Civil and Environmental Research
ISSN 2224-5790 (Paper) ISSN 2225-0514 (Online)
Vol.6, No.9, 2014

Wood Waste Generation in the Forest Industry in Nigeria and Prospects for Its Industrial Utilization

Ogunwusi, A.A.
Raw Materials Research and Development Council, Abuja, Nigeria

Abstract
The forest industry in Nigeria has traversed a variety of circumstances. Prior to I976, round wood overexploitation for export was rife, and this, coupled with high waste generation by the forest led to significant reduction in industrial round wood availability in the forest reserves. With an average recovery rate of between 45-55%, the waste generated in the sawmill industry inform of bark, sawdust, trimming, split wood, planer shavings and sanderdust in year 2010 alone was over 1,000,000m^3 . In the furniture industry, this varies from 35-45%. At the upper end of the range were the artisanal furniture makers who use crude implements and outdated process technology while the plywood mills generate about 5,000m^3 of residues inform of bark, core, sawdust, lillypads, veener clippings and waste, panel trims and sanderdusts in 2010 alone. The high quantity of waste generation in the industry is caused by factors which differ from one susector to the other. However, the general trend indicates that average percentage timber recovery is becoming lower while waste generation is on the increase. This is mainly due to the reduced size of average timber available for processing and the increasing need to utilize lesser used wood species whose properties are not well understood. Others are utilization of old and obsolete equipment, low technical knowhow, low capital input and adoption of crude hand tools, most especially, in the furniture industry. To ensure that the industry survive, it is imperative that wood waste be put to industrial use. Among the way this may be achieved include the use of wood briquettes inplace of firewood, utilization of wood waste to generate industrial energy, utilization of bark for adhesives and foam production and production of medium density fiberboard and engineered wood products from wood waste generated locally.
Keywords: Wood waste, bioproducts, briquettes, sawmill, bark.

1.0 Introduction

The performance of the forest industry in Nigeria has been evaluated by various authors,among which are GWV, (1994), RMRDC (1991), RMRDC (2003), RMRDC (2009), Ogunwusi (2012), Kukogho *et al* (2011), Ogunwusi *at al,*(2013), Larinde (2010) and Ogunsanwo (2010). From the different analyses carried out, it can be surmised that the forest industry was very and active and contributed significantly to local and international trade in the 1960's to 1980's. While the industry can be bifurcated into formal and informal sectors, both have witnessed serious anomalies dictated by sub-optimal deployment of raw materials.

The formal sector include the organized wood based industries such as the pulp and paper mills, sawmills, plymills, particles board mills and furniture factories. The informal enterprises are the small wood based enterprises operating without formal corporate entity and include enterprises that engaged in production of firewood, charcoal, chewing sticks, sculptured wood and in some cases, artisanal cabinet markers and lumber converters. The informal sector which is often downplayed in reporting activities in the wood industry, dominate the industry in terms of number, and is involved in activities which directly and indirectly influenced trade volume in the formal sector (Ogunsanwo, 2010; GWV, 1994)

A number of factors have combined to limit sustainable development of the forest industry. One of this was the overdependence on export of wood and wood products in the of the 1970's . This led to overexploitation of round logs till its ban in 1976. Another major impediment to sustainable development of the industry is contiual depedence on outdated equipment and technology. These have resulted in high quantity of wood waste generation. Thus, there is need to streamline wood waste production and promote their recovery and recycling in Nigeria. This paper examines the performance and productivity of the forest industry in Nigeria and outline avenues for optimal and sustainable utilization of the waste generated in the industry in order to promote sound wood waste management practices and its industrial utilization in the country.

2.0 Highlights of the forest industry in Nigeria

The forest industry in Nigeria is made up of the pulp and paper industry, the sawmill, wood based panels and the furniture industry. The performace of the various subsectors are discussed below:

2.1 The Pulp and Paper Industry

In Nigeria, the pulp and paper sector of the economy has experienced serious travails. The paper mills are designed to depend heavily on foreign technical knowhow, both in terms of technology and raw materials input. These problems have seriously affected the performance and productivity of the integrated pulp and paper mills. As a result, while the production of paper and paper products is increasing in developed countries, the opposite is the case in Nigeria. Paper consumption for major countries in Africa ranged from 3kg per capital in Nigeria to

11kg per capital in Egypt. This was far lower than the minimum per capital consumption level of 30kg that guarantee achievement of full literacy, adequate communication and supply of educational materials. In Nigeria, production of primary pulp and paper stopped in the mid part of the 1990's, principally, as a result of inadequate availability of foreign exchange to finance importation of long fibre pulp. It was not until 2009 that the Nigeria Paper Mill commenced production on one its paper machines using recycled paper.

2.2 Sawmill Industries

Sawmill account for 93.32% of the total number of wood based industries in Nigeria (Fuwape,1998). According to Ogunwusi (2012), the installed capacity and capital utilization of sawmills in Nigeria rose from 8,831,750m^3 in 1988 to 15,793,188m3 in 1992. It then decreased to 10,900,000m^3 in 1996 and subsequently increased to 14,684,000m3 in 2002 and 11,734,000m^3 in 2010. Capacity utilization within these periods was 6,994$_3$, 600m^3, 6,031, 922$m^3$and 7, 069, 145m^3 3,800,000m^3 respectively. This represented 79%,38%,39% and 32% capacity utilization respectively. Total number of sawmills decreased from 1617 in 1990 to 910 in 1992. It rose to 1252 in 1996 and to 1259 in year 2002. In 2010, the number of sawmills in Nigeria stabilized at 1325 (Ogunwusi, 2012). With an average recovery rate of between 45-55% (able 1) the waste generated in this subsector inform of bark, sawdust, trimming, split wood, planer shavings and sanderdust in year 2010 alone was over 1,000,000m^3 .

2.3 Furniture industries

The capacity.utilization of the furniture industry was 217,700m^2 in 1988. This increased to 250,714m^3 in 1992. In 2010, capacity utilization in the industry was 326,172m^3 of round log equivalent (Ogunwusi,2012). More than 400 furniture companies of various sizes exists in the country. The shortfall in large furniture companies is made up by the numerous cottage and small scale furniture makers which numbers more than 10,000 outlets (GWV,1994). This category of furniture makers usually operate in the informal sector and are found in the rural and urban areas where the middle and low income earners reside. Waste generation in the furniture industry varies from 35-45%. At the upper end of the range are the artisanal furniture makers who use crude implements and outdated process technology.

2.4 Plywood mills

In 1988, the total installed capacity was 126,000m^3. This decreased to 106,000m^3 in 2002 and further to 96,000m^3 in 2010. Capacity utilization in this sub sector has also being fluctuating. It increased from 67,340m^3 in 1988 to 72,240m^3 in 1992. Since 1992, capacity utilization and number of industries operating within the subsector have been on decrease from 72,240 in 1992 to 54,600m^3 in 1996 and 14,900 and 10,250m^3 in 2002 and 2010 respectively. The number of plywood mills increased from 8 in 1988 and 1992 respectively to 10 in 1996 (Ogunwusi, 2012). This decrease to 4 in 2010. With an average proportion of 45% waste generation, about 5,000m^3 of residues inform of bark, core, sawdust, lillypads, veener clippings and waste, panel trims and sanderdusts were generated by the plymills in 2010 alone.

2.5 Particle board mills

With an installed capacity of 85,000m^3 in 1988, capacity utilization was a mere 11,496m3 in 2010. Capacity utilization in 1992, 1996,2002 and 2010 were 34,290m^3,54,600m^3 12,900m^3 and 11496m^3 respectively. The number of particle board mills in the country remained constant at 4 from 1992 to 2010 (Ogunwusi, 2012). The particle boards mills generate about 5% waste inform of bark, screenry fines, panel trim, sawdust and sanderdust.

3.0 Factors responsible for high volume of waste generation

The performance and percentage waste generation in the forest industry in Nigeria have undergone critical assessments by a number of authors. Most of the wood processing outfits in the country are usually without facilities for process integration of waste, thus, making it very inefficient in terms of wood conversion. The waste generated is very enormous and the wood processing units lack the facilities for their utilization.

The high rate of waste generation is caused by a multitude of factors. The factors responsible differ from one susector to the other, but a general trend indicated that average percentage volume recovery is getting lower while waste generation is on the increase. This is mainly due to the reduced size of average timber available for processing and the increasing need to utilize lesser used wood species whose properties are not well understood. The factors responsible for increasing waste generation on subsectoral basis are discussed below:

3.1 Pulp and paper industry

The primary pulp and paper mills are mostly out of operation. Currently, Nigeria relied solely on imported printing, writing and duplicating paper. One major factor that characterize the paper industry is the near total dependence on recycled fibre. Toilet roll and serviets production in Nigeria, including the production of kraft paper for the packaging industries depend more than 90% on recycled fibre. This make the paper industry as it is presently constituted to be efficient in waste utilization. Hitherto, as non of the mills are producing virgin pulp it is expected that when the mills become fully operational, the possibility of using wood waste to produce virgin pulp and energy required by the mills will be visited.

3.2 The Sawmill industry

Sawmill industry in Nigeria is characterized by small scale operators who mostly process timber with the CD series machine. Lumber recovery which is defined as the percentage ratio of volume of sawnwood output to that of volume input of logs processed in the sawmill, regardless of the types and kind of processing equipment adopted and the species of wood involved (Badejo 1990), is low. Among the reasons for the low recovery rate according to Kukogho *et al* (2011) are;

1. Small log diameter, length, taper and quality.
2. Kerf width of the sawing machine
3. Sawing variation, rough green-lumber size and size of dry dressed lumber.
4. Product mix
5. Decision making by sawmill personel
6. Condition and maintenance of sawmill equipment
7. Sawing method.

In a study on waste generated in some selected sawmills in Kajola Local Ggovernment Area of Oyo State, Kukogho *et. al.* (2001) observed that two categories of wood waste were generated. These are those generated within the wood based plants during the conversion process and those generated during timber harvesting and transporting. (FAO, 2001) noted that about 60% of the total harvested tree are left in the forest and the non commercial species are subjected to slash and burn or merely left to rot in the forest. According to study by Kukogho *et al* (2011), the highest percentage of lumber recovery in the mills studied was 80.23% due to the fact that most of the selected logs were fairly large in girth while the lowest lumber recovery was 70.09% due to the fact that most of the selected logs where fairly small in girth and of different forms. The result agreed with the obervation of Ogunsanwo (2001) who observed logs size and shape to have direct impact on lumber recovery.Further analysis by Kukogho *et al* (2011) indicated that there was no significant difference between the volume of sawdust and that of slabs in the sampled trees while there is significant difference between volume of sawdust and tree species sampled. This may indicate that less dense tree species may generate higher volume of sawdust. Also in a similar study by Egbewole *et. Al.* (2011) on the technical performance efficiency of 27 selected sawmills using 243 logs obtained from 20 species of wood sourced from the Southwestern Nigeria, the results indicated that the large diameter logs (> 55.01cm) had the highest mean lumber recovery of 54.48%, closely followed by medium sized logs (40.01-55cm) with 54.18% and small sized logs (<40cm) with 51.77%. Analysis of variance indicated that the influence of log diameter classes was significant on the % lumber recovery. The findings of Egbewole *et. Al.* (2011) revealed that wood species, technology and headrig process machine used and operators have direct significant impact on the conversion efficiency obtained during log processing and consequently, the volume of wood waste generated.

3.3 Furniture industry

In Nigeria, the conventional furniture industry uses simple technologies. They have low technical knowhow and low capital input. They are mostly made up of outfits with crude hand tools and equipment (RMRDC 1991;2003; 2009), resulting in poor quality products (GWV, 1994). The small scale furniture producers are technically inefficient as they fall below efficiency level of 60% (Ako and Kuye,2010). The implication is that the average furniture producer need about 88% cost saving device to become an efficient producer. Most of the small scale operators are more interested in quick profit rather than quality control and expansion (NACETEM, 2010). Other problems militating against adequate performance of operatives in the subsector are low level of demand (Arowosoge et al. 2010), poor workmanship (GWV Consultants, 1994), high level of poverty and long lifespan of furniture products. Others include the inefficiency of the ban on furniture importation due to high level of smuggling (Aku, 2010), paucity of skilled manpower and non adherence to standard drying, preservative treatment and design procedures (Ogunwusi 2013). These characteristics of the furniture industry leads to high level of wastage. The level of wastage in this subsector varies from 20-40% depending on operators experience, processing methods and equipment employed.

3.4 Plywood industry

Plywood production in Nigeria has reduced drastically as a result of high reduction in the volume of economic wood species (RMRDC,1991; Arowosoge, 2010). One of the major producers, the government owned, African Timber and Plywood has closed operations. It is expected that the privatization of this company will lead to the achievement of goals of the privatization exercise among which are technological innovation and improved productivity. Other problems of face veneer producers are old equipment and lack of spare parts. The quality of plywood products is low and the waste percentage is high. These occurs as a result of dwindling availability of economic species such as *Khaya ivorensis. Khaya grandifoliola, Mansonia altissima, Terminalia superba, Entandropragma cylindrica* and *Triplochiton scleroxylum* in the national forests.

3.5 Particle board industries

While particle board production is a means of wood waste consumption, the production capacity of the mills in the country are low and investment in this area is not expanding as a result of low exchange rate of the local currency to import new equipment, spare parts and glue (GWV, 1994).

4.0 Imperatives of wood waste management in Nigeria

Less than two third of the harvested tree during logging operation are taken away from the forest. This coupled with the vast generation of waste during wood processing operations substantialy reduce wood resource availability for industrial processing. Also, less than 40% of wood taken out of the forest are actually used at industrial level while the rest waste away. This make the current pattern of industrial wood utilization unsustainable and a source of threat to ability of the forest reserves to sustain the wood industry.

In most forest industry clusters, the volume of woodwaste generated is very enormous and constitute a nuisance to the environment. In most cases, the wood waste pile up to form a big heap which disturb activities within the mills. In Oko-Baba area of Lagos, for instance, the menace of wood waste from clustered sawmills is a permanent nuisance. The heaps of the waste are burnt for days, disturbing visibility and causing pollution, thereby endangering health of residents, motorists and passers by. Wood waste that entered into water ways leached their extractives in the water, thereby, polluting the water. All these necessitated need for integrated and economic management of wood waste in Nigeria. Industral wood waste utilization and increase in the rate of timber recovery will reduce the rate of deforestation and help mitigate climate change. This will also promote production of value added products and eliminate the environmental and ecological implications of improper disposal of waste.

5.0 Factors Militating Against Industrial Waste Utilization

One of the major problems limiting high level utilization of wood waste over the years in Nigeria was that no concrete effort made to incorporate fuel burners into the wood processing companies. As a result, many mills regard wood waste as a troublesome by-product, good only for domestic energy production and landfill. This occurs mostly as wood waste handling, processing and combustion may require higher capital outlay, considerable development in new and imported technology and plant design.

Whilst it may be desirable to incorporate forest residues into the mainstream of wood waste for industrial use, transport cost has been a critical factor limiting its utilization. Also, the type of wood waste residues generated by wood processors differ from plant to plant and depends on factors such as properties of the wood, type of operation employed, and maintenance of processing plant. In general, the following factors militate against wood waste utilization in the country:

- lack of bankable studies on economic returns from wood waste processing
- lack of incentives for wood waste utilization
- Inadequate enforcement of environmental regulations and absence of policy on wood waste management in the country.
- Absence of technological knowhow on waste utilization and processing techniques.
- Inadequate vertical and horizontal integration in business strategies.

6.0 Current methods of wood waste handling in Nigeria.

Currently, wood waste in Nigeria are mainly used for particleboard production. In most cases particleboard mills are integrated with sawmills for sustainable utilization of wood waste. In the 1970's to early 1990's, the Piedmont Plywood Ltd, Ologbo, Ondo State, has a bastion bahre machine and African Timber and Plywood has a Siempelkamp machine. Each has a single line making 3-layer particleboard. Both are built to utilize the residues of wood processing complexes with which they are integrated. While plans were on to expand production capacity through increased utilization of waste and veneer residues from independent sawmills, the mills went under as a result of the general economic climate and government pravitisation policy of the 1990's. Despite the numerous potential uses of reconstituted panels in Nigeria, particles board production has declined considerably requring an extensive program of investment incentives in the subsector (RMRDC, 2009; RMRDC, 2003;. GWV, 1994).

As at present, the predominant method of wood waste disposal in the country is through open inceneration. In order to promote industrial utilization of the waste, the Forestry Research Institute of Nigeria (FRIN), conducted research into wood waste utilization in the last twenty years (Ogunsanwo, 2001). This led to development of technology to manufacture floor tiles, wall tiles and ceiling boards on commercial basis (Badejo, 2000). The latest development in wood waste utilization at FRIN is the application of lamination techniques where saw dust –cement boards and veneers are bonded into bands called SP-panels (Owonubi and Badejo, 2001). The project, according to Ogunsanwo (2001), is an innovative way of recycling wood waste to produce value added wood products. This enables optimal utilization of logs and provides a better wood waste

management strategy in the country. In addition, wood waste, especially offcuts, shaving, edgings, slabs and trimmings of various wood species are usually arranged and glued together to form a variety of laminated products which could be used to produce products such as flower vases, bowls, etc,. This use however consume less than 5% of the total wood waste produced in the industry.

7.0 Prospects for optimising wood waste utilization in Nigeria.

The 20th century's era of seemingly plentiful and cheap resources is coming to an end. Most economies are putting in place policy that will promote effective utilization of waste. The ability of any economy to adapt and become more climate change resilient, resource efficent and at the same time remain competitive depends on the high level of eco-innovation (EC,2014). It has become important to reduce resource use and its environmental impacts while increasing competitiveness. Using recycled content in products instead of new materials usually result in less Green House Gas (GHG) emissions over a products life cycle. Recycling more materials means less original resources are being used in the manufacturing process. More recycling means less waste would end up in landfills, thereby decreasing landfill emissions. As higlighted earlier, the high level of paper recycling in Nigeria saves GHG emissions that could have been generated from cutting and processing trees as well as allowing trees to continue to act as carbon sink. Closely allied with these, wood waste management has a number of advantages. It encourages total wood utilization, reduces cost of production and promotes a cleaner environment. It also prevents burning of wood waste and thus mitigate climate change. Various value added products has been produced from wood waste. These products have eliminated most of the negative implications posed by improper disposal and management of wood residues as mere waste. Some of the wood waste management methods that can be adopted to turn the country's wood industry into a sustainable industrial sector are subsequently discussed.

7.1 Reduction in wood utilization

Bioenergy is a major source of heat energy in Nigeria and more than 80% of the population depends on wood biomass for their domestic energy. As a result of near total dependence on bioenergy, the rate of deforestation has been high. The forest resources survey, 1996-1998, revealed that forest cover has decreased by 20% of the preceeding 18 years (FORMECU, 1996). Adeyoju (2001) reported the total forest estate in the country to be less than 6% of the land area. Recent statistics, (RMRDC, 2009), indicated that the total volume of useable wood down to 30cm cutting diameter in the forest resources is 239,775,500cm^3 which is not significantly different from 437,507,205cm^3 reported by Akindele *et al* (2008). As a result of these, the country must take urgent steps to reduce the rate of industrial wood decimation in the nation's forests, This could be achieved through the following ways:

- By decreasing in the volume of wood utilized for domestic energy generation through wood briquetting production and utilization.
- Through initiating measures for sustainable industrial utilization of wood waste locally.
- By ensuring improvement in the efficiency, productivity and performance of the forest industry.

Some of these can be addressed as follows:

7.1.2 Replacement of fuelwood with briquettes.

There is a growing awareness in recent years in the area of utilization of wood waste inform of briquettes, pellets or logs as a domestic or industrial fuel. Briquetting is a process of binding together pulverised materials into a solid block of compressed material under pressure, often with the aid of a binder such as cassava starch. In most cases, briquettes are generally formed by forcing dry sawdust or shavings through a split cylindrical die using a ram under an exerted pressure of about 1,200kg/cm^3 and the resultant heat generated bonds the wood particles together (FAO, 2001)

The production of pellets involvethe reduction of wood waste to the size of sawdust which are then dried to about 12% moisture content before being extruded in specially adapted pellet mills. The use of briquettes can reduce the demand for fuel wood and therefore, decrease the pressure mounted on forests and plantations. Wood briquettes is usually regarded as a high grade source of energy due to its high heating value which is four times the energy concentration of wood fuel (FAO, 2001). Briquetting also lower transportation cost, most especially when the distance is less than 250km from the source of raw material (FAO, 2001).

7.1.3 Utilization of wood waste for energy generation

The use of wood to produce energy open up two opportunities. One has to do with utilising harvest residue for electrical power generation rather than allow it to accumulate and decay on site or removing it by open field burning. The other is substitution of woody biomass for fossil fuels. This will offset fuels such as coal, natural gas, gasoline, diesel oil and fuel oil. At the same time it can enhance economic development by supporting economies and fostering new industries making bio based products.

Wood, can contribute significantly to the energy mix in Nigeria. No single energy resource can sustainably meet the energy demands of any country (Uzoma and Nnaji, 2012). In Nigeria, the energy mix is

made up of hydro, coal and gas generated power. The electric power obtained from these sources are grossly inadequate interms of total national energy demand. Wood has a key environmental benefit over fossil fuels as it is carbon neutral. In contrast to the fossil fuels, wood as a source of energy does not release extra carbon, except those absorbed from the atmosphere when growing. While Nigeria is not a major emitter, a strategy designed to reduce dependence on fossil fuel for energy generation will be a welcome policy. The use of wood fuel has the potential to create numerous new jobs in the rural areas in the country. According to FAO (2001), a mill or an integrated complex with a supply of hog fuel has several methods through which it can convert waste into useable energy. The range of combustion systems available is considerable and large choice of equipment is available for each category. Among the major combustion processes that can be adopted are fire tube and water boilers, pile burners, suspension and cyclone burners and fluidized bed conductors. A broad outline of possible application of different types of wood waste are shown in Table 2. In addition, Kelvin (2002), reported that the production of heat and electricity from wood is possible with appropriate equipment and scale of operation. The methods of achieving these includes manually fed fireplaces, automatically fed chip and pellet boilers, electricity generation plants, districts heating systems and co-firing. The simplest way to use wood waste as fuel is the manually fed fire places. Significant advances have been made over the last 15 years in the design and manufacture of boilers and stove to improve the efficiency, reduce emission and increase conveniences associated with this method. According to lrBEA (2000), the efficiency of manually fed stoves and boilers is now up to 75% compared to about 20% for the typical open fire and presently according to CBT (1999), about 300,000 stoves are in operation in Denmark alone.

Kelvin (2002) also reported the efficiency of automatically fed boilers to be about 85%. The boilers are available in a wide range of sizes from small domestics to large commercial industrial systems. Also solid fuel electricity generating station burns fuel to convert water into steam at high temperature and pressure. The steam then drives a turbine engine which in turns drives a generator to produce electricity (Kelvin, 2002). In a combined heat and power plant, the heat resulting from power generation is also harnessed. The size of combined heat and power plant (CHP) is generally based on the available heat demand. According to Kelvin (2002), the plants are now highly advanced and can be designed to use different fuels. Another major energy generation system is the direct heating system. Direct heating is the direct common production, distribution and supply of heat and hot water services (Kelvin, 2002). The concept was first implemented in USA in 1870 It is now applied in North America, China, Korea and Japan. The three main components of a district heating system are a heat production plant, a heat distribution network and network/consumer interface equipment (Kelvin, 2002). Typically hot water at 70 to 120^0Cis produced by the plant and pumped into the network. Denmark has over 50 wood chip fired district heating plants with an average output of 3.5mW (Mega Watts thermal) (CBT, 1999).

Another important way of promoting utilization of wood waste for energy generation is through co-firing. The co-firing approach burns biomass together with other non biomass fuels (Alakangas and Veijonen 1998). According to Kelvin (2002), there are several examples of co-firing of wood with coal across Europe. The approach allows wood fuel to be introduced into the commercial energy system at relatively low cost and risk (Kelvin, 2002). There are several examples of co-firing of wood with coal across Europe.

7.1.4. Bark Utilization

While bark is an important component of hog fuel, Ogunwusi (2013) observed that the utilization of wood bark has not enjoyed tremendous development as wood utilization. The petroleum crises of 1970's has however led to renewed interest in wood bark as an industrial raw material leading to bark being mainstreamed as an important raw material for industrial use. Ogunwusi (2013) observed that major areas of focus for industrial utilization of bark are bark adhesives and bark based foams. The bioproducts can either be used as substitutes or replacement for petroleum based products and thus, helps to mitigate climate change. In addition, innovative research in these areas has great potentials to improve forest industries, chemical and automotive industries as well promoting higher economic and environmental benefits (BBP,2011). Apart from this, bark also finds low grade outlets as a soil conditioner or mulch (Harkin and Rowe, 1971). Bark is used in horticulture as primary component in the nursery and as greenhouse substrates.

7.1.5 Production of Engineered Wood Products

This is an important outlet for wood waste utilization. Engineered wood is the term give to derived materials from smaller pieces of wood that are bound together thorough a variety of glues, resins, and other chemicals to form wood like products (Tariq, 2013). Examples of engineered wood products are oriented strand board, glue laminated timber, laminated lumber, wood 1- joist, and finger jointed studs. The most important of these is Medium Density Fiberboard (MDF) which is formed by breaking wood residuals into fibres in a defiberator and mixed with wax and resin binders. These are converted into panels through application high temperature and pressure. MDF is denser than plywood and can be used in similar applications.

8.0 Conclusion

Due to the use of obsolete equipment and production processes, the forest industry in Nigeria generate high quantities of waste. This, coupled with high losses of wood during logging operations, the low recovery of industrial wood products due to low eficiency of the mechanical wood processing mills have substantially reduce the volume of industrial wood in the national forests. To promote development of a sustainable forest industry in Nigeria, it is important that industrial outlets be found to utilize the wood waste generated. This paper highlighted the ways by which this can be acieved. To enforce industrial utilization of wood waste in Nigeria, appropriate policy and a regime of incentives may heowever be necessary.

References

Adeyoju,S.K(2001)Forestry for National Development: A critique of the Nigeria situation. In L. Popoola, J. E. Abu and P.I. Oni (ed.) Proceedings of the 27th Annual Conference of the Forestry Association of Nigeria, Abuja FCT. Pp 34-42.

Akindele, S.O. Dyck.J. Akindunmi, F.F.Papka, P.M. and Olaleye, O.A. (2001) Estimate of Nigeria's Timber Resources. In L. Popoola, J. E. Abu and P.I. Oni (ed.) Proceedings of the 27th Annual Conference of the Forestry Association of Nigeria, Abuja FCT. Pp1-11.

Ako, J.S and E.D. Kuye (2010). Determination of Technical Efficiency and Production Function for small scale furniture industry in Lafia Metropolis, Nassarawa State Nigeria. J. ARIC Soc. Soc; 6: 64-66.

Aku, S. (2010). For over 15 years, prices of our products have remained the same. The Sun News Online http://www.punchon the web.com/articleweb.com/article2print.aspx?theatric=art200805506280 Retrieve Oct 7 2011.

Alakangas, E. and K. Veijonen (1998). Combutsion and gasification plants in the EU. AFB- net phase 111 report quoted in : Jariven, T and E. Alakanges (2001). Conference on Biomass: Part 2. VTT Energy

Arowosege O.G.E. (2010). Lesser used wood species and their relevance to sustainability of tropical forest. In S.Kolade Adeyoju and S.O. Bada (ed) Readings in Sustainable Tropical Forest Management pp.

Badejo, S.O.. (2001) Sawdust Utilization for Building Materials manufacture in Nigeria. A technical report FRIN, Ibadan.

Badejo, S.O (1990). Sawmill wood residue in Nigeria and their utilization. Invited Paper. Proceedings of National on workshop on Forestry Management Strategies for Self Sufficiency in wood production, Ibadan 12th-15th June, 1990.

EC (2014) Climate Action, Environment, Resource Efficiency and Raw Materials. Horizon 2020. The EU framework programme for research and innovation, unpublished.

Egbewole Z.T, Ogunsanwo O.Y and Omole A.O (2011). Technical efficiency of lumber recovery from high forest tree species in selected saw mills of south western Nigeria. Journal of Agriculture, Food and Environment 7(1):34-41

FAO (1990). Energy conservation in the mechanical forest industries FAO paper no 93 pp 118.

FAO (2001). Global forest resource assessment. FAO publication. FAO Rome

Formecu (1996). Nigerian Forest Action Programme. Volume 11. Main Report. February, 1996.

Fuwape, J.A. (1998): Combustion characteristics of wood briquette produced from sawdust. National conference of Nigeria society of Agricultural Engineering. Pp 1-11, 8th-11th September, 1998.

G.W.V. Consultants (1994). Review of Wood Based sector of Nigeria. Final Report. Presented to Forest Management, Evaluation and Coordination unit, Federal Ministry of Agriculture and Natural Resources. Federal Department of Forestry, Abuja, Nigeria.

IrBEA (2000). Fire away with Domestic Wood –Fulled heat systems. Irrish Bioenergy Association, Co. Tipperary. see http://www.irbea.org

Kelvin H. (2002). Wood as a renewable source of energy. Socio-Economic Aspect of Forestry No 1.

Kukogho, J.E.V Aghimien, M,O, Ojo, B.A Adams and B.S Akinbosoye (2011). Assessment of wood waste generated in some selected sawmills in Kajola local government area of Oyo State. Continental Journal of Agricultural Economics 5(2): 8-11.

Larinde S.L. (2010) Secondary processing and the Nigeria saw mill industry. Issues, Challenges and Monograph Series (Nos 4) National Centre for Technology Management. ISBN 987-978-49820-3-0.

NACETEM (2010). Association of Innovation Capability in the Manufacturing Sector of Nigeria.

Ogunsanwo, O.Y.(2010) Challenges of wood utilization in Nigeria. In S.Kolade Adeyoju and S.O. Bada (eds) Reading in sustainable tropical forest management. Pp 293-303.

Ogunwsanwo, O.Y (2001). Effective management of wood waste for sustainable wood waste utilization . Paper presented at the 27th Annual Conference of the Forestry Association of Nigeria held in Abuja FCT 17-21st September, 2001.

Ogunwusi, A.A , Jolaoso, M.A, Onwualu, A.P. and M.A. Onilude (2013). The challenges of optimizing use of wood in tackling climate change in Nigeria. Journal of Sciences Research 3(5): 106-115

Ogunwusi, A.A. (2013). Potentials of industrial utilisation of bark. Journal of Natural Sciences Research (3)5:106-115.
Ogunwusi, A.A. and M.A Jolaoso. (2012). Forest Products Industry in Nigeria. Africa Rresearch Review. 6(4) 191-205.
Opportunities. In S. Kolade Adejoju and S.O. Bada (ed.) Readings in sustainable tropical forest management .Pp 277-291
Owonubi, J.J and Badeo, S.O.O. (2000). New trend in cement board research for plywood manufacture at FRIN, Ibadan. Proceeding of the conferece on enterprises, University of Benin. Pp 2.
RMRDC (2002) Techno Economic Survey Report on Wood and Wood Products Sector of Nigeria, Raw Materials Research and Development Council's Publication , 2002.
RMRDC (2003) Techno Economic Survey Report on Wood and Wood Products Sector of Nigeria, Raw Materials Research and Development Council's Publication , 2003.
RMRDC(1991). Techno Economic Survey Report on Wood and Wood Products Sector of Nigeria, Raw Materials Research and Development Council's Publication , 1991.
Tariq, Z. (2013). Utilization of wood waste. Logging and industrial waste. Arid Agriculture University. Unpublished.

Table 1: Percentage Volume Recovery and Waste Generation in Selected Forest Industries

Product/Waste	Sawmilling	Plywood Manufacture	Particle board	Integrated Operation
Finished product	45-55	40-50	85-90	65-70
Finished product Average	50	47	90	68
Residue/fuel	43	45	5	24
Losses	7	8	5	8
Total	100	100	100	100

Table 2: Broad outline of possible application of wood waste

Heating medium	Broad outline of possible applications
Hot air	For direct drying of
	(a)Lumber
	(b)Plywood veneer
	(c)particleboard furnish
Hot water and thermic oil	As an indirect means to supply heat for
	(d) log conditioning
	(e)lumber and veneer drying
	(f)glue and resin preparation
	(g)hot pressing of ply and particleboard
	(h)space heating.
Steam	May be used as a hating medium in all the above mentioned applications as well as
	(i)to provide transmission power to process plant through the use of a system of line-shaft and belt drives (in the past, may sawmills were powered in this way, a large number of which are still operating successfully.
	(j)to directly drive plant, such as boiler feed water pumps, induced draft fans, large air compressors etc, by way of small steam turbines.
	(k)steam which is surplus to the mills requirements may be sold to neighbouring consumers for industrial, commercial and community use.
	(i)to produce electricity by way of a turbine-generator to help meet the power demand of the integrated complex.
	(m) in the case of the non-integrated sawmills and plywood plants, in which their residue production far exceeds their actual heat energy needs and market demand, consideration may be given to on-site power generation to meet their own requirements , with the sale of the surplus to the public utilities.

The IISTE is a pioneer in the Open-Access hosting service and academic event management. The aim of the firm is Accelerating Global Knowledge Sharing.

More information about the firm can be found on the homepage:
http://www.iiste.org

CALL FOR JOURNAL PAPERS

There are more than 30 peer-reviewed academic journals hosted under the hosting platform.

Prospective authors of journals can find the submission instruction on the following page: http://www.iiste.org/journals/ All the journals articles are available online to the readers all over the world without financial, legal, or technical barriers other than those inseparable from gaining access to the internet itself. Paper version of the journals is also available upon request of readers and authors.

MORE RESOURCES

Book publication information: http://www.iiste.org/book/

IISTE Knowledge Sharing Partners

EBSCO, Index Copernicus, Ulrich's Periodicals Directory, JournalTOCS, PKP Open Archives Harvester, Bielefeld Academic Search Engine, Elektronische Zeitschriftenbibliothek EZB, Open J-Gate, OCLC WorldCat, Universe Digtial Library , NewJour, Google Scholar