ECOLOGICAL IMPACTS OF UNCONTROLLED CHAINSAW MILLING ON NATURAL FORESTS

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ABSTRACT

Logging operations, conventional or otherwise can have both positive and negative ecological impacts on the forest ecosystem. The objective of this paper is to evaluate the ecological impacts of chainsaw milling in terms of its contribution to degradation of forest resources and damage on ecologically sensitive sites. Field assessments of ecological impacts of chainsaw milling were conducted in four Forest Reserves (Asenayo, Nkrabia, Tano Offin and Atiwa Range) and two areas outside forest reserve in the Goaso and Kade districts. We assessed selected ecological impact indicator variables related to illegal chainsaw logging and conventional logging along four transects laid at 400m intervals along the long axis of the compartments in the selected forest reserves. Assessment of the off-reserves was similarly done using the indicator variables applied in the forest reserves. The disturbance around a single felled tree and total area of operational zone disturbed appeared wider in chainsaw milling compared with conventional logging whereas in terms of forest canopy reduction no difference was observed between the impact of chainsaw milling and conventional logging as shown by comparative data from Asenayo Forest Reserve. The study also revealed that chainsaw millers fell wide range of tree sizes, unaware of the felling restrictions on harvestable diameters and more seriously do not pay attention to conservation practices. Our current results though do not support the general view that chainsaw milling is more wasteful than conventional milling (as conducted in Ghana) in terms of residue generation, however, there is strong evidence to indicate that in the short term uncontrolled chainsaw milling will have several negative impacts on the forest ecosystem.

Keywords: Chainsaw, conventional, ecological, environmental, forests, impacts

INTRODUCTION

Tree felling as an integral part of logging operations and in-situ conversion of logs to lumber as is the usual case in chainsaw milling (CSM), can have both positive and negative ecological impacts depending on the mode of operation [these may be in reference to: choice of tree (species, tree size, and location) to be felled; felling techniques (as it relates to minimization of felling damage) and; sawing techniques (as they affect recovery or residue generation and consequently sustainability of resource)].

Previous survey reports from Ghana have indicated that chainsaw milling is conducted indiscriminately without the operators observing any prescribed logging and environmental standards (Adam *et al.*, 2006). If there is the real need to make chainsaw milling a sustainable avenue for employment and revenue generation it would be very necessary to understand its potential ecological and environmental impacts so as to enhance its positive aspects and develop strategies to mitigate its negative impacts especially as other components of this study have shown that over the last 5 years between 60 to 80% of local lumber supply is obtained through chainsaw milling.

This paper has been prepared from field studies that form part of a bigger project "Developing alternatives for illegal chainsaw lumbering through multi-stakeholder dialogue in Ghana and Guyana" funded by the European Union and conducted in Ghana from August to November 2008. The objective of this paper is to evaluate the ecological impacts of chainsaw milling in terms of its contribution to degradation of forest resources and damage on ecologically sensitive sites. As has been reported (Afranie, 2003; TROPENBOS, 2004), chainsaw milling in Ghana was banned in 1994 as a result of the government's inability to control the business of producing and selling lumber from chainsaw milling. One of the strongest public opinion for the ban is that lumber recovery is low and over a short time would lead to significant decline in the timber resources (Otoo, 2004). The claim of low recovery from chainsaw milling has been challenged by Frimpong-Mensah (2004).

The purpose of the studies that form the bases for this paper is to contribute to the debate on whether to continue the criminalization of chainsaw milling as a commercial activity because it has been described as wasteful or to regularise it because it is not more destructive than conventional logging.

METHODOLOGY

The studies address specific research questions that lead us to present both quantitative and qualitative assessments of the ecological impacts of CSM. The research covers two broad issues. The first issue deals with degradation to forest resources as associated with illegal chainsaw milling where we want to know the actual volumes of standing trees removed through CSM per year as against conventional logging; and how much of the protected or restricted species are being removed through CSM? The second issue deals with encroachment and damage on ecologically sensitive sites. Here also we want to know the nature and extent of negative impacts of CSM on forest ecology and the sensitive ecological areas that are impacted.

The environmental impact assessment involved three stages. The first stage was stakeholder consultations in selected sites to identify components of forest and rural environment that are perceived to be impacted upon by chainsaw lumbering. We did this by talking to community leaders, farmers (including men and women), timber concession holders, and forest managers. In the second stage following the stakeholder consultations, six indicator variables (ground vegetation disturbed; forest/tree canopy loss during felling and milling; harvesting density as a measure of frequency of illegal felling; amount of residue generated; recognition for protection of immature trees and; recognition for protection of agricultural crops) were identified. In the third stage field surveys were conducted to have a quantitative assessment of the selected indicator variables as they relate to illegal chainsaw logging and conventional logging.

Field assessments of ecological impacts of chainsaw milling were conducted in four Forest Reserves (Asenayo, Nkrabia, Tano Offin and Atiwa Range) shown as squares in Figure 1 and two areas outside forest reserve in the Goaso and Kade districts shown as circles in Figure 1. In each Forest Reserve two compartments were selected for the impact study. In each compartment 4 transects were laid at 400 meters interval along the long axis of the compartment.

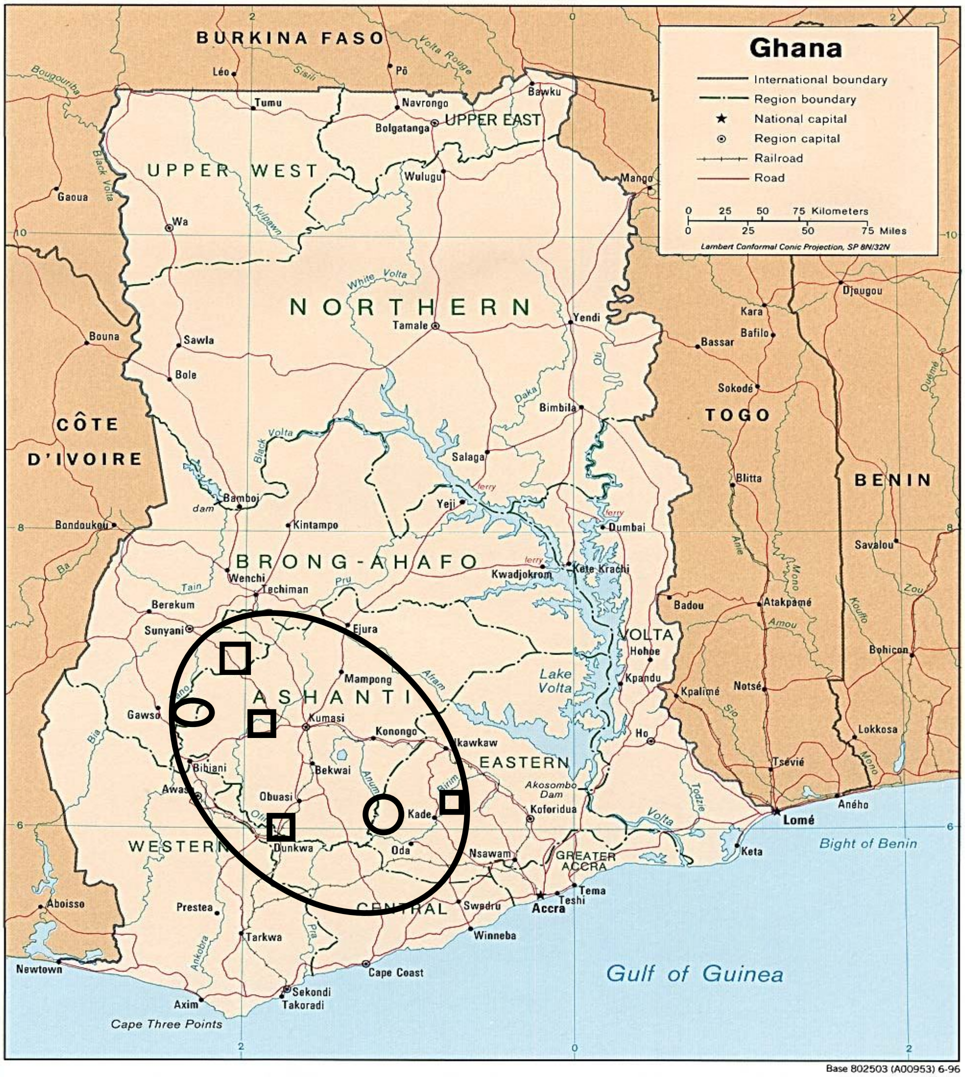

Figure 1: Map of Ghana showing the location of the main study zone (Marked by the black large oval) and the sites for the environmental impact assessment. The squares indicate location of Forest Reserves and circles the off-reserve (outside reserve) logging areas.

The field team walked along these transects and searched for felled trees within 100 meters on both sides of each transect. The felled trees were then classified into chainsaw milling and conventional logging. Around each felled tree, assessment was done using standard forest mensuration procedures to determine ground vegetation disturbed and forest canopy loss (due to felling and milling); harvesting density as a measure of frequency of felling; amount of residue generated; recognition for protection of immature trees; recognition for protection of water bodies. In the areas outside forest reserves the team were assisted by local operators to visit old milling sites. In the off-reserve areas assessment was done on harvesting density as a measure of frequency of felling; amount of residue generated; recognition for protection of immature trees; recognition for protection of water bodies and recognition for protection of agricultural crops.

Data Analysis

Field measurements were summarized into tables to facilitate quantitative descriptions. Means were calculated for comparison of parameters between conventional logging (CONV) and chainsaw milling (CSM). Chi-square test for independence was used in comparing canopy openness of gaps in CONV and CSM.

RESULTS AND DISCUSSIONS

The findings from the field assessment of environmental and ecological impact of chainsaw milling are presented and also discussed in the light of the research questions.

Disturbance to Ground Area

Ground area disturbed is described in terms of land area within the operational zone that showed visible signs of plant destruction or damage and soil disturbance during the felling, milling and transportation of lumber. Assessing the disturbed area in terms of the magnitude of the average gap width (Table 1), the disturbed zones around a single felled tree appeared wider in the case of chainsaw milling compared with conventional logging.

For total area of operational zone disturbed, measurements at Nkrabia (Table 2) indicates larger areas disturbed by chainsaw milling compared with conventional logging. This is explained by the fact that stump area disturbed in chainsaw milling is a combination of the tree fall gap and clearings using machete to ease movement of the milling crew (Figure 2).

Table 1: Widths (m) of ground areas disturbed around felled trees in Asenayo and Nkrabia Forest Reserves

Location	Minimum gap width		Maximum gap width		Mean (±SD)	
	CSM	CONV	CSM	CONV	CSM	CONV
Nkrabia	6.3	2.2	25.5	10.6	6.3 ± 3.5	5.3 ±2
Asenayo	4.7	2.5	6.6	3.8	-	-

Table 2: Total ground area disturbed around felled trees in CSM and conventional logging operation at Nkrabia Forest Reserve

Type of Logging	Range of diameter of trees felled (cm)	Minimum area disturbed (m^2)	Maximum area disturbed (m^2)	Mean area disturbed (m^2)
CSM	60-120	140	589	293 ±115
CONV	70-160	75	595	238 ± 121

A **B**

Figure 2: Picture showing instances of ground area disturbed in a chainsaw milling (A) and conventional logging (B)

A **B**

Figure 3: Pictures showing the widths of – (A) foot path used by CSM operators to cart lumber from stump site at Tano Offin Forest Reserve and (B) Primary trail used by skidding machines to move logs from stump site to loading bay at Asenayo Forest Reserve

However, in the case of conventional logging the area disturbed at the stump site is only by the tree fall. For the evacuation of the harvested timber, the chainsaw milling only leads to the creation of foot paths (Figure 3A) as against wider skid trails (Figure 3B) in the case of conventional logging. The foot paths are obviously narrower than the skid trails and also do not turn over the soils as in the case of the skidder.

This very difference between skid trail damage and that of the foot paths is used by the CSM operators to argue that chainsaw milling is more environmentally friendly than conventional logging. This claim is however debatable since it has also been shown that soils turned over by the skidder machine or the logs been dragged on the forest floor promote natural regeneration from the soil seed banks (Pinard *et al.*, 2000).

Forest/Tree Canopy loss during Felling and Milling

In terms of forest canopy reduction, no difference was observed between the impact of chainsaw milling and conventional logging as demonstrated with comparative data from Asenayo Forest Reserve (Table 3). This means that canopy openness resulting out of tree felling is independent of the two types of operation. Forest canopy openness is described here as the percentage of area 1.5 meters above forest floor that receives overhead light due to the felling of the tree. The extent of openness affects microclimatic variables such as irradiance, air and soil temperature, relative humidity, and soil moisture that influence seed germination, seedling survival and growth.

Though this study did not go beyond assessing degree of canopy openness resulting out of tree felling it is well documented that germination and growth responses to gap openness vary with species guild and therefore the degree of openness favour different species.

Table 3: Chi-square test for independence of forest canopy openness on chainsaw and conventional logging gaps

Location	Test of dependence	Percentage canopy openness in the felling gap area	
		Chainsaw	Conventional
Asenayo FR	χ^2 = 67.2, df 61, 1; P=0.27 two sided	53.7 ±10.9	50.2 ±12.1

Table 4: List of tree species milled at Nkrabia FR by CSM operators and estimates of residue generated according to volume and as percentage of total log volume

Scientific name	*Local name*	*Vol. total log*	*Vol. residue*	% Recovery of total log
Entandrophragma angolense	Edinam	3.68	3.03	17.6
Entandrophragma angolense	Edinam	10.27	4.52	55.9
Entandrophragma angolense	Edinam	19.32	2.66	86.2
Khaya ivorensis	Mahogany	22.56	6.52	71.0
Khaya ivorensis	Mahogany	11.00	2.03	81.5
Nesogordonia papaverifera	Danta	6.79	2.15	68.2
Nesogordonia papaverifera	Danta	7.81	1.26	83.8
Nesogordonia papaverifera	Danta	3.14	0.42	86.3
Petersianthus macrocarpus	Esia	9.11	2.36	74.0
Petersianthus macrocarpus	Esia	3.50	1.65	52.7
Petersianthus macrocarpus	Esia	14.01	2.10	84.9
Petersianthus macrocarpus	Esia	4.56	3.7	18.5
Piptadeniastrum africanum	Dahoma	7.58	1.46	80.7
Piptadeniastum africanum	Dahoma	4.57	2.00	56.0
Sterculia rhinopetala	Wawabima	6.97	1.02	85.4
Triplochiton scleroxylon	Wawa	5.25	3.14	40.2
Triplochiton scleroxylon	Wawa	8.81	4.59	47.8
Triplochiton scleroxylon	Wawa	6.29	1.37	78.1
Triplochiton scleroxylon	Wawa	14.08	7.45	47.0
	All spp avg.	8.91	2.81	64.0

Harvesting Intensity

Transect survey in previously logged compartments in Nkrabia and Asenayo Forest Reserves showed that illegal chainsaw activities are more frequent in areas closer to villages and also distant to active logging operational areas. Harvesting intensity of up to 7 trees per hectare was encountered at Asenayo Forest. In Nkrabia Forest there was a frequency of one tree felled per 30 meter of transecting. These harvesting intensities far exceed the conventional allowable felling intensity of 2-3 trees per hectare. Since these illegal activities are happening in already logged compartments the implication is that, the residual forest is severely being impoverished in terms of future economically harvestable stems per unit area

Amount of Residue Generated

Nineteen trees made up of seven different species encountered at Nkrabia Forest Reserve were noted to have been milled by illegal chainsaw operators. For these trees, the estimated average lumber recovery was about 64% and ranged between 18% and 86% of the total bole volume (Table 4).

In another sense the milling process generated residue amounting to 36% of the bole volume. The residues comprised slabs, off-cuts in the shape of billets and saw dust (Figure 4).

Figure 4: Types of solid wood residue generated during chainsaw milling process. Picture from Nkrabia Forest Reserve showing residue from a sawn mahogany tree

The average recovery appears to be similar to the average logging recovery of 76% of bole volume reported by Adam *et al*. (1993). The similarity lies in the fact that logs taken to the mill have up to 60% milling recovery of log volume that translates to 45.6% of the harvestable bole volume. If we assume 70% recovery for re-sawing of chainsaw beams (lumber sizes ranging from 10 cm thickness by 20 cm width and over and of varying lengths) to smaller dimension lumber that also come to around 45% of the tree bole volume, then following these analyses the argument that chainsaw milling is more wasteful than conventional sawmilling in Ghana is weakened. Field trials have shown that for crooked boles the application of chain sawing using trained operator yields higher lumber volume compared with milling in band or circular mills (Pasiecznik *et al*, 2006).

Recognition for Protection of Immature Trees and Restricted Species

Interviews with operators and field observations revealed that chainsaw millers fell wide range of tree sizes and unaware of the felling restrictions on harvestable diameters. For instance 9 out of 21 trees felled in Nkrabia Forest by the illegal chainsaw millers were below the legal felling limit (Table 5). At Asenayo 6 out of 21 illegally felled trees were also below felling limit. It appears the most important criteria for the chainsaw millers in selecting a target tree is the presence of a marketable tree species.

Table 5: Range of stem sizes of various species processed by illegal chainsaw operators in relation to the prescribed minimum felling limit (MFL)

Location	Species		MFL	Diameters of felled trees
Nkrabia	*Nesogordonia papaverifera*	Danta	70 cm	92, 76,50*
Nkrabia	*Khaya ivorensis*	Mahogany	110	108,90*,
Nkrabia	*Triplochiton scleroxylon*	Wawa	90	63*, 79*, 73*, 109, 109
Nkrabia	*Piptadeniastrum africanum*	Dahoma	110	70*, 86*,
Nkrabia	*Petersianthus macrocarpus*	Esia	70	78, 80, 101, 60,
Nkrabia	*Sterculia rhinopetala*	Wawabima	70	80
Nkrabia	*Entandrophragma angolense*	Edinam	110	55*,84*, 116, 116,
Asenayo	*Nesogordonia papaverifera*	Danta	70	99, 100, 70,
Asenayo	*Terminalia superba*	Ofram	70	110
Asenayo	*Aningeria spp*	Asamfena	90	140, 100,
Asenayo	*Entandrophragma cylindricum*	Sapale	110	95*, 95*,
Asenayo	*Daniella ogea*	Shedua	90	75*, 110, 122,
Asenayo	*Khaya ivorensis*	Mahogany	110	95*, 100*,
Asenayo	*Petersianthus macrocarpus*	Esia	70	100,
Asenayo	*Mansonia altissima*	Prono	70	59*
Asenayo	*Tieghemella heckelii*	Baku	110	110
Asenayo	*Triplochiton scleroxylon*	Wawa	90	175, 95, 115, 110, 102

Note; * Stem diameters lower than the permissible felling diameter size

It is worthy of note that most of the trees harvested by the illegal chainsaw millers from forest reserves are of high economic value in terms of demand and export price per unit volume as well as those restricted from heavy exploitation such as *Tieghmella heckelii* (Makore). Again since the operators work mainly in logged compartments, the appearance of very large trees (diameter greater than 100cm) among the harvested list means the removal of large size trees that have been retained as seed trees or those to give structure to the residual forest. The impacts of this operation in Forest Reserves can be: i) reduction in potential crop trees when immature stems are removed, ii) reduction in seed supply and subsequent decline in natural regeneration when retained seed trees are removed, iii) further opening of canopy by removal of large trees retained for structure will significantly modify the microclimatic conditions which may increase the seedling mortality of non-pioneer species and cause shift in species composition possibly in favour of low value pioneer species.

Recognition for Protection of Sensitive Ecological Areas

Illegal chainsaw millers probably because they are not working under a regularised condition are not paying attention to conservation practices. They have extended their operations into wholly protected and sensitive ecological areas such as Globally Significant Biodiversity Areas (GSBAs) and convalescent areas in Forest Reserves. Reconnaissance survey in Tano Offin and Atiwa Range Forests Reserves GSBAs (selected specifically to address this section of the study), revealed a high prevalence of chainsaw lumbering in these ecologically important forest sites.

Globally Significant Biodiversity Areas are areas within Forest Reserve set aside to ensure that some forest blocks are preserved in a condition that is as close to the natural condition as much as possible for the preservation of unique flora and fauna. The GSBA concept is an innovation in conservation that calls for the protection and conservation of all kinds and sizes of living organisms as well as the ecosystems within which they have evolved and in this case the tropical high forest. For effectiveness and acceptability, the GSBA concept is being pursued through collaborative management planning and implementation processes. The communities around these GSBA are benefiting from schemes such as alternative livelihood, and small financial grants. In return they are among other things to help prevent illegal activities in the GSBA. It is doubtful if the communities around these GSBAs are fulfilling their responsibilities under the collaborative arrangement for the management and protection of the GSBAs.

Areas set aside in forest reserve to convalescent (i.e. to recover from heavy exploitation) are not given out to the Timber Utilization Contract holders for logging. In most case convalescence area have individual large size timber trees scattered over a wide area but not occurring in concentration to allow for economic logging. Invariably these scattered trees have become the target of illegal chainsaw millers. This development has caused many TUC holders we interviewed to question the relevance of the convalescence area as a management intervention if the remnant trees cannot be protected against illegal felling.

Recognition for Protection of Agricultural Crops

The field observations in farm lands did not reveal that operators do pay any attention to minimize damage to agricultural crops. It was noted from informal interviews with operators that they do not practice directional felling for the sake of reducing crop damage but to direct the trees such that it will ease the sawing process. However, the operators claimed that because they do not use heavy machinery like the timber jack or crawler tractors to move the logs or lumber, the damage to crops is minimal and invariably the crops are able to sprout back few months after the operation. This claim from the operators was corroborated by many farmers who were also interviewed. This assertion among farmers was identified as one of the major reasons for their partnership with the chainsaw millers to work on their farms instead of the conventional loggers.

CONCLUSIONS

The objective to estimate actual volume of trees harvested per year through chainsaw milling could not be obtained in this study due to the relatively short period for field data collection as well as the lack of any extensive secondary data to form bases for such calculation. However, the frequency of milled trees as observed in the field is strong evidence to show how wide spread and intensive the CSM operations have become and especially in Forest Reserves.

Production forest reserves are extensively and aggressively been invaded by chainsaw millers removing mainly high value species, restricted species as well as potential crop trees. This trend of indiscriminate felling in logged over forests and convalescent areas will significantly reduce future commercial value of the production forests.

There is the likelihood of severe reduction in the population of large size trees that have been retained as seed trees or canopy trees leading to the deprivation in the residual stand of good quality seeds and appropriate environmental conditions for effective natural regeneration. Similarly the removal of the remaining few trees of species like Makore, Asanfena and Wawabima whose seeds serve as food for wildlife will impact on the wildlife population and their roles (seed dispersal, control of pest insects, etc) in the forest. Chainsaw milling operations as observed in the Atewa and Tano Offin GSBAs are developments that will defeat the purpose for which the GSBAs were created.

The findings as presented above though do not support the general view that CSM is more wasteful than conventional milling (as conducted in Ghana) in terms of residue generation, there is strong evidence to indicate that in the short term uncontrolled chainsaw milling will have several negative impacts on the forest ecosystem. It is also important to recognise that for effective conservation of any forest types and other plant species, disturbance from humans must be very minimal and definitely not to the extent that the chainsaw logging and milling is conducted. An important ecological concern is the removal of both mature and immature trees in convalescence areas and in GSBAs which is likely to lead to the decline in the forest integrity and the inability for natural recovery. These sensitive ecological areas will need more effective protection strategies to ensure the maintenance of their ecological status. In respect of GSBAs protection the role of the immediate communities need to be re-examined. There is indeed a need for aggressive measures to control the operations of chainsaw millers if the law banning their operations cannot be fully enforced.

REFERENCES

Adam, K. A., Pinard, M. A., Cobbinah, J. R., Damnyag, L., Nutakor, E., Nketiah, K. S., Boateng, K. and Nyarko, C. (2006) Socio-Economic Impacts Of Chainsaw Milling And Lumber Trade In Ghana. Final report on DFID/NRI/FORIG study - Chainsaw Milling and Lumber Trade in West Africa. FORIG, Kumasi. 94pp.

Adam, A. R., Ofosu-Asiedu, A., Dei-Amoah, C. and Asante-Asiamah, A. (1993) Wood waste and logging damage at Asukese and Afram Headwaters forest reserves. Better utilization of tropical timber resources in order to improve sustainability and reduce negative ecological impact. *In report of ITTO Project PD79/90.* FORIG, Kumasi, Ghana

Afranie, S. (2003) The Ban on Chain Sawn Lumber in Ghana: Review of Policy outcomes and lessons. *Ghana Journal of Forestry* Vol. 11. pp 71-81.

Frimpong-Mensah, K. (2004) Chainsaw Lumber Production is wasteful, fact or myth? Tropenbos International - Ghana Workshop *proceedings 2. 'Chainsaw lumber production: a necessary evil?* pp 62-67

Otoo, J. E. (2004) Chainsaw Lumber Production and Sustainable Forest Management. Tropenbos International - Ghana *Workshop proceedings 2. 'Chainsaw lumber production: a necessary evil? Pp. 16-21.*

Pasiecznik, N. M, Brewer, M. C. M., Fehr, C. and Samuel, J. H. (2006) Turning Trees to Timber: A Chainsaw Milling Manual HDRA, Coventry, UK 40pp.

Pinard, M. A., Barker, M. G. and Tay, J. (2000) Soil disturbance and post-logging forest recovery on bulldozer paths in Sabah, Malaysia. *Forest Ecology and Management* 130, 213–225.

Tropenbos International (2004) Workshop *proceedings 2. 'Chainsaw lumber production: a necessary evil?'*11 November 2003 (Nketiah, K., Wieman, A and Asubonteng, A. O.) Tropenbos International, Wageningen, the Netherlands. 71 pp.