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Processing and utilisation of trees on farmlands and logging residues through collaboration with local communities

TECHNICAL REPORT

BY

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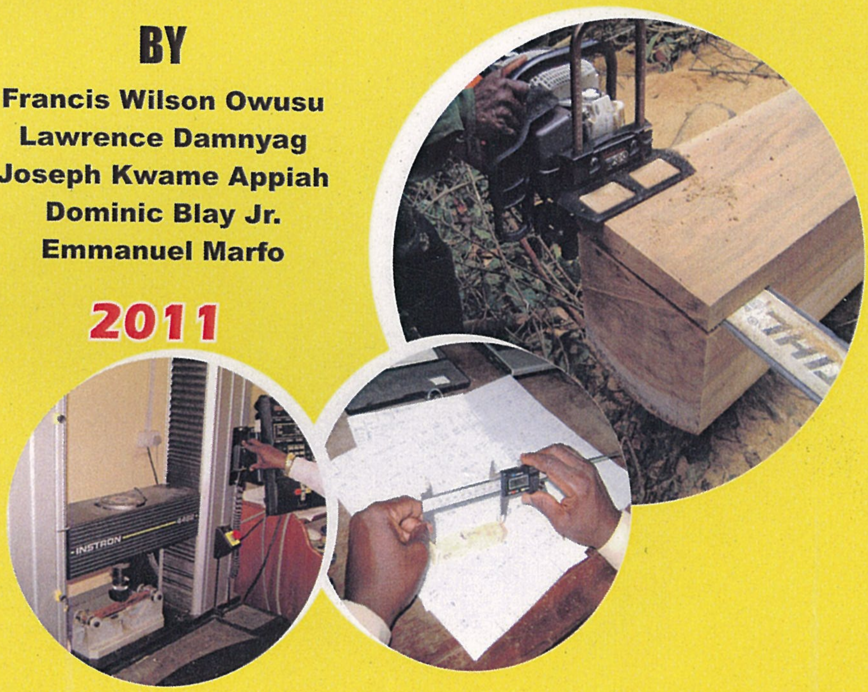

PROCESSING AND UTILISATION OF TREES ON FARMLAND AND LOGGING RESIDUES THROUGH COLLABORATION WITH LOCAL COMMUNITIES

PD 431/06 Rev. 1(1)

REPORT

BY

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Preface

This proposal originated from an ITTO Pre-project (PPD39/02 (I)) which was aimed at determining the social acceptability, economic viability and environmental impact of collecting and processing logging residues by local communities with collaboration of the local timber industry. During the implementation of this project, some members of the local communities (both beneficiary and non-beneficiary communities) expressed the desire for trees on their farmlands to be extracted and processed into lumber. Their main reason was that timber companies who operate on their farmlands do not pay any compensation to them for the crops they destroy during their activities. Because of this some of the farmers were either burning timber trees on their farms or felling them to rot since there is no definite policy on the extraction of trees on farmlands by communities. Meanwhile these communities travel to the cities to acquire timber for their constructional purposes and the manufacture of school / room furniture. So having been successful in the pre-project, the local communities requested for a full project which will consider the processing, utilisation and marketing of not only logging residues but trees on their farmlands from which they can derive some revenue .

In the face of dwindling natural forest resources, the efficient utilization of timber resources is a priority. Illegal chainsaw milling activities, which have become a lucrative venture, especially in local indigenous forest dependent communities, is noted to have an unfriendly environmental effect in addition to low lumber yield, high risk of operation and subject to unsustainable forest management. All attempts made by successive governments in Ghana to stop this illegal lumbering has not been successful rather it is on the ascendancy. There is therefore the need to introduce an improved chainsaw milling machines that will minimize the negative aspect of the chainsaw milling operations that also make lumber available to the local communities for use. Hence this project, which has established the efficiency of the logosol machine as well as the techniques in operation. Again, processing of trees on farmlands by the local communities with the improved chainsaw milling machine (ICSM) could have a positive impact on their livelihoods when it well managed. This technical report presents the results of study on this project entitled "Processing and Utilization of Trees on Farmland and Logging Residues through Collaboration With local Communities"

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CHAPTER 1

PROCESSING OF TREES ON FARMLANDS AND GRADING OF LUMBER GENERATED

Abstract

Trees on farmlands in the Central and Western regions of Ghana where the pre-project was undertaken were selected. Off-reserved farmlands that were conflict-free and had not been given to concessionaires in the forest districts of the two named regions were considered for selection as project sites. Trees on the farmlands of these communities were then inventoried by a team of personnel from Forestry Services Division (Forestry Commission), Forestry Research Institute of Ghana and the local Communities. The findings from the inventory enabled the Project Team to select six communities (Twifo-Kyebi, Japa, Gyaman (Nsupunu/Dadieso), Nsabrekwa, Dominase and Ankasie) as project sites. From the inventory results farmers who had three or more trees of commercial species in their farms, were selected as beneficiaries from each community. With the help of a tree spotter in a community, two of the trees per each beneficiary farmer were felled using the required felling techniques. The butt and top diameters and length of each bole (from butt to first canopy level) were taken and recorded. Lengths of logs ranging between 1.0m and 5.0m (depending upon the quality of the log) were measured and crossed cut. The logs were milled, one after the other, using logosol chainsaw with milling attachments. The time for milling each log/bole was recorded as well as the petrol and engine oil used. Dimensions of each lumber generated (thickness, width and length) were taken at two points near the ends and lumber volumes determined. The quantity of lumber obtained per log or per tree was also recorded. These were then stacked. A total bole volume of 961.9 m^3 was obtained of which 763.4 m^3 of logs was recovered. Therefore a percentage log yield of 79.4 was estimated. One hundred and twenty-six (126) trees were felled from farmlands, which consisted of 13 economic timber species, including Odum, Mahogany spp, Edinam, Ofram, Dahoma, Essia and Cedar. The four most abundant timber species felled were Ofram, Essia, Wawa and Emire in descending order. The recoveries of the logs for the thirteen species and hence their residues have been established. The percentages of log yield generated at the communities varied from 76% - 86.7% with the residues recording 13.3% – 24%. The logosol system has successfully been used to convert logs of hardwood species of

densities ranging between 380 kg/m^3 and 800 kg/m^3 into lumber. The quality of the lumber generated was equivalent to that produced by conventional milling facilities. The lumber pieces produced from the 126 tree was 10,128 and the machine effective time, petrol and oil used were 817 hours, 3,727.8 litres (828.4 gallons) and 1,994.0 litres (443.1 gallons) respectively. An average of 80 pieces of lumber was obtained per bole of a tree. The quantity of lumber pieces generated at each community ranged between 535 and 2,348. Farmers who benefited from the lumber generated have expressed the desire to nurture trees on their farmlands as there is hope for the marginalized communities.

With the lumber pieces graded (10,128), 89.5% was estimated as first and second grades, 8.1% grade three and 2.4% with the fourth grade. The lowest quality of lumber grade (fourth grade) at all the communities also ranged from 2.0% to 4.5% of the total lumber graded. Generally the first grade level recorded higher numbers of lumber than the second grade. Lumber from logging residues obtained from three communities (Dominase, Nsabrekwa and Abesewa Gyaaman) were from nine species (both primary and lesser-used species). A total of 1,483 lumber pieces were obtained and graded into second, third and fourth grade levels, which was made up of 698, 693 and 92 respectively. The quantities of lumber recorded for the fourth grade (as percentage of the total lumber) at the three communities ranged between 5.6 and 18.5%. These are clear indications that logging residues is a good resource to be re-considered for utilization especially at the local level, hence policy guidelines to make its extraction, processing and utilization a reality.

CHAPTER 1.1

PRODUCTION OF LUMBER FROM TREES ON FARMLANDS AND LOGGING RESIDUES AT SIX COMMUNITIES IN THE CENTRAL AND WESTERN REGIONS OF GHANA

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Background

During the implementation of a pre-project funded by ITTO, some members of the local communities (both beneficiary and non-beneficiary communities) expressed the desire for trees on their farmlands to be extracted and processed into lumber. Their main reason was that timber companies who operate on their farmlands do not pay any compensation to them for the crops they destroy during their activities. Again, the benefits do not get to the farmers who cater for the trees concessionaires extract. Because of this, some of the farmers either burn timber trees on their farms or fell them to rot since there is no definite policy on the extraction of trees on farmlands by communities. Meanwhile these communities travel to the cities to acquire timber for their constructional purposes and the manufacture of school / room furniture. Therefore processing trees on their farmlands will help them derive some revenue.

The project PD 431/06 titled "Processing and Utilization of Trees on Farmlands and Logging Residues through Collaboration with Local Communities" was also funded by the International Tropical Timber Organization (ITTO) and implemented by Council for Scientific and Industrial Research (CSIR)-Forestry Research Institute of Ghana (FORIG). The specific aim was to increase timber products thereby generating employment and income to local communities and some individual farmers. The quantities of trees, logging residues generated during industrial logging, the lumber generated and the facilities for milling are indicators of the sustainability of the project. The overall development objective is to increase the benefits that local communities derive from forest resources and thereby enhance their contribution to sustainable forest management. The specific object is to promote processing of logging residues and trees on farmlands and thereby provide increased timber products as well as generate employment and income to local communities and some individual farmers.

With local communities being major stakeholders who benefit from the forest resources, the specific object focuses on working with them to extract, process and utilise lumber and lumber products from logging residues and trees on farmlands, which will give them the confidence and the zeal to assist in the sustainable management of the Ghanaian forest. The successful implementation of the activities could serve as a demonstration of which other communities could learn from thereby becoming continuous beneficiaries of the forest.

The report gives some background on the forest resources of Ghana and its depletion rate, the timber industry & milling technologies in Ghana and conversion of timber. The felling of trees on farmlands, milling of logs & logging residues using logosol facilities, the lumber generated, lumber production rate and the fuel consumption rate. Lastly conclusion and recommendations have been given.

Introduction

The contribution of Ghana's Forest resources to rural livelihoods and to the rural economy cannot be over emphasized. These are necessary for the development and future prosperity of Ghana. Reports indicate that the Forestry Sector contributes about 6% of the country's gross domestic product (GDP), employs about 100,000 people and provides direct and indirect livelihood to about 2.5 million people in the country (DFID, 2007a, 2007b; Forestry Commission, 2003; MLF, 1997/9, cited in Brown, 1999; Asiseh *et al*, 1996; TEDB, 1995).

Notwithstanding these, the depletion of the forest zones in Ghana has reached its alarming state, which are attributed to various human activities such as farming, surface mining, bushfires, charcoal burning, constructional projects, logging and illegal chainsaw milling (Forestry Commission, 2003). The report continues that during the last century, the area of high forest dwindled from 8.2 million hectares to about 1.6 million hectares with an average annual deforestation rate of 65, 000 hectares. According to Agyeman (2004) illegal chainsaw operation is one of the major factors that have been contributing towards the rapid decline of forest resources in Ghana. The impact of deforestation in Ghana is widespread, affecting the livelihoods of local people and disrupting the tropical ecosystem.

The survival for majority of people in the developing countries is the possession and use of the natural resources. Birgegard (1993) and Lawry (1990) have reported that the control and use of land and other natural resources have been the way to sustain the family or the household.

In Ghana the timber industry is made up of three categories whereby industrial processing is undertaken. These include primary processing (mainly logging and harvesting), secondary processing (the break down of logs into lumber using the sawmilling machines or into veneer using a rotary or slicing machine or reconstituting the veneer into plywood using ply mill machines) and tertiary processing (this involves the conversion of lumber or any reconstituted wood into semi-finished or finished products). In Ghana the numbers of primary, secondary and tertiary categories of the industry are 250, 160 and 66 respectively. Table 1 gives an overview of sawmills and bush/mobile mills in Ghana. The sawmills are concentrated in Ashanti, Western and Eastern regions while bush/mobile mills are mostly found in Brong Ahafo and Ashanti regions.

Table 1: Distribution of sawmills in the administrative region in the forest zone

Region	No. of sawmills	No. of bush/mobile mills
Ashanti	64	4
Western	24	2
Eastern	14	1
Brong Ahafo	4	12
Central	2	1
Volta	1	-
Greater Accra	1	-
Total	110	20

Source: *Asamoah Adam and Duah-Gyamfi (2009)*

Technologies for converting timber into lumber in the so-called primary processing have evolved from the manual pitsawing to modern sawmills which used electric powered sawing machines (Asamoah Adam & Dua-Gyamfi, 2009). The report continues that the two sawing techniques that dominate the primary processing of wood in Ghana are the electric-powered bandsaws used in conventional sawmills and portable chainsaws used by chainsaw operators. Chainsaw milling (CSM) has been described as destructive and wasteful.

Measures that have been put in place in banning the CSM operation have not yielded the required results. Therefore promotion of the use of improved CSM (chainsaw with milling attachments) and mobile milling machines is imperative. Among some determining factors for their better promotion is the efficiency of the machines/devices. Again, such machines should be comparable to conventional mills in terms of cost of investment, employment and profit flows, processing cost and relevance with respect to supplying domestic market.

Incremental improvements in the milling of logs by replacement of obsolete machines, improved sawing pattern and flow through the mill, better maintenance practices, reduction in saw kerf and sawing variation will improve volume conversion/efficiency (Walker, 1993).

In-situ milling of logs has some advantages over that of the conventional methods. These include the avoidance of the construction of logging roads and camps, skidding and log yard operations and haulage (transportation of logs from the forest to the mill). Ofori *et. al.* (1993) in ITTO Project PD 74/90 established that for every tree that is felled in Ghana, 50% of the tree volume is left in the forest in the form of branch wood, crown wood and stumps. This will be reduced when logs are processed at the site where they are felled.

Conversion of timber is the process of sawing logs into square edged pieces suitable for use by carpenters, joiners, cabinet makers. Walton (1974) reports that logs are converted into commercial sizes as soon as possible after the tree has been felled to minimize shrinkage damage. The methods of converting logs vary according to the class of timber, the quality and sizes of the logs, the effect of shrinkage and seasoning of some timbers and market requirements (Walton, 1974)

Sawing patterns

Sawing patterns interact unpredictably with log form and size. It has been reported that there is no sawing method for all logs. The four basic sawing patterns are live-sawing, sawing around, cant-sawing and quarter-sawing. Sawing around and quarter-sawing are only appropriate for large logs of diameter more than 50cm while quarter-sawing is used rarely with softwoods. In general cant-sawing gives higher volume yields than live-sawing (Hallock *et al,* 1976). This is because in cant-sawing some of the taper in the cant can be recovered as short boards whereas in live-sawing this taper is lost as edgings.

Methods

Inventory

Trees on farmlands in the Central and Western regions of Ghana where the pre-project was undertaken were selected. Off-reserved farmlands that were conflict-free and had not been given to concessionaires in the forest districts of the two named regions were considered for selection as project sites. Trees on the farmlands of these communities were inventoried by a team of personnel from Forestry Services Division (Forestry Commission), Forestry Research Institute of Ghana and the local Communities. The findings from the inventory enabled the Project Team to select six communities (Twifo-Kyebi, Japa, Gyaman (Nsupunu/Dadieso), Nsabrekwa, Dominase and Ankasie) as project sites.

Felling of trees on farmlands

Before felling and processing of trees on farmlands began, a mini-durbar chaired by the paramount chief of Wassa Amenfi, was held at Wassa Akropong. This offered the Project team the opportunity to officially hand over the acquired logosol facilities to the selected local communities to begin the project. In attendance were a member of Council of State of the President of Ghana, Forest Managers of Western and Central Regions, District Forest Managers in charge of Asankragwa and Dunkwa on-Offin (where the projects were located), District Chief Executive at Wassa Amanfi, trained logosol machine operators (14), 3 supervisors of the machine operators (representatives of the project team at the local level), representatives from the six local communities of the project sites, the press and the general public.

The six project sites (Twifo-Kyebi, Japa, Gyaaman (Nsupunu/Dadieso), Nsabrekwa, Dominase and Ankasie) were divided into three Blocks (B), which consisted of: B1 – Twifo-Kyebi and Japa; B2 – Gyaman (Nsuopunu/Dadieso), B3 - Nsabrekwa, Dominase and Ankasie. Blocks 1 & 2 were made up of four logosol machine operators while Block 3 consisted of six operators.

From the inventory results farmers who had three or more trees of commercial species in their farms, as figure 1A depicts, were selected from each community. With the help of a tree spotter in a community, two of the trees per each beneficiary farmer were felled using the required felling techniques (Plates 1 & 2). The butt and top diameters and length of each bole (from butt to first canopy level) were taken and recorded. Lengths ranging between 1.0m and 5.0m (depending upon the quality of the log) were measured and crossed cut. The same dimensions were also taken for each log.

Plate 1: Beneficiary's farmland

Plate 2: Application of felling techniques

The logs were milled, one after the other, using logosol chainsaw with milling attachments. Plates 3-6 show the logosol chainsaw machines, the Basic mill facilities, some logosol accessories and aluminium rail. A Logosol product, Bigmill mobile system, is a sawing system with a well thought outline of components making it possible to extend and suit the sawing equipment to a particular need. This system is available in four packages, which include Big mill timmerjig as shown in Plate 3 (mills log diameter of maximum 60cm) with one mounted on a chainsaw, Big mill Basic, Plate 8 (mills log diameter of maximum 80cm), Big mill PRO see Plates 4, 6 & 7 (mills log diameter of maximum 135cm) and Big mill LSG (mills log diameter of maximum 135cm) as shown in Plate 4. The first two systems aim at sawing normal-sized logs while the last two are used to saw oversized logs. Most of the components are the same for the different systems and can thereby be used for different applications. All the aluminium components have been anodized to offer a smooth, hard surface. Some of the steel components are treated with nitrogen gas and hardened in oil, which gives the steel increased corrosion resistance, higher durability, low friction and a characteristic black colour. The logosol with the three frame attachments also has an aluminium rail (Plate 6) on which the machine moves during initial milling.

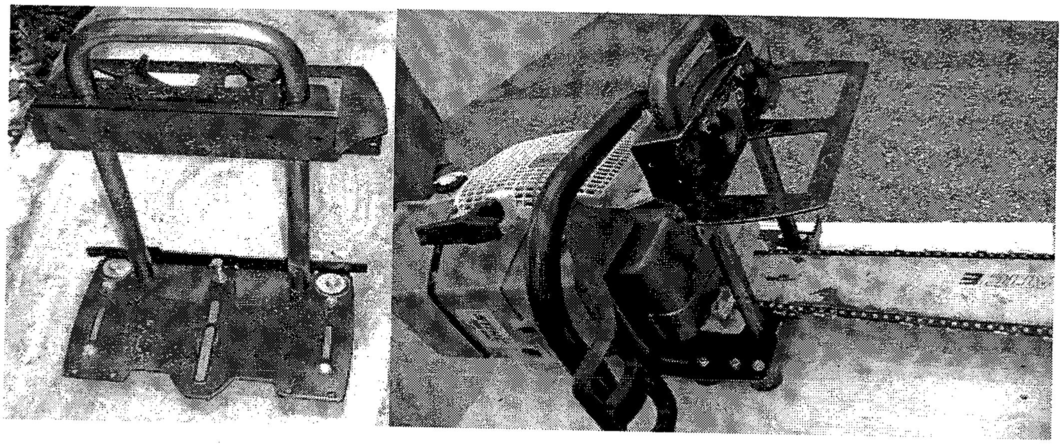

Plate 3: Timberjigs with one mounted on a chainsaw

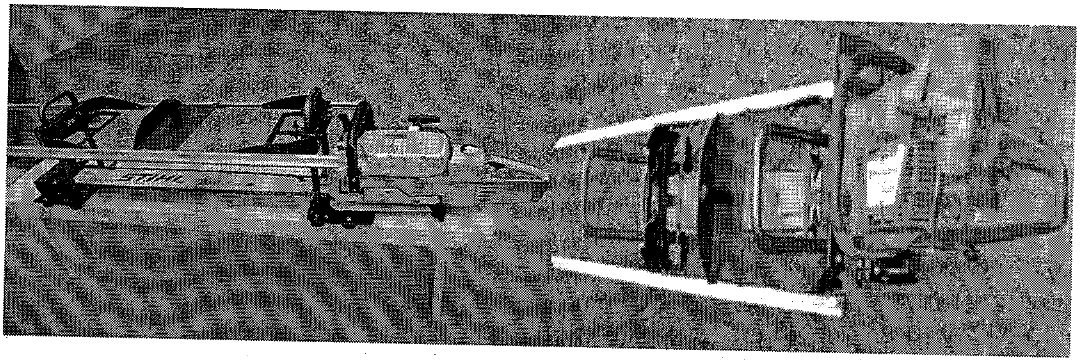

Plate 4: Bigmill PRO & LSG

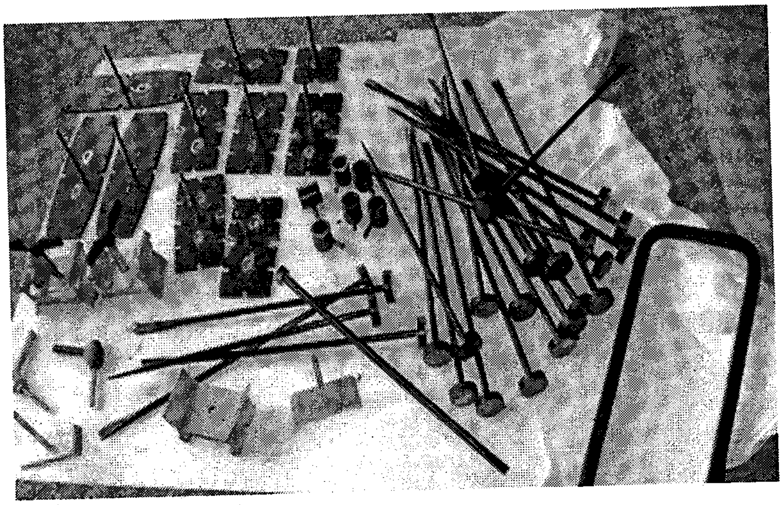

Plate 5: Some accessories of Bigmill system

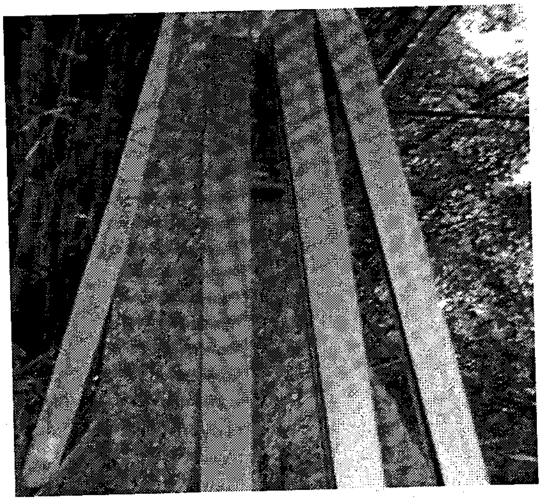

Plate 6: Logosol rail

The time for milling each log/bole was recorded as well as the petrol and engine oil used. Dimensions of each lumber generated (thickness, width and length) were taken at two points near the ends for lumber volumes to be determined. The quantity of lumber obtained per log or per tree was also recorded. These were then stacked, as seen in Plate 9 to avoid rot and other drying defects as the lumber pieces waited for carting to a drying shed.

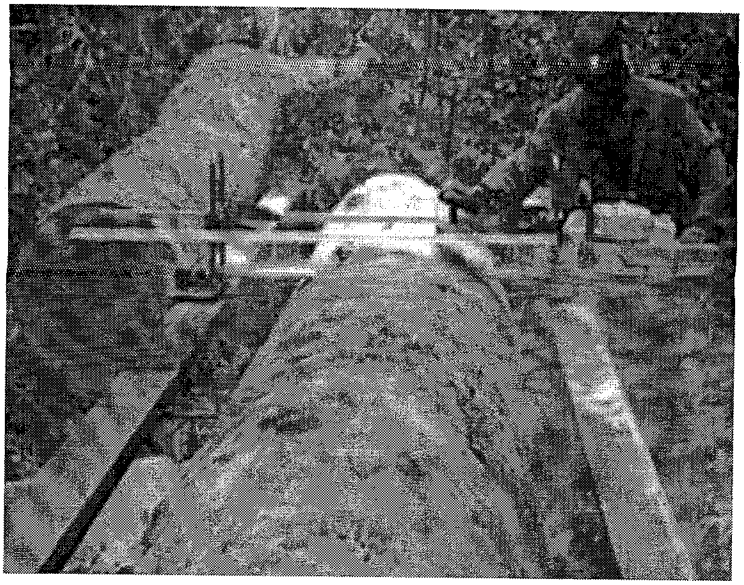

Plate 7: Milling with Bigmill PRO

Plate 8: Milling with Bigmill Basic

Plate 9: Logosol milled lumber

Dimensions of some logging residues (Plate10) from a logged concession at Abesewa Gyaaman and those obtained from the trees on farmlands, as shown in Plate 11, (in log form) were taken as before and subjected to milling using the method as described above. Data was collected and analyzed.

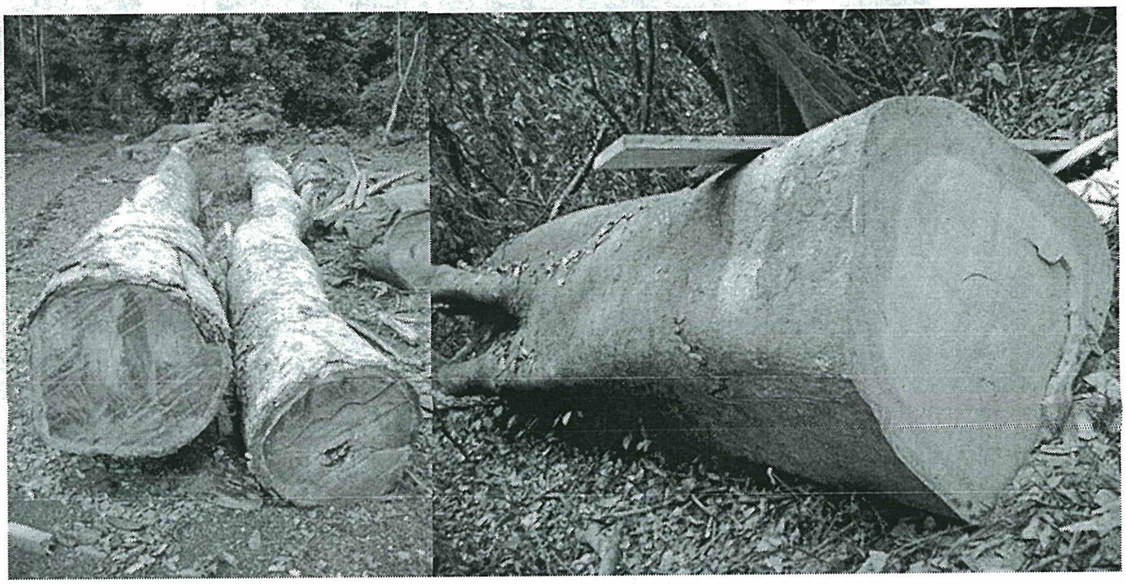

Plate 10: Residues from conventional milling

Plate 11: Residue from logosol milling

Results

Inventory

Three hundred and fifteen (315) pieces of farmlands were visited of which about 40 economic timber species were inventoried. The total number of trees was 1800. The diameter at breast height ranged from 30 – 150 cm and the most occurring dbh are in the regions of 50 – 90. However most trees species had about 70 cm dbh. The highly abundant species were found to be Ofram, Wawa, Sinuro, Esia, Emire, Otie, Ceiba and Odum.

Extracted trees and lumber production

The number of trees felled per community as shown in Figure 1 ranged from 10 to 30. A total of 126 trees were felled, hence an average of 21 trees per community. Figure 1 indicates that the highest number of trees felled occurred at Nsabrekwa (30) followed by Dominsae (27), Gyaaman (25), Ankasie (20), Japa (14) and Twifo-Kyebi (10). The number of trees felled was due to the cooperation of the community, rate of operation of the field staff and the working distance of the operators from their residence. A total of 13 different species (ranging from primary to lesser-used timber species, according to FIP, 1989 classification) were felled (Fig. 2)

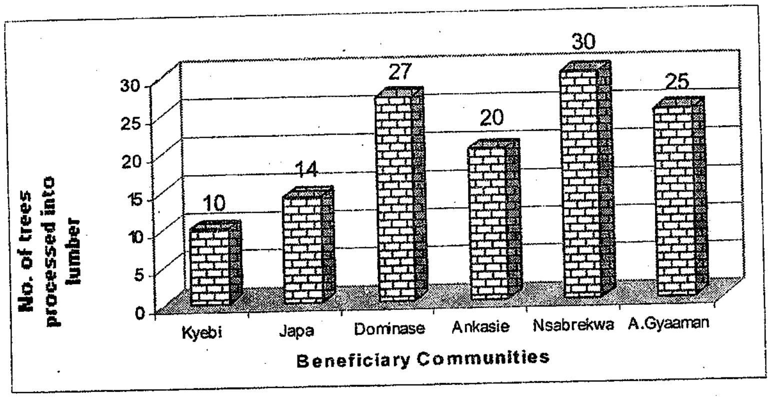

Figure 1: Timber trees processed at beneficiary communities

Figure 2 shows the number of trees extracted per timber species. The first three timber species that recorded the highest number of trees felled were Ofram (29), Essia (26) and Wawa (18) while the least was Cedar. This indicates the type of species that are mostly found on farmlands within the communities operated.

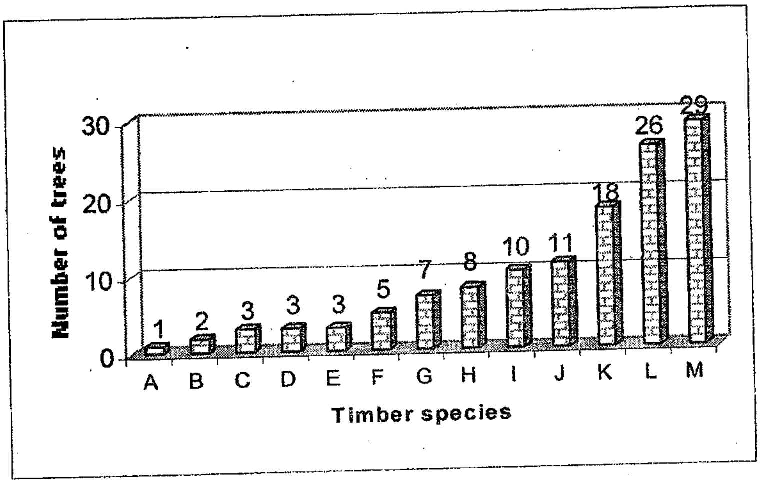

Figure 2: Commercial timber species and the quantity of trees felled

Species: *Cedar (A), Awiemfosamina (B), Sapele (C), Odum (D),Brown mahogany (E), Dahoma (F), Edinam (G), Avodire (H), Danta (I), Emire (J), Wawa (K), Essia (L), Ofram (M)*

The volume of each bole of a tree was determined per community, hence the total volume for every species and community as shown in Table 2. Ofram and Cedar recorded the highest (266m^3 & 206.8m^3) and least (17.8m^3 & 15.8m^3) volumes of boles and & logs respectively and that the total volumes of boles and logs were respectively determined as 961.9m^3 and 763.4m^3. The first two localities that registered the highest volumes of boles were Nsabrekwa (244m^3) and Ankasie (242.5m^3) but recorded same volume of logs (192.1m^3) while the lowest volumes of boles and logs obtained from Twifo-Kyebi were 53.5m^3 and 43.7m^3 respectively. It was observed that apart from Japa and Twifo-Kyebi, the volumes of boles obtained from each community were not dependant on the number of trees felled but rather on the quality of trees/boles. Therefore among Gyaaman, Dominase, Ankasie and Nsabrekwa communities the best quality of trees/boles was comparatively obtained from Ankasie (Fig. 1 and Table 2). The community recorded a volume of 242.5 from 20 trees/boles, which is the least number of trees amongst the four). The percentages of log and residue yield ranged from 76.0 to 86.7 and 13.3 to 24.0 respectively.

Table 2: The total volumes of boles and logs for the 13 species and the localities from which they were extracted

Species	Total bole volume m^3	Total log volume m^3	Locality	Total bole volume m^3	Total log volume m^3
Wawa	185.5	153.0	Gyaaman	102.9	89.2
Dahoma	46.4	38.6	Japa	82.1	66.4
Edinam	58.4	42.7	Kyebi	53.5	43.7
Danta	30.9	23.3	Ankasie	242.5	192.1
Avodire	21.4	20.2	Dominase	236.7	179.9
Essia	149.4	118.1	Nsabrekwa	244	192.1
Ofram	266.0	206.8	Total volume	961.7	763.4
Emire	85.7	66.6			
Mahogany	23.0	16.7			
Cedar	17.8	15.8			
Sapele	25.6	20.2			
Odum	30.9	23.3			
Awiemfo	20.8	18.2			
Total volume m^3	961.9	763.4			

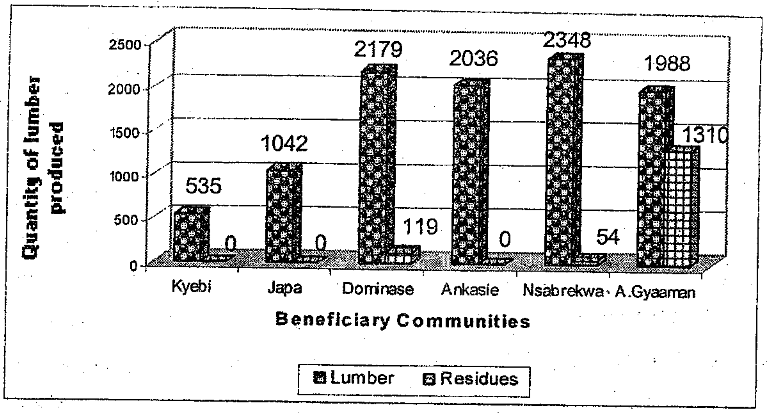

Figure 3: Lumber generated by field operators at the six communities

The number of lumber pieces obtained from the six communities was 10,128 while those obtained from logging residues was 1,483 totalling 11,611 pieces. These were into dimensions (that is thickness and width in centimeters) of 5.1x7.6; 5.1x10.2; 5.1x15.2 and 5.1x30.5. From Figure 3 the lumber pieces obtained from each of the beneficiary communities ranged from 535 (Twifo-Kyebi) to 2,348 (Nsabrekwa). This indicates that more lumber was generated at Nsabrekwa than the rest of the communities and the least was Twifo-Kyebi. Higher quantities of lumber obtained from Nsabrekwa, Dominase, Ankasie and Abesewa Gyaaman was as a result of their cooperation and commitment towards the project in addition to the dimensions of the trees and the defects developed in the boles/logs. Generally an average of 80 pieces of lumber was obtained from each tree in every community.

Analysis of the results also indicate that the quantity of lumber obtained from each of the species per tree as shown in Figure 4, does not follow the same pattern as the number of trees extracted per species Figure 2). Although it does not conform to a particular trend, the species that are rarely found on farmlands, like Cedar, generated more lumber per tree than those that are easily available, like Ofram, Essia and Wawa. Hence Cedar and Avodire timber species generating high and low quantities of lumber respectively.

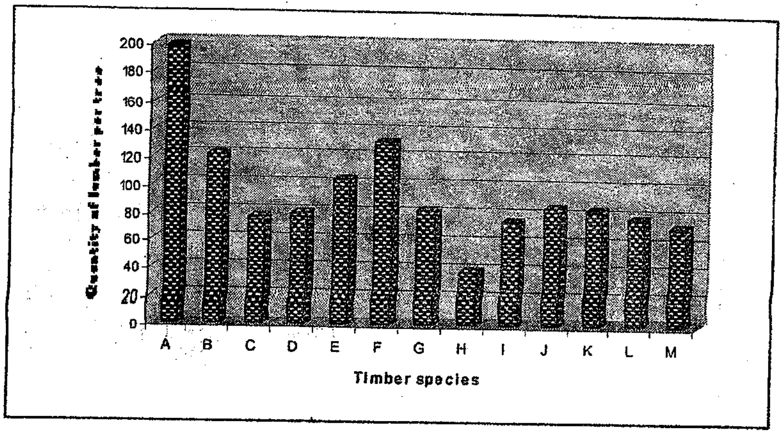

Figure 4: The lumber produced from each species per tree

Species: Cedar (A), Awiemfosamina (B), Sapele (C), Odum (D), Brown mahogany (E), Dahoma (F), Edinam (G), Avodire (H), Danta (I), Emire (J), Wawa (K), Essia (L), Ofram (M)

A total of 828.4 gallons (3,727.8 litres) of petrol and 443.1 gallons (1,994.0 litres) of engine oil were used in processing the trees to obtain the said quantities of lumber (10,128). Therefore one piece of lumber was produced using 0.36 and 0.19 litre of petrol and engine oil respectively. Alternatively, 12 pieces of lumber were produced using 4.5 and 2.4 litres of petrol and engine oil respectively. Figure 5 shows the petrol and engine oil used per community for the production of 10,128 pieces of lumber. Petrol and engine oil consumptions were higher at Ankasie and Abesewa Gyaaman respectively (Figure 5). Generally the quantity of engine oil used is estimated to be 53% of the petrol consumption hence a ratio of approximately 1:2.

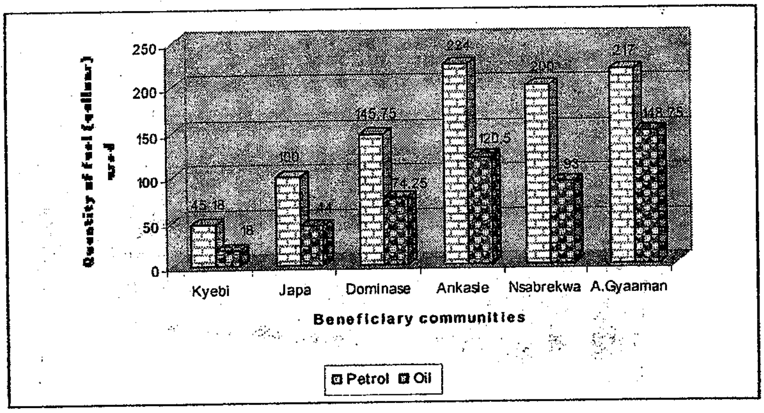

Figure 5: Fuel used for the production of lumber at six communities

The actual machine time (which excludes machine down time) was 820.41 hours hence about 12 pieces of lumber were produced in one hour. The machine operators at Ankasie spent 32% of the total time to produce 2,036 pieces of lumber while those at Nsabrekwa used 30% of the time to generate 2,348 pieces of lumber (figure 6). The time spent at Abesewa Gyaaman was 11% while Japa and Twifo-Kyebi communities recorded 5% each for the lumber pieces generated. This means that the operators at Nsabrekwa performed better than those who operated at the other communities. This might be due to their fast adjustment in the handling of the logosol Big mill facilities that were used in milling the timber. The lumber recovery rate was between 6% to 10% more with logosol facilities than freehand chainsaw and small-scale sawmill lumber recovery of 40% in Ghana (Gyimah and Adu, 2009 and Frimpong-Mensah, 2004).

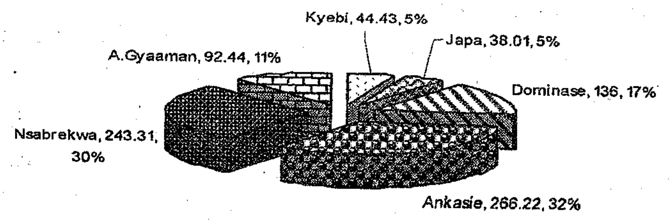

Figure 6: Machine engagement time (hrs) in producing lumber at six communities

The logging residues were only extracted from Abesewa Gyaaman, Nsabrekwa and Dominase communities. This is because the species felled did not have sizeable branches for utilization while utilizable buttressed logs were considered as normal boles. A total of 1,483 pieces of lumber from logging residues were generated of which 159.1 hours was spent in processing while 171.9 and 85 gallons of petrol and engine oil respectively were used. The highest quantity of lumber, which is 1,310 was obtained from Abesewa Gyaaman with the least (54) from Nsabrekwa. The species from which the logging residues were generated included Danta, Wawa, Dahoma, Avodire, Sapele, Mahogany, Emire and Awiemfosamina.

Conclusion

A total bole volume of 961.9 m^3 was obtained of which 763.4 m^3 of logs was recovered. Therefore a percentage log yield of 79.4 was estimated. One hundred and twenty-six (126) trees were felled from farmlands, which consisted of 13 economic timber species, including Odum, Mahogany spp, Edinam, Ofram, Dahoma, Essia and Cedar. The four most abundant timber species felled were Ofram, Essia, Wawa and Emire in descending order. The log recoveries for the thirteen species and hence their residues have been established. The percentages of log yield generated at the communities varied from 76% - 86.7% with the residues recording 13.3% – 24%

Bigmill logosol system has successfully been used to convert logs of hardwood species of densities ranging between 380 kg/m^3 and 800 kg/m^3 into lumber. The quality of the lumber generated was equivalent to that produced by conventional milling. The lumber pieces produced from the 126 tree was 10,128 and the machine effective time, petrol and oil used were 817 hours, 3,727.8 litres (828.4 gallons) & 1,994.0 litres (443.1 gallons) respectively. An average of 80 pieces of lumber was obtained per tree/bole. The quantity of lumber pieces generated at each community, in ascending order are (Twifo-Kyebi), 535 (Japa), 1,998 (Abesewa Gyaaman), 2,036 (Ankasie), 2,179 (Dominase) and 2,348 (Nsabrekwa). Farmers who benefited from the lumber generated have expressed the desire to nurture trees on their farmlands as there is hope for the marginalized communities. It is hoped that this will encourage farmers to conveniently adopt agro-forestry practices in order to help sustain the management of the Ghanaian timber species.

EVALUATION AND GRADING OF LUMBER PRODUCED FROM TREES ON FARMLANDS AND LOGGING RESIDUES AT SOME COMMUNITIES IN THE CENTRAL AND WESTERN REGIONS OF GHANA

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Introduction

Lumber or timber is wood that is used in any of its stages from felling through readiness for use as structural material for construction, or wood pulp for paper production. Lumber is produced and supplied either rough (nominal lumber) or finished/planed (dimensional lumber). Besides pulpwood, rough lumber is the raw material for furniture-making and other items requiring additional cutting and shaping. Finished lumber is produced and supplied in standard sizes, mostly for the construction industry.

Timber and lumber are used interchangeably. In some countries like Austrialia and the United Kingdom timber is a term also used for sawn wood products (boards), while in the United States and Canada, the product of timber cut into boards is referred to as lumber. lumber. It is often referred to the wood contents of standing, live trees that can be used for lumber or fibre production.

Defects occurring in Timber are grouped into conversion defects (chip mark, diagonal grain, torn grain, fuzzy grain, and wane); fungi (when lumber moisture content is above 20%, the environment is warm enough and there is air. Some fungi defects in lumber include blue stain, brown rot, dry rot, heart rot, sap stain, wet rot and white rot); insects (beetles, marine borers, termites and red ants); natural forces (abnormal growth and rupture of tissues) and seasoning (splinters and slivers) (ATBIT, 1982, FPL (1983) and Guiscafre (undated)).

Lumber is graded or classified according to its quality and uses. These depend on the defects which may affect the strength and or appearance of the lumber. The permissible defects in each grade are determined by their size, frequency and position in the lumber (ATBIT, 1982, FPL (1983) and Guiscafre (undated)). Grading helps the timber merchant to fix prices according to quality and thus the buyer can select the grade which will be suitable for his requirements. Hence grading is to determine the quality of a piece of wood.

The main aim was to assess the quality of lumber generated from trees on farmland and logging residues using logosol milling facilities. The specific objectives were to: 1) evaluate and grade the machining quality of lumber generated from trees on farmland and logging residues after milling with logosol facilities and 2) determine the major defects on species basis.

Materials for lumber grading

The materials used for the grading of lumber generated at the six local communities included SATA grading rules (An internationally recognized grading rules for lumber), steel measuring tapes and electronic veneer calipers for taking measurements, markers for making marks on lumber, note book and pen for taking records

Methods of grading lumber

In grading the lumber generated by the field operators at the six project sites, SATA grading rules that are used in Ghana in grading lumber was used. Four grade levels (1st, 2nd, 3rd, 4th) were considered. The criteria used were generally based on clear cuttings (a cutting free of defects though some defects may be tolerated in certain grades and for particular timber species) and cutting units (the surface area of a cutting of 0.25 metre long by 0.025 metre wide. Where this area is free of all defects it is conventionally known as unit of clear cutting (UDN). Hence the minimum size, minimum defects and minimum percentage grade as shown in table 3.

Table 3: Condition for grading lumber using SATA grading rules

Grade	Minimum lumber size	Minimum cuttings sizes	% grade type	Minimum UDN
First	Length: 2.25m Width: 0.15m	6x4 8x3	90	129
Second	Length: 2.25m Width: 0.125m	5x3 4x4	80	115
Third	Length: 1.75m Width: 0.1m	4x3 3x4	60	86
Fourth	Length: 1.75m Width: 0.1m	-	-	-

Each lumber was graded by identifying the defects, taking measurements of defects and the thickness, width & length of boards. Grading was undertaken on species basis for each of the six communities. The percentage of the quantity of lumber under each grade was computed. The total percentages of both the first and second grades have been classified into:

Class I - having a grade more than 85% of the lumber graded (Excellent grade).
Class II – having 70-85% of the lumber graded (Very good grade).
Class III – having 45 – 69% of the lumber graded (Good grade).
Class IV – having below 45% of the lumber graded (Fair grade).

Results and Discussions

The results generated after grading the lumber at the six sites are shown in Tables 4-9 while Table 10 is the summary results of the lumber graded at the local communities. Lumber pieces were obtained from both primary species (are species that are very popular and frequently exported and also used locally) and lesser-used timber species (timber species, which show promising market potential with high standing volumes, strategically positioned as a substitute to primary commercial species, potentially of high value and have been exported at least once since 1973).

From Table 4, four species were milled and a total of 535 lumber pieces were generated at Twifo-Kyebi. The quantity of lumber graded second was more than that graded first. Some of the Emire and Ofram trees were defective hence the low grade hence a higher score for the second grade level. The percentage score for first grade was 31.2 as against 40.7, 23.6 and 4.5 for second, third and fourth grades. The first and second grades constituted 71.9% of the total lumber graded, hence classified as very good grade (class II). None of the Mahogany lumber pieces was given grade four, therefore the trees of the species as well as the milling qualities were good.

Table 4: The degree of quality of lumber generated at Twifo-Kyebi

Species	Lumber from trees on farmland				
	Quantity	First grade	Second grade	Third grade	Fourth grade
Emire	78	10	45	15	8
Ofram	368	127	135	92	14
Brown mahogany	34	10	20	4	0
Essia	55	20	18	15	2
Total	**535**	**167**	**218**	**126**	**24**

Table 5 shows the results of lumber graded at Japa. Three species consisting of 14 trees were felled and processed into lumber, the quantity of which was 1,042 pieces. The quantity of first grade lumber was 513 as against 404 of second grade representing 49.2% and 38.8% respectively a total percentage of 88. The lumber in this case falls under class I category (good quality grade). Higher quantity of first grade lumber was obtained for the species except Ofram of which the second grade was more than the first grade (Table 5).

Table 5: The degree of quality of lumber generated at Japa Community

Species	Lumber from trees on farmland				
	Quantity	First grade	Second grade	Third grade	Fourth grade
Dahoma	153	98	51	4	0
Essia	799	383	309	82	25
Ofram	90	32	44	10	4
Total	**1042**	**513**	**404**	**96**	**29**

The total lumber generated from Ankasie community and graded from first-fourth has been shown in Table 6. Seven timber species were extracted and a total of 20 trees were felled and processed into lumber. A total of 2,036 pieces of lumber was obtained. The quantity of lumber graded decreased first grade (1,008) to the fourth (42). The total percentage of lumber graded as first and second was 91.1% and therefore classified as superior or excellent grade (class I). This shows that the trees on farmlands at Ankasie were well nurtured hence defects were minimal.

Table 6: The degree of quality of lumber generated at Ankasie Community

Species	Lumber from trees on farmland				
	Total lumber	First grade	Second grade	Third grade	Fourth grade
Wawa	418	203	154	47	14
Cedar	198	99	78	21	0
Ofram	508	221	257	22	8
Odum	240	207	32	1	0
Edinam	322	136	155	20	11
Sapele	99	45	50	4	0
Emire	251	97	120	25	9
Total	**2036**	**1008**	**846**	**140**	**42**

At the Dominase community 2,179 pieces of lumber were generated from 27 trees, which were made up of seven different timber species as shown in Table 7. The first and second graded lumber recorded were 1,037 and 961 respectively, which represent percentages of 47.6 and 44.1 in that order. For some of the species, the quantity of first grade was more than the second grade and vice versa, hence there is no particular order. The percentage of first and second grades is 91.7 of the total lumber graded, hence falls under class I. The fourth grade recorded a percentage of 2, an indication that the quality of lumber was high. Some quantities of lumber from logging residues were obtained from Dominase community. These were produced from three species: Emire, Ofram and Mahogany (Table 7). None of the lumber was graded 1 but 2, 3 and 4. Therefore the percentage of the second grade was estimated as 48.7 which falls under class III. The fourth graded lumber from logging residues was comparatively low (9 pieces), equivalence of 7.6%.

Table 7: The degree of quality of lumber generated at Dominase Community

Species	Lumber from trees on farmlands					Lumber from logging residues			
	Quantity	1st grade	2nd grade	3rd grade	4th grade	Quantity	2nd grade	3rd grade	4th grade
Emire	211	84	95	22	10	53	23	27	3
Ofram	805	341	413	39	12	32	12	15	5
Danta	256	139	98	17	2	0	0	0	0
Mahogany	278	144	103	26	5	34	23	10	1
Sapele	130	92	31	5	2	0	0	0	0
Edinam	108	47	54	7	0	0	0	0	0
Wawa	391	190	167	22	12	0	0	0	0
Total	**2179**	**1037**	**961**	**138**	**43**	**119**	**58**	**52**	**9**

Nsabrekwa is the community of which as much as 30 trees were felled during the study and that 2,348 pieces of lumber were generated. From Table 8, the number of trees felled was from seven species, Wawa and Edinam being primary species while Ofram, Essia, Dahoma and Awiemfosamina were lesser-used timber species, according to Ghana Forest Inventory Project report (FIP) classification. The quantities of first and second grades lumber were 1,141 and 943 respectively, a percentage of 88.8 and hence rated as class I – excellent grade. The quantities of lumber under the first and second do not follow any trend and that as more lumber pieces were graded 1 (for instance Wawa), others like Ofram had less pieces graded 1. The fourth grade recorded 54 pieces of lumber and that a percentage of 2.3 was estimated, which comparatively was lower. The lumber obtained from logging residues were 54 pieces as depicted in Table 8, with the second and third grades recording 28 and 16 pieces respectively. The percentage of the first 2 grades is 51.9, hence class III, an indication that the quality generated from such resource using the lumber grading rules in Ghana/West Africa (SATA) is quite low but very substantial on the local market.

Table 8: The degree of quality of lumber generated at Nsabrekwa Community

Species	Lumber from trees on farmlands					Lumber from logging residues			
	Quantity	1st grade	2nd grade	3rd grade	4th grade	Quantity	2nd grade	3rd grade	4th grade
Wawa	397	205	172	20	0	0	0	0	0
Ofram	340	121	151	50	18	30	17	9	4
Emire	402	159	170	53	20	24	11	7	6
Essia	583	317	212	49	5	0	0	0	0
Edinam	117	61	48	5	3	0	0	0	0
Dahoma	266	145	93	21	7	0	0	0	0
Awiemfo	243	133	97	12	1	0	0	0	0
Total	**2348**	**1141**	**943**	**210**	**54**	**54**	**28**	**16**	**10**

Table 9 shows the species that were extracted from Abesewa Gyaaman community, the quantity of lumber generated from trees on farmlands & logging residues and their grades. As the trees felled from farmlands came from six species, lumber from the residues resource were extracted from eight species (Table 9). From the total of ten species, Wawa, Edinam, Sapele and Mahogany are primary species while the rest (Dahoma, Danta, Avodire, Essia, Awiemfosamina and Emire) are lesser-used species. The total number of lumber pieces obtained from trees on farmlands 1988 of which 1.024 and 798 were graded first and second respectively while the third and fourth grades were 119 and 47 in that order. The percentage of lumber graded first and second was computed to be 91.6 and therefore put under class I. This means that most of the lumber pieces obtained were of high quality. Of the total number of lumber graded 2.4% came under grade 4. The quantities of lumber graded for first and second grade levels do not conform to any particular trend. The quantity of lumber obtained from logging residues at Abesewa Gyaaman was 1,310. These consist of 612 grade 2, 625 grade 3 and 73 grade 4 representing percentages of 46.7, 47.7 and 5.6 respectively of the total lumber graded. The number of lumber pieces obtained from the first four species with decreasing order is Dahoma, followed by Wawa, Sapele and Mahogany. This means that logging residues are generated from such species than the rest of the species in Table 9.

Table 9: The degree of quality of lumber generated at Abesewa Gyaaman

Species	Lumber from trees on farmlands					Lumber from logging residues			
	Quantity	1st grade	2nd grade	3rd grade	4th grade	Quantity	2nd grade	3rd grade	4th grade
Wawa	313	162	115	25	11	380	149	211	20
Edinam	33	10	14	6	3	0	0	0	0
Dahoma	239	126	89	15	9	478	222	244	12
Danta	504	296	194	10	4	62	35	21	6
Avodire	309	130	156	13	10	12	5	7	0
Essia	590	300	230	50	9	0	0	0	0
Awiemfosamina	0	0	0	0	0	14	10	4	0
Sapele	0	0	0	0	0	218	131	79	8
Mahogany	0	0	0	0	0	83	41	32	10
Emire	0	0	0	0	0	63	19	27	17
Total	**1988**	**1024**	**798**	**119**	**47**	**1310**	**612**	**625**	**73**

The total number of lumber pieces generated from 126 trees that were felled and processed was 10,128, which was made up of 13 timber species (six primary and seven lesser-used timber species). The quantities of first and second grades of lumber were recorded as 4,890 and 4,170 respectively while the third and fourth grades were 829 and 239. The estimated percentage of 89.5 was recorded for both grades 1 & 2 with grades three and four being 8.1% and 2.4% respectively. This means that the trees from farmlands at the six project sites were not disturbed very much and that management was quite good. Also, the logosol facilities that were used to process the logs into lumber were efficient. Considering the pieces of lumber graded under the first and second grade levels as shown in Table 10, Japa, Dominase, Ankasie, Nsabrekwa and Abesewa Gyaaman had more of their lumber pieces graded 1 while Twifo-Kyebi was the reverse. With respect to the fourth graded lumber, the percentage of the pieces of lumber ranged from 2.0 to 4.5. These also indicate that there are various levels whereby trees on farmlands are managed. 2.0 to 4.5

Table 10: Lumber graded from six project communities

Local community	Lumber from trees on farmlands					Lumber from logging residues			
	Quantity	1st grade	2nd grade	3rd grade	4th grade	Quantity	2nd grade	3rd grade	4th grade
Twifo-kyebi	535	167	218	126	24	0	0	0	0
Japa	1042	513	404	96	29	0	0	0	0
Dominase	2179	1037	961	138	43	119	58	52	9
Ankasie	2036	1008	846	140	42	0	0	0	0
Nsabrekwa	2348	1141	943	210	54	54	28	16	10
A.Gyaaman	1988	1024	798	119	47	1310	612	625	73
Total	**10128**	**4890**	**4170**	**829**	**239**	**1483**	**698**	**693**	**92**

Logging residues were only extracted from three of the six communities (Dominase, Nsabrekwa and Abesewa Gyaaman). The quantity of lumber pieces obtained was 1,483 but none of the lumber was graded 1. The 2^{nd} , 3^{rd}, and 4^{th} grades recorded 698 (47.1%), 693 (46.7%) and 92 (6.2%) lumber pieces respectively and that there was no significant difference between grades 2 and 3 at 5% significant level hence almost equal number of lumber was obtained. More lumber pieces were obtained from Abesewa Gyaaman (1310) than those obtained from Nsabrekwa (54) and Dominase (119). The percentage of lumber generated from residues and graded 4 were 5.6 (from Abesewa Gyaaman), 7.6 (from Dominase) and 18.5 (from Nsabrewa).

Defects identified

The quality of lumber depends, among other things, on greater extent of the quality of the raw material to be processed. Some defects of tropical logs are not acceptable for decorative products.

The major defects that were identified on lumber faces included sound knots, dead knots, pin holes, heart decay, wane, blue stain, abnormal growth and sap stain.

Conclusion

The total number of trees felled and processed was 126 (consisted of 13 timber species of both primary and lesser-used species) of which 10,128 lumber pieces were graded as first, second, third and fourth grades using SATA grading rules. This total number of lumber graded at all the six communities yielded 89.5% with the first and second grades and 2.4% with the fourth grade.

Considering the first and second grades of lumber obtained at the six projects sites, the percentage for the two grades ranged from 71.9 (class II) to 91.7 (class I). Those of class II were from Twifo-Kyebi while the remaining communities scored class I. The percentages obtained, in order of decreasing order, were Dominase (91.7%), Abesewa Gyaaman (91.6%), Ankasie (91.1%), Nsabrekwa (88.8%) and Japa (88%). The lowest quality of lumber grade (fourth grade) at all the communities also ranged from 2.0% to 4.5% of the total lumber graded. Generally the first grade level recorded higher numbers of lumber than the second grade.

Lumber from logging residues obtained from three communities (Dominase, Nsabrekwa and Abesewa Gyaaman) were from nine species (both primary and lesser-used species). A total of 1,483 lumber pieces were obtained and graded into second, third and fourth grade levels, which was made up of 698, 693 and 92 respectively. The quantities of lumber recorded for the fourth grade (as percentage of the total lumber) at the three communities ranged between 5.6 and 18.5%. These are clear indications that logging residues is a good resource to be re-considered for utilization especially at the local level, hence policy guidelines to make its extraction, processing and utilization a reality.

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CHAPTER 2

SOME PROPERTIES OF TREES ON FARMLANDS IN TWO FOREST DISTRICTS OF GHANA

Abstract

Materials (in the form of discs of 30cm thicknesses) from trees on farmlands of the project communities in the Central and Western Regions of Ghana and logging residue in a forest reserve in the Dunkwa-on-Offin district in the Central Region, were used for the study. The oven-dry test and hydrostatic test methods were used to determine moisture content and basic density respectively of the wood species selected. Ovens, electronic balances, digital calipers and micrometer screw gauge equipment were also used for the determination of directional shrinkage of the selected species. Kiln drying schedules were determined for the selected species using the methods of Terazawa (1965) and the USDA-Forest Products Laboratory. Drying sheds with dimensions of 4.88metres by 11.88metres and each consisting of three chambers were constructed. Lumber produced in the field were first promptly end racked or end piled for rapid surface drying to avoid degrade. Since longer periods of end racking could result in warping, the lumber were always re-piled within a few days in flat piles since degrade from warping could be costly if end racked for a very long time. All the individual boards were examined visually to determine types of drying defects on them, if any. The extent of the drying defects was also measured using the evaluation methods in the SATA grading rules. All the individual boards were examined visually to determine the types of drying defects on them, if any. The extent of the drying defects was also measured using the evaluation methods in the SATA grading rules. These grading rules were also in grading the lumber pieces that were generated from the project. Four grade levels (1^{st}, 2^{nd}, 3^{rd}, 4^{th}) were considered. The criteria used were generally based on clear cuttings (a cutting free of defects though some defects may be tolerated in certain grades and for particular timber species) and cutting units (the surface area of a cutting of 0.25 meter long by 0.025 meter wide. Where this area is free of all defects it is conventionally known as unit of clear cutting (UDN), hence the minimum size, minimum defects and minimum percentage grade. Again, wood samples (Dahoma, Black Ofram, White Ofram, Wawa, Essia, Avodire, Edinam, Sapele, Emire and Bompagya) from the project sites were prepared into specimens for bending, compression parallel to the grain, shear and hardness tests using carpentry machines and ASTM D 143-94/B.S. 373: 1957. Specimens were prepared at green and 12%

moisture contents. Universal instron machine of 100 kN type connected to a software was used to conduct the tests. Specimens were tested to failure and the software generated the required data for further analysis.

From the study results the radial and tangential shrinkage values of six species (Wawa, Sapele, Odum, Ofram, Essia and Danta) were higher than figures from world literature whose samples are only vaguely referred to as from tropical forests. The temperature schedules component in the proposed kiln schedules for trees on farmlands and logging residues compare favourably with dry bulb temperatures (DBTs) of the kiln schedules of tropical trees from world literature. The results of some of the strength properties of the species, especially Dahoma and Essia are better than those species from literature and that of Odum (Iroko). Timber trees from farmlands equally have versatile usage and hence their processing needs to be encouraged in a sustainable manner. These therefore are indications that wood from trees on farmlands could effectively be utilized alongside materials from on- and off-reserves (forest trees) without any hindrance from defects

CHAPTER 2.1

PHYSICAL PROPERTIES AND DRYING CHARACTERISTICS OF TREES ON FARMLANDS IN FIVE COMMUNITIES IN THE CENTRAL AND WESTERN REGIONS OF GHANA

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Introduction

Ghana's forest industry is a major foreign exchange earner and contributes about 6% to Gross Domestic Product (GDP). The industry directly employs about 100,000 people. Between 2002 and 2007, the country earned an average of about US$261.4 million annually from export of wood products (Marfo 2010).

Oteng-Amoako (2006) reports that based on current stocking and forest growth dynamics, there had been the need to impose an annual allowable cut (AAC) which is currently at 2 million m^3 of timber, although the installed capacity of the wood industry was estimated at 3 to 4 million m^3. This has therefore resulted in many wood processing mills producing under capacity, with some even closing down. Birikorang (2001) as reported by Oteng-Amoako (2006) indicates that the shortage of timber in the industry has promoted illegal logging and chainsaw fellings which are patronized in the local and export markets, and estimated at 2.625m^3 annually.

In Ghana, majority of the large and medium-sized wood processing mills are located in the cities and other urban centres. Whilst the high quality products from these mills are exported for hard currency, the lower grade products sold on the domestic market benefits only the urban dwellers to the neglect of people living in the rural areas and especially those on the fringes of forests. Apart from being denied access to products from the forests, the ordinary members in local communities living near the resource do not derive any benefit from royalties paid from concessionaires for harvesting timber from the forests. Again, trees on farmlands in Ghana are harvested, much benefit does not get to the farmers who cater for the trees. As a result, these people who should have protected the forests from damaging activities like illegal logging and mining care little about what happens in the forests.

Despite its ban in Ghana, coupled with its environmentally unfriendly practices as well as fatal accidents, illegal chainsaw logging and milling has become a very important enterprise in deprived rural communities. Again, chainsaw lumbering is on the ascendancy in the country's forests in spite of more than a decade of its ban. It is reported to provide jobs for about 130,000 people and livelihood for about 650,000 people (Marfo, 2010). Marfo (2010) again reports of the challenge illegal chainsaw lumbering poses for Ghana since it provides about 80% of lumber supply for the domestic market with an estimated volume of 497,000m^3 and a market value of about GHC279 million. This is affecting the national economy through non-payment of stumpage revenue and other fees by chainsaw operators through illegal harvesting of forest trees. While Marfo (2010) dwells on an average loss of stumpage revenue of about GHC25 million annually, it is reported to be about an average of 12.8 million US dollars as general loss of forest revenue annually through illegal chainsaw activities (World Bank 2005).

Adam *et al.* (1993) established that for every tree that is felled in Ghana, 50% of the tree volume is left in the forest in the form of branch wood, crown wood and stumps. Ofori *et al.,* 1993 under ITTO Project PD 74/90 indicated that percentage wood volume composition of tree sections in Ghana are: stumps 3.42%, stems 67.65% and crown 28.93% for trees with diameters higher than 20cm. While extracted volumes amounted to between 53 and 79% of stem volume, branchwood constituted about 60% of the logging residue. The report estimated that wood residue on the forest floor amounted to 48%, 50% and 63% respectively in three forest reserves studied. Again, average lumber recoveries from some sawmills studied gave the following: 44 - 45% raw lumber, 4.2 - 8% by-products, 6.2 - 8% sawdust and 39 – 46% solid residue.

Knowledge of the physical properties, drying characteristics and appropriate kiln schedules of trees on farmlands and logging residue, is important and required to provide information concerning the suitability of the timber species and residues for utilisation as raw material for specific end-uses. This would then lead to effective utilisation, possible sustainability of the species and reduction of pressure on the forests through the provision of additional materials for the timber industry in view of the current dwindling volumes of wood in Ghana's forest estate.

With the involvement of local communities in legalized production of logging residues using refined portable and efficient machines, local employment will be generated and the sale of the sawn products will generate revenue to improve local economies. These benefits will directly go to the local communities and thus affect their social and economic lives. A way of stimulating the interest of local communities to protect the forest is to enable them have some income from the forest while at the same time having timber products for their needs.

Objectives:

The main objectives for the study were:

i) To determine physical properties and drying characteristics for the wood of timber species extracted from farmlands in the Western Region of Ghana

ii) To assess quality of the extracted products (including construction of drying sheds for quality improvement and evaluation of drying defects)

iii) To compare physical and drying characteristics of the wood from farmlands with information from world literature.

Methodology

Materials from trees on farmlands in five communities in the Central/Western Regions of Ghana and logging residue in a forest reserve in the Dunkwa-on-Offin district in the Central Region, were used for the study.

Determination of physical properties of wood from trees on farmlands/logging residues

Materials in the form of discs of 30cm thicknesses were extracted from logs of the selected species on farmlands in the communities and conveyed to the laboratory at FORIG for physical and drying characteristics studies. Woodworking equipment at the Institute's workshop was used to prepare samples for the studies. The oven-dry test and hydrostatic test methods were used to determine moisture content and basic density respectively of wood of the species selected. Equipment like ovens, electronic balances, digital calipers and micrometer screw gauge were also used for the determination of directional shrinkage of the selected species. Kiln drying schedules were determined for the selected species using the methods of Terazawa (1965) and the USDA-Forest Products Laboratory.

Construction of drying sheds in five (5) collaborative study communities

Five (5) drying sheds with dimensions of 4.88metres by 11.88metres and each consisting of three chambers were constructed in three communities (Nsabrekwa, Dominase and Ankaasie) in the Asankragwa forest district in the Western Region, and in two communities (Japa and Wassa Akropong) in the Dunkwa-on-Offin forest district in the Central Region. For the construction of each of the sheds, a total of twelve holes were dug to depths of 660mm at distances of 2.44metre and 3.96metre along the width and length of the structures respectively. Metal brackets made of U-plates of 20cm length each welded to 8cm diameter metal pipes of 56cm length and connected to metal strips which served to anchor the metal bracket in place, were used for each of the dug holes. Concrete was prepared and poured around each of the metal brackets to hold them firmly in place (Fig. 12). Type number 24 bolts and nuts were used to hold 100mm by 150mm boards which served as poles to heights of 2.74metre and 2.29metre for the front and back of the structures. 50cm by 75cm purlins and 50cm by 150cm rafters with 32mm by 30cm fascia boards were used to form a structure on which roofing sheets were nailed to. Claddings at distances of 76cm apart were erected around these sheds to prevent unlawful entry or intrusion into the sheds. Timber species used for the construction of the five sheds in the collaborative communities were: Bompegya for Nsabrekwa and Dominase; Awiemfosamina for Ankaasie and Japa; and Dahoma for Wassa Akropong.

As a means to minimize or eliminate drying degrade to improve on the quality of the lumber produced, the Logosol operators and some selected members of the Lumber Marketing Committee were trained in the rudiments of air drying and therefore proper stacking of the lumber in the field (farm/forest) and drying shed (Plate 13). Lumber produced in the field (reserve) were first promptly end racked or end piled for rapid surface drying to avoid degrade. Since longer periods of end racking could result in warping, the lumber were always repiled within a few days in flat piles since degrade from warping could be costly if end racked for a very long time.

Plate 12: The U-plates to hold the poles in position for shed construction at Dominase

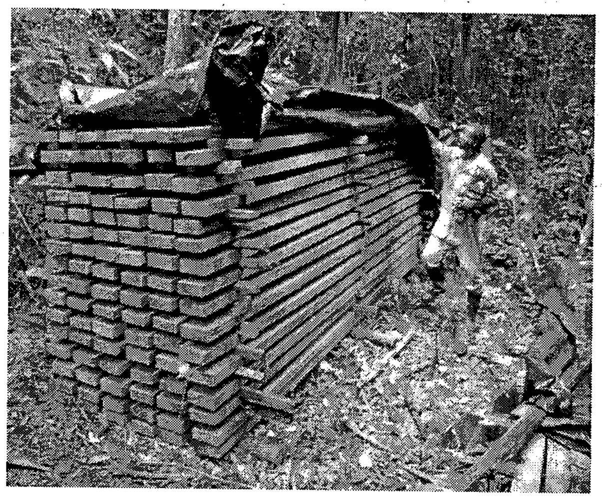

Plate 13: In-situ processed lumber stacked to prevent weathering and staining

Monitoring of moisture content and assessment of quality of boards in the sheds

Air drying is the practice of placing stacks of lumber in a yard and obtaining reduction in moisture content merely through the action of the prevailing wind and atmospheric conditions. Since there was virtually no control of temperature, relative humidity and air circulation in the drying sheds, care was taken to properly stack the lumber as well as obtain sufficient air movement in the sheds. This is in agreement with McMillen and Wengert, 1978 which state that the major purposes for stacking lumber in a specified manner are twofold: i) to promote uniform air circulation, which in turn results in good drying; and ii) to reduce or eliminate warping.

Sufficient air movement was achieved by setting these drying sheds at areas with good drainage and away from buildings, trees or other obstructions which cause reduction in airflow. Proper stacking of the boards too helped to prevent or keep degrade due to warping, twisting and checking to a minimum. This was done by avoiding close spacing of the stacks as a means to prevent increasing the holding capacity of the drying shed. Optimum spacing between boards was therefore used for effective air circulation in the stacks.

Since the sheds had no fans to circulate air but low air velocity without venting, less air therefore moved around and within the stacks. This necessitated construction of narrower stacks or piles for faster and effective drying. These hand-stacked piles did not exceed 1.52 metre (5-ft) width since there was no provision for vertical flues. The Committee members were therefore taught to construct box piles which aim for square, level and straight-sided stacks with all stickers and bolsters in perfect alignment. This was because board lengths were both odd and even lengths. They were taught to place full-length pieces on the outer edges of each layer and full support under each end of each board.

Again, to avoid reduced drying, stain and rot in the stacks, stacks with widths less than two metres and heights limited only by stability and ease of piling, were erected in the drying sheds. Cross-members (bearers) of 100mm by 100mm in section were used. They were clear from the ground, lying on rejected timber sections (discs) which acted as piers. These piers were about 300mm high indicating that the cross-members were lifted to such a height from the ground to ensure air movement beneath the stacks to prevent uneven drying of boards. Piling sticks (stickers) of 25mm by 25mm and sawn from sapwood and other rejected residue, were used in the stacks to prevent distortion during drying. During stacking of the various species, thicker boards of 50mm and above were placed beneath with the thinner 25mm boards on top.

In each of the stacks, a moisture meter was used to determine moisture contents of six selected sample boards. The average values of these moisture content readings were used to determine as well as monitor overall moisture contents of all the boards in the sheds using the air drying method. A Protimeter Surveymaster (moisture meter), manufactured by Koenders Instruments BV of the United Kingdom was used to determine MC of the sample boards.

In the drying shed at Ankaasie, four large stacks were erected to dry 1157 boards obtained from the five species worked on, i.e. Sapele, Odum, Ofram, Edinam and Wawa. Similarly, five large stacks were erected to dry 1237 boards obtained from the six species worked on at Dominase, i.e. Sapele, Edinam, Danta, Ofram, Emire and Wawa. At Nsabrekwa cottage, three large stacks were erected in the drying shed to dry 982 boards obtained from the three species worked on, i.e. Dahoma, Essia and Wawa. It took 30, 48 and 54 days respectively to air-dry the Wawa, Essia and Dahoma boards from green to an average of about 18%, from a range of 16.2 to 7.1% moisture content.

Debris (scrap lumber), weeds and other forms of rubbish were removed from beneath stacks and the drying shed floor through spraying with Kadilach (a weedicide) to ensure free flow of air.

Drying defect evaluation

All the individual boards were examined visually to determine types of drying defects on them, if any. The extent of the drying defects was also measured using the evaluation methods in the SATA grading rules.

Results and discussions

Evaluation of moisture content, basic density and shrinkage characteristics of lumber worked on in the five communities

On the average, all the processed boards were air-dried from green to 21% MC within sixty-two days during the wet period and fifty-one days during the dry period with an overall average of fifty-six days for lumber dried in the five communities. While total number of stacks of lumber air-dried in these communities ranged from three (3) to five (5), total number of lumber in the stacks ranged from 982 at Nsabrekwa to 1375 boards at Abesewa-Gyaaman (Table 11).

Table 11: Total number of lumber stacked in the sheds of the collaborative communities

Collaborative Community	Number of stacks	Total number of lumber in stack	Drying time
Nsabrekwa	Three (3)	982	54 days
Ankaasie	Four (4)	1157	52 days
Dominase	Five (5)	1237	66 days
Japa	Four (4)	1215	60 days
Abesewa-Gyaaman	Five (5)	1375	51 days

Table 12: Moisture content and basic density of the six timber species worked on at Ankaasie

Timber Species	Moisture content (%)			Basic density (kg/m^3)		
	Mean	SD	Range	Mean	SD	Range
Bompegya	45.7	1.44	37.8 – 63.6	666.3	25.1	557.7 – 720.0
Odum	95.1	22.2	60.6 – 161.9	560.8	56.1	408.3 – 738.5
Ofram	135.0	62.1	69.1 – 233.0	415.3	68.6	236.8 – 574.2
Sapele	47.0	6.3	36.8 – 61.9	687.7	40.5	601.7 – 770.1
Wawa	58.7	16.0	35.7 – 130.1	503.2	62.9	353.2 – 595.5

Table 13: Moisture content and basic density of two selected species from Nsabrekwa

Timber Species	Moisture content (%)			Basic density (kg/m^3)		
	Mean	SD	Range	Mean	SD	Range
Dahoma (All samples)	32.89	10.69	19.62 – 70.85	641.06	69.01	614.08 – 761.28
(Bottom)	28.49	5.05	19.62 – 46.32	664.58	41.87	577.31 – 761.28
(Top)	39.25	13.27	22.41 – 70.85	607.03	85.04	614.08 – 678.73
Essia (All samples)	60.88	11.19	28.46 – 76.41	618.99	36.77	521.06 – 684.82
(Bottom)	58.53	12.64	28.46 – 76.41	638.99	19.75	581.58 – 684.82
(Top)	62.80	9.53	32.77 – 75.96	594.54	38.10	521.06 – 651.55

Table 14: Moisture content and basic density of Wawa from Abesewa-Gyaaman

Timber Species	Moisture content (%)			Basic density (kg/m^3)		
	Mean	SD	Range	Mean	SD	Range
Wawa (All samples)	40.85	2.52	29.30 – 54.30	518.99	105.55	287.47 – 641.14
(Bottom)	38.10	1.64	25.68 – 54.30	560.86	64.53	349.51 – 641.14
(Top)	41.79	0.95	29.30 – 47.60	344.55	47.09	287.47 – 479.43

Table 15: Mean directional shrinkage values for Wawa worked on at Abesewa-Gyaaman

Timber Species	Total shrinkage (%)				Partial shrinkage (%)			
	L	R	T	T/R	V	L	R	T
Wawa (All samples)	0.30	1.99	4.13	2.08	6.04	0.11	1.01	2.20
	(0.13)	(0.23)	(0.64)	(0.19)	(0.21)	(0.10)	(0.18)	(0.47)
(Bottom)	0.29	2.02	4.37	2.16	6.30	0.11	1.04	2.33
	(0.11)	(0.21)	(0.39)	(0.35)	(0.09)	(0.10)	(0.15)	(0.37)
(Top)	0.37	1.90	3.16	1.66	1.20	0.10	0.88	1.65
	(0.18)	(0.30)	(0.54)	(0.56)	(0.28)	((0.11)	(0.25)	(0.43)

( ) – Standard deviation   L – Longitudinal   R – Radial   T – Tangential   V – Volumetric

Table 16: Descriptive Statistics of directional shrinkage of Dahoma wood worked on at Nsabrekwa

Statistic	MC (%)	Total shrinkage					Partial shrinkage		
		L	R	T	T/R	V	L	R	T
Mean	38.47	0.29	3.11	6.70	2.15	9.60	0.10	1.22	5.91
Standard Deviation	5.20	0.17	0.43	0.83			0.10	0.25	0.86
Sample variance	37.05	0.03	0.19	0.68			0.01	0.06	0.74
Minimum	33.55	0.12	2.65	5.74			0.01	0.99	4.97
Maximum	46.87	0.47	3.82	7.86			0.22	1.62	7.21
Count	48	48	48	48			48	48	48
Conf. Level (95%)	6.46	0.21	0.54	1.03			0.12	0.30	1.07

L – Longitudinal   R – Radial   T – Tangential   V – Volumetric

Table 17: Descriptive Statistics of directional shrinkage of Essia wood worked on at Nsabrekwa

Statistics	MC (%)	Total shrinkage					Partial shrinkage		
		L	R	T	T/R	V	L	R	T
Mean	28.40	0.28	5.49	8.82	1.61	13.83	0.10	3.03	5.33
Std. deviation	8.75	0.16	1.59	2.49			0.09	1.43	2.63
Sample Var.	76.60	0.03	2.53	6.20			0.01	2.04	6.89
Minimum	19.33	0.04	2.31	5.20			0.01	0.69	2.20
Maximum	47.08	0.74	8.66	15.50			0.43	6.40	11.42
Count	48	48	48	48			48	48	48
Conf. Level (95%)	3.16	0.06	0.57	0.90			0.03	0.52	0.95

L – Longitudinal   R – Radial   T – Tangential   V – Volumetric

Table 18: Mean directional shrinkage values for Four timber species worked on at Ankaasie

Timber Species	Total shrinkage (%) L	R	T	T/R	V	Partial shrinkage (%) L	R	T
Odum	0.45	3.36	4.73	1.46	7.96	0.13	1.25	1.83
	(0.21)	(0.68)	(0.77)	(0.34)	(0.16)	(0.12)	(0.50)	(0.87)
Ofram	0.38	4.08	5.46	1.42	9.32	0.14	2.12	3.08
	(0.28)	(0.93)	(0.41)	(0.41)	(0.22)	(0.22)	(0.60)	(0.87)
Wawa	0.36	2.66	3.92	1.49	6.48	0.09	1.35	2.05
	(0.09)	(0.34)	(0.35)	(0.18)	(0.10)	(0.05)	(0.30)	(0.35)
Sapele	0.44	5.49	7.04	1.41	12.14	0.18	2.85	3.90
	(0.27)	(1.56)	(1.27)	(0.59)	(0.39)	(0.11)	(1.25)	(0.80)

( ) – Standard deviation   L – longitudinal   R – radial   T – Tangential   V – Volumetric

Table 19: Mean directional shrinkage values for Two timber species worked on at Dominase

Timber Species	Total shrinkage (%) L	R	T	T/R	V	Partial shrinkage (%) L	R	T
Wawa	0.38	1.76	4.39	2.08	6.01	0.16	1.01	2.20
	(0.19)	(0.41)	(0.74)	(0.14)	(0.22)	(0.17)	(0.18)	(0.47)
Danta	0.23	3.67	7.37	2.01	10.50	0.10	1.96	4.07
	(0.13)	(0.38)	(0.50)	(0.28)	(1.01)	(0.09)	(0.27)	(0.46)

( ) – Standard deviation   L – longitudinal   R – radial   T – Tangential   V – Volumetric

Table 20: Kiln schedules and directional shrinkage values of timber species worked on and related information from World literature

Timber Species	Kiln schedule obtained from study	Kiln schedule information from literature	Directional shrinkage information from study L	R	T	Directional shrinkage information from literature R	T
Wawa	$T_{14}D_5$	Sch. L*	0.39	2.16	4.22	2.0	3.0*
Sapele	T_3D_4	Sch. A*	0.36	2.68	4.72	2.5	4.0*
Odum	T_6D_3	Sch. E*	0.22	2.91	4.51	1.5	2.0*
Offram	$T_{10}D_5$	Sch. J	0.24	3.10	5.34	Variable	Variable+
Essia	T_2D_5	Unavailable	0.43	5.12	7.39	Unavailable	Unavailable
Dahoma	T_5D_4	Unavailable	-	-	-	2.0	5.0*
Danta	T_4C_2	Sch. A	0.38	3.67	5.58	3.5	5.0*
Bompegya	T_3C_5	Unavailable	-	-	-	Large	Large+

Source: * *Handbook of Hardwoods (by R. H. Farmer), Princes Risborough Laboartory, U. K.*
+ *The Tropical Timbers of Ghana, TEDB, Ghana*

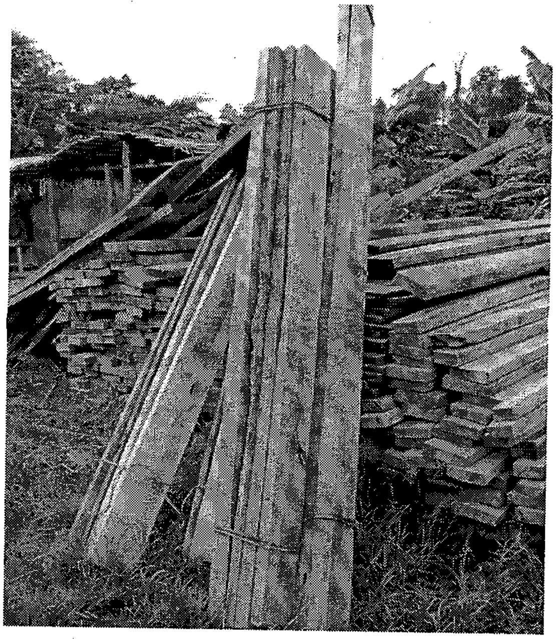

Plate 14: Lumber awaiting conveyance to a community drying shed

Plate 15: Lumber to be temporarily stacked before conveyance to a drying shed

Plate 16: Conveyed lumber awaiting proper stacking in a drying shed

Density values act as guide to the working properties of various species and give indication of possible end-uses of these species. From the results of the five timber species worked on at Ankaasie (Table 12), while mean MC ranged from 45.7% to 135% for Bompegya and Ofram; mean density ranged from 415 to 688kgm^{-3} for Offram and Sapele. Using the classification of density in TEDB 1994, Ofram could be described as Light density species, while Wawa and Odum could be described as moderately heavy density species. Bompegya and Sapele could be described as Heavy density species.

For the three species worked on at Nsabrekwa and Abesewa-Gyaaman (Tables 13 & 14), mean basic density values of the butt samples were observed to be higher than those of the samples from the top regions of the trees. Overall mean basic density values were 641 kg/m^3, 619 kg/m^3 and 519 kg/m^3 respectively for Dahoma, Essia and Wawa. Thus Wawa from Abesewa-Gyaaman could be described as a medium density species, while Essia and Dahoma from Nsabrekwa could be described as moderately heavy density species. It took 30, 48 and 54 days respectively to air-dry the Wawa, Essia and Dahoma boards from Abesewa-Gyaaman and Nsabrekwa from green to an average of 18% moisture content. While Wawa dried easily, Dahoma and Essia needed extra care in drying to avoid distortion.

From Table 14, there is an inverse correlation between green moisture content and basic density for the butt and top ends of the Wawa species from Abesewa-Gyaaman worked on. This could probably be due to the top material being predominantly made of sapwood of lower density but higher moisture content while the butt samples mainly consisted of heartwood of higher density but of lower moisture content. This again reflects in the mean shrinkage values for this Wawa species from Abesewa-Gyaaman (Table 15), where the tangential, radial and volumetric shrinkage values for the top material are comparatively very low when compared with those for the heavier or denser butt samples. This again could probably be due to the phenomenon of materials of higher density normally shrinking more than materials of lower density.

From Table 16, the T/R ratio of Dahoma is slightly above 2% (2.15) while from Table 17, it was found to be less than 2% (ie. 1.6%) for Essia wood. This is an indication that the Essia wood would be more dimensionally stable than the Dahoma and therefore would shrink less. However, volumetric shrinkages of the two species gave values of 9.60% for Dahoma and 13.83% for Essia. Dahoma which exhibits low volumetric shrinkage thus has lower tendency to exhibit drying defects like checking, warping and splitting when compared with Essia with moderately high volumetric shrinkage of 13.83%. Added to its medium density status, Essia wood could be used for high grade furniture, millwork and joinery while Dahoma could be very useful as a construction timber species.

On the possible uses of the five timber species in Table 12 based on their densities, Ofram, being light density, could be good material for grocery pallets, boxes, mouldings, rotary veneer, and plywood core. Wawa, being moderately heavy, could be used in building construction as scaffolding and as form lumber while Bompegya and Sapele could be used for furniture and heavy construction work.

Apart from being used in building construction as scaffolding and as form lumber, Wawa from Abesewa-Gyaaman (in Table 14) could be used for shoe heels, interior mouldings, utility furniture, plywood and rotary veneer. With Essia and Dahoma from Nsabrekwa in Table 13 being described as moderately heavy density species, they could then be good material for heavy construction work, mining timbers, outdoor furniture, marine work, sleepers, trailer decking and wagon work. Sliced veneer could also be produced from the Essia species.

From Table 18, both partial shrinkage values at 12% moisture content and total shrinkage values at oven dry moisture content for the four species worked on indicate that they would undergo very small to medium shrinkage in service. While Odum and Wawa exhibited very small to small shrinkages, Sapele and Ofram exhibited small to medium shrinkages respectively. T/R ratio indicates the level of dimensional stability wood species would exhibit in service. The ratios for the four species were below 2.0%, ranging from 1.41 for Sapele to 1.49% for Wawa. This indicates dimensional stability for the four species when utilised. It also means that the four timber species have the tendency to exhibit less checking, warping and splitting. Furthermore, volumetric shrinkage values for the four species ranged from 6.48% for Wawa to 12.14% for Sapele, an indication that they could be classified as low and medium volumetric shrinkages respectively (Alipon *et al*, 2000).

Essia, in Table 20 has a low kiln schedule of T_2D_4, indicating that the species cannot withstand high drying temperatures. This is due to to the low temperature of T_2. The species is virtually impracticable to kiln dry and would therefore require some amount of air drying if kiln drying is to be undertaken. Bompegya with a schedule of T_3C_5 (Table 20) would require mild initial dry bulb temperatures if it is to be successfully kiln dried. This is because it cannot withstand high temperatures and undergoes high initial checking during drying. It might require some initial air drying before kilning. From Table 20 again, tangential and radial shrinkage values of wood from trees on farmlands obtained from the study were generally higher than values from some published world literature whose source is only indicated as tropical forests.

Education of the wood processing and marketing committee members in the various communities on handling of the processed lumber to avoid practices that tended to lower the quality and value of the lumber as can be found in Plates 14, 15 and 16, was advantageous. Also, avoiding termite and fungal attack as well as weathering and the need to stack the lumber immediately they were conveyed to the drying shed improved on the quality of boards dried in the sheds. Again, further education on the need to clear the immediate surroundings of the shed of weeds and debris prevented mould and fungal infestation which generally improved on air movement beneath and within the stacks.

On the possible uses of the species based on the shrinkage values from Table 15 to Table 18, Sapele could be used for high-grade furniture, cabinetry, millwork and joinery, turnery, boat construction and carving because of its medium volumetric shrinkage.

Odum and Ofram exhibited moderately low volumetric shrinkage characteristics. Ofram can therefore be used for high to common grade furniture manufacture, rotary veneer for plywood, flooring, ceiling and interior joinery. Odum can be used for house framing, flooring, ceiling, millworks and joinery (both interior and exterior), boat work and decking. With Wawa exhibiting low volumetric shrinkage, the species can be used for furniture and cabinetry, rotary veneer, shoe heels and other uses where shrinkage is critical such as mouldings, parquet, flooring, musical instruments and sporting goods. Bompegya, with its high basic density and high shrinkage values, can be used for bridges and heavy construction work.

Danta, with a volumetric shrinkage of 10.50% (Table 19) indicating moderately low volumetric shrinkage, could be used for common-grade furniture manufacture, rotary veneer for plywood, house framing, flooring, ceiling, millworks/joinery, woodcrafts, novelties and musical instruments.

Conclusion

From the results, it could be concluded that: i) radial and tangential shrinkage values of six species (Wawa, Sapele, Odum, Ofram, Essia and Danta) were higher than figures from world literature whose samples are only vaguely referred to as from tropical forests.

ii) The temperature schedules component in the proposed kiln schedules for trees on farmlands and logging residues compare favourably with dry bulb temperatures (DBTs) of the kiln schedules of tropical trees from world literature.

These therefore are indications that wood from trees on farmlands could effectively be utilized alongside materials from on- and off-reserves (forest trees) without any hindrance from defects.

CHAPTER 2.2

STRENGTH PROPERTIES OF TEN TIMBER SPECIES FROM TREES ON FARMLANDS AT SOME COMMUNITIES IN THE CENTRAL AND WESTERN REGIONS OF GHANA

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Introduction

Over the centuries timber has been used for an ever wider range of purpose yet part of our tradition associates familiar timbers with special qualities and uses.

Strength is defined in terms of the ability of a material to sustain a load. The magnitude of the load that can be sustained varies with the shape and size of the sample being tested. Strength is therefore considered in terms of stress and it is the internal force exerted by one part of an elastic body upon the adjoining part. Stress is the load or force per unit area. There is a critical stress at which a material fails, but simply compresses stretches or burns at a stress below the critical stress. Loads are applied in tension, compression, shear or a combination (Walker, 1993).

The properties of timbers are determined by the structure of the wood, that is, the types of cells and the chemical composition of the cell walls and cell contents and by the proportion of the various cell types present in the wood. The distribution and arrangement of these wood elements vary considerably in different species of trees. Other factors which affect the properties of the wood, especially strength, are density, moisture content, rate of growth, proportion of early wood or late wood in the growth rings, position in the trunk habitat and defects which exist in the growing tree (Walton, 1974).

Mechanical tests are most important for timber used for constructional work. They assess the various strength properties, such as compressive or crushing strength, shearing strength, bending strength, stiffness strength, etc, which enable the timber to resist different forces or loads. The designer of a building has to consider the types of loads the individual structural members, or groups of members, have to carry so that having selected timber possessing known strength properties, the required sizes of the members can be computed (Walton, 1994).

The anisotropic nature of wood makes it imperative for the direction of the stress with respect to the grain of the wood. Wood tested in tension or compression and loaded parallel to the grain is considerably stronger than when loaded perpendicular to the grain. Strength is also a function of moisture content. The testing procedures (ASTM, 1994; BSI, 1986a) to determine the properties of wood used small specimens, either 20x20mm or 2x2 inches in cross section and free of all defects. The tests included bending, compression, shear, cleavage, hardness and toughness (Walker, 1993)

Modern technological processes make it possible to obtain materials with extremely high strength. Trees on farmlands is said to have been subjected to some environmental hazards and may affect their properties, especially the strength, which is one of the determining factors in the selection of timber for a particular purpose. Research must be done on these materials, whose behavior under loading may not be the same as those from the reserved forest whose properties have been adequately studied.

Materials for tests

The materials used for the study included:
Wood samples of different species (7) from trees on farmlands selected from three localities, steel measuring tapes, Wood-Mizer machine for milling into boards, rip saw & planer machines for preparing samples into specimens, polythene bags for keeping moisture content of specimens constant (immediately after preparation and testing) and Universal Instron Machine (100 kN) and accessories for the testing of specimens & generation of data. Tests were conducted at the timber testing lab of CSIR-FORIG, Fumesua-Kumasi.

Methods

Wood samples of ten different species were collected from the project sites at Abesewa Gyaaman, Ankasie, Nsabrekwa and Dominase. The samples were prepared into specimens using carpentry machines (Plate 17) and ASTM D 143-94/B.S. 373: 1957 into dimensions of 2x2x30 cm (for bending test), 2x2x6 cm (for compression test), 5x5x5 cm (shear test) and 5x5x5 cm (for hardness test). These tests were considered as they are the most important properties of timber. Specimens were prepared at green and 12% moisture contents. The species were (Dahoma, Black Ofram, White Ofram, Wawa, Essia, Avodire, Edinam, Sapele, Emire and Bompagya)

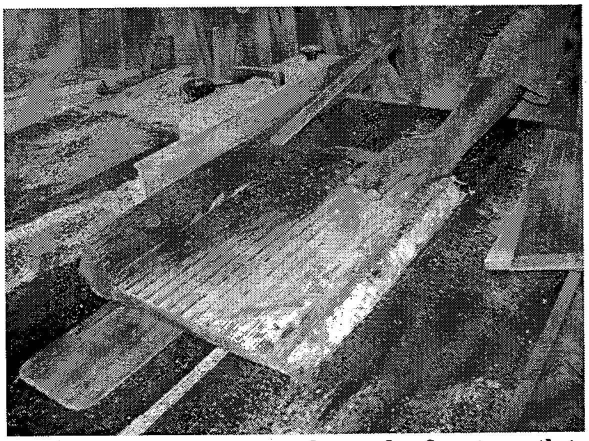

Plate 17: Preparation of wood samples for strength tests

Universal Instron Machine of 100 kN type connected to a software (Plate 18) was used to conduct the tests. Specimens were tested to failure and the software generated the required data for further analysis.

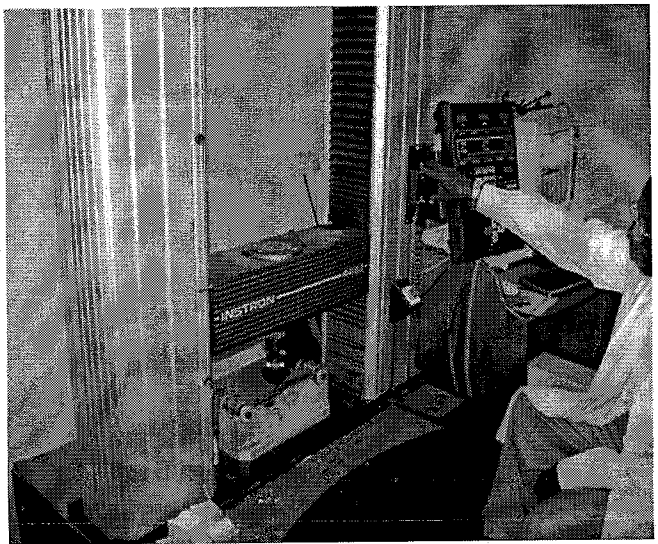

Plate 18: Mechanical strength test of timber species with instron

Results and Discussions

These strength properties included shear parallel to grain, Modulus of rapture (MOR), Modulus of elasticity (MOE) and compression parallel to grain. The literature information on some of the ten species have been provided to compare the tested species with. The results at both green and 12% moisture contents are shown in Tables 21 & 22. The moisture content at green gives lower strength properties than at any given moisture content, which is below fibre saturation point (30% moisture content).

Table 21: Mechanical strength properties at green moisture content of some wood species

Strength properties	Wood species										
	Dahoma		Black Ofram	White Ofram	Wawa		Essia	Avodire	Edinam	Odum
	Test	Literature	Test		Test	Literature	Test	Test	Test	Literature
Shear (N/mm^2)	15.3	7	9.49	8.8	3.3	3	9.8	8.7	9.1	7.4
Compression (N/mm^2)	39.3	36.7	24.4	24.2	19.5	18.5	40.5	23.8	22.6	35.4
MOE (N/mm^2)	9191	9900	6018.4	5832.8	4735.8	4600	9945.3	5760	6008	8300
MOR (N/mm^2)	79.6	76	45.7	45.3	38.4	37	75.9	55.3	51.4	74

Source: Project results and Farmer et al (1972); PROTA Timbers 1 (2008)

Using timber species in Tables 21 and 22 the maximum load or strength to be applied should not exceed the tested strength values otherwise the timber will fail. Therefore strength properties increase with decreasing moisture content. Tables 21 and 22 indicate that the strength properties of the tested wood species are comparable to that in literature and in same cases better. Again, comparing the species with Odum (Iroko), Dahoma and Essia (whose densities are 690 kg/m^2 and 800 kg/m^2 respectively), for instance, are better in all the properties than Odum, while the others do not vary so much from it (Tables for 21&22). Moreover, the Ofram species, especially the white Ofram, are better substitutes for Wawa, which is getting extinct in the Ghanaian forests.

Table 22: Mechanical strength properties of some wood species on farmlands at 12%

Wood spp	Results	Strength properties				Density @ 12% m.c (kg/m³) from literature
		Shear (N/mm²)	Compression (N/mm²)	MOE (N/mm²)	MOR (N/mm²)	
Dahoma	Test	19.5	59.5	11845	130.7	
	Literature	7-18	46 – 74	9300-16500	80 – 178	590-800
Black Ofram	Test	13.8	46.9	9919	82.9	
	Literature					550
White Ofram	Test	13	46	9885	82.5	
	Literature					550
Wawa	Test	7.6	36.9	5784	53.5	
	Literature	-	24 - 43	4800 - 9200	52 – 110	320-490
Essia	Test	14.8	70.7	14476	135.4	
	Literature	15.4	72 -74.9	13790 - 14500	132 – 140	800
Avodire	Test	15.2	45.9	8950	93.4	
	Literature	14	36 - 61	8300 - 12100	69 – 166	480-660
Edinam	Test	12.7	41.3	7580	69.2	
	Literature	-	45	8600 - 9015	52 – 75	560-750
Sapele	Test	16.8	58.9	11450	125.3	
	Literature	7-18	40-75	8900-13800	66-184	560-750
Bompagya	Test	12.7	69	14150	161	
	Literature	9-13	45-77	10300-14600	81-201	650-860
Emire	Test	-	37.9	10644	83	
	Literature					550
Odum (Iroko)	Test					
	Literature	14.1	42 - 65	13300	156	550-750

The colour of White Ofram is equivalent to *Gmelina arborea* and since its strength properties are also comparable (MOR, MOE, compression parallel to the grain and shear strengths of *Gmelina arborea* are 55-102, 5500-10800, 20-39 and 5-11 N/mm2 respectively) they can be substituted for each other. These show that trees on farmlands are as good as those from the forest and plantations. Based on the strength properties determined the species could be useful in heavy & light construction, general flooring, utility furniture & general carpentry, packaging (Boxes and crates), joinery, tool handles, sports goods, railway sleepers, agricultural implements, panelling and doors as recommended in Table 23.

Table 23: Recommended end-uses / application of some timber species in Ghana

No.	End-use / application	Timber species
1	Heavy construction	Dahoma, Essia, Emire, Bompagya
2	Light construction	Ofram species, Avodire, Wawa, Edinam, Emire and Wawa
3	General flooring	Dahoma, Essia, Bompagya, Emire and Iroko
4	Utility furniture/general carpentry	Ofram, Essia, Avodire, Sapele, Edinam and Iroko
5	Boxes and crates	Emire, Ofram, Avodire and Wawa
6	Joinery, tool handles, sports goods railway sleepers, agricultural implements	Essia, Bompagya, Dahoma, Emire and Iroko
7	Panelling	Ofram, Emire, Avodire, Sapele, Edinam and Iroko
8	Doors	Essia Ofram, Emire, Avodire, Edinam, Sapele, Bompagya and Iroko

Conclusion

The results of some of the strength properties of the species, especially Dahoma and Essia are better than those species from literature and that of Odum (Iroko), an internationally known timber species, which is also primary species in Ghana. Timber trees from farmlands equally have versatile usage and hence their processing needs to be encouraged in a sustainable manner.

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CHAPTER 3

IMPACT ASSESSMENT OF THE PROCESSING OF TREES ON FARMLANDS WITH LOGOSOL ATTACHMENTS

Abstract

The assessment of capacities of the machine operators and operational supervisors was based on visual observation of their activities and the administration of questionnaire. The visual observation was undertaken by two technical staff on the activities of the machine operators. The results obtained were rated as Grade 1 (exceptionally good operators) to Grade 3 (fair). Again, a prepared questionnaire for the assessment of field staff was administered to the project field operators (machine operators and supervisors). The questionnaire administered were all answered and returned for analysis. The environmental impact assessment was conducted at the six project sites (Twifo-Kyebi, Japa, Abesewa Gyaaman, Ankasie, Dominase and Nsabrekwa) in the Central and Western Regions of Ghana. Three indicators that were considered in the study through the survey conducted included the land/milling areas disturbed by the improved chainsaw milling and conventional logging activities, quantities of residue generation by the improved milling on log basis and the effect on agricultural crops by the improved milling. Conventional logged areas at Bowie Forest reserve, Wassa Akropong were included to compare results. In each of the six communities, field assessment was conducted in the farmlands of the beneficiaries whose trees had been felled and processed into lumber. Measurements (width at 3 different points and length) were made at each operated area where a tree was felled and processed to estimate the total area disturbed. Dimensions of butt and top logs as well as other utilizable portions that were left behind were also taken to determine the volume of residues. Agricultural crops destroyed were counted and recorded. In six and 12 months after operation visits were made again to observe the situation at the operated farmlands by considering the rate of growth of some food crops and regeneration of the vegetation including the types of wood species. For the impact assessment of livelihoods, 88 people were interviewed using questionnaires in 4 villages involving-three in the Western and one in the Central regions before the intervention of the project. Three years after the intervention of the project 72 people were interviewed in the same villages in the same forest districts, which were the project areas. The major findings of the assessment of the field operators are

that the majority of the machine operators could assemble, disassemble and operate the logosol machines independently. Machine operators have had the desire to use logosol facilities than the chainsaw freehand milling but the quantity of lumber produced in a day was said to be higher with the freehand method. Lumber produced with logosol machines were of equivalent quality as that of sawmill, hence of better quality than chainsaw milled lumber. Repairers of chainsaw machines were capable of repairing the logosol system hence no special group of people are required for their maintenance and servicing. Minor repairs could be taken up by most of the operators and availability of spare parts for the logosol facilities on the Ghanaian market was highlighted. The use of logosol facilities discouraged illegal lumbering as it is with ordinary chainsaw for freehand milling. Generally the level of co-operation by four of the beneficiary communities was estimated to be higher (80% - 95% rating). The study has also revealed that in-situ processing of trees on non-reserved forests using logosol (improved chainsaw milling) facilities could be managed sustainably with communities' involvement. Improvement has been made on the log recovery over that from sawmills and illegal milling hence lumber obtainable being higher. Yield from crops on farmlands could be increased due to increase in planting area, avoidance of shadows on crops and enrichment of soil with sawdust generated on farmlands. Indiscriminate burning and felling of trees on farmlands by farmers to protect their crops will be minimized. Areas disturbed after in-situ processing and conventional logging have been estimated and that area disturbed by conventional logging is much more than that by logosol milling. About 54% of the species extracted were made up of lesser-used timber species that are of economic value. The average butt diameters of trees felled ranged from 0.583m to 1.062m. On livelihood impact, the most important contribution is in the area of social, human and physical assets status of participating community members. This is derived from the project through revenue generated from the processing of the trees on farmlands and logging residues that has been distributed to community members. Other community members also benefited from the project through earnings from services delivery in the form of lumber carrying, lumber sales or marketing. For crisis that communities go through, the report has identified irregular and poor rainfall pattern leading to drought, excessive rainfall leading to flooding and damaging of crops by the wind. This brings about poor production of food that leads to food shortages, illnesses and funerals among communities. The ways community members cope with these crisis are the sale of trees possibly due to the presence of illegal chainsaw operators, sale of food products at reduced prices to attend to the crisis. Sustained education and assurance of forest *communities that have been done in this project that they can benefit directly from timber trees on their farmlands in future can let them stop or minimise the sale of trees on their farmlands to the illegal chainsaw operators. However, this should be backed by changing the laws governing the access of trees on farmlands in favour of communities. Interventions in these forest communities would make meaningful impact if they are designed to target the general conditions of living of these community members. They would again bring significant relief to the communities if they also target these short term crisis that communities go through and the way they cope, particularly sale of farmland trees and food products at reduced prices. This therefore points out the importance of processing trees on farmland. Although, its impact on the livelihood of community members may not be so significant, it shows one way through which livelihood of the forest communities could be improved and at the same time ensures sustainable management of the forest resources. That is if due to the benefits that communities members enjoy from the project, they become committed to the growth and protection of trees on their farmlands.*

Chapter 3.1

PROCESSING OF TREES ON FARMLANDS WITH LOGOSOL FACILITIES: ASSESSMENT OF CAPACITIES OF MACHINE OPERATORS AND SUPERVISORS

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Introduction

Under an ITTO project PD 431/06 Rev 1 (I) on processing and utilisation of trees on farmlands and logging residues through collaboration with local communities, seventeen members from six local communities in the Central and Western regions were trained in the use of logosol timber milling machine. This machine is a portable and improved chainsaw type, whose finishing is equivalent to that of a conventional type. These operators and supervisors were grouped into three and operated in the farmlands of six communities. A maximum of two trees were felled and processed in-situ into lumber for sale and the income generated was shared according to a formulae that the communities had agreed upon.

In order to train others in future for the sustainability of the project, participants needed to be assessed for their competence to enable the project management team to make some recommendations at the end of the project.

Methods

The assessment of capacities of the machine operators and operational supervisors was based on visual observation of their activities and the administration of a questionnaire. The visual observation was undertaken by two technical staff on the activities of the machine operators only. This was undertaken for one week per month for six months. The results obtained, as shown in Table 24, were discussed by the team and rated. Grade 1 was for those operators whose performance was exceptionally good; Grade 2 –good and grade 3 - fair. Again, a prepared questionnaire for the assessment of field staff was administered to the project field operators (machine operators and supervisors) in February/March 2010. They were assisted in answering the questionnaire by interpreting them in the language that was best understood by the operators. Seventeen copies of the questionnaire administered were all answered and returned. The results generated are summarised in Table 25. Plate 19 is one group of operators being given some technical instructions while an ITTO representative, Mrs. Celestine Ntsare-Okwo, engages a benefifiary farmer in a discussion and Plate 20 shows two operators exhibiting their skills on logosol lumbering.

Plate 19: Milling techniques being given to some operators

Plate 20: Skilled operators lumbering with logosol timberjigs

Results and discussion

The activities that were selected for observation were those that can lead to generation of logging residues when they are disregarded. Observation made by technical people on tree felling techniques was that 50% paid attention to all felling techniques while the rest ignored some of them. For instance, paths of escape for the operator were not made while those who made them were wrongly sited. Brushing around trees was done instead of making proper clearing. Again, felling notch (undercut) and felling cut (back cut) were wrongly done and therefore caused barber's chair and or sloven as shown in Plate 21. In cross-cutting a few operators started wrongly which could lead to kick-back and some cross-cut surfaces were not smooth. Of the seven techniques observed, cross-cutting was the activity that recorded the highest grade 1 score of 84%, which means that the operators were exceptionally good. 79% of the operators strictly adhered to milling strategies which enabled them to mill faster with high lumber accuracy. Some operators were unable to identify the cutting edge of saw chains and hence were sharpening the back edge of saw chains. This is possibly could increase the production cost of lumber. The confidence level of four operators was low, as they could not handle the machine to suit the direction/angle of cut. Therefore, thick and thin lumber pieces were produced thereby recording a lower grade. Maintaining the air filter is very important and hence needs to be inspected, cleaned and replaced when necessary, but this was not properly observed by the operators in general. Only about 21% of the operators were very serious with the filter maintenance while 36% ignored it until the machine indicated signs of faulty filter. On the average, ten operators (71%) were technically good and undertook the observed techniques/activities seriously and with ease.

Table 24: Grading of 14 logosol operators on the basis of visual

Activity	Grade 1	Grade 2	Grade 3
Tree felling techniques	7	5	2
Cross – cutting techniques	12	2	-
Milling techniques	11	1	2
Confidence in machine handling	10	3	1
Accuracy in logosol lumbering	9	2	3
Sharpening of saw chain	10	2	2
Maintenance of air filter	3	6	5

Plate 21: Poor felling techniques resulted in barber's chair/sloven

Table 25 shows the summary results of the questionnaire that was administered to the seventeen field operators. The views of only the machine operators were highly considered for the asterisked (*) questions.

The frequency of machine breakdown was quite low as 76% of the field operators answered in affirmative and it was added that if maintenance precautions are not observed the tendency for the machine breaking down will be higher. For the 17 field operators, 10 could undertake minor repairs and servicing of the Bigmill system while 4 said the machine is complex and delicate, hence specialists (machine repairers) should be allowed to take up any repairs (Table 25). This indicates the availability of qualified repairers who can take care of the machines when major faults are developed, which was confirmed by 76% of the respondents.

Table 25: Summary results of questionnaire administered to field operators

Questionnaire	Frequency Yes	No
Can you assemble, disassemble and operate the logosol machines independently? *	12	2
Is it safe and easy to fill machine with fuel while engine is running? *	8	6
Do you prefer using the logosol machines for milling than the chainsaw? *	13	1
Does it produce more lumber than chainsaw milling in a day? *	13	1
Is the quality of lumber generated by logosol better than chainsaw milling (CSM) ?	17	0
Is the degree of vibration of the logosol machine lower than the CSM? *	14	0
Is it easy to maintain / service the logosol facilities?	13	4
Will you be able to make minor repairs ?	10	7
Does the machine breakdown so frequently ?	13	4
Are you able to use personal protective equipment ?	5	12
Do you use the scabbard ?	4	13
Is it easy to move around in the forest with logosol facilities ?	15	2
Are the spare parts for the logosol facilities availability ?	16	1
Are you adhering to the proper fuel mix ? *	9	5
Do you regularly correct the chainsaw chain tension ? *	6	8
Has there been some casualties since the commencement of the project?	17	0
Will you be able to train people to use the logosol facilities? *	11	3
Has the local community been co-operative?	15	2
Is logosol machines convenient to use for illegal lumbering activity	0	17

* *The views of only machine operators were considered*

Although the risk of injury in using the logosol facilities was rated very low, 57% of the population was fuelling the machines with the engine running – very risky indeed. Vibration was rated lower than the freehand milling because the logosol attachments have added extra weight to the chainsaw and that some of the vibrations are dissipated without getting transferred to the human body. Market was said to be available for logosol products, willingness of farmers to nurture trees on farms is high, and majority of the operators (79%) had the capacity to train others. This is a very good result since their services will be needed in future to train others in some parts of Ghana. 86% of the operators could use the facilities independently while 21% will need some kind of assistance. The cutter chain is sharp enough to cause injury even when it is not being driven. The scabbard covers the chain when the saw is in storage or being transported. It also protects the chain from damage, for instance blunting by contact with concrete floors but this was poorly practised as only 23% of the field operators patronized it. The saw chain has to be correctly tensioned at all times. Incorrect saw chain tension is the cause of most saw chain and chain saw guide bar problems. A new chain saw chain quickly stretches and therefore needs to be adjusted after even a few minutes of use. Surprisingly less than 50% of the operators were doing that. With use of personal protective equipment, about 29% was confortable in using them while the major reason for the remaining 71% was that they found it difficult to work with. The degree of proper fuel mix was quite good as 64 % of the machine operators gave the correct ratio of engine oil to petrol and were able to state some of the problems to be caused should the proportion be changed.

The results indicate that most of the operators (93%) had developed interest in using the logosol machines (Table 25). Some of their major reasons were that the machines were environmentally friendly, comparatively lumber recovery was better than freehand (chainsaw) milling and that lumber quality was comparable to that of conventional milling but the number of lumber pieces obtained in a day was said to be lower with logosol machines, difficult to use the facilities for illegal operations, spare parts for the logosol facilities were available in Ghana. The level of co-operation exhibited by each of the local communities was rated by the field operators, which ranged from 45% (Twifo-Kyebi) to 95% (Abesewa Gyaaman)

Conclusion

In conclusion, the summary of the findings of the assessment of the field operators are that:

- Majority of the machine operators could assemble, disassemble and operate the logosol machines independently
- Machine operators have had the desire to use logosol facilities than the chainsaw freehand milling but the quantity of lumber produced in a day was said to be higher with the freehand method. Lumber produced with logosol machines used were of equivalent quality as that of sawmill, hence of better quality than chainsaw milled lumber
- Logosol system generated minimal vibration than the chainsaw milling (CSM)
- Repairers of chainsaw machines were capable of repairing the logosol system hence no special group of people are required for their maintenance and servicing. Minor repairs could be taken up by most of the operators and availability of spare parts for the logosol facilities on the Ghanaian market was highlighted. Even though the rate of

machines breakdown was lower it would depend on the degree of adherence of safety precautional measures and servicing and or maintenance schedules

- The use of personal protective equipment was not enforced during the study hence most of the operators did not develop the habit of using them
- Safety method of transporting the chainsaw machines was not strictly complied. Some techniques in tree felling and log processing into lumber were not implemented by some of the operators
- The use of logosol facilities could not encourage illegal lumbering as it is with ordinary chainsaw for freehand milling and
- Generally the level of co-operation by four of the beneficiary communities (Dominase – 80%, Ankasie – 85%, Nsabrekwa – 90% and Abesewa Gyaaman – 95%) was estimated to be higher.

Recommendations

- Intensive training on safety precautional measures, servicing and maintenance schedules of the logosol machines or any other improved chainsaw milling (new) machines need to be introduced.
- Major techniques in the use of any improved chainsaw milling (new) should also be fully covered.

CHAPTER 3.2

ENVIRONMENTAL IMPACT ASSESSMENT ON FARMLANDS: PROCESSING OF TREES ON FARMLANDS INTO LUMBER USING IMPROVED CHAINSAW (LOGOSOL) FACILITIES IN SOME COMMUNITIES OF GHANA

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Introduction

Illegal logging, which includes illegal chainsaw logging, has raised global concerns. This global forestry issue came to the fore at the World Bank/IMF meeting in Singapore in September 2006 where a platform was created to bring together legislators of the group member countries and key timber producing ones including Ghana, Brazil, Cameroon, etc. (Tacconi, 2007).

In Ghana, felling of trees and in-situ processing of logs into lumber, which are chainsaw milling activities, constitute the major item on the illegal logging agenda. The activity has been described to be environmentally unfriendly. This notion has over clouded the positive aspect of the chainsaw milling operation. Hence the use of chainsaw to convert trees to lumber has generated a lot of debate. Although the practice has been banned over a decade ago it is widespread despite measures put in place by government to enforce the ban. Enforcement has not been effective leading to proliferation of the practice at levels that threatens sustainability of Ghana's forest resources.

According to Damnyag and Darko-Obiri (2009), chainsaw lumber production is one stage of the process and the lumber is mostly produced by the chainsaw operators. These operators arrange for the timber trees for processing from farmlands, forest reserves and plantation. For the farmland trees, operators get the trees from the farmers and community elders through payment of small sums of money or freely without the knowledge of the farmer.

According to Asamoah Adam and Duah-Gyamfi (2009), the impact could be assessed based on the on the mode of operation, which is dependent on the choice of tree to be felled in terms of species, size, and location and felling and sawing techniques to be adopted in relation to minimization of felling damage, quality of lumber, recovery and residue generation. These consequently affect the sustainability of resource either positively or negatively. Since the ban has become a problem, it is imperative that alternative means of operation that will minimize the negative aspect is established to sustain employment, revenue generation and lumber availability on the market. Introducing an improved chainsaw milling facilities therefore requires an assessment of their environmental impact with respect to damage to agricultural crops, residue generation and milling area disturbed (both logosol and *conventional milling*).

Methods

The environmental impact assessment was conducted at the six project sites (Twifo-Kyebi, Japa, Abesewa Gyaaman, Ankasie, Dominase and Nsabrekwa) in the Central and Western Regions of Ghana. Three indicators that were considered in the study through the survey conducted included the land/milling areas disturbed by the improved chainsaw milling and conventional logging, quantities of residue generation by improved milling on log basis and the effect on agricultural crops by the improved milling. The operators were not told of any subsequent study that would follow after their operational activities, hence were given the freedom to work normally. Conventional logged areas at Bowie Forest reserve, Wassa Akropong were included to compare results.

In each of the six communities, field assessment was conducted in the farmlands of the beneficiaries whose trees had been felled and processed into lumber. Measurements (width at 3 different points and length) were made at each operated area where a tree was felled and processed to estimate the total area disturbed. Dimensions of butt and top logs as well as other utilizable portions that were left behind were also taken to determine the volume of residues. Agricultural crops destroyed were counted and recorded. In six and 12 months after operation of an area visits were made again to observe the situation at the operated farmlands. The materials used in taking data included measuring tapes, note book and pens/pencils. The data was then analyzed using Mirosoft Excel and where appropriate tables were also employed.

Results and discussion

The results have been presented into three forms as milling area disturbed, residue generation and effect on agricultural crops.

Milling area disturbed (both logosol and conventional milling)

The milling area, in this case, is defined as the maximum land area disturbed when a tree is felled, cross-cut and milled or transported whereby there is evidence of damage to plants / agricultural crops and disturbance to the soil.

Table 26 shows the mean dimensions and area disturbed around a tree after logosol milling on farmlands at six communities and conventional logging in Bowie Forest Reserve (Plates 22 &23). The mean width of the area disturbed by logosol (on site processing) and conventional logging were 4.98m (0.57* standard deviation) and 3.45m (0.78*) respectively with a mean length of 25.35m (2.13*) and 96.01m (3.98*) in that order.

Table 26: Dimensions of areas disturbed during logosol milling and conventional logging of some trees

Statistics	Mean width (m)		Mean length (m)		Mean area (m^2)	
	Logosol lumbering	Conventional logging	Logosol lumbering	Conventional logging	Logosol lumbering	Conventional logging
Average	4.98	3.45	25.35	96.01	129.83	331.25
Standard deviation	0.57	0.78	2.13	3.98	20.19	23.47
Minimum	3.70	2.80	17.65	31.50	65.31	88.20
Maximum	6.60	4.11	40.00	160.53	264.00	659.78

These indicate that the width of the area disturbed with logosol facilities (improved chainsaw milling) was wider than that by conventional method but the mean length disturbed by conventional logging was higher. This is because with the conventional logging approach, trees felled were cross-cut and skidded away through skid trails to logging yards as shown in Plates 23 & 24. With the in-situ milling facilities, the human activities involved after felling (cross-cutting, milling and stacking of lumber) opened up the area more laterally than lengthwise as operators worked within the utilizable length of a tree. Again, farmers' paths were used for carting lumber generated on farmlands to the nearest road side. The mean disturbed areas were estimated as 129.83 m^2 (at 20.19* standard deviation) and 331.25 m^2 (23.45*) for the logosol milling and conventional logging respectively with minimum and maximum areas ranging between 65.31-264 m^2 and 88.20-659.78 m^2 in the same order.

Plate 22: Disturbed area after logosol milling

Plate 23: Disturbed areas after conventional logging

Plate 24: Loading bay in a concession

Residue generation

At each of the six study areas, dimensions of every bole and logs were taken. Microsoft Excel was used to analyse the results from which the minimum, maximum and mean butt diameters including the volume of every bole/tree were estimated, hence the volume of residue generated (Tables 27 and 28). This was compared with that by conventional method as reported by Adam *et al* (1994).

The minimum and maximum butt diameters of trees felled from each of the communities is shown in Table 27. In this case trees from Ankasie were generally bigger than the rest while Abesewa Gyaaman recorded the smallest. The minimum and maximum average diameters of trees felled in the six communities ranged between 0.4m (Essia) and 1.63m (Ofram) with the average butt diameter of each tree in a community being 0.818m.

Table 27: Butt diameters of boles of tree species extracted from six local communities

S/no	Local Community	Minimum Diameter (m)	Maximum diameter (m)	Average diameter (m)
	Twifo – Kyebi	0.42	0.955	0.655
	Japa	0.605	1.25	0.838
	Nsabrekwa	0.615	1.13	0.889
	Dominase	0.49	1.63	0.88
	Ankasie	0.755	1.341	1.062
	Abesewa Gyaaman	0.4	1.03	0.583

Table 28, which shows the log yield and logging residue generated indicates that trees on farmlands are composed more of lesser-used timber species (LUS) than primary species (PS), which are getting extinct and are of high demand. This is good news because extracting such LUS species will enhance their promotion and may not affect the sustainability of non-forest reserves.

The percentages log yield for the 13 timber species varied from 70.4% to 94.5%. The species that recorded the lowest and highest log yields were Mohogany and Avodire respectively. The mean log yield per tree/bole is estimated as 80.1% with a residue generation of 19.9%. This is an improvement upon the average logging recovery of 76% estimated by Adam *et al* (1994) for conventional logging. Considering the fact that logs taken to the mill have up to 60% milling recovery of log volume, then the harvestable bole volume will be 48.1% with the logosol mill as against 45.6% obtainable by sawmills and 45% by freehand chainsaw milling.

Table 28: Timber species extracted with percentage log yield and residue generated

Species Local name	Scientific name	Classification of species	% mean log yield	% mean residues
Wawa / Obeche	*Triplochiton scleroxylon*	Primary	83.4	16.6
Dahoma	*Piptadenia africana*	LUS	84.6	15.4
Edinam	*Entandrophragma angolense*	Primary	77.8	22.2
Danta	*Nesogordonia papaverifera*	LUS	76.1	23.9
Avodire	*Terreanthus africanus*	LUS	94.5	5.5
Essia	*Petersianthus macrocarpus*	LUS	79.8	20.3
Ofram	*Terminalia superba*	LUS	79.5	20.5
Emire	*Terminalia ivorensis*	LUS	77.5	22.5
Mahogany	*Entandrophragma utile*	Primary	70.4	29.6
Cedar	*Entandrophragma candollei*	Primary	89.0	11.0
Sapele	*Entandrophragma cylindricum*	Primary	78.6	21.4
Odum / Iroko	*Milicia excelsa*	Primary	75.5	24.5
Awiemfosamina		LUS	87.4	12.6

Plate 25: Residue by conventional logging.

Plate 26: Extracting logging residue for processing with logosol machines

The 76% of average logging recovery by sawmills means that an average logging residue of 24% is generated as against 19.9% generated by logosol milling facilities. This could be confirmed photographs shown in Plates 25 and 26, which represent the situation on the field. As big and long logs are left to rot in the forest bed after conventional logging (Plate 25), the improved chainsaw (logosol) milling machine seeks to process both the butt and top portions of trees felled (Plate 26 – left and middle) to obtain usable lumber (Plate 26 - right), which increases the lumber yield. This makes the forest bed free to enhance regeneration or creates cropping area for farmers.

Effect on Agricultural Crops

During the field study it was observed operators embarked on directional felling. A interview with some of the operators revealed that there was no sense in destroyin farmers' crops since they were operating legally, hence directional felling technique wa employed (Plate 27).

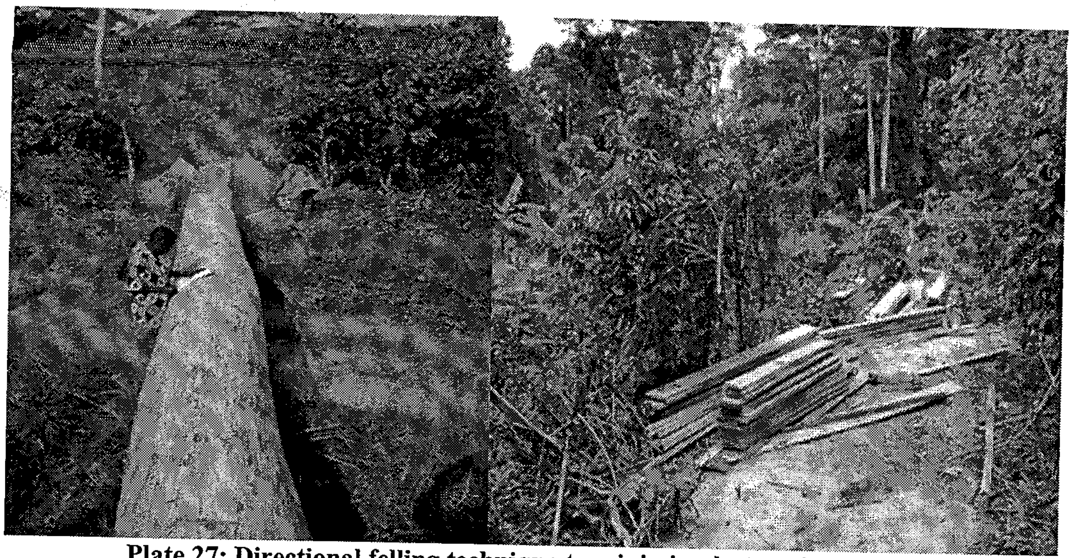

Plate 27: Directional felling technique to minimize destruction of crops

The second observation was that damage to crops was minimal and in some cases (especially during the rainy season) within 2-3 months after operation crops had sprouted. Again, in a situation where a tree had been uprooted or felled by a farmer and or field operators, a sizeable land area was created after processing the bole to enable the farmer plant more crops (Plate 28). These views were also expressed by the farmers who had had trees felled and lumbered on their farms. It was added that crops at boundary lines where trees had been felled were also doing well as seen from Plate 29. This could be attributed to the shadows of trees that are cast on crops around the boundary lines. Also the sawdust generated added some nutrients to the soil making it richer than other areas even on the same farmland. A farmer who later agreed that his trees be felled also revealed that the operators were co-operative and caring as against his prejudiced mind of wickedness. These, in addition to their share of the lumber generated from their farmlands were enough education for them to stop indiscriminate burning and felling of trees on their farmlands just to leave them to rot in order to avoid conventional logging or illegal chainsaw milling onto their farmlands.


Plate 28: Planting area created for more crops to be planted


Plate 29: Crops doing well on farmslands where lumbering has taken place

Again, some of the farmers (both beneficiaries and non-beneficiaries of the project) had a change of mind to plant commercial trees on their farms in order to benefit from what the future holds for the farmers in the rural communities. Some of the operators in an informal discussion said "the project has helped us redeem our image because it had created a good working relation between us and the farmers (communities)". Some wood species, especially lesser-used and lesser-known timber species, were observed to have regenerated.

Conclusion

The study has reaveled that in-situ processing of trees on non-reserved forests using logosol (improved chainsaw milling) facilities could be managed sustainably with communities' involvement.

There is an improvement on the log recovery over that from sawmills and illegal milling hence lumber obtainable being higher. Yield from crops on farmlands could be increased to increase in planting area, avoidance of shadows on crops and enrichment of soil with sawdust generated on farmlands.

Indiscriminate burning and felling of trees on farmlands by farmers to protect their crops will be minimized if not eradicated.

Areas disturbed after in-situ processing and conventional logging have been estimated and that area disturbed by conventional logging is much more than that by logosol milling.

About 54% of the species extracted were made up of lesser-used timber species that are of economic value. The average butt diameters of trees felled ranged from 0.583m to 1.062m.

CHAPTER 3.3

IMPACT OF ON-FARM TREES REVENUES ON RURAL LIVELIHOODS IN TWO FOREST DISTRICTS OF GHANA

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Introduction

The benefits trees offer to farmers include food, medicine, timber, fuel wood and commodities, as well as fodder and shelter for livestock and fertilizer to boost crop yields and enrich soils (Mongabay.com, 2009). In Ghana one of the most important direct benefits from trees is timber. It ranks only behind gold, tourism and cocoa in export earnings and a key provider of income for government, industry, and workers. In 1994 timber exports contributed 18 percent to total external earnings of Ghana. In 1990, the overall contribution of the forestry sector to GDP was 5.1 %. In 1995, timber exports alone contributed US$ 230 million which was 11 % total of export earnings (FAO, 1997).

However these benefits are under threat owning particularly to the high level of deforestation and forest degradation due to a number of factors. Notable among these is illegal logging that takes place both in the state forest reserves and on the farmlands or outside reserve areas. Studies have found that forest loss and degradation are not the only reasons why many poor households in sub Saharan Africa face declining access to forest resources (Oksanen *et al*, 2002). These studies have observed that local communities, poor households and women have lost access to forest resources as a result of the elite groups obtaining a greater share of the existing resource (Anold, 1991; Scoones *et al*., 1992; Shepherd *et al*., 1991; Wachiira, 1987). Logging and mining companies often displace traditional forest owners (Ribot, 2000; World Rainforest Movement, 2002, a, b, d; World Rainforest Movement, 2001). Also government policies frequently favour these groups with concessions, licenses and permits whilst denying similar rights to poorer local inhabitants (Ribot, 2000; World Rainforest Movement, 2002, a, b, d; World Rainforest Movement, 2001).

The causes for the decline of forest resources, particularly timber to local communities in Ghana are not different. Whilst it is recognized that government revenues from timber exports, taxes and levies are used for the overall development of the economy which indirectly impact on rural communities livelihood, the other direct benefits that are supposed to get to the local communities are the stumpage revenue earned from the extraction of timber. According to Forestry Commission, (2009), the office of Administrator of Stool Lands (OASL) and Forestry Commission (FC) are responsible for the management of the Forest proceeds on behalf of stool / landowners. The FC manages the Forest and collects revenue by way of stumpage and the OASL ensures that the stool / landowners are fairly treated in the context of the prevailing disbursement laws. For the management of the forest on behalf of the Government and the Stool/Landowners, the Forestry Commission is authorized to retain some percentage of the stumpage fees. It is provided in the constitution that the net revenue accruing from Stumpage/Rent after providing for FC's management fees of 50% and 10% for the OASL shall be deemed as 100% and to be distributed as follows; 25% to Stool; 55% to District Assembly and 20% to Traditional Council (Owusu *et al.*, 2008). This stumpage revenue is expected to be the direct benefits to local communities and is expected to get to them through the district assembly and the traditional council development activities. However, most of these benefits do not flow regularly to these local communities. Even if it gets to them, they get it in the form of public goods which make it difficult for them to perceive it as the benefit coming from their trees. As result of these, local communities do not adequately protect timber trees on their farmlands and others tend to condone illegal chainsaw operators to harvest these trees against the law.

The present ITTO project on processing trees on farmlands and logging residues with local community's collaboration is intended to address this problem. It intends to make local communities benefit directly from trees on their farmlands with the ultimate aim of encouraging them to protect the trees so that the desired overall benefits of trees on farmlands can flow to them in the long run. This study reports on the impacts of the processing, utilization and marketing of lumber and lumber products from this project on the livelihood of the participating local communities. The aim is provide information to support forest policy decisions in enabling local communities derive benefits directly from timber trees on farmlands that will motivate them to nurture and protect trees on their farmlands.

Methods

Study area

This study was conducted in Dunkwa forest district in the Central Region and Asankragwa forest district in the Western Region. Before the intervention of the project

88 people were interviewed in 4 villages involving-three in the Western and one in the Central (Table 29). Three years after the intervention of the project 72 people were interviewed in the same villages in the same forest districts, which were the project areas.

Table 29: Distribution of number of people surveyed in communities in the project areas

	Name of Forest District			
	Before		After	
Community	**No. of people in Dunkwa**	**No. of people in Asankragwa**	**No. of people in Dunkwa**	**No. of people in Asankragwa**
Japa	44	0	12	0
Nsabrakwa	0	2	0	17
Ankaasie	0	10	0	25
Dominase	0	9	0	14
Total	67	21	16	56

Conceptual framework on livelihood

In order to assess the impact of the revenue from processing trees on farmlands on livelihoods, a livelihood systems model adapted from Soussan *et al.*, (2001), as shown in Figure 7, was used. Carney, (1998) presents a definition of livelihoods based on the work of Robert Chambers and Gordon Conway and quoted in Prakash *et al.*, (2003) as:

"A livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both now and in the future, while not undermining the natural resource base". (Carney, 1998, p. 4).

Based on this definition, the framework for analysing the impact of timber revenue on the livelihood of the participating communities is depicted in Figure 8.

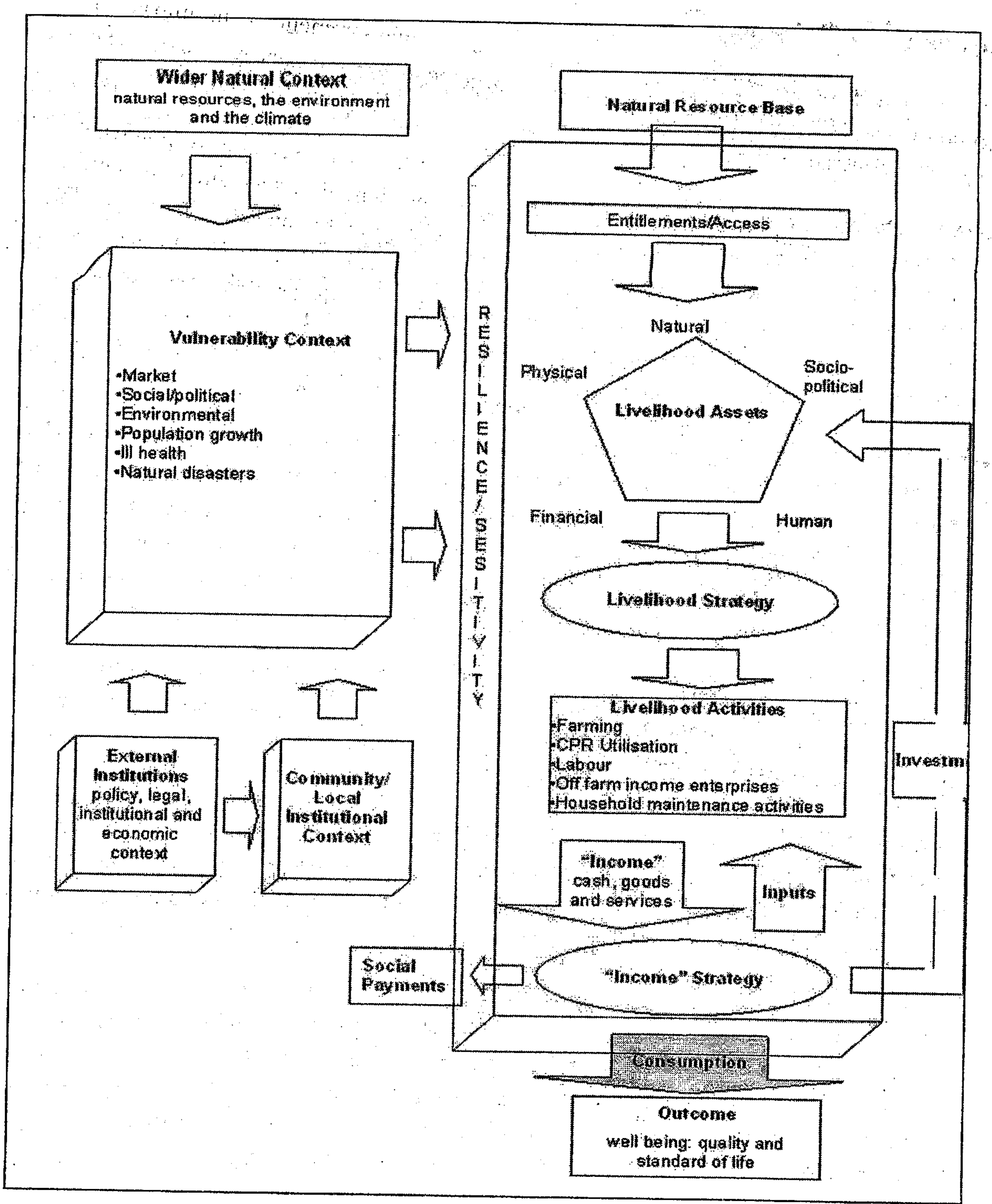

Figure 7: Livelihood Systems model (Soussan et al., 2001)

Construction of indicators of livelihood improvement

The five livelihood indicators have been adopted for the measurement of the impact of this project. Variables for these have been constructed using the survey results. The constructed variables include:

Physical capital: This is measured as the percentage of the total household respondents in the survey indicating that they have the basic household assets such as farm implements, jewellery, transport, cooking utensils and clothing among others. It is anticipated that with the implementation of this project, where lumber is sold and the revenue distributed to community members, they could increase or acquire these basic physical assets to make life worth living.

Natural capital: This is measured as the average number of timber trees age 2 years and above possessed by household respondents on their farmlands in each community. It is expected that with the execution of this project, where community members begin to see the tangible benefits they stand to gain from these timber trees on their farmlands, they will be more careful and interested in maintaining and protecting these trees on their farmlands. Over time the number of trees per the survey participants will increase.

Financial capital: Is measured as the average income earned from forestry activities in a year by the household members that are surveyed. With this project, household members earn income directly either by engaging in the project through carrying of lumber or having trees processed on their farmlands.

Human capital: Is measured as the average annual expenditure on education by household members that are interviewed. It is also expected that with the income communities members earn from the project, many more will be able to spend more on the education of their children in the form of the secular training and learning of trade.

Social capital: Is measured as the average annual expenditure on social and religious activities by household members. It is hypothesised that, at these gathering, communities' members form their networks and connections that assist them to improve their livelihood. Therefore with the money earned from the project, many more of them will be able to pay their church dues, harvest levies, association dues, 'susu' deposit savings and funeral donations and therefore strengthen their ties with their various social groups.

Data collection

Questionnaire was designed to collect baseline livelihood information on the communities' participation in the project. This was done in the early part of the project in February and March 2007. Reconnaissance visits were first made to these communities. At these visits themes or open ended questions were discussed with the community members. From these a closed ended questionnaire was designed and pretested and the full scale survey of the communities conducted. This was done to provide the baseline livelihood information upon which the projects intervention in the area of livelihood impact is measured using results of the survey of the same sample units in February and March 2010, three years after the project's intervention. The questionnaire focused on the livelihood activities of communities' members, household characteristics and their coping strategies following crisis in the previous years. The distribution of the number of people interviewed across the two forest districts are indicated in Table 29.

Data analysis

Descriptive statistics including means, percentages and frequency tables were used to analyse the data. For the livelihood measure, radar diagrams and principal component analysis were used upon the construction of the livelihood indicators from the data. The analyses were made separately on village basis and then the combination of all the villages using spread sheet in excel.

Results and Discussion

Household characteristics

For the 81 individual respondents before the intervention of the project, mean household size was 5, which is slightly higher than the mean national household size of 4. However the standard deviation of 3 clearly point out a wide variation of the household size around the mean. It is not surprising that the minimum household size was one and the maximum was 14. On distribution of the sample by gender, more males were interviewed than females as indicated in Table 30. Similar patterns were observed, before and after the project intervention.

Table 30: Distribution of respondents by gender across the different target communities under the project

Community	Gender of respondent			
	Before		After	
	No of Male (%)	Female (%)	No. of Male(%)	Female (%)
Japa	77	23	92	8
Nsabrakwa	100	0	88	12
Ankaasie	80	20	76	24
Dominase	100	0	93	7

Access to facilities in communities

On availability and access to basic facilities that contribute to the livelihoods, Japa community seems to be better off in terms of water supply, as 62% of them have access to water from the bore holes, while only 42% of all the 85 respondents have access to this source of water. As indicated in Table 31, 55% of the respondents depend on hand dug wells and rivers for their water supply. This implies interventions to improve the water supply in these communities might be useful to them.

Table 31: Number of respondents (%) indicating type of water supply accessible in the community

Community	Number of respondents(%) indicating type of water supply							
	Before				After			
	River (%)	Hand dug well (%)	Bore hole (%)	Pipe borne (%)	River (%)	Hand dug well(%)	Bore hole(%)	Pipe borne(%)
Japa	18	14	66	2	25	8	58	9
Nsabrakwa	50	0	50	0	17	12	53	18
Ankaasie	10	60	30	0	0	12	44	44
Dominase	22	78	0	0	0	8	21	71

The situation of solid waste disposal is typical of most rural communities in the country where the free range disposal is prevalent in most northern parts of the country and the pit latrines in the southern part. It is not surprising that majority of respondents make use of this type of solid waste disposal compared to only a few who have access to the improved

KVIP system (Table 32). While before the project, 60% of respondents used the free range (open) solid waste disposal, three years after the project intervention, fewer (20%) people now used this type of facility as against 76% that used the pit in Ankaase community.

Table 32: Number of respondents indicating type of solid waste accessible in the community

Community	Number of people (%) indicating type of solid waste disposable available							
	Before			After				
	Pit	Water closet(water sealed)	Open	KVIP	Pit	Sanitary/ring-slab	Water closet(water sealed)	Open
Japa	68	2	0	30	33	17	8	42
Nsabrakwa	100	0	0	0	94	0	0	6
Ankaasie	40	0	60	0	76	4	0	20
Dominase	100	0	0	0	36	21	0	43

Access to electricity seems better. Most households have access to electricity as indicated in Table 33. Nsabrakwa community seems to be worst off before the project, but has slightly improved three years after the intervention of the project, as 12% of respondents managed to have access to electricity. This might be due to the rural electrification drive embarked on in the country. The results show that some level of development is taking place in these communities.

Table 33: Access to electricity in communities

Community	Is there electricity in the house			
	Before		After	
	Yes(%)	No(%)	Yes(%)	No(%)
Japa	80	20	92	8
Nsabrakwa	0	100	12	88
Ankaasie	90	10	88	12
Dominase	78	22	86	14

Housing facilities for communities

The houses the communities live in are mainly the mud bricks houses. Over 94% of respondents in all communities lived in such accommodation before the intervention of the project; while cement block houses were barely 2% as indicated in Table 34. There seems to be improvement, three years after the implementation of the project. As indicated in Table 35, many more respondents now live in cement block houses than before.

Table 34: Access to housing facilities for communities-nature of wall

Community	Number of respondents (%) indicating type of residential main house (wall)								
	Before				After				
	Brick	Cement block	Bamboo	Wood	Brick	Cement block	Bamboo	Wood	Straw
Japa	94	2	2	2	50	42	0	8	0
Nsabrakwa	100	0	0	0	41	6	6	35	12
Ankaasie	100	0	0	0	56	32	4	8	0
Dominase	100	0	0	0	57	36	0	7	0

The roofs and floors of the houses of these community members appear better. Majority of respondents are able to acquire iron sheets (zinc) to put over their roofs particularly three years after the intervention of the project. While in Nsabrekwa community, no respondent had iron sheet roof before the intervention of the project, 77% of respondent are able to roof their houses with iron sheets, three years after the intervention of the project

Table 35: Access to housing facilities for communities-nature of roof

Community	Type of residential main house(Roof)			
	Before (%)		After (%)	
	Zinc	Bamboo	Zinc	Bamboo
Japa	98	2	92	8
Nsabrakwa	0	100	77	23
Ankaasie	100	0	64	36
Dominase	78	22	79	21

In the case of the floors of the houses in which these communities' members live in, majority of them are able to afford cement for flooring their rooms, while few community people still use ordinary mud for their floors (Table 36). There appears to be improvement three years after the intervention of the project, as many more respondents used cement floors compared to the mud floors (Table 36)

Table 36: Access to housing facilities for communities-nature of floor

Community	Number of respondents (%) indicating type of residential main house(Floor)					
	Before			After		
	Tiles	Mud	Cemented floor	Mud	Cemented floor	Clay
Japa	0	3	97	8	58	34
Nsabrakwa	0	50	50	12	53	35
Ankaasie	0	0	100	0	88	12
Dominase	0	22	78	0	69	31

Livelihood activities of communities

Primary occupation of the community members show that they are mainly engaged in agriculture for their livelihood in both districts (Table 37). The large dependence on agriculture by these communities' members for their livelihood indicates the importance of forest resources, particularly the on-farm trees.

Table 37: Primary occupation of household members in communities

Primary occupation	Before % total respondents (N=86)	After % of total respondents (N=71)
Agriculture	238.4	204.2
Unemployed	2.4	1.4
Agricuture labour	4.7	1.4
Blacksmith,Cobbler,Carpenter,Sewing etc	23.3	53.5
Salaried worker	4.7	5.6
Petty business	10.5	11.3
Business	7	1.4
Handicraft	2.3	7
Student	201.2	260.6
Private/government service	1.2	-
NGO worker	1.2	5.6

Levels of impact of on-farm tree revenue on community's livelihood

The initial assets levels of the household respondents are indicated in Figure 8 for the different communities. In Figure 8, the value for the natural capital for the Nsabrekwa community members could not be found and that makes the bar to be zero. In all the four communities, the natural assets involving average number of timber trees owned by communities' members is the lowest of all the five livelihood indicators (Figure 8). This might be as a result of their lack of awareness of these trees due to their perception that they do not get much benefit from them. Among the five livelihood indicators in all the communities, the financial assets indicator appears to be the highest. This might be driven by earnings from cocoa, which most of these communities' members are engaged in. For this indicator shown in Figure 8, Nsabrekwa community leads.

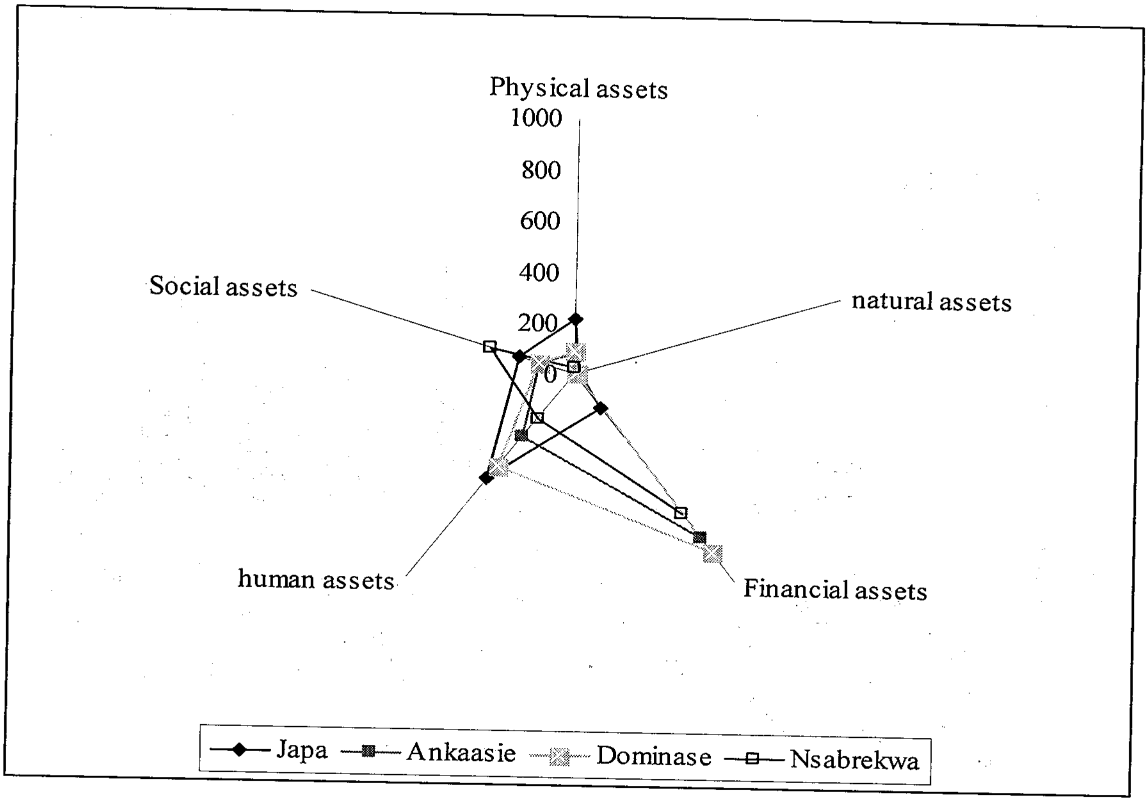

Figure 8: Initial levels of livelihood assets possession in the 4 communities

The performance of the livelihood indicators before and after the intervention of the project is indicated in Figure 9 for the four project communities. There appears to be improvement in the physical assets status of the household respondents in Ankaase, Dominase, and Nsabrekwa communities. The social and human capital status has, however, improved for these four communities (Figure 9). Contrary to expectations, the financial capital status of respondents has rather declined, three years after the project intervention. The cause for this could be attributed to the lack of proper data collection on this key variable. Some amount of physical cash was distributed to participating community members. Other community members also earned some money directly and indirectly from the project, and these monetary benefits appear not to have reflected on this indicator. The improvement in these livelihood indicators, could not be entirely attributed to the project interventions, but can be concluded that, it has contributed to it, though minimally. Possibly a more significant contribution could be made if the intervention of the project is sustained for a longer period of time than these initial three years.

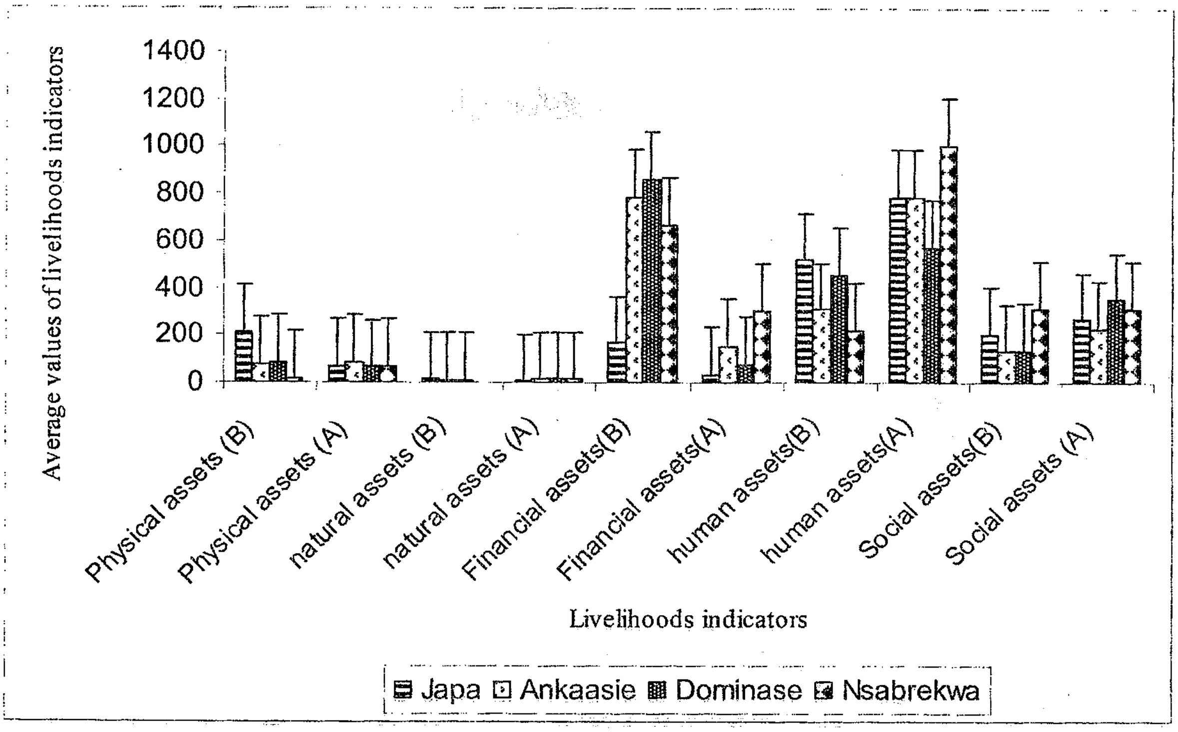

Figure 9: Assets levels of household respondents in 4 communities before (B) and 3 years after (A) project intervention

Mitigative effect of on-farm tree processing on community's crisis status

The crisis households have been through is indicated in Figure 10 before and after the intervention of the project. These include a wide range of problems among these communities in the forest areas. Key among them is illness, poor food production, food shortage and loss of household members and funerals. As shown, these crises cover all aspect of life including financial, social, natural, human, and physical. Some of these crisis are natural and possibly beyond the direct control of communities. For instance, drought, excessive rainfall, and wind damage to crops are crisis that appear to go beyond the control of members. These are the indicators that have rather increased beyond the base year level three years after the project intervention. For the remaining indicators, there seems to be no significant decline in these crisis levels that community members encounter. All these have negative impact on the livelihood of these community members and point at the trouble forest community members go through. It also points to the fact that short, long term, as well as multi sectorial interventions might be required to improve the livelihood of these forest community members.

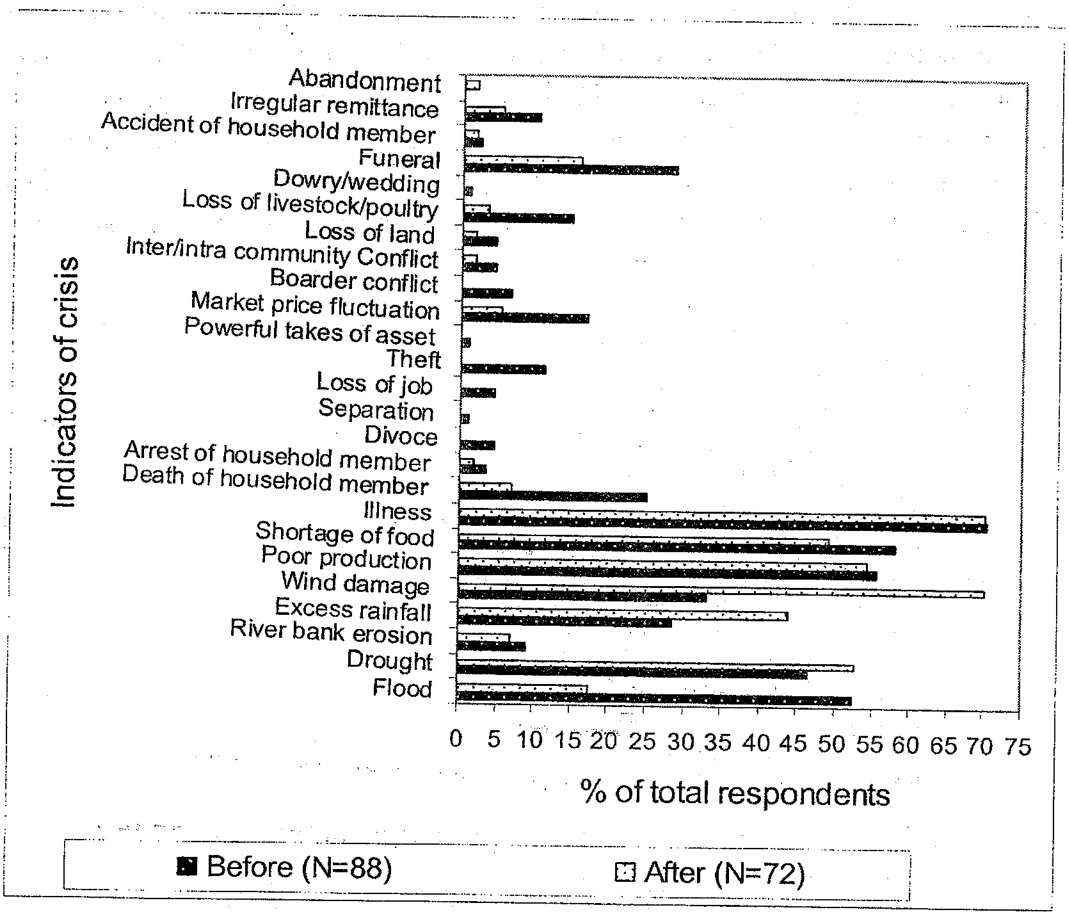

Figure 10: Crisis communities experienced in the course of the year before and after project

Indication of community coping strategies with crisis

In the event of crisis, community members have their own way they go about to cope with the crisis. These coping strategies include loan from neighbors or relatives, adjustment of meals, sale of agricultural produce at reduced prices and sale of trees. This later action possibly is the sale of timber trees on their farmlands to the illegal chainsaw operators in order to get out of the crisis (Figure 11). Three years after the project intervention this strategy did not seem to have reduced significantly as compared to the baseline level, pointing out that community members still resort to sale of trees on their farmlands to get out of crisis situation. Though the project has shown how community members can benefit directly from trees on their farmlands, once the laws and rules governing access to these trees have not changed in their favour, it appears these community members still harbour the fear of non benefit from timber on their farmlands, hence their continuous sale of trees to the illegal chainsaw operators.

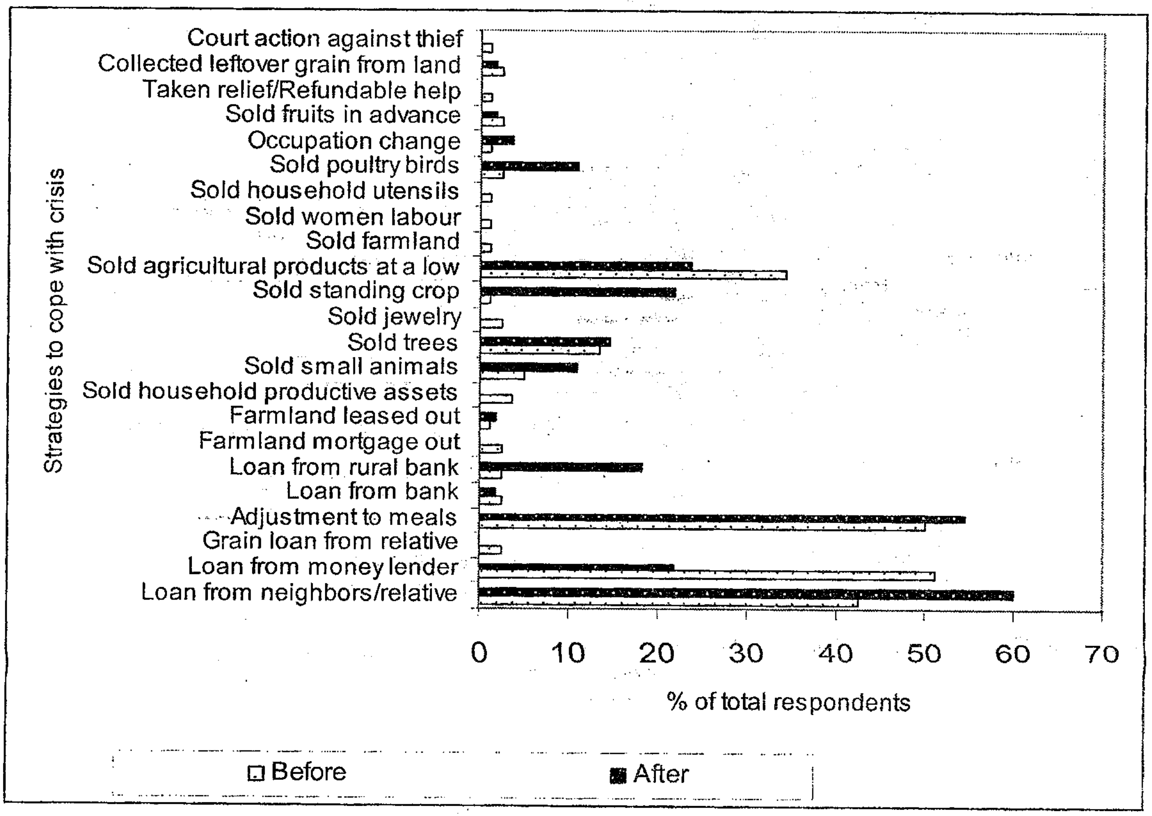

Figure 11: Community coping strategies with crisis before and after project intervention

Conclusion and policy implications

Understanding the living conditions of local community members is the starting point for providing the relevant interventions that will improve their living condition and ease the pressure on the environment and also make them committed to its management. This report has provided important information on how the processing of farmland trees impact on the livelihood and living conditions of community members in the project area and for that matter the forest areas. The most important contribution is in the area of social, human and physical assets status of participating community members. This is derived from the project through revenue generated from the processing of the trees on farmlands and logging residues that has been distributed to community members. Other community members also benefited from the project through earnings from services delivery in the form of lumber carrying, lumber sales or marketing, etc.

For crisis that communities go through, the report has identified irregular and poor rainfall pattern leading to drought, excessive rainfall leading to flooding and damaging of crops by the wind. This brings about poor production of food that leads to food shortages, illnesses and funerals among communities. The ways community members cope with these crisis are the sale of trees possibly due to the presence of illegal chainsaw operators, sale of food products at reduced prices to attend to the crisis. The sale of trees to illegal chainsaw operators did not seem to have reduced drastically in the target communities three years through the project. This may be due to fears among community members about their inability to benefit directly from timber trees on their farmlands due to the laws governing the access of such trees; though the project has shown them the way they can directly benefit from trees on their farmlands. Sustained education and assurance of forest communities that have been done in this project that they can benefit directly from timber trees on their farmlands in future can let them stop or minimise the sale of trees on their farmlands to the illegal chainsaw operators. However, this should be backed changing the laws governing the access of trees on farmlands in favour of communities.

In general, interventions in these forest communities would make meaningful impact if they are designed to target the general conditions of living of these community members. They would again bring significant relief to the communities if they also target these short term crisis that communities go through and the way they cope, particularly sale of farmland trees and sale of food products at reduced prices. This therefore point out the importance of processing trees on farmland. Although, its impact on the livelihood of community members may not be so significant, it shows one way through which livelihood of the forest communities could be improved and at the same time ensures sustainable management of the forest resources. That is if due to the benefits that communities members enjoy from the project, they become committed to the growth and protection of trees on their farmlands.

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CHAPTER 4

IDENTIFICATION OF GAPS IN POLICY AND REGULATORY FRAMEWORKS ON GOVERNANCE RELATED TO PROCESSING OF TREES ON FARMLANDS AND LOGGING RESIDUES

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Abstract

The ITTO funded project titled 'processing and utilization of trees on farmlands and logging residues through collaboration with local communities' was developed to address the need to optimise resource utilization by streamlining policies and procedures that govern communities' access to timber both from standing trees and logging residues in their farmlands. There are several legislative and institutional constraints for communities to have access to trees on their farms and logging residues from logging companies and to process them for some economic benefits.

This does not promote collaboration which is very much needed to ensure protection of forest resources from illegal exploitation. The study explored these constraints through desk review of relevant policies and laws and active stakeholders' participation including communities and recommends that:

1. *a memo should be submitted to the national forest policy review team to consider ways of internalising key lessons from the project into the new forest and wildlife policy which is under preparation.*
2. *The Ministry of Lands and Natural Resources should initiate appropriate legislative reforms that can promote benefit sharing arrangements to include farmers and to ensure accountability of community revenue through traditional authorities and District Assemblies*
3. *Specifically, mechanisms must be developed to support the proposal for farmers/landowners to get a direct 40% of stumpage value of trees on farms to compensate for management (tending and protection of trees); FC could take 10% to cover administrative costs and the remaining 50% sent to the AOSL to distribute according to the constitutional formula.*

4. *A project should be designed to pilot the establishment and operation of Community Logging Enterprises in selected forest areas in order to learn lessons for up-scaling. In particular, the policy, institutional and regulatory framework that can improve access, utilisation, management and benefit sharing of benefits must receive attention.*

Background of Study

The ITTO funded project titled 'processing and utilization of trees on farmlands and logging residues through collaboration with local communities' was developed to address the need to optimise resource utilization by streamlining policies and procedures that govern communities' access to timber both from standing trees and logging residues in their farmlands. The overall development objective is to increase the benefits that local communities derive from forest resources and thereby enhance their contribution to sustainable forest management. The specific object is to promote processing of logging residues and trees on farmlands and thereby provide increased timber products as well as generate employment and income to local communities and some individual farmers.

Against this background, this report attempts to contribute to the development of governance and policy framework for the extraction, processing and utilisation of logging residues and trees on farmlands. Specifically, it reviews the existing policy and regulatory framework with the view to identifying the relevant gaps and to propose policy options to fill these gaps.

The identification of the gaps will be determined by a deeper assessment of what is desired by stakeholders, especially communities with respect to sustainable access to legal timber and the extent to which the existing policy and regulations provide for this. The report gives some background to the extent of dependency of local communities on forest, particularly for timber. It follows by elaborating the context by highlighting the tree tenure and timber rights regime prevailing and the extent to which it mediates local people's access and use of legal timber. The next section focuses on a description of the sector forest policy and legislative framework with respect to access, processing and utilization of timber. The next section then analyses the previous sections to identify the relevant gaps that need to be filled. The conclusion section gives suggestions on possible policy options to fill the identified gaps and proposes that this be subject to stakeholder discussion and validation.

Introduction

Security of tenure of natural resources is an important issue if local communities are to use the natural resources in their localities sustainably. Natural resources tenure simply refers to the terms and conditions on which natural resources are held and used. Thus forest and tree tenure refers to the terms and conditions on which forests and trees are held and used (Bruce, 1986). It includes questions of both ownership and access or use rights. The set of rights that a person or some private entity holds to forests or trees may include the right to own, to inherit, to plant, to dispose of and to prevent others from using trees and tree products (Fortmann, 1985). Hackett (2001) also describes five rights that, when combined, form the bundle of rights usually referred to as ownership. These are (a) Access - the right to use (but not harvest) a resource; (b) Withdrawal - the right to both access a resource and withdraw resource units (harvest); (c) Management - the right to manage the use, maintenance, and monitoring of a resource; (d) Exclusion - the right to determine the rules governing who can and cannot use the resource; and (e) Alienation - the right to sell the resource. Tenure is not a matter of man's relationship to natural resources such as forests and trees. It is a matter of relationships between individuals and groups of individuals in which rights and obligations with respect to control and use of natural resources are defined. It is thus a social institution (Birgegard, 1993).

Access to and use of natural resources is the key to survival for a majority of people in the developing world. The control and use of land and other natural resources have been the way to sustain the family or the household (Birgegard, 1993; Lawry, 1990). One of the factors that affect the level and type of consumptive utilisation of forests in many settings is the security of tenure that local residents possess in relation to forests. Individuals who lack secure rights are strongly tempted to use up these resources before they are lost to the harvesting efforts of others (Banana and Gomya-Ssembajjwe, 1998). Similarly, where forest habitats have little economic value to local people because of restrictive access rules, sustainable local management institutions are unlikely to emerge (Lawry, 1990). Tenure therefore determines, in large part, whether local people are willing to participate in the management and protection of forest and tree resources.

This analysis does not primarily concern itself with the technical feasibility aspects of utilisation of trees on farmlands or logging residues. It is mainly concern with the extent to which the existing policy and regulatory framework allow local people to commercially utilise trees on farms and logging residues.

2. Understanding the Context

2.1 Tree tenure rights in Ghana

One of the several reasons[1] that have been identified to explain the continuation and expansion of 'illegal' chainsaw milling in Ghana is the lack of clarity over forest and tree tenure, particularly tenure of trees on farms (Odoom, 2005; Marfo 2004; Agyeman, 2003; 2004). This has resulted in strong support of some local communities for 'illegal' chainsaw operations. For example, reviewing underlying causes of 'illegal' chainsaw

[1] Other reasons include corrupt practices within various institutions entrusted with the management of forests and control of timber harvesting (Adam *et al.* 2007a), the deficit of saw mill timber for local markets and the low price of chainsaw lumber relative to sawmill lumber produced for local markets (Adam *et al.* 2007b), and the lack of employment opportunities in villages in rural areas (Afranie, 2003). Also see Marfo and Nutakor (this volume)

operations, Agyeman (2004) noted the strong support of some local communities for 'illegal' operators as a significant reason. Indeed, there is increasing evidence that farmers continue to play significant role in this illegality by conniving with chainsaw operators (Lambini *et al.*, 2005). Odoom (2005) also asserts that the alienation of traditional authorities and tree-tenure insecurity on the part of farmers have promoted their connivance with and participation in the chainsaw lumber trade. It has been identified that such cooperation with 'illegal' chainsaw operators offers better economic incentive to farmers than official logging arrangements (Marfo, 2004).

Forest and tree tenure arrangements and timber logging rights in Ghana, especially in the off-reserve areas of the high forest zone (HFZ), is highly complex. Depending on whether trees are planted or are naturally occurring and whether they occur on family, communal or rented land, several usufruct rights exist. Thus, tree tenure systems operating in forest reserves are different from those outside reserves. In off-reserve areas, tree tenures are also different for planted trees compared to those growing naturally, and for timber trees compared with non-timber species (Marfo, 2006; Acheampong, 2003; Agyeman, 1993; Asare, 1986). These differences are considered below.

Rights to planted trees outside reserves

In a study of indigenous tenures relating to trees and forests, Asare (1986) observed that, in most parts of the HFZ, any individual (man or woman) who has the right to use a piece of land in perpetuity also has the right to plant any species of trees, and such trees are vested in the planter/cultivator. People who have the right to use a piece of land in perpetuity are individual members of the land-owning group who have acquired land through inheritance, gift or allocation. Strangers who have acquired long-term title or right to the use of land through some form of agreement (such as granting on leasehold basis) also have the right to plant and use any species of tree. However, strangers with temporary use of land do not have the right to plant permanent trees on those lands.

Although customary laws do not prevent tenants from planting trees, landowners do not encourage this because most people believe that the long production period and the lack of appropriate documentation of land ownership increases the security of the tenant to land rights when trees are planted. Thus, an attempt by a tenant to plant trees is regarded as an attempt to acquire permanent ownership of land. This appears to be a common practice throughout much of Africa (Arnold and Bird, 1999; Warner, 1993; Agyeman, 1993).

In a study of the extent and manner in which forest-based resources form part of livelihood structures of forest fringe communities in the Asankrangwa Forest District, Acheampong (2003) noted that people generally have more secure rights to planted trees than those occurring naturally. The planter can will trees planted on privately acquired land to anyone he likes. However, trees that are planted on family or lineage lands can only be inherited by members of the lineage group. Apart from the use of small portions for medicinal purposes, no one has the right to any other use of planted trees and their products without permission from the planter (including even fruits that are found under the trees). Persons with temporary rights who cultivate sites planted with trees enjoy only subsistence rights; they can pluck fruits or any other produce for their personal use but not in commercial quantities (Asare, 1986). According to Agyeman (1993), trees that have been planted on communally owned land cannot be harvested by individuals without the approval of the Chief or Town Development Committee.

Rights to naturally-occurring trees outside reserves

Rights to naturally-occurring trees outside reserves vary between timber and non-timber species. In the case of non-timber trees (such as kola, oil palm, raphia palm, bamboo, etc.), the rights also depend on whether the tree has some commercial value or it is for subsistence use only (Acheampong, 2003; Asare 1986). Rights to naturally-occurring non-timber trees that have some commercial value, such as kola, oil palm, raphia palm, etc. are restricted and are vested in the landowner. For example, only landowners or people who have perpetual use of land on which kola or oil palm trees occur can harvest the fruits. Members of the community can, however, pick fruits that have fallen on the ground. Any other use of such commercially valued non-timber trees will have to be agreed by the landowner. For example, permission has to be obtained from the landowner before naturally-occurring oil palm or raphia palm can be tapped for palm wine (Acheampong 2003; cf. Asare 1986)

The right to naturally-occurring non-timber trees that are only of subsistence value is very much more relaxed. For example, bamboo and fruit trees (such as pawpaw, *Dacryodes klaineana, Chrysophyllum albidum, Spondias monbin*, etc.) can be collected from anywhere without permission from the landowner provided crops are not damaged (Asare, 1986). In general, naturally-occurring non-timber trees on communal land belong to the whole community and anyone can harvest products from them (Agyemang, 1993).

All naturally-occurring timber trees - whether on private or on communal land, or even on private farms - however, 'belong' to the government. The use of such trees is controlled by legislation and it is an offence for an individual or community to cut or sell timber or merchantable tree species without permission from the appropriate government institution. The right to control and manage tree resources, including allocation of logging rights, is vested in the state (cf. Matose, 2002). Farmers have no legal rights, either to harvest timber trees they maintain on their farms, or to any of the revenue accruing to timber extraction, though they continue to exercise judgement over which trees to maintain on their farms during clearing for cultivation (Amanor, 1999, cited in Marfo, 2006). The revenue accruing to timber sales, irrespective of source of timber, is shared among the District Assembly, landowners (Chiefs), Administrator of stool lands (public agency) and the Forestry Commission (Marfo, 2006). Farmers therefore do not benefit directly from timber trees they protect on their farms, which is a strong disincentive to farmer tree management and protection (Ardayfio-Schandorf *et al.*, 2005). This appears to be the result of British colonial forest policy; virtually all ex-British forestry departments regulate local people's access to forest and tree products (cf. Bradley, 1992; Cline-Cole, 2000).

Even though farmers' right of consultation before timber harvesting operations has been admitted by law[2], loggers rarely consult them when timber trees on their farms are felled and are rarely compensated for damage to food and cash crops resulting from logging operations on their land (Marfo *et al.*, 2006). This, in addition to frustrations in claims processes, and the fact that farmers do not benefit from timber trees they protect on their farms, has resulted in some farmers selling trees to 'illegal' chainsaw operators and illegally destroying valuable tree species on their farms before concessionaires can gain access to them. The frequency of such conflicts casts doubt on the effectiveness of forest and tree tenure systems in Ghana regarding adoption and implementation of sustainable forestry practices (Owubah *et al.*, 2001).

Rights to trees and other products in forest reserves

In pre-colonial Ghana (then called the Gold Coast), forests were owned in common by communities (families, clans and 'stools'[3]). However, the country's Forest Ordinance of 1927 gave authority to the colonial government to reserve parts of the country's forests. Although the bill did not alter ownership of the forest reserves, it vested control of them

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[2] First, the Forestry Department (now Forest Services Division) instituted some Interim Measures in 1995 to guarantee farmer consultation and compensation payment. This was given additional administrative force by enshrining the provision in the FSD's Manual of Procedures for controlled timber production in off-reserve areas (Section F). These regulations were given full legal force with the promulgation of the Timber Resource Management Act, 1998 (Act 547) which admitted the right of farmers/owners for consultation and authorization prior to the granting of any timber right (Section 4.2).

[3] A 'stool' refers to a community governance or administrative structure similar to dynasties (Kasanga *et al.*, 1996, cited in Owubah *et al.* 2001).

in the government of Ghana and prescribed that they should be held in trust for the communities. Thus, all forest products within forest reserves, including both timber and non-timber tree species and even NTFPs are vested in the government (Owubah *et al.* 2001).

Although, in theory, the ownership of land and forests did not alter at the time of reservation, in practice, the traditional owners have no right of access to the trees or land in the reserve, except on permit from the competent government authority, the Forest Services Division (FSD). The management of trees, the right to own, plant, use and dispose of trees within the forest reserves is controlled by the state, through the Forest Protection Decree of 1974 (or National Redemption Council Decree (NRCD) 243). This decree has, from the beginning, created a feeling of animosity between local communities and the FSD (Agyeman, 1993).

Under the working plans of all forest reserves, the following communal rights are usually admitted in forest reserves on permit: communal rights to hunting, fishing, collecting of fuelwood, snails, medicine, etc.; and farming rights to admitted or allowed farms. These communal rights, admitted in forest reserves only on permit, have been the subject of several disputes between the FSD and local communities (Agyeman, 1993). Communities want less restricted access to forests. Indeed, in a study of the contribution of forests to livelihoods in the Asankrangwa Forest District, several households complained that the procedure for acquiring a permit is cumbersome and that the FSD does not readily give permits for the collection of certain forest products (Acheampong, 2003). While the FSD claims that subsistence uses of NTFPs, such as snails, mushrooms, fruits, etc. from forest reserves is allowed, local communities report that this is rarely the case. The problem therefore seems to be one of distinguishing between what constitutes subsistence use and commercial use. Local people resent this form of exclusion and see the permit as too expensive and complicated for obtaining items for personal or domestic use

(Acheampong, 2003). Most admitted that they sometimes sneak into the reserved forests to hunt game and collect other forest products. This raises questions about the effectiveness of the permit system itself.

2.2 Policy and regulatory framework

What does the 1994 Forest and Wildlife policy say? Since the establishment of forest reserves, forest management was solely the preserve of the state forestry department and communities were alienated. The only management practice with community involvement was the taungya system. In this system, farmers were allowed to cultivate crops in forestlands while tending timber seedlings until they grow to cover crops when the farmer is required to harvest his crops and leave the land. Increasingly, the awareness of the need to involve communities in forest management resorted in the establishment of the Collaborative Forest Management unit within the then forestry department in 1992. The 1994 Forest and Wildlife Policy of Ghana responded to the need for recognising community rights to access and benefit from forest resources:

> The Government of Ghana recognizes and confirms the right of people to have access to natural resources for maintaining a basic standard of living and their concomitant responsibility to ensure the sustainable use of such resources (3.2.1)
>
> A share of financial benefits from resource utilization should be retained to fund the maintenance of resource production capacity and for the benefit of local communities (3.2.8)

There are additional supporting actions in the policy document that set the tone for the development of social forestry:

> The need to develop a decentralized participatory democracy by involving local people in matters concerned with their welfare (3.2.15)

The urgent need for addressing unemployment and supporting the role of women in development (3.2.16)

Two concrete strategies were laid out to provide a basis of some power and benefit sharing in forest management

Encouragement of local community initiative to protect natural resources for traditional, domestic and economic purposes, and support, with the reservation of such lands to enable their legal protection, management and sustainable development (5.3.10);

Development of consultative and participatory mechanisms to enhance land and tree tenure rights of farmers and ensure access of local people to traditional use of natural products (5.5.5)

As far as supply of wood for domestic consumption, either directly by rural dwellers or traded is concerned, the policy has been regulated supply by sawmills.

The 1994 Forest and Wildlife policy make some explicit commitment to the supply of wood to the domestic market. The second policy objective seeks to:

"Promote the development of viable and efficient forest-based industries, particularly in secondary and tertiary processing, so as to fully utilise timber and other products from forests and wildlife resources and satisfy domestic and international demand for competitively-priced quality products"

Additionally, drawing from its various guiding principles, on the right of people to have access to natural resources for maintaining a basic standard of living and the urgent need for addressing unemployment, one can conclude that government, theoretically, has a clear policy direction towards addressing domestic timber issues.

The two specific instruments to implement this policy have been:

- issuance of special timber utilisation permits to selected 78 small to medium scale sawmills to produce entirely for the domestic market
- a directive in accordance with section 36 of LI1649 that all holders of TUCs were to supply 20% of their lumber production to the domestic market.

According to recent reports (TIDD, 2005; Parren et al. 2007), these instruments have largely failed. In practice, one can argue that there is no well-enforced policy directive to ensuring supply of saw mill lumber. The lee way for communities to have access to timber was guaranteed by L.I 1649 in the form of issuance of timber utilisation permits (TUPs). However, Parren et al. (2007) in their review also observed that this has been abused and TUPs have mainly been given to commercial timber interests.

However, domestic timber demand is high and there is increasing evidence that chainsaw lumber has largely been the source of supply (see Adam and Dua-Gyamfi, 2009). Using the average per-capita consumption of sawnwood in Africa of 0.02 m^3/year (Whiteman, 2005), the domestic timber demand for Ghana's 22 million population can be estimated as 440,000m^3. The conventional figure often quoted stands at about 456,000 m^3 (TIDD, 2005). Parren et al. (2007) recently reviewed the domestic market situation with emphasis on off-reserve forest timber production. The review highlighted some facts that can inform an analysis on the consistency of sector policies with respect to chainsaw milling.

First, it established that during 2003 and 2004, sawmills together supplied 92,000 m^3 of lumber to the domestic market. This was only 20% of the estimated domestic demand of over 450,000 m^3. Second, it observed that the quantum of lumber supply, envisaged under regulation 36 of LI 1649 (20% supply by all sawmills) is inadequate to address the domestic demand. Third, the trend of supply of timber to the domestic market from sawmills has been dwindling since 1999, with an average of 25%.The report asked, so where does the difference come from? The answer they gave, which is very consistent with observation by Adam et al (2007) and Adam and Dua-Gyamfi (this volume) was chainsawing.

In spite of the ban of chainsaw milling, it has been documented that:

- It is the major supplier of timber to the domestic market and almost the main source for rural timber needs and
- It employs nearly the same number of people engaged in the formal timber industry. In 2005 and 2007, Adam et al. (2007) and Marfo and Acheampong (2009) estimated employment levels in the enterprise as 77,500 and 92,000 respectively.

In many respects, it can be argued that the policies on chainsaw ban and domestic timber supply have been inconsistently implemented. Fundamentally, the policy to supply 20% of industrial sawnwood for the domestic market was unrealistic. Taking the Annual Allowable Cut of 2 million m^3, it is expected that only 1 million m^3 of sawnwood can be produced by an industry with a recovery efficiency of about 50%. 20% of this volume will translate to 200,000 m^3 as the legal supply and this is only about half of the domestic demand. Where will the rest come from? Second, the estimated amount of legal timber purported to be supplied by sawmills has been shown to be theoretically below existing domestic demand. This means that even if the enforcement of the chainsaw ban were effective, there would be some demand-supply gaps. Third, deviating from the use of TUPs to address domestic timber needs of communities meant an indirect official encouragement of chainsaw milling, as it exist as the only alternative source of wood aside sawmills. Fourth, allowing timber markets selling an illegal product to flourish when there is a regulation that bans its products meant that successive governments have approached the problem using essential pragmatism even though they clearly conflict sector policy.

Relating this to the 1994 Forest and Wildlife policy, the ban has been short-sighted in terms of its consistency with the provision on employment and local peoples' right of access to timber for their daily needs. To some extent, the nationalization of timber in off-reserve areas by the Concessions Act (Act 124) which led to loss of right to access to timber on farmlands has been inconsistent with the 1994 policy which sought to recognize such rights. Again, it is inconsistent to ban an activity that economically engages people when there is a clear sector policy commitment to creation of employment.

2.3 Legislative framework

In spite of the pursuit of a collaborative forest management regime, this has not significantly influenced the pre-1994 tenure rights, especially on alienation and management, over forest lands and resources. The state still holds the right to grant timber utilisation rights. The significant tenure-related rights that have evolved are:

- The right of landowners or farmers to be consulted and their consent sought for the granting of timber harvesting rights over their lands (Act 547/LI1649, as amended)
- The right to own a planted tree, manage it and exclude others from using it [Act 547 (as amended) Act 617; Forest Plantations Development Fund Act (as amended) of 2002, Act 623]
- The right of local people (private) to co-own co-manage and exclude others with regards to trees planted in forest reserves. This right is purported to be secured under mutual agreements such as the Modified Taungya Agreement
- In association with the MTA, local people have increased access to forest land for the cultivation of food crops of which all proceeds go to the people concerned.

3. Identification of gaps

In the light of the above, what factors hinder communities' opportunities to have legal access to timber (standing trees and residues on their farms) and to use them both for domestic and commercial ends?

3.1 Exclusion of communities in active timber governance arrangement

The timber sector in Ghana is over industrialised and heavily dominated by large scale corporate industries. Local communities are generally absent mainly because they lack organised enterprises with the requisite legal and financial status to compete and participate in timber business. Therefore, regulations defining access to timber utilisation rights have largely been formulated to isolate community's potential commercial interests. For example, the concessions in the law for timber rights for communities in the form of Timber Utilisation Permits have even been formulated to ignore commercial interests. This is a structural gap that needs to be overcome through a paradigm shift that recognises that allowing communities to be involved in commercial timber business can impact on improved livelihoods and better monitoring and protection of forest resources against illegal operators.

3.2 Tenure insecurity

Tenure insecurity over trees on farmlands and communal lands is a major problem militating against community investment in forest protection and the development of community timber enterprises (see Amanor, 1996, 2000; Marfo 2009). The excessive state control over tree resources is a disincentive partly accounting for the high level of connivance with illegal chainsaw operators. Even though farmers, de facto, exercise control over trees on their farms, the fact that they do not have any legal control of their use makes it difficult to trade in trees and make 'lawful' economic gains from them.

3.3 Prohibition of commercial chainsaw milling

Perhaps the most important issue hindering the processing and utilisation of trees on farmlands is the prohibition of chainsaw milling in Ghana. This is important because chainsaw milling is the most accessible and affordable technique widely available to local people.

The applicable laws on this matter are the Timber Resources Management Regulations, 1998 (as amended) (LI 1649), Trees and Timber (Chain Saw Operations) Regulations, 1991 (LI 1518), Timber Resources Management Act 1997, (as amended) Act 547, the rules of common law and the laws of natural justice and equity save in so far as they are inconsistent with the express provisions of these laws. There are two main aspects of this topic; the production of chainsaw lumber for sale, exchange and for commercial purposes on the one hand and the production for domestic use by the indigenous people.

Provisions in other legislation have been employed to highlight an opinion on the meaning of the letter and spirit of the main applicable laws. This is important as the chainsaw milling issue operate in a land use context, forestry, which is also governed by several regulations. Thus, we have attempted to interpret the applicable laws taking notice of other relevant provisions that makes the interpretation holistic. These complimentary regulations are the Plantation Development Fund Act of 2000 (Act 583) and the Manual of Operation for harvesting timber in on and off-reserve areas. In order to understand why the prohibition chainsaw milling is an important gap in the utilisation of trees and logging residues, the ramifications of the relevant law must be expatiated.

Prohibition of chainsaw milling

The Timber Resources Management Regulations, 1998 (as amended) (LI 1649) is the main applicable law. Regulation 32 of the Timber Resources Management Regulations provides as follows:

Prohibition of use of Chainsaw to Convert Timber into Lumber for Sale -

1. No person shall use a chainsaw whether registered or unregistered, to convert timber into lumber or other forest products for sale, exchange or any commercial purpose.

2. No person shall sell or buy timber product to which sub-regulation (1) applies.

This is the main regulation that prohibits the use of chain saw to convert timber into lumber or other forest products. The emphasis as far as this work is concerned is on the words for the purposes of selling, exchange or any commercial purpose. The regulation in our opinion has a clear meaning and therefore its ordinary meaning in context must be adopted.

This therefore means that once the lumber is not meant for sale, exchange or for any commercial purpose then it becomes permitted. For a better understanding of this provision we may have to critically look at the meaning of the words sale, exchange and commercial purpose. According to the Oxford dictionary *"sale"* means the exchange of a commodity for money etc; an act or instance of selling. *"Exchange"* means the act or instance of giving one thing and receiving another in its place. *"Commercial"* means to be engaged in or concerned with commerce, having profit as a primary aim rather than other artistic etc. value.

This therefore suggests that if one uses a registered chainsaw to convert timber into lumber and uses the lumber for his benefit which cannot be caught under the meaning of sale, exchange or commercial purpose then such an activity becomes legal. For example if the farmer in the village converts a timber tree on his farm into lumber using a chain saw and uses the lumber for constructing a house for habitation either by himself and/or his family and does do anything with that lumber to fall within the meaning of the words sale, exchange or commercial purposes then he cannot be said to be in breach of regulation 32 of LI 1649. This therefore answers the most often asked question as to whether or not a registered chain saw can be used to convert lumber for domestic use. The answer is yes once it does not violate regulation 32 of LI 1649. Natural law and justice will also suggest that indigenous people have the right to exist and to depend on the natural resources for their survival and therefore it will look unjust to deprive them the right to use this resource as a means of providing their basic needs of life with the excuse that registered chain saw cannot be used to convert timber into lumber.

Vested rights in trees, chainsaw milling and the law

The issue of land ownership and property rights though very important in forest governance and management, it has no bearing on the interpretation of regulation 32 of LI 1649. In other words, whether or not a person is the owner of a particular timber tree does not exempt him from what has been set out in regulation 32 of LI 1649. The main issue here once again is whether the timber sawn with a registered chain saw is for sale, exchange or for commercial purpose. In fact if the legislation is intended to exclude timber owned by individuals then it would have excluded same. It therefore means that the right that an individual can derive from timber on his farm by using a registered chain saw to sawn such timber into lumber is based on the fact that he will use such timber for his own benefit and not for any other purpose as captured in regulation 32 of LI 1649. This therefore answers the question as to whether timber owners in the form of plantations or trees planted themselves can use a registered chain saw to sawn such timber. The answer is yes but the usage of such lumber must not infringe upon regulation 32 of LI 1649.

It is also of great importance to state here that every individual has the right to enjoy his property but usage in the case of timber trees is regulated by LI 1649. Again whether or not the timber is coming from a forest reserve or outside forest reserve is not relevant.

Section 4 of the Timber Resource Management Act 547, 1998 has defined lands which are subject to timber rights:

1. Timber rights may be granted under a timber utilization contract in respect of—

   a) Lands previously subject to timber rights, which have expired and are suitable for re-allocation;

   b) Unallocated public or stool lands suitable for timber operations in timber production areas; and

   c) Alienation holdings.

2. No timber rights shall be granted in respect of—

   a) Land with forest plantations;

   b) Land with timber grown or owned by any individual group;

   c) Land subject to alienation holding; or

   d) Lands with farms without the authorisation in writing of the individual, group or owner concerned.

This means that one needs timber rights under a Timber Utilisation Contract (TUC) before he can even harvest timber from such lands. However the mere rights under a TUC does not give any rights whatsoever to use a registered chain saw to convert timber to lumber for sale, exchange or commercial purpose. Act 547 has also exempted certain lands as not requiring a TUC. This therefore means that individual land owners do not need any permit whatsoever to fell a tree on such a land and can convert same into lumber with the use of a registered chain saw provided its usage does not fall within the ambit of LI 1649. It therefore means that by virtue of section 4 of Act 547, 1998 as amended that whenever there is a timber right in the form of TUC covering an area with farmland for which the landowner or farmer's consent was sought, the farmer or land owner does not have the right to cut a tree on his land without permission from the owner of the said TUC. It need not be over-emphasized the fact that the exploitation of certain timber tree is prohibited and therefore cannot be harvested for one's personal use. Such species are exempted from the discussion herein.

The gravamen of this point is that the source of the timber whether from forest reserves, admitted farms within forest reserves or community forest is not relevant in the interpretation of the L.I. The main issue is whether or not the lumber sawn with a registered chain saw is for sale, exchange or for commercial purpose. If the answer is yes, then it is illegal, but if no, then it may be allowed provided it does not violate other regulations.

Transporting chainsaw lumber and the law

Again, this is an important issue if processing of logging residues using chainsaw is intended to be involved in transportation of processed wood from the vicinity of the community. Again the legal position in regulation 32 has been strengthened and supported by Regulation 24(2) which states that 'no Conveyance Certificate shall be issued for any lumber produced by chain saw'.

Regulation 24—Conveyance Certificate —

1. No timber shall be transferred or moved from any forest area unless there is carried with it a timber conveyance certificate.

2. No Conveyance certificate shall be issued for any lumber produced by chain saw.

3. A timber Conveyance certificate is issuable only by an officer of the Forestry Department not below the rank of a Senior Technical Officer and may only be issued on an application from the contractor.

This really means that for lumber produced which requires carriage from one locality to another it must be given a Conveyance Certificate but same should not be given if it is produced using chainsaw. This also does not mean that carrying lumber for example manually without the use of vehicles by persons makes it legal if such is for sale, exchange or commercial purpose since it will result in a breach of regulation 32 of LI 1649.

There seems to be a lacuna created when the law on the one hand seems to allow lumbering with a registered chain saw for domestic purposes but on the other hand does not allow the transportation of same unless covered by conveyance certificate. Because the law prohibits in a blanket for the transportation of chain sawn lumber even for domestic use, the results has been to the effect that some District Managers of the Forestry Services issue waybills for such lumber to be transported. One needs to find out whether or not the intention of the framers of the LI is for chain sawn lumber to be used within the same locality where the timber is found. It seems in our opinion that it is so otherwise individuals will abuse the system under the guise of using the lumber for their domestic needs which in actual fact may not be so. The issuance of all forms of permits by District Managers to transport chainsaw lumber is a practice which must be condemned. The law as it stands must be amended if its intendment is not to restrict the usage of chain sawn lumber to the locality in which the lumber is found. If it is so then it must also define and determine the meaning and extent of locality.

3.4 Clarity of regulations that allow subsequent utilisation of logging residues

To ascertain any gaps with respect to the use of logging residues, especially those on farmlands, it may be important to identify the legal status of timber residues in terms of who 'owns' it. Two schools of arguments may be advanced from the current legislative framework governing timber rights. The question is 'does the possession of timber rights in the form of permits exclude anybody, except the holder of the permit, from utilising timber residues? If the answer is yes, then it will imply that all timber in the yield allocation of a contractor, irrespective of whether they are standing or lying and partly or fully used, will be deemed to belong to the contractor holding timber utilisation contract covering the yield. One may call this argument the legalistic interpretation. If the answer is no, then it will imply that the permit covers those allocated trees which the contractor deems to be commercially useful. After all, the Forestry Commission only charges stumpage on the volume of trees actually exploited and extracted. This argument may be called the pragmatic interpretation. Within the thinking of sustainable forest management and the Ghana Forest and Wildlife Policy, which requires that resources are used judiciously and optimally, it will seem more reasonable to follow the pragmatic interpretation as it seems to give more effect to the national policy objective.

Taking this point of departure, it will seem more practical, at least for the purposes of advancing the cause of optimal resource utilisation, to develop the procedures for accessing logging residues and to incorporate them into a Manual of Operations to provide more certainty. At the moment this is a gap. The legal position with respect to the legalistic and pragmatic interpretations need to be clarified and made more certain. This will require either a specific legislation or incorporation of the regulatory procedures into one of the existing MOPs. Both instruments may be useful in this case. For example, an amendment to the Timber Resource Regulations may specifically enshrine a provision that defines the legal status of logging residues; what is a logging residue, how long should a timber be left in the forest for it to be declared a 'abandoned' residue which could be allocated to another user and who may use such timber under what fiscal regime. The MOPs can then be revised to detail out the procedures for accessing and using such residues.

4.0 Proposed policy options for commercial processing of trees on farmlands and logging residues by local communities

4.1 Recommended policy interventions for promoting commercial processing of trees by communities

The general policy recommendation to deal with supply of legal timber to local people and for that matter indirectly with illegal logging is to allow communities to organise themselves to participate in timber business. It is recommended to establish community logging enterprises which can be run as a small-scale business to process logs for the local timber market. Under such a venture, the key areas for interventions include access to resource, management of the enterprise, logging and equipments and benefit sharing arrangements.

Access

To have access to timber trees for commercial purposes will require that a special permit be created for community-based enterprises that will process timber solely for the local markets. A commercial timber utilisation permit (CTUP) can be created for such categories of registered community-based logging enterprises with relaxed investment requirements. Alternatively, Salvage Permits may be issued to such enterprises for the same purpose. Another consideration is that holders of TUCs can also be given permission to issue Timber Use Permits (TUPs) to specific individuals/enterprises to cover the logging and processing of specific trees or residues, especially in off-reserve

TUC areas which may be within their approved yield but may not be needed by the TUC holder.

It is recommended that the existing manual of logging procedure for on-farm logging should be followed both for standing trees and residues since the utilisation of residues for example may cause the same impairment to a farmer without his prior knowledge and consent.

Management

To ensure that communities develop the commercial capacity for processing timber to meet the local timber market demands, a Community Logging Enterprise (CLE) is recommended to be established. The CLE can be managed by a five-member management team consisting of representatives from the Traditional Authority, District Assembly, Town/Village Development Committee, farmer groups and the FSD Technical Officer in charge of the area. The CLEs should be registered as Community Company with established by-laws. The CLEs can engage chainsaw operators and train them in the use of improved technologies.

Logging and processing

One of the major difficulties that might be associated with any policy consideration will be which processing technique to be allowed for processing on-farm trees and logging residues to lumber. The freehand chainsaw milling technique is the most basic one. A recent study reports that it recovers 31% of tree volume and processes 43% of log volume into lumber (Owusu et al. 2009). Using chainsaw with guide bar attachments such as Logosol improved milling efficiency by about 6% (i.e. processing efficiency is about 49%). It may be useful to encourage the use of chainsaws with attachments.

Option 1: Using freehand chainsaw milling

This option will require some amendments in current legislation to give waiver for the use of chainsaw for commercial purposes. A specific provision in the form suggested below will be required:

The use of chainsaw machines for processing trees to timber for sale, exchange or any other commercial purposes shall only be permitted if:

- the relevant public authority has given permit to farm/landowner to harvest the tree(s)
- the timber processed will be used for the permit holder's domestic use

The issue of commercial use of processed timber using chainsaw is completely prohibited under current laws and developing the commercial capacity of communities will need a full legislative amendment of LI 1649. This study does not support any such amendment but rather recommend a second option as follows.

Option 2: using improved chainsaw with attachment techniques

There is some uncertainty with regard to LI 1649 about the use of chainsaw with attachments. The question is whether from a definitional angle, a Logosol for example will be caught under the ambit of what the law refers to as chainsaw machines. If yes, then the same legislative amendments as in option 1 will be required. It will be argued that chainsaw-with-attachment is an improved milling technique and given the proof that they improve recovery by some 6% over freehand chainsaw milling, it should be permitted for commercial processing.

Benefit sharing for commercial processing

The recommended benefit sharing arrangement is based on three fundamental observations:

1. that the existing benefit sharing of timber revenue allow the Forestry Commission to, in principle, deduct its management cost before the net is given to the Administrator of Stool Lands for distribution using the formula in Article 267 of the Constitution.

2. that local communities, in particular, farmers are known to contribute substantially to tree resource management in off-reserve areas especially on communal and farmlands (see for example Amanor 1996, 2000; Ardayfio-Schanforf et al 2007)

3. That farmers, de facto, sell trees on their farms to illegal chainsaw operators at average price equivalent to 38% of official stumpage (Marfo et al. 2009).

Thus, it is recommended that stumpages paid by the CLEs could be shared as follows:

- 10% to be retained by FC to support its administrative expenses
- 40% to be paid to farmers/landowners who tended the tree to compensate for management tasks.
- 50% to the AOSL to be shared among the traditional authorities and district Assemblies

This arrangement is very consistent with current regulations and the only requirement for the FC to agree that four-fifth (80%) of the revenue that would have accrued to them to off-set their management cost will now go directly to the community. This helps to deal with broader sector problems related to forest monitoring, especially in ensuring that government is also building a strong net with economic incentives with local people to fight illegal logging. This is one policy reform that will make collaborative forest management meaningful and can have real impacts on resource monitoring and protection.

With respect to revenue from the processed logs, it will be recommended to invest substantial part in timber resource development and to support some community development ventures that will benefit all the people. In this regard, the net revenue after salaries and operational costs could be shared 50:50. Since off-reserve resources are dwindling, it should be required to integrate the CLEs into the national plantation development programmes and to allow them to invest into plantations to make their operations sustainable.

4.2 Negotiating options: towards a participatory policy diagnosis analysis

A participatory policy diagnosis workshop involving farmers and community-based stakeholders was helpful in further enlightening the theoretical recommendations (see report as annex 1). The basic question for the analysis is how can Ghana implement a policy that allows communities to utilise logging residues in a manner that respect logging laws and the rights of other stakeholders, particularly landowners and timber contractors? To a large extent, the workshop participants agreed that the sharing of revenue from off-reserve and on-farm tree utilization must include farmers and they earn as much as 40%. However, communities preferred dealing directly with the Forestry Commission to TUC holders.

A policy workshop was held to bring various stakeholders together to discuss the conceptual and community perspectives about access, logging, management, benefit sharing aspects of utilising logging residues and trees on farms. Annex 2 gives a list of participants of this workshop held in Kumasi on 5th April 2011. At the end of the workshop, the following conclusions and recommendations emerged:

Promoting community enterprises is preferred to any kind of individual logging arrangements. This is easier to control and regulate

The standards to follow in granting access must include:

- Minimum standard equipment criteria should be set to allow qualification
- Identifying a resource base – that gives a means of justification for permit application

On the type of permit to consider, participants concluded that:

1. The use of TUC should be out
2. TUP – purposely for non-commercial domestic use
3. Salvage permit – has limited use in terms of its conditions by law
4. Mobile recovery – communities work together with TUC holders to process their residues.

Option:

Special provision for community commercial permits . This requires legislative amendments

However, using Salvage permit or attaching community mobile recovery teams to TUC holders does not require any legislative amendments except rules of procedure to be developed by the Forestry Service.

On logging equipments, it was recommended that at minimum logosols could be used. This was because it has better recovery, easy to train users and with low capital requirement. This meant that free hand chainsaw milling was not preferred

Two issues were brought up for further clarification:

(a) Is logosol acceptable under the current legislation or by defination qualifies as chainsaw machine?
(b) The need to establish standards on types of equipment and recovery factors permissible

In terms of management of the community-based logging and utilisation of residues and on-farm trees, the workshop concluded that:

(a) The model should be limited to off-reserve lands
(b) Forestry Commission and community should collaborate
(c) Products should be limited to supplying the domestic market

On benefit sharing, there are legal hitches because of the constitutional formula for distributing timber revenue. The workshop accepted the proposed benefit sharing ratios but recommended that there is the need to get a constitutional backing on the current proposal by taking advantage of the on going constitutional review process.

Recommendations

1. Submit a memo to the national forest policy review team to consider ways of internalising key lessons from the project into the new forest and wildlife policy
2. The Ministry of Lands and Natural Resources should initiate appropriate legislative reforms that can promote benefit sharing arrangements to include farmers and to ensure accountability of community revenue through traditional authorities and District Assemblies
3. Specifically, mechanisms must be developed to support the proposal for farmers/landowners to get a direct 40% of stumpage value of trees on farms to compensate for management (tending and protection of trees); FC could take 10% to cover administrative costs and the remaining 50% sent to the AOSL to distribute according to the constitutional formula. In a sense, this will give a true meaning to collaborative forest management, which should also mean other stakeholders being recompensed for their contribution.
4. A project should be designed to pilot the establishment and operation of CLEs in selected forest areas in order to learn lessons for up-scaling. In particular, the policy, institutional and regulatory framework that can improve access, utilisation, management and benefit sharing of benefits must receive attention.

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Annex 1

Workshop Report on

ITTO project on processing of logging residues and trees on farmlands in collaboration with local communities

27 May 2010

Introduction

The prevailing ways forest communities obtain wood for use are through the forestry officials and direct felling of trees in the forest using the chainsaw operators, which is against the forestry rules and laws. It is imperative a way is found to enable communities get access to wood for their personal use. This is against the background that even for personal use of lumber community members are not allowed to get wood since the law prohibits that except for community use. Generally the law is against the use of chainsaw machine to process wood for commercial purposes, leaving no avenue for community to access wood particularly for personal use.

Against the use of the chainsaw machine to process wood, the logosol machine seems to be more efficient and produces more wood. Equally against the conventional milling by the timber contractors, the logosol machine again appears to be more efficient in terms of wood production. In the project communities the conventional saw mills are not available to supply them with legal timber, whilst it is against the rules to use the chainsaw machine to process wood. In this context the use of logosol may be seen to be helpful, in addition to the fact that it gives more security.

Background information to formulation of options for access of lumber to community

- Taking away chainsaw in the lumber production system, what changes are likely to be brought on the farmlands and the forests
- What will be the ways to obtain timber with the elimination of the chainsaw?
- Proper management of the processing of wood with the use of the logosol machine may be required
- For proper benefits sharing of the processed wood from the farmlands, who should be the actual beneficiaries of such processed wood?

It is important to note that the law states that the tree ownership is vested in the state or president. And community members can rightfully obtain tree for use though a permit from the right authority

Issues for discussion

- In which ways can the law be changed to let communities have access to wood. Should it be through the use of appropriate means such as the use of the logosol machine
- What management systems can be put in place to ensure proper management of timber access with the use of the logosol machine-making sure that all loopholes of conflicts, misunderstandings are checked
- How can the benefit sharing of proceeds from the timber be improved upon. Or how can the benefit sharing be made to get to all stakeholders satisfactorily. Note that the prevailing benefit sharing takes the form of royalties that is paid mainly to stool land owners. Forest community do not benefit directly from these royalties.

Participants were informed that the project (processing trees on farmlands with the use of the logosol machine) was meant to provide lessons for the formulation of policy options to address community access to lumber as against the illegal lumber sourcing. It has a fixed time period of 3 three years, which can not be exceeded. The issue about its continuation is not considered as community members wanted to know how it will continue after its life span.

In line with this community members provided suggestions on how these project activities could be made into a policy. Some of these suggestions include

- Tree planting on farmlands by farmers
- Farmers to be allowed to plant trees to replace logged ones

On the community access to trees the issues were

- Should individuals be given permits/certificate to fell trees for personal use
- Community to make an enterprise to access wood. Majority of participants agreed to the later with the reasons that it will help in monitoring, regulation of illegal activities and will bring about community development. Participants were of the view that community be given the opportunity to apply for trees for a fee.

On the structures to be put in place to ensure the efficient management of logosol project, participants were distributed into 3 groups to do the discussion around three issues which include

- Management of the processing of trees on farmlands and
- Benefit sharing. For this one, participants were to suggest how the benefit distribution among the following beneficiaries would be. These include the Forestry Commission (FC), District Assembly (DA), Traditional Authority (TA), Farmers and the Community.

Group presentation

Group 1

Group 1 suggested the following for the management of the programme

- Tree Hunters-2
- Operators-2
- Marketing-2
- Trustees-2
- Director-1
- Chief and Elders to provided seed money for the processing
- Operators- to be Paid

They provided suggestions on distribution of the benefit as follows

- FC-10%
- DA-20%
- TA-20%
- Farmer-40%
- Community-20%

Group 2

On management, group 2 suggested, a 9 management committee to consist of

- 2 persons and one security person to monitor operations including the supply of logistics
- 3 persons to take charge of the marketing of the lumber
- 3 Persons to take charge of banking operations

For the sharing of the benefit, they suggested the following distribution

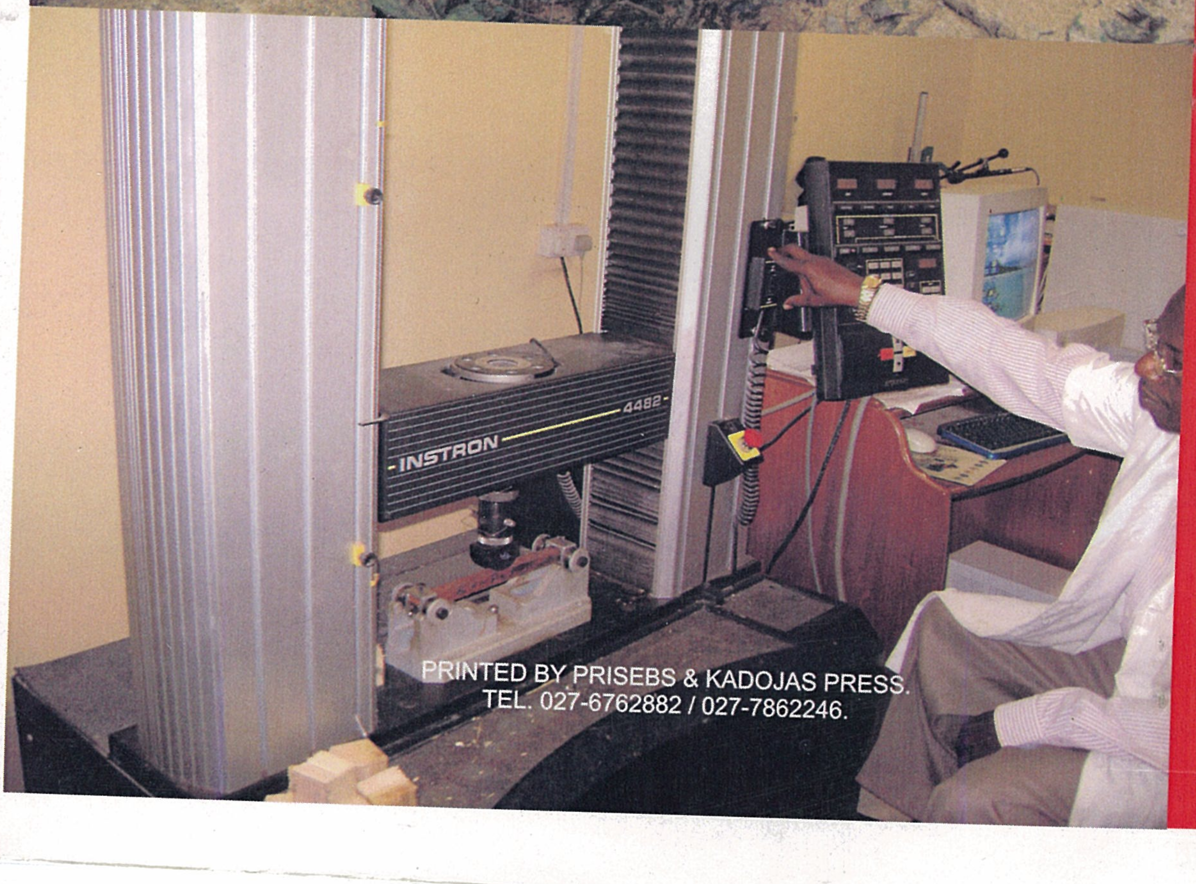
- FC 15%
- DA 15%
- TA 20%
- Farmers 35%
- Community 15%, where 5% will be used for tree planting and the remaining 10% for community development

Group 3

On management, group 3 suggested the positions of a chairman, secretary, hunter, marketing personnel and a treasurer. In addition to these, they suggested the institution of routine meetings to be held monthly and organisation of communal labour to convey processed lumber in the bush to a shed

Their idea about the functions of management included the following

- Management to render accounts to the communities every month.
- Treasurer to deposit the money accruing into the bank every month
- Community members to construct a shed and convey the processed lumber every week to this shed
- Operators and the community to negotiate their monthly salaries.
- Community to implement laws to prevent theft of produce by operators/community
- FC to provide seedlings to community members to replant felled timber species.



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