Implications of sawmill by-products management in rural economies of three local Government Areas of Benin metropolis, Edo State, Nigeria

KALU, P. C., IMARHIA, I. V. and AIGBOBO, E.N.
Department of Forest Resource and Wildlife Management, Faculty of Agriculture, University of Benin, Benin City.
e-mail cpkalu@uniben.edu

Abstract
The neglect of sawmill by-product management presented economic challenges which underscored the objectives of sawmill by-product management such as saw mill waste collection patronage, employment on waste collection and salaries, uses of various waste and revenues from waste management. Data was obtained with the aid of a close-ended questionnaire administered to 68 respondents, at 60% sampling intensity on sawmills greater than two registered mills in each location. Empirical observation was also adopted to generate data from records and measurement of by-product indices. These data were collated and analyzed using descriptive statistics such as frequency and percentages which were summarized in tables and inferential statistics using Analysis of variance.
The results showed that the quantity of sawdust collected varied significantly among various regimes of collection considered in the study ($p<0.05$) with bi-weekly collection dominating other collection regimes. The results also showed that less than five persons (<5) accounted for 41.8% of those who collected sawdust from sawmills. The results further revealed that there was significant difference ($p<0.05$) amongst the income generated from the various sawmill by-products in the study area with the income from offcuts dominating the income from other by-products. The results showed that there was significant difference between the applications of sawmill by-products by end users ($p>0.05$). It also revealed that there was significant difference ($p<0.05$) among the different charges paid to government by the sawmill operators. The study recommended that efforts should be made to develop markets for sawmill by-products, such as sawdust, offcuts and wood chips.

Key words: Economic implication, end-users, management, sawmill byproduct, sawmill operator

Introduction

Waste generation is a concomitant aspect of wood processing producing residues which cannot be avoided but managed (Odewunmi, 2001; Aina, 2006). The economic value of sawmill lies in its ability to generate revenue and income through effective utilization of sawmill waste for additional income and to improve the overall welfare of the people in the enterprise. The waste generated from sawdust has a lot of economic benefits. According to Oluoti *et al* (2014), studies have shown that several Renewable Energy Technologies (RET) would be in a position to compete with fossil fuels by the year 2025 if properly managed. These residues could generate income and employment for prospective investors. Small and medium scale factories could be established for the production of sawdust pellets and briquettes. The channeling of sawdust into useful energy for cooking and other heating purpose would reduce unemployment and bring about increase in economic growth. Essentially, the introduction of briquettes or pellets made from sawdust for energy purposes would bring about diversification and increase in the renewable share of the nation's energy mix (Oluoti *et al.,* 2014).
Locally, wood wastes currently enjoy patronage in areas like beddings for animals and cooking, money generated from this patronage bring additional income to the sawmillers. Wood wastes are also used by farmers as farm manure and to protect yam seedlings from excessive water and sun rays which is an efficient method of mulching so as to prevent leaching and enhance farm yield produce (Akhator *et al*., 2017)
Sawmill residue is utilized within the sawmill itself or by other industries for various purposes such as heat generation and special products. It can be utilized in various ways such as the production of charcoal, as souvenirs such as notepad, candle holder, bowls and jewelry boxes (Larinde and Aiyeloja, 2009). Though there is limited utilization of these residues in Nigeria due to the fact the techniques for utilizing them are not developed and no particular desire for industries at present. The sawmill produces different residues like sawdust, wood shavings, wood off cuts and wood chips (Dosunmu and Ajayi, 2002; Akinbode and Olujimi, 2014). If sawmill waste cannot be effectively utilized or sold, it may need to be disposed off properly to prevent environmental pollution. Improper disposal such as heaping at saw mill sites, dumping on road sides, drainages or water bodies and open burning are common practices. These indiscriminate disposal practices result in untoward environmental and human hazards (Arimoro *et al.,* 2006). Improper disposal of sawmill waste can lead to soil contamination via leaching, or perhaps fire outbreak due to their inflammability, impacts negatively in rural economies. The economic potential of these wastes remains largely untapped at the existence of traditional disposal practices such as landfilling and burning not only result in environmental degradation but also represent a trade off in income regeneration due to marginal propensity to consume. This invariably constitutes a drawback in revenue and job creation. Furthermore, the demand increase and corresponding price rise of fossil fuel necessitates the demand for sawmill wastes which have economic implications associated with high waste disposal cost which imposes a substantial financial burden on the sawmill owners. There are no proper sensitization in the sawmill premises which results to sawmill wastes being littered all over the place especially when they are abandoned.
Attempts are therefore made to assess the implications of various uses of sawmill by-products with special attention

on accruable income, revenue and employment creation which underscores optional uses of by-products instead of outright disposal or burning.

Materials and Methods

Study Area

The study was carried out in Benin metropolis, at selected sawmills in the study area. Benin metropolis situated in a humid tropical urban settlement within the lowland rainforest. It is located within latitudes 6°26'N and 6°31'N and longitudes 5°35'E and 5°41'E .

The climatic condition of Benin metropolis is a distinct wet and dry season. It is characterized by high rainfall with an average annual rainfall varying between 1500mm to 2000mm (FORMECU, 1999).The annual temperature ranges from 27°C to 32°C with an average of 27°C. (FORMECU, 1999).

The state is endowed with about 37 forest reserves which cover a total of about 597,557 hectares (FORMECU, 1999). These reserves, though have decreased in number as a result of deforestation, urbanization and degradation, supply the raw materials to the numerous sawmills. ||Benin metropolis boasts of a rich number of small-scale sawmills, some of which are registered while others are unregistered.

Data Collection

Data was collected with the use of a close-ended questionnaire which was administered to the respondents comprising of the sawmill owners and employees. This was supplemented with oral interview so as to elicit information on the weekly level of patronage on residue collection, weekly income to the sawmillers from various by-product sales, monthly revenue to government for sawmill residue management, the staff employed for waste management and their salaries as well as various uses of sawmill residue. The average weights for measured sawmill by-products consisting sawdust, woodchips and offcuts were obtained with the use of weighing balance. In case of sawdust, volume of cement bag measure weighing 3.5kg stood at cost of ₦700 while big rice bag of 8.75kg and wheat flour bag of the product 12.5kg sold for ₦1000 and ₦1500 respectively. In case of wood poultry chip, feed bag measure weighing 5kg was sold at ₦500 while medium bags and big bags weighing 10kg and 25kg respectively sold for ₦2,750 and ₦4,000 respectively. In case of offcuts, cement bag measure weighing average of 9kg was sold for ₦3,000, while rice bags weighing 30kg was sold for ₦4000. Big bag of 35kg and wheel barrow load of 75kg stood at ₦5,000 and ₦10,000 respectively (Table 3).

Statistical Analysis

Data generated were subjected to various analytical tools such as descriptive statistics (frequency and percentage) which was later summarized in tables while Analysis of Variance (ANOVA) was applied to various regimes of collection of by-products and charges paid for the associated products as well as income from the sales of products.

Sampling Methods

A reconnaissance visit was made to the Forestry and Conservation Department of the Edo state Ministry of environment to obtain information on the registered sawmills within the state. Twenty eight registered sawmills were identified in three Local Government .Areas namely; Egor, Ikpoba-okha and Uhunmwonde. Using 60% sampling intensity, 17 sawmills were selected. A total of 68 copies of questionnaires were distributed for the study while four respondents in each of these sawmills randomly selected for administration of the questionnaires (Tables 1 and 2).

Table 1: Sampled Sawmills and Respondents

L.G.A	NSI	60% S.I	NR
Egor	5	3	12
Ikpoba-Okha	5	3	12
Uhunmwonde	18	11	44
Total	28	17	68

L.G.A= local government area, NSI=number of sawmill identified, S.I= sampling intensity, NR= number of respondents.

Results and Discussion

Table 4 shows that the quantity of sawdust collected varied significantly among the regimes of collection considered in the study ($p<0.05$). The mean of Bi-weekly collection of sawdust dominated the means of other periods of collection in the study.

Residue currently enjoy patronage in areas like beddings for animals and cooking. In addition, sawmill wastes are also used by farmers to protect their seedlings from excessive water and sun rays. These uses for wood wastes account for a little percentage of wood residue generated in three LGAs in Benin Metropolis as evident from the huge quantity of wood wastes littering the premises of sawmills and other wood processing industries in the metropolis. The poor utilization of wood waste in Nigeria can be adduced to several factors; lack of incentives for economic returns of wood waste utilization, inadequate information on economic returns of wood waste utilization, lack of technical know-how on wood waste processing and utilization, among others.

Table 5 reveals that there was significant difference between the collectors of the sawmill by-products ($p>0.05$). Private businesses were predominant in the collection of the sawmill by-products in the study.

The findings show that within a week, few individuals visit sawmills for sawdust collection. This level of patronage for sawdust is attributed to the usefulness of sawdust as household energy for cooking, and also for poultry and animal bedding as well as raising of seedling which bring to the understanding that saw mill by-product have positive economic implication in Edo State.

Table 7 shows that there was significant difference ($p<0.05$) among various by-products of sawmill activities. Further analysis indicated that the quantity of offcuts produced dominated other by-products in the study.

Table 2: Names of Sawmills in the Study Area

L.G.A	TSM	SSM
Egor	Gabriel Evbuomwan	Gabriel Evbuomwan
	Kingsley Ogbebor	Kingsley Ogbebor
	Mrs. Grace Obhiebo	Mrs. Grace Obhiebo
	Fetus Iyahen	
	Omorodion Sawmill	
Ikpoba-Okha	M.A. Ehigiator Sawmill	Emmanuel Igiebor
	Emmanuel Igiebor	Imade Enomayo sawmill
	Imade Enomayo Sawmill	Morgan Ekiosa (Goody-Goody
	Frederick Egbe Uyi Sawmill	Sawmill)
	Morgan Ekiosa (Goody-Goody Sawmill)	
Uhunmwonde	Osas & Sons (C/0 Billy)	Justina Diode
	J.C Okoye Afulenu	Helen Aideyan
	Edith Ofure Onnaiwu	Bishop Ogbomo
	Ben Haulage	Sunday Alohan
	Juliet Ikhira	Mama Uwaila
	Itohan Justina Diode	Sunny Omuwa
	Helen Aidyan	J & D Agbedion
	Justina Diode	Collins Osarenmwinda
	Bishop Ogbomo	Imasuen
	Sunday Alohan	Friday Aguokhian
	Collins Osarenmwinda	Emily Iyawe
	Ogbomo Friday	
	J & D Agbedion	
	Felix Osabuohien	
	Eghosa Uzamere	
	Mama Uwaila	
	Imasuen	
	Sunny Omuwa	
	Osas & Sons	
	Ojo VentureE	
	Ffriday Aguokhian	
	Foma	
	Justina Amufia	
	Eunice Sado Osunoubu	
	Vivian Diode	
	Solid	
	Owen Ndynamic Global	
	Felosas's Ssawmill	
	Monday Osunde	

Key: TSM= total sawmill, SSM= sampled sawmill

Table 3: Average weight for measuring sawmill by-products (kg/₦10^{-2})

Volume	Sawdust	Woodchips	Offcuts
Cement bag	3.5(7)		9(30)
Feed bag		5(5)	
Medium bag		10(27.5)	30(40)
Big rice bag	8.5(10)	25(40)	35(50)
Wheat flour bag	12.5(15)		
Wheelbarrow			75(100)

Table 4: Total Sawdust Collected by End-users (kg)

L.G.A	Daily	Weekly	Bi-Weekly	Monthly
Egor	-	225	300	-
Ikpoba-Okha	165	150	-	-
Uhunmwonde	135	242.14	300	135
Total	300	617.14	600	135
Mean	150[b]	205.71[ab]	300[a]	135[b]

Table 5: Collectors of Sawmill by-products in the Study Area

By-products	PB	IND	GRP
Sawdust	-	8	3
Offcuts	9	-	-
Woodchips	9	2	-
Total	18	10	3
Mean	9[a]	5[b]	3[b]

Key: PB= private business, IND=individuals, GRP= group of people

Sawmill residue is a valuable resource for various purposes, it is utilized for energy production such as heat and biofuels which is sold on-site. The findings reveal that the by-products generated from sawmills are mainly collected by private businesses such as bakeries, farmers raising seedling, poultry production. The reason cannot be far from the fact that sawdust is one of the cheapest inputs of their production activities.

The results showed that <5 persons accounted for 41.18% of those who collected sawdust from sawmills weekly, while the least individuals were between 11 to 15 persons and above which stood at 11.76% each (Table 6).

Table 6: Weekly Customer Patronage for Sawdust Collection Services

WCP	Frequency	Percentage
< 5 persons	7	41. 18
6 - 10 persons	6	35.29
11 - 15 persons	2	11.76
> 15 persons	2	11.76
Total	17	100

Key: WCP= weekly customer patronage

Table 7: Various by-products output from Sawmill production Activities (kg)

LGA	Sawdust	Woodchips	Offcuts
Egor	300	40	250
Ikpoba-Okha	175	25	290
Uhunmwonde	186.82	35.45	320
Total	661.82	100.45	860
Mean	220.67[b]	33.48[c]	286.67[a]

Fuwape (1998) succinctly puts it that sawmill industry accounts for 90.32% of the total number of wood based industries in Nigeria in 1997. The lumber recovery factor in most sawmills vary between 40 and 50% (Alviar, 1983; Fuwape, 1989). This implies that about 50 to 55% of log input into sawmills are left as wood residues. The findings agree with the view of Wieruszewski and Mikolajczak (2017) who noted that wood residues is dominated by chunk wood in the form of wood offcuts. The by-products generated from sawmill activities are specifically sawdust and wood off-cuts, presents significant opportunity for further economic exploitation. Utilizing these residual materials properly could potentially enhance the desire for gain as a motive in economic activity and overall profitability of sawmill business.

The results showed that there was significant difference ($p<0.05$) amongst the income generated from the various sawmill by-products considered in the study. Income from offcuts dominated the income from other by-products in study. The findings agree with the view of Ohwo *et al*. (2020) who stated that sawmill by-products can yield substantial revenue, potentially millions of naira, if a stable market for their sale is established. These findings also agree with Mikołajczak *et al,* (2016) who reported that revenue from the sales of unprocessed sawmill by-products constitute an important source of income for both natural Forests based enterprises as well as wood industrial business.

Table 8: Income from the sales of Sawmill by-product (₦'000)

L.G.A	Sawdust	Woodchips	Offcuts
Egor	2	3.2	80
Ikpoba-Okha	2	2.5	75
Uhunmwonde	2.6	3.5	65
Total	6.6	9.2	220
Mean	2.2[b]	3.07[b]	73.33[a]

The results showed that the various payment schedule considered differed significantly in the study ($p<0.05$). Further analysis reviewed the payment plan on weekly basis dominated other payment schedules in the foregoing analysis (Table 8).

Table 9: Payment plan for Sawmill workers in charge of wood residue

LGA	PR	Wk	Mo
Egor	1	-	2
Ikpoba-Okha	1	2	-
Uhunmwonde	2	9	-
Total	4	11	2
Mean	1.33[b]	3.67[a]	0.67[b]

Key: PR= piece rate, Wk= weekly, Mo= monthly, L.G.A=local government area

The findings reveal that most sawmills owners paid workers who manage the residue generated on a weekly basis. This might be as a result of the production output of the sawmill residue which is most often deposited randomly at various points where they are generated which makes the place utterly untidy even with one-day operation without removal. Furthermore, this might be related to the amount of waste produced and the money available for payment. This to a large extent agrees with the fact that there is correlation with the input price which commands higher employment in lower input price and vice versa for lower employment in case of higher input price.

Table 9 shows that there was significant difference between the applications of sawmill by-products such as cooking, composting, animal bedding and cottage industrial purposes but there was significant difference ($p>0.05$) between the other applications of sawmill by-products by end users. Further analysis revealed that the sawmill by-products were mainly used for domestic purposes such as cooking and in agriculture for poultry and animal bedding. compost manure, OTH=other uses (cottage industries).

Table 10 Application of sawmill by-products.

L.G.A	COG	AB	CM	COI
Egor	3	3	-	-
Ikpoba-Okha	3	3	1	1
Uhunmwonde	11	11	-	1
Total	17	17	1	2
Mean	5.67^a	5.67^a	1^b	2^b

Key: COG=cooking, AB=animal bedding, CM= compost manure, OTH=other uses (cottage industries)

The findings agrees with the view of Ohwo *et al*. (2020). who noted that wood by-products are used as compost, mulch and soil conditioners in Nigeria and sub-Saharan Africa. Ogunwunsi (2014) has noted that sustainable wood utilization drastically reduces volume of wood waste, increases profitability and enhances environmental cleanliness. Egbewole *et al.,* (2011) has added that amongst other factors, inadequate information on economic returns from wood by-products, rather it contributes to a large extent to the, purchase, utilization and societal relevance of the products as well as sawmill enterprises.

Table 10 indicates the charges paid to government by sawmill operators in the study. The results revealed that there was significant difference ($p<0.05$) among the different charges paid to government by the sawmill operators. The results further highlighted the point that development levies dominated all the charges paid by these operators to government for waste management.

Table11 Charges Paid to Government by Sawmill Operators (₦'000)

Charges Paid	DED	WDD	TFL
Egor	70	10	40
Ikpoba-Okha	70	10	40
Uhunmwonde	70	10	40
Total	210	30	120
Mean	70^a	10^c	40^b

Key: DED=development dues, WDD=waste disposal dues, TFL=task force levy

The findings reveal that the domination of development levy corroborates strongly with the fact that this form of revenue mobilization system has existed for more than five decades in the neighouring Western States of Nigeria which was later introduced to Edo and Delta States. It is also added that sawmill industries also contribute to economic growth through the products they supply for immediate consumption as well as the charges and taxes whose payment are not based on the capital generated over short period of time, rather it is based on annual payment (Larinde, 2016).

The results indicated that annual sawmill renewal fee accounted for 50%, while sanitation fee and sawmill industrial charges accounted for 37.5 and 12.5% respectively.

Table 12: Other Government Fees Based on Sawmill Operation (₦'000)

Charges	Amount	Percentage
ARF	200	50
ASF	150	37.5
SIC	50	12.5
Total	290	100

Key:ARF=annual renewal fee, ASF=annual situation fee, SIC=sawmill industrial charges

The above findings suggests that Edo State government uses the above fees and charges as a source of revenue generation. This corroborate with the work of Igugu, (1981) who noted that the sawmill industry serves as an important source of revenue for the government through fees, levies and royalties paid on licenses given to the sawmill operators.

Conclusion

The study provided critical insights into the management practices of saw mill by-products and economic implications of sawmill operations. It is observed that while sawmills generate substantial by-products, such as sawdust, offcuts and woodchips, many are not fully capitalizing on these opportunities for revenue generation. In order to attain efficiency in resource utilization and maintain a stable forest base, it is imperative for sawmills to judiciously utilize the wood residue generated by maximizing use, reuse and recycling potential of the residues. The findings reveal that while there are potential economic benefits to be gained from effective waste management and utilization practices, the high charges imposed on these sawmill operators hinder optimal performance and dangerously encroaches on the profit margin. Economic stabilization of rural communities through the provision of employment opportunities, will also help to foster the socio-economic development of the people.

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