance indicated that there was significant difference in the TPE, time efficiency, machine efficiency, man efficiency in terms of years of log conversion operations both within and between sawmill scales and selected states at ($P < 0.05$). The results are in conformity with Fuwape, (1985) who obtained a result of idle working time ranged between 12.79-76.43%, effective working time ranging between 23.6-87.21 and mean 56% LR in His evaluation of 18 sawmills for log conversion efficiency in Ondo State. (Table 5)

CONCLUSIONS

The findings have revealed that the kind of wood species process, the type of headrig machine (band saw) used to process it and the kind of operator who manned the head rig machine have direct and significant impact on the conversion efficiency obtained during log processing and consequently the volume of wood waste generated. If this volume of generated wood waste can be drastically reduced at any particular time, sawn board available for use in the housing and construction industry will increased. It will be possible to reduce the extent of exploitation pressure on the forest reserve areas, invariably therefore, the existing forest Reserve Area may be made to last longer. However, the findings have also shown the value of conversion efficiency in a sawmill as an important forest management practice in any country and have also provided valuable information that could enhance efficiency in log conversion process in sawmills through reduction of wood waste and dust volume. Since the logs used were obtained from species of well-known timber trees commonly sought after by saw millers due to their high utility values, coupled with the classification of such logs into diameter classes, the results of this study would no doubt have wide range of applicability, moreso as various classes of sawmills were considered.

RECOMMENDATIONS

In order to reduce the voulume of wood wastes in the log conversion process to engender sustainable forest management and profitable production of the sawmills, the following recommendations are made
(i) It is suggested that obsolete headrigs be replaced promptly (where and when necessary). Cognate experience should be a major determinant in the appointment of headrig operators in sawmills, where feasible, only logs of large diameter sizes (≥45cm) with good and fairly cylindrical bole should be processed. The sawmillers should be given technical advice on new conversion process regularly especially on small diameter logs. Maintenance culture should be encouraged in sawmills as expected in a well managed sawmill.
Finally, it is recommended that at regular interval, the performance efficiency of any sawmill should be assessed by adopting the equation used in this study since the equation is flexible enough to accommodate any quantifiable factor in the process of estimating sawmill efficiency instead of equating lumber recovery factor which is the ratio of lumber output to log input, this is necessary to ensure high level of performance in sawmilling industry. Adoptions of these approaches will undoubtedly result to high level of performance in sawmilling industry.

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Table 1: Mean values of some assessed parameters on wood species processed across surveyed sawmills

S/N	Sources of variation	Trade name	No of logs	Total volume (m^3)	Slab volume (m^3)	Bark volume (m^3)	Dust volume (m^3)	Lumber recovery volume (m^3)	Lumber recovery factor (LRF)	% lumber recovery
1	*Zanthoxylum leprieurii*	Ata	8	.688	.139	.042	.091	.384	.559	55.92
2	*Mitragyna ciliate*	Abura	12	.624	.125	.045	.093	.317	.508	50.77
3	*Phyllanthus discoideus*	Ashasha	17	.640	.133	.048	.101	.332	.519	51.86
4	*Pterygota macrocarpa*	Oporopor o	13	.660	.134	.044	.099	.362	.549	54.85
5	*Blighia sapida*	Ishin	8	.340	.068	.019	.042	.191	.561	56.08
6	*Ceiba pentandra*	Araba	22	.974	.186	.068	.135	.567	.582	58.21
7	*Milicia exceslsa*	Iroko	10	.598	.120	.047	.094	.293	.489	48.94
8	*Funtumia elastica*	Ire	8	.635	.132	.044	.099	.350	.551	55.05
9	*Anthostemma aubryanum*	Odogbo	11	.666	.134	.048	.111	.365	.548	54.79
10	*Cola accuminata*	Igi-obi	6	.568	.120	.052	.105	.314	.553	55.31
11	*Khaya ivorensis*	Mahogany	16	.537	.113	.050	.111	.280	.522	52.20
12	*Drypetes gilgiana*	Osunsunr o	6	.603	.124	.043	.102	.332	.551	55.07
13	*Ficus exaspirata*	Ipin	13	.610	.119	.047	.106	.316	.518	51.85
14	*Mansonia altissima*	Mansonia	21	.323	.065	.024	.049	.180	.557	55.71
15	*Harungana madagascari ensis.*	Uturu	3	.671	.146	.041	.091	.383	.571	57.09
16	*Nauclea diderichii*	Opepe	18	.627	.128	.042	.090	.300	.479	47.89
17	*Distemonant hus bentamianus*	Ayan-iroko	11	.654	.129	.045	.091	.323	.495	49.45
18	*Erythrophleu m suaveolens*	Obo	16	.629	.122	.045	.094	.343	.545	54.55
19	*Anoigeissus leiocarpus*	Ayin	10	.666	.140	.048	.083	.345	.518	51.83
20	*Triplochyton scleroxylon*	Obeshe	17	.651	.136	.047	.089	.328	.504	50.40
	Total		243	.634	.128	.046	.096	.340	.5369	53.69

Field survey 2008, * highest %LR

Table 2: Mean values and Duncan's mean separation values of some assessed parameters

S/N	Sources of variation	No of logs	Total volume (cm^3)	Slab volume (cm^3)	Bark volume (cm^3)	Dust volume (cm^3)	Lumber recovery volume (cm^3)	Lumber recovery factor (LRF)	% lumber recovery
1	Diameter class (cm)								
i	Small ≤ 40 cm	81	.378[a]	.091[a]	.029[a]	.066[a]	.196[a]	.518[b]	51.77[b]
ii	Medium 40.01-55cm	81	.635[b]	.126[b]	.046[b]	.098[b]	.344[b]	.542[a]	54.18[a]
iii	Large ≥55.01cm	81	.983[c]	.194[c]	.070[c]	.147[a]	.555[c]	.565[a]	56.48[a]
2	Work experience (years)								
i	≤5yrs	27	.629[ab]	.126[ab]	.045[a]	.096[a]	.330[ab]	.524[a]	52.44[a]
ii	6-10yrs	126	.631[b]	.128[b]	.046[a]	.097[a]	.341[b]	.540[a]	54.03[a]
iii	11yrs-above	90	.663[a]	.134[a]	.046[a]	.093[a]	.353[a]	.533[a]	53.27[a]
3	Saw kerf								
I	≤2mm	27	.663[a]	.133[a]	.045[a]	.094[a]	.363[a]	.548[a]	54.80[a]
ii	2.01-2.50mm	135	.634[a]	.130[a]	.049[a]	.095[a]	.339[a]	.535[a]	53.57[a]
iii	2.51mm-above	81	.624[a]	.124[a]	.046[a]	.098[a]	.333[a]	.533[a]	53.27[a]
4	Log shape								
	straight	137	.641[b]	.128[b]	.046[a]	.095[a]	.352[a]	.549[a]	54.87[a]
	Tapered	42	.634[a]	.129[b]	.045[a]	.096[a]	.331[b]	.522[b]	52.15[b]
	Crooked	64	.623[a]	.124[a]	.047[a]	.100[a]	.334[a]	.536[a]	53.59[a]

Mean with the same letters are not significantly different at ($p<0.05$), Field survey 2008

Table 3: Regression analysis for log form, experience of headrig operators and lumber recovery (LR)

S/n	Independent Variables ($x_1..x_5$)	Unstandardized coefficient B	Std. Error	Standardized coefficient Beta	t	Sig.	Regression ANOVA	Coefficient of determination (R^2)
	(Constant)	0.0146	.048		.306	.760		
1	Log shape(x_1)	.0053	.003	0.038	1.794	.074 [ns]		
2	Length(x_2)	-0.002	.012	-0.004	-0.174	.862[ns]		
3	Total volume (x_3)	0.496	.027	0.953	18.331	.000**		
4	Diameter class (x_4)	-0.002	.010	-0.007	-0.130	.897 [ns]		
5	Experience (x_5)	0.0011	.004	0.006	0.251	.802 [ns]		
6	Kerf (x_6)	-0.003	.004	-0.012	-0.522	.602 [ns]	.00**	.897

Note: **highly significant at 1% probability level, $P<0.05$, * = significant, ns = not significant. Y (LR) = Dependent variable (Lumber recovery), $x_1…x_6$ = Predictors,

Table 4: showing log input, waste generated and the lumber recovery in selected sawmills on production scale and State basis

State	Sawmill Scale	No of logs	Log Conversion method	Total volume (m^3)	Effective Working Time (%)	Idle Working Time (%)	Lumber recovery volume (m^3)	LRF
Lagos State	Small	27	Sawing around, T&T	.542	57.78	42.22	.281	.517
	Medium	27	Sawing around, T&T	.580	68.89	31.11	.312	.540
	Large	27	Sawing around, T&T	.720	53.33	46.67	.362	.503
Oyo state	Small	27	Sawing around, T&T	.525	46.67	53.33	.279	.530
	Medium	27	Sawing around, T&T	.554	66.67	33.33	.278	.501
	Large	27	Sawing around, T&T	.660	57.77	42.22	.356	.541
Ondo State	Small	27	Sawing around, T&T	.530	61.11	38.89	.279	.526
	Medium	27	Sawing around, T&T	.613	70.00	30.00	.325	.532
	Large	27	Sawing around, T&T	.720	60.00	40.00	.362	.503

Source: Field survey 2008

Table 5: Technical Performance Efficiency (TPE) for log conversion in selected sawmills on production scale and on State basis

State	scale	Time Efficiency (%)	Machine Efficiency (%)	Men Efficiency (%)	Experience (Year)	LRF	TPE (%)
Small	Lagos	5.2/9	5/4	7/8	7.7/7	.537	55.97
	Oyo	4.2/9	4/4	6/8	9.7/7	.513	46.19
	Ondo	5.5/9	5/4	9/8	5.7/7	.543	58.07
	Mean	4.97/9	4.7/4	7.3/8	7.7/7	.531	53.41
Medium	Lagos	6.2/9	7/8	11/16	11.3/7	.533	63.47
	Oyo	6.0/9	6/8	10/16	10.4/7	.504	56.10
	Ondo	6.3/9	7/8	12/16	7.7/7	.553	56.81
	Mean	6.2/9	6.7/8	11/16	9.8/7	.530	58.79
Large	Lagos	4.8/9	10/16	15/32	6.0/7	.560	35.15
	Oyo	5.2/9	9/16	18/32	8.7/7	.549	43.42
	Ondo	5.4/9	8.3/16	13/32	7.6/7	.537	47.25
	Mean	5.13/9	9.1/16	15.3/32	7.43/7	.549	41.94

Field survey 2008