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The Demand and Supply Patterns of Timber at the Domestic Market in Ghana

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Abstract
Chainsaw milling continues to thrive with regular timber delivery for domestic timber market to meet the needs of consumers. It is largely recognized as a major challenge for sustainable forest management, hence very exigent to obtain and maintain reliable data for planning and for informed policymaking in the forestry sector. This paper aimed at determining the size of the domestic timber market in Ghana. The country was zoned into five and five survey teams were raised, collected the data within the same period for 14 days simultaneously. Data collection was through structured questionnaires and personal interviews. The study revealed that the total annual national projected stock volume of timber was estimated as 2,513,428.9 m3 of which 1,532,199 m3 was consumed. A total of 108 domestic timber markets were identified nationwide and categorized into small, medium and large based on the estimated number of sheds per market. The number of timber merchants, 1157 and timber trade associations, 55 were surveyed in the ten regions. The main sources of timber supply were bush cut and sawmill of which the percentages of the monthly timber supply with respect to the national monthly volume were 72% and 28% respectively. Major timber products identified were beams, boards and lumber. The number of dimensions recorded from the three timber products was 194 and 99 timber species were identified with six of the species available in all the 10 regions of Ghana. The stock volume of the first 10 dominant species on the domestic market constituted 72% of the total national volume stocked.

Keywords
Chainsaw lumber, domestic timber market, supply pattern, sources of supply, timber products

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1. Introduction

Domestic timber market is the type of market where buying and selling of wood and wood products are dominant products take place in a local market of a community or country. The only supply of timber for domestic consumption, either through trading or direct use by rural dwellers, recognized as legal in Ghana is through production from the sawmills. However, sawmills generally place only limited emphasis on the domestic markets because their main revenue is derived from exports [1,2]. The ddomestic markets are overshadowed by export markets because of over concentration of governments and individual firms on the export market [3,4]. Therefore, the domestic timber markets have not generally received deserving attention in most developing countries including Ghana even though more than 90 percent of the total industrial roundwood production of the developing countries is used domestically [5].

The reasons that justify why greater attention to the domestic timber market is necessary should be of considerable importance. These are that, first, the need for shelter to extend and improve infrastructure in the face of

expanding population is crucial. Second, increased (and more efficient) use of forest products can help stimulate the local economy (increase employment and improving the flow of goods and services. For instance, in Ghana, the number of people engaged in the trade is estimated to be over 14,000 [1,5]. Third, domestic markets are an outlet for substantial volumes of industrial wood [3]. The author argues that the needs and requirements of the timber markets must be taken into account if effective decisions are to be made concerning improved management and utilization of the forests as well as the climate change mitigation and livelihood improvement (ibid). And that the more efficient the markets operate, the more efficient the use and conservation of the resource can be (ibid).

In Ghana, the domestic timber markets have not generally received the deserving attention and that domestic wood supply in Ghana has been overwhelmed with a number of challenges for nearly two decades [6]. It is generally acknowledged that most regular mills rather prefer to export wood to foreign markets due to the high opportunity cost of selling locally to the lower priced domestic market. Moreover, most mills operating with Timber Utilization Contracts (TUCs) are collapsed and that sawmills who did not have TUCs or Salvage permits and bought their logs from local suppliers did not feel obliged to comply with the 20% of lumber for domestic supply [7]. Thus supplies from these mills, although are of lower grade, are unreliable and not readily available for domestic consumption.

Section 36 of the L.I. 1649 [8] , which is the principal law governing supply of timber from timber rights holders to the domestic market states that "The Minister in consultation with the Forestry Commission may by publication in the Lands and Commercial Bulletin and in the mass media direct such holders of timber utilization contracts as he may determine to supply the domestic market with timber products of specified volume, dimensions and species" [5].

Even though the law did not make it obligatory for the Minister to always direct for the supply of timber to satisfy the domestic market, there are two specific instruments that could have been used to implement this promulgated policy. These are that a) in 1999, Special Timber Utilization Permits were issued to select 78 small to medium scale sawmills to produce entirely for the domestic market and b) The Ministry of Lands, Forestry and Mines issued a directive in accordance with section 36 of L.I.1649 [8] that from March 2001, all holders of TUCs were to supply 20% of their lumber production to the domestic market. These have inhibited the supply of wood for domestic value-added processing. Therefore supply of timber and other wood products to the domestic market has been largely supplemented by illegal logging and chainsaw operations [1], which are illegally extracted from both the forests and farmlands.

Unfortunately, illegal chainsaw activities are reported to impact negatively on the country's forest estate, which has implications for the legal concessions and also for sustainable resource management as the annual allowable cut limits are being far exceeded [9,10,11] have also indicated that the practice causes loss of revenue to the state through non-payment of official royalties and taxes by operators.

Due to this challenge facing the country, a number of studies have looked into the supply of chainsaw lumber to the domestic timber market to estimate the annual inflows to enable policymakers to know the trend of supply. These include estimates made by [4,6,12,13,14,15,16] From these studies, [6] covered 44 domestic timber markets throughout Ghana while 19 were covered by [16]. The dominant wood products (beams, lumber and boards) that were sold on the domestic market constituted 94% of the total volume of all wood products that were surveyed. In addition, bush cut sources of timber supply representing 76% of the responses on the sources has been reported by [6] while [10] recorded 70%. The estimated volume of chainsaw lumber stocked at domestic timber market, according to [10] was 70% of the total stocked volume. [4,6] also recorded 84% and 80% respectively, indicating the unstable nature of the domestic timber market. The total monthly volume of wood stocked for domestic consumption at 70% market coverage has been reported as 46,000 m3 [6]. During the same study, the distribution of species stocked or handled by merchants across the country indicates that 42 species were sold on markets in Ashanti. It further recorded a total of 112 dimensions comprising a mix of lumber, boards, beams and plywood and that the first 10 dominant species stocked on the domestic market constituted 74% of the total volume bought.

The actual size of the consumption of sawn wood in the domestic market is not clear, especially due to the increasing overland export to other countries in the subregion [14]. Unfortunately, the data on such trade to help estimate the actual consumption volume within Ghana is limited and unstable. Again, Policy framework on the supply of legal timber to the domestic timber is not being enforced.

Beside the imperatives of ensuring the biological, physical and chemical integrity of wood products, current global policy initiatives such as the Forest Law Enforcement, Governance and Trade (FLEGT) are adding new dimensions to wood quality standards. The most prominent emerging 'quality standard' is that the products must be legally sourced. In Ghana, the policy direction has been towards an implementation of a Validation of Legal Timber Programme (VLTP). The implementation

of FLEGT programmes requires legal arrangements such as the Voluntary Partnership Agreements (VPAs) between specific countries. This places responsibility on Ghana to establish Legality Assurance System (LAS). This requires a clear definition of legally-produced timber, elaborating all laws needed to comply within the forest, and where applicable, in the production process. It requires a system of independent verification to ensure that timber production is law-compliant and to secure a chain of custody to track timber from the forests to the point of export and beyond. Ultimately, it is intended that the VPA (LAS) will ensure that all timber products in the domestic market are legally sourced and processed. Therefore supplying legal timber to the domestic market of Ghana is increasingly recognized as a critical policy intervention for the sustainability of forest resources and good forest governance in Ghana.

With these challenges, it is therefore, necessary for the prevailing size of the timber domestic market to be determined in order to support the planning for the legal, sustainable, regulated, cost-effective and efficient supply of timber to meet the growing demand. The data will support policy-makers in their decisions, which will then impact on livelihood improvement, sustainable resource management and climate change adaptation and mitigation. Hence, a study on the prevailing size of timber inflows and outflows of the domestic market in Ghana, in an effort to contribute to finding ways to make it legal and secure, as a measure to support climate change mitigation is of importance. The objective of this paper was to determine the size of the domestic timber market in Ghana with respect to the number of timber markets and location density, classification of the individual domestic timber markets, stock and sales volumes and values of the major timber products and their sources of supply, available timber species and the specification or dimensions of the timber products.

2. Materials and Methods

2.1 Study Area

This timber market study consisted of a survey of wood merchants/dealers or suppliers in the timber markets (i.e. the supply side) across the ten regions in Ghana. In planning for the survey, the country was divided into five zones, taking into account the structure designed and used during [6] study. These include south-east zone A (Greater Accra region), south-east zone B (Eastern & Volta regions), south-west zone (Western & Central regions), middle zone (Ashanti & Brong Ahafo regions) and northern zone (Northern, Upper East and Upper West regions) as shown in Fig. 1. According to earlier studies by [6,16], the lean period for timber is whereby large volumes of timber are conveyed to the market centres owing to the ease of felling trees and conveyance of timber from forest areas while the lean season is the reverse. These periods are the dry and rainy seasons in Ghana respectively and that the present study was undertaken during the rainy/lean season. Hence, the domestic timber market activity calendar that has been developed by [16] was used.

2.2 Sample Interface the two adapted Games App

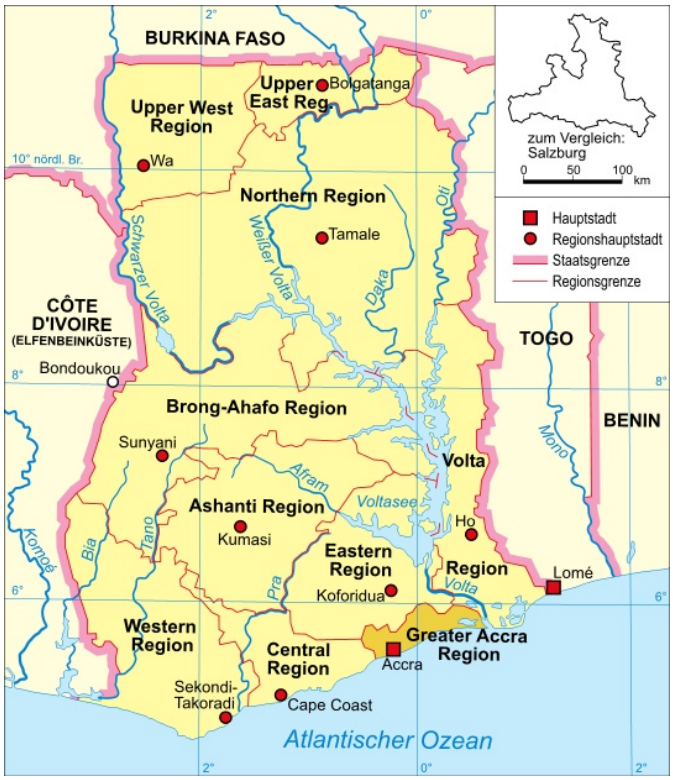

Figure 1. Map of Ghana showing the study sites

2.3 Data Collection

Five survey teams, each comprised of four enumerators (20 enumerators), collected the data within the same period of 14 days simultaneously in five zones across the nation. The enumerators were trained on national timber data collection before their departure. The aim was to help improve their human relations and the techniques to collect data from timber markets. Forty-four domestic timber markets that were surveyed by [6] were used as the baseline data. Other secondary information from past timber market studies in the country were gathered to provide background information on the sector for the study. These were augmented with names of new markets, especially those in the small-scale category, as and when enumerators encountered them in the survey zones.

Structured questionnaires, using personal interviews, were used to collect data on inflows and outflows of timber products. To facilitate collaboration and cooperation of

timber merchants in collecting the requisite data, there were initial discussions between the research team and the Domestic Lumber Trade Associations (DOLTA) and other leaders of the various timber markets. This enabled them understood the objectives of the study thereby sensitizing their members of the exercise prior to data collection. Again, the sample size for each timber market was estimated based on the data received from the market leaders on the number of sheds/dealers. The sample size of any new market identified was also determined during the survey. A sampling of respondents to be interviewed per market was based on [6] strategy, and that the size of the market or the number of sheds with sellers present at the market at the time of the visit, was used. The timber merchants interviewed per market were randomly selected, taking into consideration willingness of the merchants to grant audience for interviewing. Therefore, the total number of timber merchants/sheds in each market was obtained from the market leaders from which the number of merchants to be interviewed (sampling size) was estimated. The enumerators visited all major and most satellite markets or sale points in each region and made sure that at least 90% of the total number of domestic timber markets available in the country was covered during the survey.

2.4 Data Analysis

The data collected were analyzed using descriptive statistics. The analysis was done using Statistical Package for Social Scientists (SPSS) and excel where tables, graphs and pie charts have been used to describe the relationships. The volumes of wood stocked with respect to wood products, dimensions and species per month recorded during the survey period as per timber dealer interviewed, have been estimated. The total volume of wood estimated from each timber dealer/merchant is then summed across all those interviewed to obtain the total volume of timber inflow per month. The same approach is used in estimating the volume of timber that was sold. The assumptions here are that the stocked timber and the sales recorded during the survey is equivalent to the potential supply and demand per month for the country. Again, it is also perceived by the leaders of the survey enumerators that at least 90% of the timber markets in Ghana were covered during the survey. Moreover, the volume of timber supplied to the domestic market in the wet season was taken as 47% of that of the dry season in accordance with the report by [16]. Therefore total annual stocks and sales of wood products in the domestic market were estimated based on this 47% estimate.

All the identified domestic timber markets have been classified into small, medium and large using the percentage number of sheds per market with respect to the highest number of sheds (700) recorded nationwide during the survey. In this case, the sizes or dimensions of sheds in every timber market throughout the country were kept constant due to variations observed.

3. Results and Discussion

3.1 Classification of the size of the individual domestic timber markets in Ghana

3.1.1 Distribution and classification of domestic timber markets

A total number of 108 timber markets were surveyed (Tables 1). Additional 41 markets, with a maximum number of two sheds, along with the roads of some communities, were also identified but their merchants were not interviewed, hence a total of 149 domestic timber markets were interviewed. With the 108 markets where the timber dealers were interviewed, Greater Accra region registered the highest number of timber markets (22) and was followed by Ashanti (17), Brong Ahafo /Eastern (15) and Volta regions (14). The least number of domestic timber markets (2) was recorded in the Upper West region (Table 1). These indicate that the trade is in ascendancy in Accra and virtually non-existence in the Upper West region.

The 108 domestic timber markets that were identified throughout the country have been classified into small, medium and large markets (Table 1). This was based on the number of sheds per timber market surveyed with respect to Techiman timber market, which recorded the highest estimated number of sheds (700), where only timber products were traded. Small timber market was based on up to 5% of the timber market with the highest number of sheds (700) nationwide, more than 5% to 50% for the medium timber market and above 50% for the large market.

The floor dimensions of the sheds per domestic market in Ghana were not factored into this estimation as there were variations even within the timber markets. For instance, the floor dimensions of sheds where timber products were sold ranged from 4.5x10 to 5.4x11.7 at Techiman timber market and 4.9x7.3m to 7.3x10.9 at Muus timber market in Accra. Alternatively, the classification of the timber markets in Ghana could have been based on the volumes of lumber generated per market and the proportions estimated with respect to the market with the highest volume of lumber. The challenge with this method is that timber volume per market is not consistent and therefore changes over short periods depending on some factors. In this case, the classifications of markets will have to be undertaken on a short-term basis, hence was not considered as a good approach.

From Table 1, out of the total number of 108 timber markets, 86 (79.6%) fall under small, while medium and large consist of 20 (18.5%) and 2 (1.9%) respectively. The two large domestic markets are located in Brong

Table 1. Regional classification of domestic markets based on the number of sheds per market

Region	Timber market classification			Total number of timber markets	No. of emerging timber markets whose members were not interviewed
	Small	Medium	Large		
Greater Accra	17	5	0	22	2
Western	5	2	0	7	2
Central	6	3	0	9	0
Ashanti	10	6	1	17	1
Brong Ahafo	13	1	1	15	4
Volta	14	0	0	14	9
Eastern	12	3	0	15	20
Upper East	4	0	0	4	3
Northern	3	0	0	3	0
Upper West	2	0	0	2	0
Total	86	20	2	108	41
% of total markets	79.63	18.52	1.85	100	

Ahafo (Techiman market) and Ashanti (Sokoban market) regions. The region with the highest number of medium timber markets is Ashanti while small domestic timber markets are mostly scattered in Greater Accra, Volta, Brong Ahafo, Eastern and Ashanti regions (Table 1). The average number of staff employed per market shed identified in both the medium and large markets is three (3). A high number of other groups of people, not specifically attached to sheds, and classified as "loading/guru boys" were also identified but not enumerated. The number of emerging markets surveyed is 41, representing 27.5% of the overall total number of domestic markets (149). These are located in six regions, with the Eastern region recording the highest followed by Volta region as shown in Table 1. These might be due to the current increase in illegal operations in the Eastern region and the timber extraction from the Volta Lake that was going on.

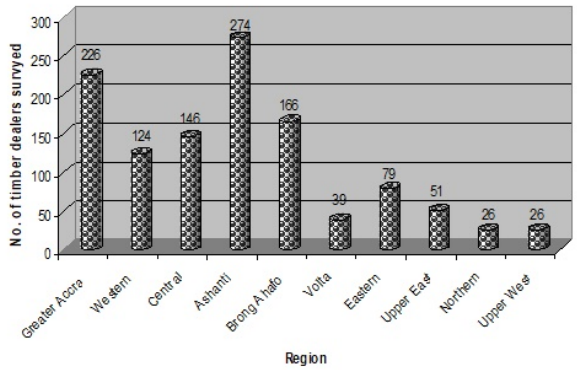

Figure 2. Distribution of timber merchants/dealers surveyed across the ten regions of Ghana

The total number of timber merchants/sheds that were surveyed in the ten regions of Ghana is 1,157 as compared to 611 recorded in [6]. The highest number of dealers (274) resulting in a percentage of 23.7% of the total, was recorded in Ashanti region (Fig. 2). The next four regions are Greater Accra (19.5%), Brong Ahafo (14.3%), Central region (12.6%) and Western region (10.7%). These indicate that more timber dealers are found in the domestic markets in Ashanti region than the other regions, which could be attributed to the location of the region, with comparatively higher numbers of timber markets, patronage of chainsaw timber products (beams, boards and lumber) and population. The trend follows the same order with the other four regions identified. The regions that recorded the least number of timber merchants (26) as in Fig. 2, are the Northern and Upper West regions, which corresponds to 2.2%, is due to the fact that the medium and large-scale wood users in the region buy timber products directly from southern Ghana thereby slowing down timber business in the two regions.

3.1.2 Regional distribution of stock and sales volumes and values of timber products in the domestic markets

The distribution of monthly timber volumes and values stocked for sale at the various domestic markets across the nation are shown in Table 2. The domestic timber markets in Ashanti region recorded the highest monthly volume of 35,174.5 m^3 of timber stocked, constituting approximately 29% of the national monthly volume in the stock. This is followed by three other regions as Greater Accra (26%), Brong Ahafo (16%) and Central (14%). The least monthly volume of 767 m3, which represents approximately 1 is recorded in the Upper West region. These indicate that more timber products are available in Ashanti for consumption while Upper West region is less stocked, hence their location in terms of timber resource as well as the degree of illegal chainsaw lumbering might be the contributing factors.

In terms of value, Greater Accra has the highest (32%) followed by Ashanti (28%) indicating that the prices of timber products in the markets of Greater Accra region are higher than that in Ashanti region (Table 2). The next three regions are Central (13%), Brong Ahafo (11%) and Western (7%). This trend conforms to the study by [6].

The price per cubic meter of timber (of any of the three products) in the ten regions ranges from GHC 309 to GHC 602. The highest and least values per cubic meter were recorded in Upper West and Brong Ahafo regions respectively (Table 2). This national trend of the value of timber per cubic meter shows that timber is comparatively less expensive in the Brong Ahafo region, even though the market is well patronized, while it is expensive in the Upper West region where the products are in short supply.

The total monthly timber stocked in the ten regions for domestic consumption is approximately 120,542 m^3 valued at Ghc 56,132,148. Since the study was undertaken in July (wet season) the supply of timber to the domestic market is reported to be lower [6,16]. A report by [16] indicates that the supply of timber to the domestic market in the wet (lean) season is 47% of the dry season. This gives an estimate of 256,472.3 m^3 of timber stock per month in the dry season, hence an average monthly stock volume of 188,507.2 m^3 for the entire country. Again, based on the perception that 90% of the domestic markets were covered nationwide, estimating 100% market coverage, gives 209,452.4 m^3 as the potential timber volume stocked per month. Therefore the annual projected stock for the domestic market is 2,513,428.9 m^3, whose round wood equivalent (RWE) is estimated at 8.043 million m^3. From Fig. 3, the total volume of timber needed per month has been estimated as 73,483 m^3 at a value, of GHC 35,364,474. There was a surplus of 47,059 m3 (39%), indicating that the stock was more than the demand for

Table 2. Regional distribution of timber volumes and values stocked for sale at the domestic markets in the ten regions surveyed

Region	The volume of timber products in stock per month (m3)	Value of timber products per month GHC	% of the total supply volume	% of the total value of timber	Price per cubic meter of timber
Greater Accra	30736.3	18006669.7	25.5	32.1	586
Western	7658.4	4060530.3	6.4	7.2	530
Central	16480.7	7329233.8	13.7	13.1	445
Ashanti	35173.5	15442108.1	29.2	27.5	439
Brong Ahafo	19709.7	6092590.8	16.4	10.9	309
Volta	1800	924640.9	1.5	1.6	514
Eastern	3165.1	1205060.6	2.6	2.1	381
Upper East	2839.4	1469403.5	2.4	2.6	517
Northern	2211.1	1139885.1	1.8	2	516
Upper West	767.4	462025.5	0.6	0.8	602
Total	120,541.60	56,132,148.10	100	100	466

the period and that 61% of the total timber products that were stocked per month was consumed. As per the assumptions above, the annual consumption of timber in the country is 1,532,198.7 m^3, estimating to 4.9 million m^3 RWE. Previous studies by [4,15,16] recorded national domestic timber consumption volumes of 1,900,000m^3 (6.0 million m^3 RWE); 760,000m^3 (2.4 million m^3) and 939,394m^3 (2.9 million m^3) respectively. These variations, apart from the different periods of study, may be due to the differences in the number of domestic markets and timber merchants (respondents) surveyed, which are comparatively far higher (108 and 1157 respectively) for this present study. There is also the perception about the inflow of illegal timber products (beams, boards and lumber) from Ivory Coast through Brong Ahafo region. This needs to be verified in order to determine the volumes that are supplied from the Ghanaian timber resources.

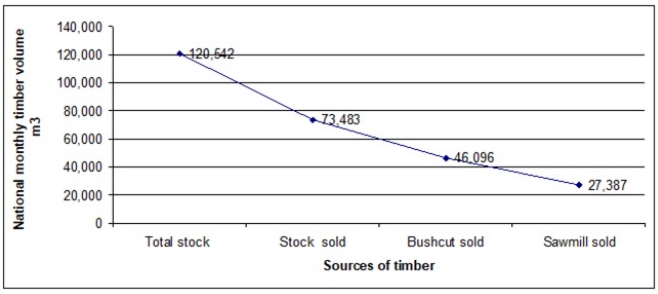

Figure 3. Total stocked and sales volumes of timber nationwide

Fig. 4 shows the mean volumes of stock timber and those sold per timber merchants in all the ten regions of Ghana per month. The volumes of timber stocked nationwide by each merchant per month ranges from 30 m^3 in the Upper West region to 136 m^3 in the Greater Accra region while the monthly volumes sold per merchant also ranges from 19 m3 (Upper West) to 121 m^3 (Greater Accra region). The results show that generally, the supply of timber exceeded demand. There is, therefore, the need to manage the resources in order to minimize the excess inflow of timber products. Again, the monthly stock volume per merchant was higher in the Greater Accra region with a corresponding sale volume per month per merchant, meaning that in each month, more timber products are supplied to and sold by the merchants in the region than any other region (Fig.4).

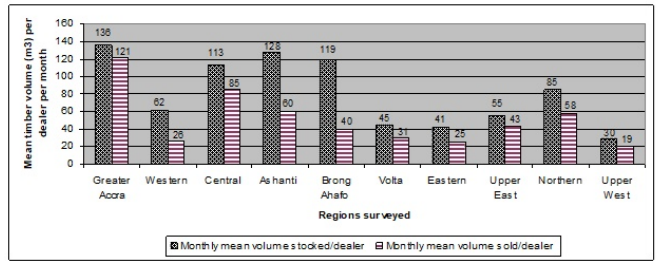

Figure 4. Regional distribution of volumes of timber stocked and sold by merchants on a monthly basis

3.1.3 Volumes and values of the major timber products and their sources of supply

3.1.3.1 Regional distribution of stocked and sales volumes of three timber products supplied and their values

Table 3 gives the monthly volumes and values (with respect to prices) of three major timber products that are stocked on the domestic timber markets in all the ten regions of Ghana. These major timber products include beams, boards and lumber. The number of respondents in the ten regions who traded in beams is 75 as against 303 and 1135 for boards and lumber respectively. This shows that the timber merchants/dealers are not too much attracted to the sale of beams. This might be attributed to the low rate of outflow of the product as well as the low-profit-margin generated as perceived by some of the respondents.

The highest monthly stock volume of 69,193 m^3 is estimated for lumber, representing 57%, followed by 42,264 m^3 for boards (35%) while the least, 9,084 m^3, which constitutes 8%, is recorded for beams (Table 3). Lumber and boards are the most patronized timber products because they are always in a semi-finished and or finished form and hence do not need much machining work before usage. Beams, on the other hand, need to be machined to boards or lumber before usage, results in low lumber recovery, extra cost and attracts a lot of security attention in transporting from one place to another.

Again, the total monthly sales volume of the board product (28,554.5 m^3), with respect to its total monthly stock volume (42,263.9 m^3), is higher (68%) than lumber and beam products, which were estimated to be 58% and 52% respectively (Table 3). On the other hand, the percentage sales volumes of each of the three products in relation to the national total monthly sales volume (73,482.7m^3), are determined to be 6% (beams), 39% (boards) and 55% (lumber). These indicate that generally, customers' patronage of lumber product is the highest, which could be attributed to the advantages of its handling and usage, followed by boards with beams lagging behind. The results, again, seem to discourage

Table 3. Monthly distribution of stock and sales volumes of three major timber products at the timber markets surveyed in all the ten regions

Region	Beams		Boards		lumber	
	Volume of beam stocked per month	Volume of beam sold per month	Volume of boards stocked per month	Volume of boards sold per month	Volume of lumber stocked per month	Volume of lumber sold per month
Greater Accra	1254.6	1184.604	14373.2	12543.26	15108.5	13689.06
Western	701.5	252.209	3059.5	1452.21	3897.5	1577.85
Central	803	713.51	6980.2	5282.98	8697.6	6454.19
Ashanti	3954.4	1734.72	8858	4569.68	22361.1	10086.39
Brong Ahafo	1917.6	628.15	4710.3	1656.33	13081.8	4277.81
Volta	0	0	943.3	632.57	856.7	578.43
Eastern	391.6	166.98	1468	1017.44	1305.4	755.74
Upper East	26.4	8.81	897.4	695.76	1915.6	1499.28
Northern	21.2	4.25	703.3	528.91	1486.6	985.63
Upper West	13.8	4.78	270.9	175.37	482.7	325.76
Total	9,084.20	4,698.00	42,264.00	28,554.50	69,193.40	40,230.10

the production of beams from the forest and farmlands. This might be due to the further process involved, which generates low recovery and the high cost of the product.

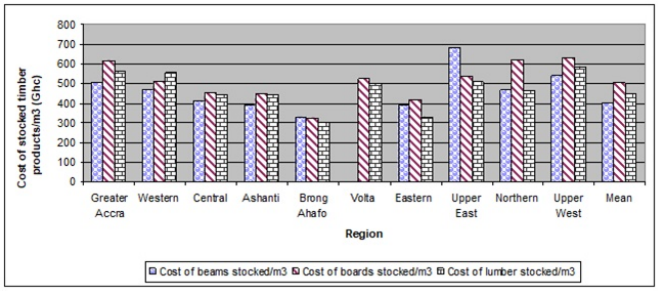

Figure 5. Monthly distribution of stock values per cubic meter of three major timber products at the timber markets surveyed in all the ten regions

The values or prices for the various monthly stock volumes for lumber, boards and beams are estimated as GHC 31,165,386, GHC 21,300,561 and GHC 3,666,201 respectively. The high values generated from lumber and boards, as a result of high demand for the products, are due to the minimum level of preparation before use as compared to beams, hence the price differential recorded. Fig. 5 shows the cost per cubic meter of beams, boards and lumber in every region of Ghana. Apart from Western and Upper East regions where the cost of lumber and beam respectively are higher than the other products, boards are more expensive in all the regions than lumber and beams (Fig. 5). The values of these products nationwide range from GHC 330 (Brong Ahafo) – GHC 681/m^3 (Upper East) for beams, GHC 324 (Brong Ahafo) – GHC 630 (Upper West) for boards and GHC 301 (Brong Ahafo) – GHC 588 (Upper West) for lumber (Fig. 5). These imply that, on the average, the domestic markets of Brong Ahafo region are where the three timber products are comparatively sold at lower values/prices, but the mean cost of beam per cubic meter is the highest (GHC 330) among the three timber products in the region. Fig. 6 also shows the mean cost per cubic meter of each of the three timber products nationally with respect to the monthly stock volume and value. This follows the regional trend (Fig. 5), where the cost per cubic meter (apart from Western and Upper East regions) is higher with boards, followed by lumber and the lowest being beams. This could be attributed to its value addition and the versatility of its usage.

From the survey results, Volta region did not record any beam product (Table 3). This means that beams are not stocked at the domestic markets in the region and that customers are not interested in the product. Again, for all the three products, five of the regions, namely, Greater Accra, Western, Central, Ashanti and Brong Ahafo always registered higher monthly stock and sales

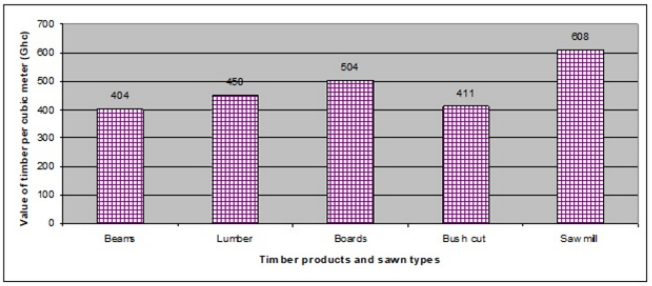

Figure 6. The value per cubic meter of three timber products and their sawn types

Table 4. Sources or types of sawn timber stocked for sale by timber merchants nationwide

Region	Bush cut dealers	Bush cut and sawmill dealers	Sawmill dealers
G. Accra	33	68	119
Western	86	10	16
Central	141	19	2
Ashanti	227	14	34
Brong Ahafo	159	5	3
Volta	33	3	2
Eastern	77	2	1
Upper East	53	0	0
Northern	23	2	0
Upper West	25	0	0
Total	857	123	177
% of respondents	74.1	10.6	15.3

volumes than the rest of the regions (Table 3).

3.1.3.2 Sources of sawn timber products supply

Table 4 shows two types of sawn timber that the 1157 merchants offer for sale in the ten regions. The main sources of timber supply are bush cut and sawmill cut. About 74% of the total number of timber merchants interviewed trade in only bush cut or chainsaw products whose stock volume totals 83,341 m^3. A volume of 33,241 m^3 lumber that generates from the sawmill is stocked by 15% of the merchants/respondents while 11% sells both bush cut and sawmill products of stock volume 3,960 m^3. Comparing the supply of bush cut timber, which represents 74% of the responses to the 76% that was recorded by [6], indicates a decline in the number of bush cut timber dealers on the domestic market. Therefore supply of sawmill lumber onto the domestic market seems to be gaining prominence as more respondents are engaged in the sale of legal timber products. In Greater Accra region, more timber merchants (67%) are into the sale of only sawmill products than any of the regions (Table 4). This is followed by Ashanti region (19%) and five of the regions also stock between 1 and 9% while Upper East, Northern and Upper West regions do not supply sawmill timber products. According to the respondents, it is increasingly becoming difficult to transport chainsaw products to long distant cities/towns, especially Accra. In this case, most of them use wood-mizer or bush mill to convert bush cut timber to sawmill products (boards and lumber) before transporting or stocking for sale. In Ashanti and other regions, it appears most sawmills have collapsed or stopped the production of lumber and boards and therefore have limited supply of sawmill products to the market. The General challenge is that even though timber dealers place orders for sawmill products, it takes them months before delivery, which is not encouraging to timber merchants.

3.1.3.3 Volumes and values of sources or types of sawn timber products supplied to the domestic market

Table 5 indicates the monthly distribution of volumes and values of the types or source of sawn timber surveyed in all the regions of Ghana and their prices per cubic meter. The total stock volume of bush cut that has been estimated per month from the 108 timber sheds is 87,058 m^3 at a value of GHC 35,760,114. This means that the average monthly stock volume per market is approximately 806 m^3 as compared to 878 m3 reported by [6]) where 44 timber markets were identified. This shows that the monthly volume of bush cut timber supply to any domestic market in the ten regions has reduced, which does not necessarily mean a reduction in the chainsaw activities nationwide. Hence the interventions that both government and Non-governmental organizations have been implementing, which are aimed at minimizing chainsaw lumbering, need to be strengthened. The first three regions with the highest monthly volumes of the bush cut timber products are Ashanti (30,405 m^3), Brong Ahafo (19,413 m^3) and Central (13,428 m^3) regions (Table 5). The trend of bush cut supply is equivalent to that established by [6] except the Central region, which has interchanged with the Greater Accra region, meaning that illegal chainsaw activity has gone up to feed the domestic markets in the Central region. On the other hand, the supply of chainsaw timber products onto the markets of Greater Accra is minimized, which could be attributed to the vigilance of the security forces with the support from the general public.

The total monthly stock volume of timber from the sawmill is also estimated as 33,484 m^3 valued at GHC 20,372,034.48. The result shows a sharp increase in comparison with that recorded by [6], of which a monthly volume and value of 5,457 m^3 and GHC39,056 respectively were estimated. Out of the monthly national consumption volume or demand of 73,483 m^3, 63% is bush cut while 37% is made up of sawmill products (in the form of lumber and boards only). The sawmill products on the market that are patronized are about 59% of the monthly volume of bush cut sold. Therefore Artisanal milling concept, which is aimed at introducing legal timber onto

the domestic market, will help increase both the stock and consumption volumes of sawmill products. There is, therefore, the need to continue the public education on the utilization of bush cut and sawmill products vis-a-vis sustainable forest management and to convert more illegal chainsaw operators into legal operators by providing alternative sources of livelihood, like the Artisanal milling concept that has been developed and being implemented.

The prices per cubic meter for the bush cut and sawmill timber for the ten regions, (Table 5) and that for the mean national monthly values Fig. 6), indicate that sawmill timber is higher than that of bush cut, which confirms the report by [6] and the perception of the respondents. The average price variation between the two swan types of timber products, irrespective of the timber species and region, is approximately GHC200.00 (Table 5).

From Table 5, the region with the highest price of timber per cubic meter of bush cut is the Upper West region (GHC602/m^3) while the least comes from Brong Ahafo region (GHC308/m^3), which is about 51% of the price in the Upper West region. These are in conformity with the economic principle that in a free market economy, the higher the supply of a product the lower the price and vice versa. Chainsaw lumbering activity is recorded to be higher in both Ashanti and Brong Ahafo regions [6]. Again, these regions are closer to the timber resource and that the expenditure incurred in supplying to the markets is comparatively lower. Therefore the domestic markets in these regions are mostly stocked with bush cut timber for sale. So the competition for timber products is not as high as it prevails, for instance, in Accra, hence the tendency for the prices of timber to be lower.

On the other hand, the price of sawmill timber in the Western region (GHC726/m^3) is more expensive than those in the other regions (Table 5). This is worrying because there are some sawmills in this region, which could feed the timber markets in the region and the timber resource available is also comparatively better. This might be due to the higher cost of lumber production by sawmills and the higher preference for export than to sell to the local market. Moreover, some lumber processing sawmills have collapsed in the region. Again, Brong Ahafo recorded the minimum price per cubic meter of sawmill timber for each month. This may be due to the easy availability of bush cut timber on the market coupled with its lower prices, which deter consumers from patronizing sawmill timber at higher prices.

Fig. 7 illustrates the supply of the sawn types of timber surveyed nationwide. The national domestic timber market reveals that the markets are supplied with bush cut and sawmill products. The monthly stock volume of bush cut is about 87,058m^3 constituting 72% of the total national stock volume of timber supplied to the domestic

Table 5. Regional distribution of volumes and values of the monthly supply of bush cut and sawmill timber

Region	Volume of bush cut timber per month m^3	Price of bush cut timber stocked per month GHC	Volume of sawmill timber per month m^3	Price of sawmill timber stocked per month GHC	Prices of bush cut timber/m^3	Prices of sawmill timber/m^3	Price variation GHC
Greater Accra	7185.9	3508119	23550.44	14498550	488	616	127
Western	6457.16	3188268	1201.26	872261.8	494	726	232
Central	13433.85	5553600	3046.9	1775634	413	583	169
Ashanti	30408.73	12707357	4764.74	2734751	418	574	156
Brong Ahafo	19373.13	5968866	336.62	123724.9	308	368	59
Volta	1720.14	895228.9	79.81	29411.96	520	369	-152
Eastern	3129.65	1159361	35.4	45699.98	370	1291	921
Upper East	2839.43	1469404	0	0	517	0	-517
Northern	1742.6	847885.1	468.49	292000	487	623	137
Upper West	767.39	462025.5	0	0	602	0	-602
Total	87057.98	35760114	33483.66	20372034	411	608	198

timber market per month (Fig. 7). [16] reporting on the supply of timber in the wet season after a survey of 19 domestic timber markets across the country, recorded a monthly mean volume of 36,147 m^3 bush cut timber products, which represented 75% of the total volume supplied and 81% in the dry season. Other studies by [6,10] have also reported on the dominance of bush cut (chainsaw) timber on the domestic market whereby 84%, 88% and 70% respectively were obtained. The results from these earlier studies in comparison with the current survey results indicate that the monthly stock volume of bush cut timber appears to be falling.

The total stock volume of timber from sawmill per month is estimated as 33,484 m^3, which also constitutes 28% of the national monthly volume supplied (Fig. 7). From studies by [6], 12% of the total monthly volume supplied by sawmills, which indicates an increase of 16% stock of sawmill timber products (boards and lumber).The results obtained from the present survey indicate that volumes of timber supply from sawmills is appreciating or increasing and hence reducing that from the bush cut source. Even though the trend continues in this study that Bush cut is the dominant type of sawn timber supply, the volume is comparatively lower than the previous studies.

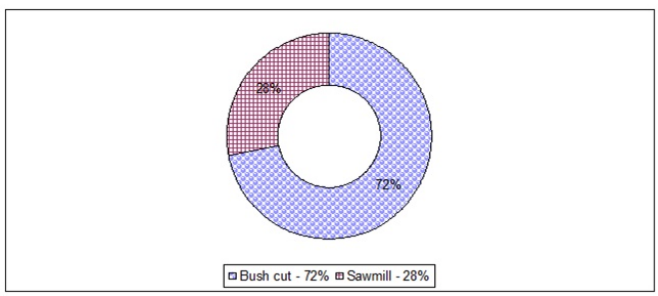

Figure 7. Percentage of the two types of sawn wood to total timber volume stocked

The monthly sales of sawmill products (27,387 m^3), with respect to its stock (33,484 m^3), is far higher (82%) than bush-cut, which is estimated to be 53%. This indicates that if sawmill products are stocked at the various timber markets consumer will patronize them, thereby increasing the profit margins of timber dealers better than bush cut products.

3.2 Timber species stocked in the ten regions of Ghana

The survey recorded a total of 99 timber species at all the domestic markets in the country (Table 6). A total monthly timber volume of 120,542 m^3 that are stocked at the timber markets are from these 99 species (Table 6). There is an increase of 34 species, which is equivalent to 52% over that of [6]. This is an indication that new timber species continue to be introduced into the domestic market, most of whose properties have not been established for efficient promotion both locally and internationally. Hence, there appears to be underutilization of most of the species on the domestic timber markets across the country.

All the species surveyed (Table 7), have been grouped into four utilization categories based on criteria by [17], which is primarily on how long a species has been exported, its quality, value and demand on the export market. These categories include premium/prime timber species (PS), commercial timber species (CS), lesser-used timber species (LUS) and lesser-known timber species (LKS). The number of timber species that come under the various utilization categories with their monthly stock volumes is Premium/Prime species 11 (26,621 m^3), Commercial species 13 (26,794 m^3), Lesser-used 30 (56,785 m^3) and Lesser-known 45 (10,343 m^3). These result in an average monthly stock volume per species as 2,420 m^3, 2,061 m^3, 1,893 m^3 and 230 m^3 in the same order. These show that consumers still patronize the prime species when they are available on the market, hence they are very selective. The comparatively high monthly volume supply of LUS to the domestic market is based on familiarity with technical information on most of the species have been established. Therefore the 45 LKS, which recorded the lowest monthly volume supply have to be technically introduced to the public for them to patronize the species, hence the need to establish their technological properties.

In terms of the monthly sale values, the prices for the premium and commercial species range between GHC 4,650 and GHC 7,614,026, in comparison with the LUS and LKS whose prices range from GHC 250 to GHC 7,856,198. On the other hand, the mean values of the stocked volume of timber per species per month for the prime, commercial, LUS and LKS are evaluated to be GHC 1,236,231; GHC 1,095,242; GHC 775,392 and GHC 93,969 respectively. Therefore, the prime and commercial timber species whose technical data have been established have more value than those with scanty or without any information. These indicate the need to add value to LKS and some of the LUS whose properties have not been developed through research and development.

On the other hand, the ten (10) timber species out of the 99 (Table 7) that are mostly traded or harvested, processed and supplied to the domestic markets (in descending order in terms of monthly volume) are *Celtis spp* (Esa), *Triplochiton scleroxylon* (Wawa), *Ceiba pentandra* (Onyina), *Piptadeniastrum africanum* (Dahoma), *Terminalia superba* (Ofram), *Cola gigantea* (Watapuo), *Daniellia oliveri* (Senya), *Alstonia boonei* (Nyamedua), *Antiaris toxicaria* (Kyenkyen) and *Khaya ivorensis* (Dubene). These comprised of 2 prime timber species, 3 commercial timber species, 4 lesser-used timber species and 1 lesser-known

Table 6. Surveyed timber species (99) available at the domestic timber markets nationwide

Ranking	Species		Stock volume m3	Stock value GHC	Sales volume m3	Sales value GHC
	Local name	Scientific name				
1	Esa	Celtis spp	15387.84	7856198	11182.93	5693479
2	Wawa	Triplochiton scleroxylon	15299.69	7614026	10644	5444844
3	Onyina	Ceiba pentandra	14166.95	4936279	9923.1	3609412
4	Dahoma	Piptadeniastrum africanum	8586.9	4930605	5660.43	3312490
5	Ofram	Terminalia superba	8366.54	4900214	4627.05	2950512
6	Watapuo	Cola gigantea	5654.3	2191086	2821.25	1136376
7	Senya	Daniellia oliveri	5054.7	1919100	2557.19	991723.4
8	Nyamedua	Alstonia boonei	4778.54	1533513	2624.67	869995
9	Kyenkyen	Antiaris toxicaria	4776.25	1895888	3240.22	1360731
10	Dubene	Khaya ivorensis	4562.62	2567188	2624.88	1685063
11	Otie	Pycnanthus angolensis	3763.27	1323815	1953.6	709627.2
12	Essia	Petersianthus macrocarpus	3362.66	1527480	1654.62	754212.5
13	Emire	Terminalia ivorensis	3054.77	1491673	1565.5	786677
14	Danta	Nesogordonia papaverifera	2185.7	1115070	1273.01	660502
15	Odum	Milicia excelsa	2062.06	1134800	1108.69	684540.5
16	Akonkodie	Bombax buonopozense	2011.11	500380	677.45	173282
17	Yaya	Amphimas pterocarpoides	1808.69	709468	1037.14	428677
18	Nakwa	Holoptelea grandis	1155.59	556750	696.07	374755
19	Asanfena	Aningeria altissima	1047.31	606585	539.63	302910
20	Denya	Cylicodiscus gabunensis	962.98	526580	679.53	380180
21	Cedrella	Cedrella odorata	883.06	455278.7	470.85	269238.3
22	Kotreamfo	Ficus sur	827.07	241572.5	322.8	98682
23	Awiemfosamina	Albizia ferruginea	796.14	359560	307.72	142285
24	Funtum	Funtumia elastica	771.31	616380	546.11	447457
25	Kusia	Nauclea diderrichii	720.5	288975	276.86	117670
26	Koto	Pterygota macrocarpa	678.41	332440	418.01	184665
27	Hyedua	Guibourtia ehie	592.38	291720	413.93	197045
28	Sese	Holarrhena floribunda	575.52	239625	160.65	63005
29	Penkwa	Entandrophragma cylindricum	542.85	267030	232.8	112375
30	Mansonia	Mansonia altissima	484.82	258790	277.35	174345
31	Otweese	Aidia genipaeflora	395.58	139395	215.5	82755
32	Edinam	Entandrophragma angolense	342.74	100730	136.93	48739
33	Tweneboa	Cordia millenii	329.79	106520	109.49	36865
34	Kokrodua	Pericopsis elata	267.19	126260	210.02	102339
35	Wonton	Morus mesozygia	266.04	94600	113.11	46460
36	Apapaye	Turraeanthus africanus	254.18	159020	145.53	94170
37	Wawabima	Sterculia rhinopetala	250.39	79600	87.72	29270
38	Okoro	Albizia zygia	246.05	99159	133.93	56164
39	Foto	Glyphaea brevis	241.89	50720	88	17130
40	Aprokuma	Antrocaryon micraster	241.2	70770	82.68	22920
41	Ngo-ne-nkyene	Cleistopholis patens	216.47	80365	88.45	34925
42	Nyankum	Heritiera utilis	200.11	112500	92.88	56450
43	Bediwonua	Canarium schweinfurthii	193.84	53620	92.53	29820
44	Akasa	Chrysophyllum spp	173.16	51400	63.1	20000
45	Kumanini	Lannea welwitschii	166.69	51160	131.62	39800
46	Wama	Ricinodendron heudelotii	159.73	43350	56.12	15350
47	Dubenebiri	Lovoa trichilioides	150.74	125300	140.55	120120
48	Papao	Afzelia africana	147.15	52170	95.66	37740
49	Bonsamdua	Distemunanthus benthamianus	138.67	71800	100.09	54670
50	Konkroma	Morinda lucida	111.18	43580	79.97	30540
51	Labicha	-	94.5	27020	94.39	27000
52	Abako	Tieghemella heckelii	94.3	44480	47.1	22590
53	Papea	Tabernaemontana crassa	88.1	32000	22.02	8000
54	Gmelina aborea	Gmelina aborea	72.11	14030	21.71	4670
55	Kwabohoro	Guarea cedrata	62.77	25000	40.71	16975
56	Obondai	-	54.12	25500	54.12	25500
57	Afam	Parinari excelsa	50.34	31000	50.34	31000
58	Efobrodedwo	Entandrophragma utile	43.61	14550	29.45	9525
59	Teak	Tectonia grandis	38.76	19400	20.64	13680
60	Oto oto	Lonchocarpus sericeus	35.9	10840	7.16	2172
61	Tia-butuo	Scottellia klaineana	35.24	11200	26.43	8400
62	Atwea	Dacryodes klaineana	35.11	9620	10.76	2930
63	Bompagya	Mammea africana	31.48	23800	13.5	6550
64	Ohaa	Sterculia oblonga	30.83	8800	21.71	6150
65	Ogogoma	-	26.43	9600	26.43	9600
66	Otoriwa	-	26.43	7200	26.43	7200
67	Subaha	Hallea stipulosa	25.12	14570	5.36	3120
68	Krayie	Pterocarpus erinaceus	24.54	7350	14.63	4350
69	Candollei	Nolapa	21.47	6450	20.81	6270
70	Kyiriwiah	Entandrophragma candollei	19.82	10500	13.21	7000
71	Gawo	Tetrorchidium didymostemon	18.69	7338	5.95	2538
72	Duadokono	Corynanthe pachyeeras	18.17	5400	18.17	5400
73	Akwaboho	Duadokono	15.1	5000	15.1	5000
74	Bese	Akwaboho	14.45	6650	10.53	4825
75	Awoti	Carapa procera	13.76	3300	9.08	2200
76	Kuntunkuri	Awoti	12.29	4170	8.15	2920
77	Sorono	Khaya senegalensis	11.88	2384	4.28	856.67
78	Chienchienga	Parkia clappertoniana	11.33	6000	10.95	5800
79	Nolapa	Entada abyssinica/africana	11.01	5500	8.81	4400
80	Abisa	Vitex simplicifolia	10.62	3000	2.65	750
81	Kwasoro	Randia genipaeflora	9.44	2500	2.27	600
82	Tanuro	Trichilia monadelpha	8.31	2240	2.08	560
83	Berekankum	Manilkara obovata	7.55	3000	2.27	900
84	Osaaba	Gossypium spp	7.55	1550	1.7	350
85	Opam	Macaranga spp	7.17	1700	2.93	800
86	Etwere	-	6.75	2225	6.09	2025
87	Piolo	Parinari temnifolia	4.96	2100	4.96	2100
88	Odwuma	Musanga cecropioides	4.46	1560	3.74	1335
89	Hotorohotoro	Balanites aegyptiace	3.78	900	0.76	180
90	Gongo	Honnoa klaineana	3.78	1120	0.94	280
91	Aboloobaa	Baphia nitida	3.3	1200	3.3	1200
92	Fetefre	Pellegriniodendron diphyllum	2.64	960	2.64	960
93	Peowa	-	2.52	1200	2.52	1200
94	Awudifokete	Anthocleista spp	1.98	600	0.66	200
95	Dawadawa	Parkia bicolor	1.65	525	0.88	280
96	Propro	Cola gigantea var. glabrescens	1.28	740	1.28	740
97	Amadodua	-	1.1	250	0.66	160
98	Asantedua	-	1.02	400	0.31	120
99	Kokoti	Anopyxis klaineana	0.76	520	0.19	130
	Grand Total		120541.6	55327028	73482.66	35364474

Table 7. Surveyed timber species grouped into four utilization categories

Premium/Prime timber species	Commercial timber species	Lesser-used timber species		Lesser-known timber species		
Abako	Apapaye	Abisa	Hotorohotoro	Aboloobaa	Funtum	Osaaba
Dubene	Candollei	Akasa	Kokoti	Afam	Gawo	Oto oto
Dubenebiri	Dahoma	Akonkodie	Konkroma	Akwaboho	Gongo	Otoriwa
Edinam	Danta	Aprokuma	Kumanini	Amadodua	Kotreamfo	Otweese
Efobrodedwo	Hyedua	Asanfena	Kuntukuri	Asantedua	Krayie	Papea
Emire	Koto	Awiemfosamina	Nyamedua	Atwea	Kwasoro	Peowa
Kokrodua	Kusia	Bediwonua	Ohaa	Awoti	Kyiriwiah	Piolo
Nyankum	Kwaboboro	Bompagya	Okoro	Awudifokete	Labicha	Propro
Odum	Kyenkyen	Bonsamdua	Onyina	Berekankum	Nakwa	Senya
Penkwa	Mansonia	Cedrella	Otie	Bese	Ngo-ne-nkyene	Sese
Wawa	Ofram	Dawadawa	Papao	Chienchienga	Nolapa	Sorono
	Subaha	Denya	Tweneboa	Duadokono	Obondai	Tanuro
	Teak	Esa	Watapuo	Etwere	Odwuma	Tia-butuo
		Essia	Wawabima	Fetefre	Ogogoma	Wama
		Gmelina	Yaya	Foto	Opam	Wonton

timber species as the utilization status. The monthly percentage supply volume and value of the first ten species with respect to the national monthly stock volume and value are estimated to be 72% and 73% respectively and the monthly sales volume is 76% with a value of 77%. These show that the ten species out of the 99 surveyed are the major sources of timber supply to the domestic market. These show that as premium and commercial timber species get extinct, lesser-used timber species take dominance while lesser-known species lag behind. The results from the first ten species also indicate that *Cola gigantea* (Watapuo), an *LUS* and *Daniellia oliveri* (Senya) - LKS are potential economic timber species whose technological properties need to be established in order to effectively promote them.

The regions where most of these 99 species are stocked include Ashanti, Brong Ahafo, Greater Accra and Eastern while Upper West, Northern and Upper East are three of the regions with the least number of timber species stocked (Table 8). The widely spread of the species in Ashanti, Brong Ahafo and Eastern regions is due to their geographical positions (forest zone) within the country while Greater Accra is the location where timber products from the three named regions, in particular, supply to. Although the Western region is also in the forest zone, overexploitation might have exhausted the area of its economic and potential timber species. The presence of the high numbers of LUS and LKS on the market indicates that most of the prime and commercial timber species are getting extinct from the timber resources. Therefore the chainsaw operators in collaboration with the timber merchants (in most cases) continuously find substitutes for the dwindling prime and commercial timber species without any technical basis. To add value to these species for efficient promotion and utilization, information on their working properties need to be established.

The level of consumption of each of the utilization categories with respect to their monthly stock volumes are 63%, 61%, 61% and % for prime, commercial, LUS and LKS respectively and the ratio of their monthly sales values in the same pattern and order are 67%, 64%, 64% and 56%. These again, indicate the positive effect of LUS on the domestic timber market as premium and commercial species dwindle. In this case, LUS surveyed are gradually being up-scaled into commercial species status. Despite the high quantities of LKS recorded, their effect is minimal, even though they are potential substitutes for some of the dwindling timber species. This is due to lack of technical information about them and that specific consumer, like building contractors, real estate developers, some individuals and or carpenters patronize those species that are technically familiar.

With the 11 premium species, Wawa, Dubene and Emire are the three species that record the highest monthly

Table 8. Regional distribution of the stock volume and value of the species under the four utilization status

Region	Premium species		Commercial species		Lesser-used species		Lesser-known species			
	Stock volume m^3	Stock value Ghc	Stock volume m^3	Stock value Ghc	Stock volume m^3	Stock value Ghc	Stock volume m^3	Stock value Ghc	Total stock Vol. m^3	Total value Ghc
Greater Accra	7714.81	4856331	6791.99	4335445	15015.44	7237725	1214.09	860532	30736.33	17290034
Western	2415	1407180	2188.7	1313020	2995.8	1473264	59.01	22230	7658.51	4215694
Central	3600.17	1709770	4417.71	2250728	8121.4	3312450	341.46	130005	16480.74	7402953
Ashanti	6810	2898168	8231.79	4215451	16565.41	6836878	3566.25	1508470	35173.45	15458967
Brong Ahafo	3110.5	1128660	3573.76	1314120	9700.38	2744798	3325.11	889749	19709.75	6077327
Volta	646.76	384103	277.64	142494	744.83	250926	130.73	38778	1799.96	816301.2
Eastern	1084.5	476335	623.44	242767	1402.09	399855	55.05	20195	3165.08	1139153
Upper East	508.08	288960	318.75	200835	1105.17	550420	907.44	452530	2839.44	1492745
Northern	520.1	317010	252.7	151980	964.41	375190	473.87	155545	2211.08	999725
Upper West	210.83	132020	117.32	71300	169.6	80240	269.63	150570	767.38	434130
Total	26620.75	13598537	26793.8	14238141	56784.53	23261746	10342.64	4228604	120541.7	55327029

sales volumes while Dahoma, Ofram and Kyenkyen are the first three for commercial species. In the same pattern, Esa, Onyina & Watapuo and Senya, Nakwa & Funtum register for LUS and LKS respectively. These reveal other potential timber species (Watapuo, Senya, Nakwa and Funtum) that need to be researched into in order to disseminate their technical information to stakeholders of the wood industry.

The average national prices per unit volume (cubic meter) of any of the species for the premium, commercial, lesser-used and lesser-known timber species are estimated to be GHC 555, GHC 550, GHC 456 and GHC 413 respectively. This shows how valuable the premium and commercial species are, as compared to the lesser-used and lesser-known timber species. Generally, for all the utilization categories, average prices per cubic volume of the timber species were cheaper in Brong Ahafo, which could be attributed to the high level of illegal chainsaw operation, and hence the easy availability of the timber products on the domestic market.

With respect to the two types of sawn timber, sawmill records 54 timber species out of the 99 surveyed while 94 timber species are also processed as bush cut for supply to the domestic market. Five of the timber species surveyed (Abisa - *Vitex simplicifolia*, Afam - *Parinari excelsa*, Kokoti - *Anopyxis klaineana*, Ohaa/Sterculia yellow - *Sterculia oblonga* and Peowa/Kane - *Khaya senegalensis*) do not have their products in bush cut to form at the domestic markets but are available in the form of sawmill products. These are only lesser-used and lesser-known timber species. The species are not harvested because, maybe, they are not within the reach of the illegal chainsaw operators who, in most case, harvest whatever is available to them.

From the estimated total monthly stock and sales volumes of the species, the bush cut products for all the utilization categories are higher than those of sawmills. This shows the aggressiveness of the chainsaw activities in Ghana, which need serious attention in order to salvage the Ghanaian forests and farmlands from total degradation.

3.3 Regional volumes and values of timber products by specification/dimensions

The number of dimensions recorded from the three timber products is 194 with the breakdown as follows: Beams – 23; Boards – 52 and Lumber – 119 (Fig. 8). Lumber, this is virtually a finished product, has varied dimensions to satisfy the needs of consumers, hence there is no extra cost to be incurred by consumers for final finishing before usage. The most acceptable form of beam dimensions that is mostly available in eight of the regions surveyed is 4”x12”x8’ interpreted as (4 inches x 12 inches x 8 feet) or (102 x 305 x 2440 mm). The next two dominant dimensions are 4” x 12” x 14’ and 5” x 12” x 8’. It is observed that dimensional lengths that are more than 8 feet (2.44 m) for beams as well as widths less than the normal or standard size of 12 inches (305 mm) are not well patronized by consumers. These are due to the handling difficulties experienced by carriers and drivers (due to the limited size of vehicle buckets/containers) with respect to the lengths. Again, the recovery is very low with high residue generation when further processed, especially when widths are under dimensioned, hence the final products (boards and lumber) becoming comparatively too expensive.

With respect to the boards, two dimensions that are found in all the ten regions include 1x12x16 and 1x12x14. Boards with shorter lengths (less than 14 feet) are seldom acquired by customers. This is because, in most cases, boards with a length of 14 feet or more are required to undertake some constructional work, especially during some heavy constructional activities.

The dimensions of lumber with the highest stock volume are 2x6x16 (18,677 m3). The lumber dimensions that were found in five or more regions are 1x9x16; 2x2x14, 2x2x16, 2x3x14, 2x3x16, 2x4x14, 2x4x16, 2x6x14, 2x6x15, 2x6x16, 2x7x16, 2x8x14 and 2x8x16. The variations in the lumber dimensions mostly came from the length, some of which are not standardized.

Considering all the dimensions generated from the three timber products, the thicknesses of all the products are less deviated from timber standard thicknesses as compared to the widths and lengths. Therefore the deviations, especially, in the width, increase wood residue generation along the chain, which affects sustainable resource management and the environment. There is, therefore, the need to have some controls at the domestic timber markets such that standardized dimensions of timber products are produced in order to minimize the volumes of wood residues generated annually. Secondly, it will improve movement of the products from one place to another in terms of cost and handling. Thirdly, it will facilitate the activities of consumers who intend to further process such products for other uses. Fourthly, it will also enable Carpenters, Architects, Engineers and Building contractors to select materials, design and construct structures to suit standard specifications.

The highest range of the dimensions of beams (Fig. 8) is recorded in Brong Ahafo region (9), followed by Ashanti (7), Greater Accra and Central (6) and Eastern (5) while the least is registered both in the Upper East (1) and Northern (1) regions. With respect to the dimensions of the boards, Ashanti region records 34 different dimensions with Brong Ahafo and Greater Accra/Volta registering 14 and 10 respectively (Fig. 8). Again, 92 different lumber dimensions are surveyed to be available at the markets

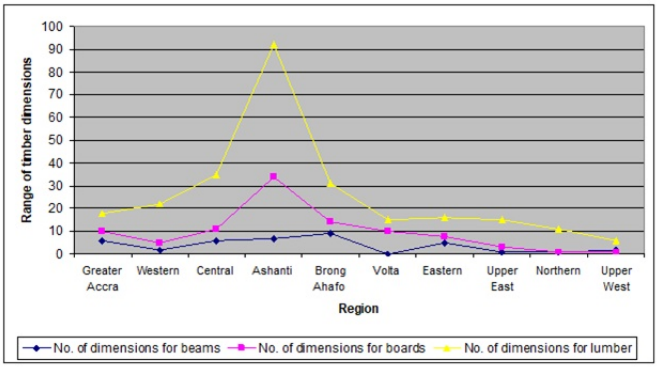

Figure 8. Range of dimensions of three timber products available at the domestic markets in the ten regions of Ghana

in Ashanti region, which is followed by Central (35) and Brong Ahafo (31) regions. Consistently Northern, Upper East and Upper West regions record a minimum number of dimensions of the three timber products (Fig. 8). These indicate the diversity of dimensions of timber on the domestic market in Ghana, which impacts negatively on timber recovery, manufactured wood products and construction and the sustainable resource management programme. The wide range of dimensions for the three timber products studied, according to [6], is attributed to the proliferation of illegal chainsaw timber products at the domestic timber market. Again, consumers and the type of vehicle that is available to cart the lumber from the timber markets determine the timber dimensions required. Some control measures have to be put in place to curb the situation.

4. Conclusions and Recommendations

4.1 Conclusions

The present domestic timber markets study covered 90% of total timber markets in Ghana. The total annual national volume of timber consumed is estimated at 1,532,199 m^3, which corresponds approximately to 4.9 million m^3 round wood equivalent (RWE). Meanwhile, the annual stock volume nationwide is 2,513,429 m^3 (8 million m3 RWE). The total monthly timber that is stocked in the ten regions for domestic consumption is approximately 120,542 m^3, valued at GHC 55,327,028 while the monthly sales volume and value are 73,483 m^3 and GHC 35,364,474 respectively. The Ashanti region recorded the highest monthly volume of 35,174.5 m^3 (29%) of timber supplied or stocked, which was followed by Greater Accra (26%). However, in terms of value, Greater Accra had the highest (32%) followed by Ashanti (28%).

A total of 108 timber markets have been recorded. Additional 41 markets, with a maximum number of two sheds, along with the roads of some communities, have also been identified. Out of the 108 timber markets, Greater Accra region registered the highest number of markets (22) and was followed by Ashanti (17), while the least (2) was recorded in the Upper West region. The total number of timber merchants/sheds that are surveyed in the ten regions of Ghana is 1157. The highest number of dealers (274) equivalent to 23.7% of the total, is recorded in Ashanti region. The three major customers of the wood dealers at the various timber markets are individuals, carpenters and or woodworkers and building contractors. Records keeping to some level are being practised by about 71% of the timber merchants. The number of timber associations that are identified throughout the country is 55. The 108 domestic timber markets identified have been categorized into small, medium and large based on the estimated number of sheds per market and that 86 (79.6%), 20 (18.5%) and 2 (1.9%) are classified as small, medium and large markets respectively. The main types of sawn timber or sources of timber supply are bush cut and sawmill cut of which the percentages of the monthly timber stock are 72% and 28% respectively. Again, the monthly volumes of bush cut and sawmill timber products that are sold with respect to the national sales volume are estimated as 63% and 37% respectively.

The total stock volume of bush cut estimated per month from the 108 timber markets is 87,058 m^3 at a value of GHC 35,760,114, and that the average monthly stock volume and value per domestic market are 806 m^3 and GHC 331,115 respectively. The total monthly stock volume of timber from the sawmill is also estimated as 33,484 m^3 valued at GHC20,372,034. The estimated prices for the bush cut lumber were lower than sawmill timber at all the ten regions in Ghana and that the average variation between the two swan types of timber, irrespective of the timber species and location, was approximately GHC200.00 per cubic meter. About 74% of the total number of timber merchants interviewed trade in only bush cut or chainsaw products, 15% of the merchants/respondents stock only sawmill products for sale with 11% selling both bush cut and sawmill products. Three major timber products identified during the survey include beams, boards and lumber and that the number of respondents in the ten regions who trade in beams is 75 as against 303 and 1135 for boards and lumber respectively. The national average prices (values) per cubic meter of boards, lumber and beams are evaluated as GHC 504, GHC 450 and GHC 404 respectively.

The survey recorded a total of 99 timber species at all the domestic markets in the country. These timber species have been grouped under three utilization categories with their monthly stock volumes recorded. Six (6) timber species that are available in all the regions include Odum/ Iroko & Wawa/Obeche (premium species), Ofram & Kyenkyen (commercial species) and Onyina &

Nyamedua (LUS). On the other hand, the ten (10) timber species out of the 99 that are mostly traded or harvested, processed and supplied to the domestic markets have been recorded. Bush cut wood products stocked per month are extracted from 94 timber species while those of sawmills is 54. The number of dimensions recorded from the three timber products is 194 with the breakdown as follows: Beams – 23; Boards – 52 and Lumber – 119.

4.2 Recommendations

The study recommends that: 1. Research into the utilization of lesser-used and lesser-known timber species should be pursued, as a matter of urgency, in order to introduce more of such timber species onto the timber market. 2. Dimensions of timber products nationwide should be standardized to promote easy management of the trade and its sustainability. 3. Recognized timber merchants associations should be encouraged and or supported to go into plantation establishment to sustain the timber resource base. 4. The three major measures as the way forward by which legal lumber could be supplied to the domestic market should be thoroughly discussed and fine-tuned at multi-stakeholder dialogue meetings for effective implementation.

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