5 Section

Technical aspects

13

Appropriate Forest Harvesting and Transport Technologies for Village-based Production of Bamboo Charcoal in Mountainous Areas of Northern Lao PDR

Bernhard Mohns
Lao-German Programme on Rural Development in Mountain Areas of Northern Lao PDR
Lao PDR

Introduction

With a forest cover of over 60%, Northern Lao People's Democratic Republic (Lao PDR) has considerable development potential for forest-based industries. This resource is currently being used primarily for swidden agriculture or exploited as round wood to neighboring countries. This is leading to a situation where forest areas consist of remnant forest largely

depleted of valuable timber, or heavily degraded secondary vegetation that has undergone several cycles of shifting cultivation. These degraded sites are often dominated by bamboo stands. Thus, any future scenario for forest industry development, and forest rehabilitation for commercial purposes, will have to take into account the sustainable use of the present stock of small-sized woody biomass and bamboo.

In contrast to saw logs, which have a high value to volume (weight) ratio, the financial value of wood (and bamboo) for fuel, charcoal, pulp, particle board, bamboo plywood or other applications is entirely dependent on the cost of extraction from the forest stands and subsequent transport by roads or rivers to processing sites. Northern Lao PDR has very limited road infrastructure. This situation is expected to improve considerably with the ongoing construction of a road linking Thailand (Chiang Mai) with China (Kunming). In conjunction with this axis, a network of rural feeder roads is presently underway in the study area, which will eventually create an economic corridor interlinking the three countries.

The removal of bedrock from the Mekong River over the last 10 years allows for year-round navigation along the river from China to Chiang Saen in northern Thailand. Improved harbors and loading facilities are presently under construction at several points in northern Lao PDR. With improved accessibility by road and water, the forest resources of northern Lao PDR will gain interregional importance in the near future.

Industrial-scale forest harvesting in Lao PDR has been carried out under a system of concession logging, mostly by companies from neighboring countries. Harvesting technologies for such operations have been imported and range from converted agricultural tractors, bulldozers and specialized skidders to cable logging systems. Local community involvement has largely been omitted from this process, and in many cases their traditional access and use of forests has been infringed upon considerably by such concessions.

The present policies on land use in Lao PDR over the next decade focus on the elimination of shifting cultivation and creation of permanent settlements. Within this framework, concepts of community forestry have so far focused only on the utilization of forest products such as non-timber forest products (NTFPs), firewood and construction timber for domestic demand. Strategies for involving communities in more broad-based forest harvesting and processing activities (Lawlor *et al*. 2004) have so far not been developed for the secondary forests of northern Lao PDR. Experiences from the Finland/ World Bank funded FORMACOP project (1996-2002) in southern Lao PDR have only limited applicability in the secondary forests of the north, since that project focused on community participation in harvesting higher value round wood only. A recently established study site in southern Lao PDR under the FAO-supported regional project, "Enhancing Sustainable Forest Harvesting in Asia," involved local communities in the harvest of small-sized residual wood from forest concessions. The lack of appropriate technologies for the extraction of such material has already become evident as an issue in this project.

The Lao-German Programme on Rural Development in Mountainous Areas of Northern Lao PDR (RDMA) is presently working on concepts for community-based forest management as a component of both village and regional economic development, covering clusters of villages or complete districts. In this context, the commercial-scale production of bamboo charcoal in several villages along the Namtha river in Pa Oudom District, Bokeo Province, is a first step toward developing sustainable forest utilization as an income generating activity, over and above supplying for local demand. This study focuses on the importance of appropriate forest harvesting technologies for use by local communities.

A recent review by USAID on community forestry projects, oriented towards wood processing and marketing, in six countries, indicates that none of the projects could show conclusive

evidence of community control over all stages of the value chain (Lawlor *et al*. 2004). A major common obstacle is the lack of control over extraction and transport processes. It follows that rural communities can only benefit considerably from woody biomass-based value chains if technologies are available to them which allow their control over the initial stages of tree felling, and transport to the sites of selling, processing or loading for road or river transport (Lux 2005). The lack of appropriate forest harvesting technologies has two additional crucial aspects:

- Commercial-scale harvesting of (low-value) wood biomass components without means for covering greater extraction distances will eventually lead to over-exploitation of resources along access roads or points of processing. It is therefore critical for decision makers to recognize that commercial viability of harvesting needs to be incorporated into sustainable management plans for specific forest areas.
- Due to the lack of appropriate harvesting technologies, reforestation with commercial-scale forest plantations (teak) has so far only been undertaken in areas surrounding roads and navigable rivers, thereby occupying sites that could otherwise be brought under considerably higher value land use due to their accessibility or soil conditions.

Small-scale forest harvesting in the community forestry context

The terms "small-scale forestry" or "small-scale forest harvesting" have been used mainly in European and North American forestry circles. In general, they refer to timber harvesting operations carried out by owners of smaller woodlots in contrast to larger scale government or industrial operations. Harvesting technologies in this context are within the financial reach of individual forest owners or producer groups, and are very often linked to farm machinery such as logging winches mounted on agricultural tractors, these being the standard equipment of most farm forestry operations in Europe.

In recent years, the Forestry Institute of Garpenberg, Sweden, and the UK Forestry Commission have conducted extensive research on the economic and ergonomic performance of a wide range of small- scale forest harvesting equipment. For the special conditions of small-scale harvesting in mountainous areas, the well-documented AUSTROFOMA exhibitions by Austrian manufacturers of forest harvesting equipment is an excellent source of information. Most of the information from these sources is highly applicable to the rural development context of Southeast Asia.

In Southeast Asia, the topic of forest harvesting has in recent years been dominated by the term 'reduced impact logging,' which refers to improved methods of pre-harvest tree inventories, directional felling and extraction methods aimed at reducing damage to the "mainly natural" residual forest stands. The harvesting systems promoted under this concept have focused entirely on large- scale forest operations. Involvement of local communities and small-scale forest enterprises has so far been largely left out under the reduced impact logging approaches. This is due largely to the fact that such actors play only a minor role in commercial scale wood-extraction operations. As such, information on the application of appropriate technologies for forest harvesting at levels below state- owned or concession forest enterprises remains very limited in the region.

Project context

During a recent analysis of various value-chain options for non-agricultural income generation, and based on earlier forest resource assessments for Bokeo Province, it became apparent that industrial-scale processing of bamboo was a viable option for the RDMA target areas. Paktha village was selected in 2005 as an initial pilot site for bamboo charcoal manufacturing, storage and loading for transport by both river (Mekong) and road.

Under the RDMA's private-public partnership concept, a tripartite agreement was drafted between:

- A private Lao enterprise engaged in bamboo-charcoal processing and export, whose role was to introduce special technology for high-quality charcoal production, provision of storage, packaging and loading facilities, and export marketing. The entrepreneur would obtain a bamboo concession, for which he would pay a royalty to the government for raw materials.
- The RDMA and its government counterpart organizations, whose roles were the preparation of forest management plans in the production areas, and introduce appropriate technologies to allow bamboo harvesting in an economically viable and ecologically sustainable way.
- Villages along the Namtha river that would engage in bamboo harvesting, transport and charcoal processing.

Under the agreement, the price for fresh bamboo was calculated at about US$ 17 per ton when delivered to the processing site at Paktha. The price for bamboo charcoal was estimated at US$ 110 per ton (including any future royalty payments to the government) at the point of road or river transport to northern Thailand. This price compares well with the present price range of US$ 90–130 per ton for this product in northern Thailand.

Assessment of forest biomass production and terrain conditions

Preliminary assessments were carried out on the extent of bamboo stands within the designated areas of upland agriculture and production forests within village boundaries and along the lower Namtha river. It was estimated that each charcoal kiln with an annual production of 30 tons of charcoal would require about 150 tons of green bamboo, which in turn could be harvested annually on a sustained basis from about 30 ha of bamboo stands (Dransfield and Eijada 1995). Sufficient bamboo resources could be found in most areas within a radius of 2–3 km around potential processing sites, assuming that subsequent transport of the charcoal was via all weather access roads or rivers.

It was realized that the anticipated yearly production of 1,000 tons of charcoal could only be realized by either spreading kilns over a wide area, or by bringing green bamboo over greater distances to central processing sites by way of road or river transport. Cartographic assessments of slope class and direction were carried out in a corridor of 2 km on both sides of the Namtha River and over a distance of 180 km. In order to assess the potential bamboo resources in this corridor, aerial photo interpretation and visual assessments of transects were conducted at regular 5 km intervals during a cruise along the river. Both methods revealed that a total of about 55,000 ha would fall into the slope classes and directions that would allow for downhill skidding of bamboo to the river over maximum distances of 2,000 meters. It was estimated that approximately 20% or 11,000 ha of this area, is covered with exploitable bamboo stands.

Suitable bamboo stands were found along all-weather roads, covering a total distance of 35 km, with a maximum distance to processing sites of 22 km. Within these river and road corridors, an area of about 11,000 ha of bamboo stands are found within an accessible range of the proposed central processing site at Paktha. Following these studies, it was decided to carry out further research on the feasibility of harvesting and transporting bamboo under existing stand and terrain conditions.

Felling and bunching along skidding trails

Due to the difficulties in bringing individual bamboo culms to the ground, felling is done in teams of at least two persons. The culms are carried out with axes or straight-bladed machetes at a height of about 0.8 to 1.2 m above ground, due to the dense growth of culms at the base of the clumps. For the trials, culms were selected with a diameter at breast height of between 10 and 15 cm in order to minimize variation due to diameter and length differences and their effect on weight per piece. This diameter range is also most suitable for the construction of bamboo rafts, as used in the subsequent transport trials.

The distance to the skidding trails was kept to a maximum of 20 m to eliminate further variations. The performance of labor in the felling and bucking process was as follows: the time for cutting, dragging to the ground, cutting off branches and delivering the culms to a point of initial stacking along skidding trails took an average of 4.7 minutes per culm, calculated from a total of 180 culms harvested with a variation of between 3.3 minutes and 9.2 minutes. In cases where a group of culms was entangled and had to be brought down together, the time was calculated as an average of such a group of culms. The average culm harvested had a weight of 14.4 kg with 13.5 cm diameter and a length of 13.4 m.

Harvesting time per ton for a two-person team was 326 minutes, or in other words, one person was able to harvest about 0.5 tons in one day. Assuming an average wage of US$ 2 per day, the operation of felling and stacking at the skidding trail will cost approximately US$ 4 per ton. These costs for the felling and bunching operation are surprisingly high. Due to the low weight/volume ratio of bamboo, few options are available to improve the felling operation significantly (Efthymiou 2002). The costs might be slightly lower in situations where whole fields may be harvested in clear-felling operations.

Manual transport to loading sites

Manual transport of bamboo culms is presently the most common form of forwarding. This is mainly done for domestic consumption over distances of up to several kilometres. The optimal range for manual transport is between 50 and 150 m. For commercial-scale operations, the maximum range considered economically viable would be around 500 m for downhill transport. Due to the relatively high friction of long bamboo culms, manual transport is most suitable for this terrain condition. For transport over level or uphill terrain, the acceptable range diminishes considerably. Manual uphill transport on slopes steeper than 35–40 % is limited to distances of less than 50 m.

Horse logging

In spite of the extensive use of buffalo and cattle in agricultural operations and horseback transport by certain ethnic groups (Hmong, Yao), animal traction has so far not been applied to forest harvesting operations in the project area. Buffalo and cattle are mostly

used in pairs, which makes them unsuitable for forestry operations along relatively narrow foot paths and skidding trails. The slow reaction capability makes these animals also very vulnerable to leg injuries during downhill skidding, where easy manoeuvrability is required. Suitable logging harnesses for these types of draught animals could also not be identified immediately (FAO 1986).

It was therefore decided to concentrate further investigations on horse logging operations. Harnesses, self-locking skidding chains and ropes were imported from Europe. Skidding troughs were manufactured locally from 2-mm tin sheets with two different opening widths (80 and 100 cm). Two horses the size of large ponies (shoulder height of 115 cm) were trained by a traditional Hmong horse-keeper in bamboo logging, using the above equipment. Performance of the horse-logging operations were tested on the two felling sites over level and downhill sloping (10–20%) terrain, and over distances of between 200 and 3,000 m with a total of 180 harvested bamboo culms.

Time for loading the skidding trough (shoe) with 10–15 culms for each trip and tying the bundle with a self-locking chain required an average of 4 to 5 minutes. The mean load per trip was 172 kg (with a range of 145 to 195 kg). During the observation of 21 roundtrips, the self-locking chains failed in only one case. The utilization of this kind of equipment was found to be indispensable, since it was not possible to tie bamboo culms with locally available material into bundles and drag them over larger distances without the slippage of individual culms leading to the loosening of the bundle. The economically viable maximum range for horse logging was found to be about 2500 m, keeping logging costs below US$ 10 per ton.

On steeper downhill sections, a second operator is required to apply tension to the load to prevent it from slipping into the rear legs of the horse or the feet of the front operator. This will increase costs for the operation on these terrain conditions by about 30%. Some preliminary trials to extract bamboo on steeper uphill terrain showed that the performance dropped dramatically. Further tests would be needed to establish accurate performance data, but it is suggested that the economically viable range for uphill skidding with horses on slopes above 20% would be reduced by about 50%. On slopes above 40%, horse logging will not be viable.

Development of a 2-wheel tractor-based mini-skidder

Due to difficulties in introducing horses to ethnic groups without previous experiences in keeping such animals, and the limitations of horse logging in terms of maximum skidding distance and poor performance on steeper slopes, it was decided to explore additional skidding technologies. The conversion of locally available 2-wheel tractors into a pedestrian operated skidding device was identified as the obvious alternative due to the following reasons:

- The basic technology of two-wheel tractors is widely spread in the RDMA target areas. One can easily remove the engine, gear box, and belt-driven device and combine it with other appliances such as water pumps, threshing machines, and small sized 4-wheel trucks.
- Over the last two decades, a variety of wheel- and rubber-tracked pedestrian operated mini-skidders have been developed in Scandinavian countries. They use motors in a power range similar to the 9 to 15 hp 2-wheel tractor. Two models, the Jonsereds Iron Horse (9 and 19 hp) and the Gustafsson Oxen (15 hp, described on www.gosta-gustafsson.se) find widespread application in the forests of northern Europe. An earlier model, the so-called Wheel Horse, was in its design nearly identical to the regionally available 2-wheel tractors, but it is no longer manufactured.

A review of the literature on pedestrian-operated mini-skidders revealed the following data on their performance and operational costs (see also Table 1):

- The maximum loading capacity is in a range of 0.7 to 1.2 tons, whereby part of the load is dragged behind the vehicle.
- Transport speed is determined by the operator's walking speed, typically around 4 km per hour.
- Up and downhill skidding can be done with sufficient safety on slopes of up to 35%.
- Typical performance rates at skidding distances of between 50 and 150 m are approximately 2 to 4 tons per hour. Due to the high labor costs under European conditions, the maximum economically viable skidding distances are below 200 m.
- Machine costs include annual depreciation of the purchase price, operation and maintenance of about 400 hours per year. These costs range from US$ 3 to 8 per hour.
- The purchase costs for such machines range from US$ 11,000 to 14,000, which is prohibitively high for the rural community context of Southeast Asia.

A prototype of a mini-skidder is presently under construction at the Faculty of Mechanical Engineering, National University of Laos, Vientiane. Field trials on the machine are expected to commence towards the end of 2006. The prototype uses a 14 hp Yanmar engine and gearbox. The undercarriage consists of six 14-inch-diameter truck wheels and rubber belts with a circumference of 2 m, cut from used excavator or truck tyres of about 1.1 m diameter. The mini-skidder will be designed in a way that the engine is interchangeable with the standard two wheel agricultural tractor and other local agricultural devices. For safety reasons the operator will walk sideways in front of the skidder and control speed, direction and breaks via a handlebar. The skidder will have a clamp bank loading device allowing the dragging of stems or bamboo culms of up to 15 m in length. It is estimated that the undercarriage, control handle bar and loading device can be locally manufactured at a cost of around US$ 800 to US$ 1,000, thereby totalling about US$ 2,200, a price range affordable to cooperative forest user groups.

Table 1: Costs for horse logging and mini-skidder system components (US$)

System component	Horse	Harness Loggingtrough	Mini-skidder
Purchase price	150	225	2,200
Residual value after 5 years	100	50	125
Depreciation	12	35	400
Interest 15%	22	34	320
Maintenance/repairs	90	75	200
Fuel (per day)			11
Total costs per year for an effective utilization period of 100 days	265		930
Machine costs per day	2.65		9.30
System costs incl. 1 operator	4.65		11.30

Based on the analysis of its Scandinavian counterpart models, the proposed mini-skidder is predicted to have the following performance rates:

- The machine costs are estimated at around US$ 9 per day, which is slightly higher than the costs of the 2-wheel tractor, especially due to the wear on the undercarriage, wheels and tracks.
- The costs for harvesting and forwarding bamboo (or timber of equivalent dimensions) on slopes below 30% are estimated in relation to distance according to Table 2. The table assumes a harvesting team of two persons for felling and forwarding to the skidding trail and one person for the operation of the mini-skidder. The daily wages are set at US$ 2 per day per person.

Table 2: Estimated performance of pedestrian operated mini-skidder on slopes below 30% in relation to transport distances

Skidding distance (m)	Estimated travel time for return single trips (min)	Total trips per day	Total weight of transported material (tons)	Transport costs (US$ per ton)
100	24	15	9.0	1.25
250	30	12	7.2	1.4
500	38	9	5.4	2.1
1000	50	7	4.2	2.6
2000	80	4	2.4	4.7
3000	120	3	1.8	6.2
4000	160	2	1.2	9.4

Road transport of bamboo

Costs for road transport, assuming five 1-ton trucks over typical distances of between 20 and 100 km, range between US$ 0.2 and US$ 0.3 per km per ton, the figures being based on data from transport of agricultural commodities in the project area. They are also in line with a preliminary feasibility study involving a truck operated by the proposed central charcoal processing plant, at an estimated cost of US$ 0.23 per km per ton. For distances below 10 km, costs for transport by 2- or 4- wheel tractors with a load capacity of 1 to 1.5 tons fall within a range of US$ 0.35 to $ 0.50 per km per ton. Charges for loading bamboo on trucks or tractors are about US$ 0.5 per ton.

River transport of bamboo

The use of bamboo rafts for transport on the Mekong river and its tributaries is common. Such rafts are typically constructed for the transport of culms themselves, whereas transport of other commodities on such rafts is rarely found with the exception of transporting tourists, in the north of Thailand. Rafts are normally built in the rivers from 40 to 60 culms, in a crosswise double layer arrangement, with a total bamboo weight of about 600-900 kg.

Field trials on the Namtha River have revealed that bamboo rafts could be constructed easily with a width of about 3-4 m and a length of 15-20 m. These would be made with up to 4-5

layers of bamboo culms which would result in individual raft panels of about 150-200 culms weighing about 2.5 to 3.5 tons. The construction time is approximately 6-8 hours, involving a three-person team. Such raft panels require two people for steering. The average actual travel time of such rafts is around 5-6 km/hour, not accounting for rest periods and other delays. Based on these observations, the costs for river transport of bamboo by raft can be estimated as follows in relation to transport distance.

Table 5: Transport costs for bamboo by river rafting in relation to transport distances

Transport distance (km)	Travel time (days)	Travel costs for personnel incl. return trip by speed boat (US$)	Cost per ton of transported bamboo (US$)	Transport cost per ton per km (US$)
10	1	9	3.0	0.30
40	2	18.5	6.2	0.15
70	3	23	7.7	0.11

Note: Six hours are estimated on the first day of operation for the construction of the rafts by a three-person team. Thereafter, rafting is done by a two-person team for a period of about 2 hours.

There is considerable room for improving the present rafting technology through:

- more standardized raft designs;
- improved tools for building and steering the rafts, including small hand-operated winches to remove rafts stuck on underwater obstacles;
- construction of the rafts with gross bound floor panels and pyramid shaped 3-4 layer side walls on dry ground river banks over bamboo rails, allowing for a later sliding of the raft into the river; and
- linking several raft panels behind each other in order to reduce person power for steering, which seems to be possible at least during higher water levels in the rainy season.

Conclusions

The three methods of skidding operations are compared in Figure 1. The following table presents the cost estimates for current manual practices, horse logging and the proposed mini-skidder. For each of the systems an annual operation time of 100 days is assumed. This relatively low figure is due to two main factors: (1) harvesting operations will be restricted to the dry season of only 8 months and (2) due to employment in subsistence agriculture, availability of labour for forestry operations will be rather limited in the target areas.

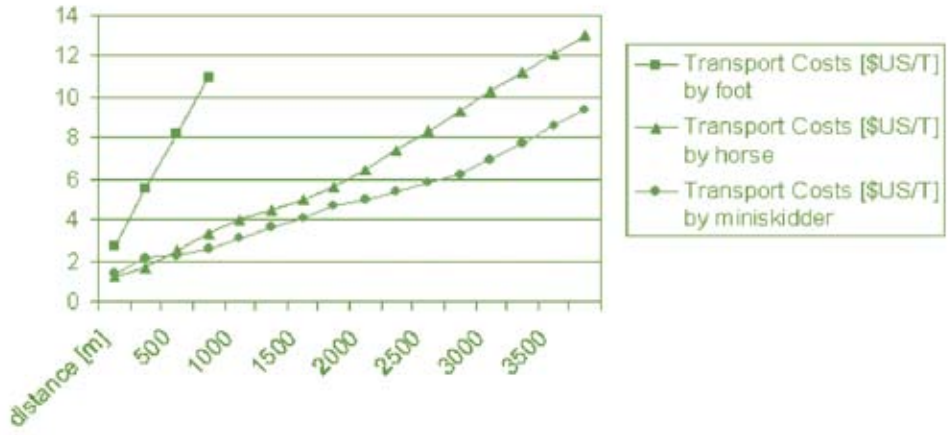

Figure. 1: Transport costs (US$/ton) of systems in relation to transport distance

In view of the total harvesting and transport chain, an average outlay of about US$ 8 could be allocated for skidding, taking into account the expected upper limit of $US 17 per ton for the material delivered at the processing site, US$ 4 per ton for felling and bunching, and US$ 5 per ton for road transport (including loading) or river rafting. The table shows that costs for manual transport rises sharply, and would allow this method to be feasible for distances of up to 600 m only, not withstanding considerations of ergonomic limitations for repeated applications of this method.

Horse logging would be economically feasible up to distances of about 2,500 m, whereas the proposed mini-skidders would have a viable range of about 3,500 m. With uphill skidding situations the performance of horse logging systems drops dramatically to distances of between 1,000 and 1,500 m. In view of this, it is recommended to focus initially on horse logging as a superior option for extracting bamboo on a commercial scale in the project areas. However, due to the limitations of this system to only slightly inclined downhill or level terrain conditions, and due to the presently questionable acceptance of keeping horses by some ethnic groups, the introduction of the proposed conversion of 2-wheel tractors into forest harvesting machinery should be followed further.

The preliminary results of these studies have noteworthy implications for forest management planning at the community and regional levels in Laos. In situations where forest harvesting is being considered on a larger scale (the commercial level as opposed to domestic use only) much more attention needs to be given to both the technical and financial viability of extraction methods. Developing road access and laying out skidding trails to the production forest areas under consideration has to become an essential element of forest planning within such development strategies. If the economics of forest harvesting operations are not taken into account, forest resources are typically over-exploited in the immediate vicinity of roads and rivers, or under-utilized in areas with limited accessibility.

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Processing Lumber with Chainsaws: Relevance for Households in the Forest Zone of Ghana

Michelle A. Pinard
University of Aberdeen
UK

Kwame A. Adam, Joseph R. Cobbinah, Eric Nutukor, Lawrence Damnyang and Charles Nyarko
Forest Research Institute of Ghana
Ghana

K Samual Nketiah and Kyereh Boatang
Tropenbos International
Ghana

M. Owusu Abrebresse
Forest Services Division
Ghana

Introduction

Chainsaw milling, or stump-site production of lumber using a chainsaw, is thought to hold considerable promise as an enterprise among rural communities because of employment opportunities and because it is a way to increase the benefits gained from trees on farms. Chainsaw milling requires a relatively small investment, since the machines are readily available and are inexpensive to buy or rent. A single person and machine can fell, crosscut and mill one or more trees in a day. The machinery is portable and efficient. Chainsaw milling can increase the value of trees on farms by providing a means through which the trees can be readily converted into revenue for the tree owner. Chainsaw milling can also stimulate the local economy through the provision of raw materials (Pasiecznik 2006). Because small and poorly formed trees can be utilized, chainsaw milling also represents a way to increase the efficiency of conversion of trees into lumber.

However, in Ghana, chainsaw milling activities are currently considered a major threat to the sustainable use of forest resources. There are several reasons for this:

- it is very difficult to regulate this highly localized and widely dispersed industry;
- the government associates chainsaw milling with loss of revenue from the non-payment of tax and royalties;
- chainsaw milling competes with sawmill operations for available resources;
- it is considered to be wasteful due to low recovery and poor quality of produced lumber (i.e., rough, curvy boards, prone to failure, with relatively short lifespan); and
- chainsaw milling is dangerous to the operators (most sawing is done freehand without training or safety equipment).

Chainsaw milling activities became widespread in Ghana in the 1980s when an economic recession caused a decline in lumber production from sawmills. The government attempted to regulate the operations in 1991 by mandating the registration of chainsaws with District Assemblies and by requiring permits for tree felling by District Forestry Officers (Legislative Instrument 1518). But this attempt to regularize chainsaw milling activities failed, with indiscriminate harvesting of prime species, felling of immature trees, and non payment of royalties, rents and other taxes being widespread. In 1997 (Act 547) and 1998 (Legislative Instrument 1649) the government outlawed the production, sale and use of chain-sawn lumber in Ghana. The rationale for this ban was to: 1) allow the Forestry Commission to gain greater control over the marketing of logs and lumber; 2) guarantee a supply of raw materials to local sawmills and the timber industry; 3) protect the wood processing industry; and 4) create jobs within the sector.

The ban on chainsaw milling and its associated lumber trade have been ineffective to date. The majority of the lumber sold in domestic markets continues to be sourced from chainsaw operators. The failure is attributed mainly to corrupt practices within various institutions entrusted with forest management and the control of timber harvesting. However, corruption alone doesn't explain the continuation and expansion of the industry in Ghana. The reality is that there is a deficit of sawmill timber for local markets, [1] the price of chainsaw lumber is low relative to sawmill lumber produced for local markets, there is a lack of employment opportunities in villages in rural areas, and there is a lack of clarity over tenure of trees on farms. (Nketiah *et al*. 2004)

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1 The traditional mills by law (Section 36 of Legislative Instrument 1649a) are obliged to supply not less than 20% of their mill output to the local market. If this law were complied with, the mills would deliver about 120,000 m^3 to the local market annually. This represents only 24% of the estimated local consumption of about 500,000 m^3 (Coleman 2004).

Illegal logging, including chainsaw milling, is overwhelming the capacity of the forest administration in Ghana. More staff hours are devoted to the control of illegal activities than are available for all other management activities required to sustain the resource base. Chainsaw milling is now associated with much conflict, as various actors perceive the actions of others as impeding their use and control of forest resources. The conflicts are largely between the state (via its implementing agencies), the "recalcitrant" citizens who attempt to access timber illegally, the sawmill industry and the chainsaw millers, all of whom are competing for an ever scarcer resource. It is evident that chainsaw logging and milling is prevalent in West Africa, whether it is legal or not. If we hope to move towards sustainable forest use, we need to better understand the conditions under which chainsaw milling can be made sustainable.

As part of a larger study to determine the governance requirements under which chainsaw logging and milling could be conducted in a socially, environmentally and economically acceptable ways, we conducted a comparative socio-economic study of chainsaw and industrial timber production in Ghana in November and December of 2005. The specific objectives were to:

- identify the costs and benefits to households in rural communities in the forest zone from logging and milling activities and to compare small-scale chainsaw milling operations with large-scale industrial operations;
- characterize the extent of involvement in, and economic reliance on logging and milling by households within various communities in the forest zone; and
- identify the attributes of the households that predispose them to involvement in chainsaw milling for their livelihoods and the attributes of communities that tend to make them reliant on chainsaw milling.

Methods

Semi-structured interviews were conducted with members of households in nine communities in the forest zone. The households were selected from focal communities using a stratified random sampling strategy, where strata were based on household asset holdings (wealthy, middle, poor) using Rapid Appraisal Techniques or interviews with key informants. Sampling was distributed across the three strata, and included respondents representing a mix of ages, gender, and education levels.

Study area

The focal communities were selected to represent the variability amongst communities in the forest zone, particularly in relation to the level of logging and milling activity (both small-scale chainsaw milling and large-scale milling). The following variables were taken into account in the selection of focal communities for the study, as they were thought to influence the prevalence and profitability of chainsaw milling: status of the forest (i.e., protected, managed by the Forestry Commission, managed by communities, farmland); resource endowment or forest quality (i.e., good, moderately degraded and highly degraded); and, presence or absence of a large mill.

Benefits derived from logging and milling activities

When respondents were asked about the benefits they received from timber harvesting and milling, whether large-scale operations or chainsaw operations, the majority replied they

received no benefit. However, the frequency of respondents citing no benefits was greater for large-scale operations (78%) than chainsaw operations (53%). Although large-scale operators enter into a Social Responsibility Agreement with communities, in practice most members of communities are not aware of the benefits it brings (87%). Some community members believe that the Social Responsibility Agreement does not exist (7%), which may result from a lack of direct benefits. Despite this apparent lack of awareness and appreciation of benefits, there is some evidence from the interviews that logging companies have provided facilities such as school buildings, street lighting in communities and market buildings through the Social Responsibility Agreement.

There was regional variability in terms of the perceived benefits to logging and milling operations. Respondents in Ashanti and Brong Ahafo regions were more likely to report benefits associated with large-scale operations than those in other regions. For chainsaw operations, about 70% of respondents in the Brong Ahafo region identified benefits, whereas only 35% and 38% in the Central and Eastern Regions responded positively. The frequency of citing benefits associated with chainsaw operations was independent of the management scheme of the forest area in question (forests managed by the Forestry Commission, referred to as PFC).

When respondents identified benefits, the list of benefits differed for the two forms of logging and milling (Table 1). The principal benefits associated with large-scale operations were sawn timber, wood residues, social amenities, employment and use of logging roads. The principal benefits associated with chainsaw operations were sawn timber, employment and help in land preparation for farming.

Table 1: Percentage of respondents citing specific benefits associated with tree harvesting and milling activities in their local forest

Benefit	Large-scale logging and milling	Chainsaw logging and milling
No benefit	77.7	53.3
Lumber for construction	8.0	29.2
Wood residues	4.6	1.5
Social amenities (roads, schools, toilets)	4.3	0.0
Employment	4	9.8
Use of logging roads	3.4	0.0
Help in land preparation, getting rid of unwanted trees	0.0	6.0

Lumber, in one form or another, was the most frequently cited benefit of both large-scale and chainsaw operations. In addition to identifying lumber as a benefit, respondents were asked where they obtain lumber for building materials, and also were asked to identify any difficulties they faced in sourcing lumber.

The most commonly cited source of lumber for the households interviewed was chainsaw operators (Table 2). Some respondents differentiated chainsawn lumber from lumber acquired from farmlands and seized lumber bought from the Forest Services Division; however, these two sources are ultimately processed by chainsaw operators. Sourcing patterns appear to differ among the regions, with 60% of respondents relying on lumber from sawmills in the Ashanti, compared to 70% relying on chainsaw operations in the Western Regions (Table 3).

The presence of a large mill in the district, however, did not appear to influence sourcing patterns, nor did the management regime in place for the forest (whether managed by the Forest Service Division or the community). Sourcing did depend on the quality of the forest, with respondents from degraded forest regions indicating a greater reliance on sawmill timber (62%), than those from either moderate or high-quality forest regions (38–48%).

Table 2: Sources where households obtained wood for building

Sources	Percent of total respondents
Saw mills	48.5
Chain-sawn lumber	30.6
Farmland	28.0
Seized lumber	2.2
Other	4.4

Table 3: Main sources of lumber for building

Region	Percentage of respondents	
	Saw mills	Chainsaw lumber
Ashanti	64	36
Brong Ahafo	39	61
Central Region	47	53
Eastern Region	46	54
Western Region	30	70

Most respondents said they did not have any difficulty in obtaining wood for construction (Table 4). The main difficulties identified were transportation of wood, fear of arrest and imposition of fines by the forestry service or law enforcement agents, and a cumbersome permit process. The frequency of respondents citing difficulties varied by region (Table 5), and was greatest in Brong Ahafo (61%), where fear of arrest and fines, difficulties with transportation, and a cumbersome permit processes were the main difficulties cited. The Ashanti region had the second highest incidence of difficulties (46%), with transportation constraints being cited most often. Respondents living in districts without a large mill found difficulties in sourcing lumber (52%) more frequently than did those living in districts with a large mill (25%). Only 20% of the respondents from high quality forest areas reported difficulties in sourcing lumber, whereas 58% and 60% from degraded and moderate-quality forests reported difficulties.

Table 4: Difficulties faced in getting wood for construction

Challenges	Percent of total respondents
No difficulty	67.8
Transportation	10.1
Fear of arrest and fines	8.7
Permit process	7.8
High cost of wood	5.0
Scarcity of wood at saw mills	2.0
Permission from land owner to fell and mill for trees on farm	2.0
Scarcity of wood in forest	1.7

Table 5: Percentage of respondents experiencing difficulty when sourcing lumber for building materials in relation to region

Region	Percentage of total respondents experiencing difficulties
Ashanti	46
Brong Ahafo	61
Central Region	10
Eastern Region	39
Western Region	12

Costs associated with large-scale logging and chainsaw milling activities

When respondents were asked about the costs of logging and milling activities to themselves and their communities, a large proportion believed that there were no costs (Table 6). The frequency of respondents citing no costs was similar for large-scale and chainsaw operations, and was comparable across regions. For those households that identified costs, the most frequently cited costs were the same for the two types of logging and milling operations (i.e. damage to their crops, forest degradation and conflicts with operators). Respondents also cited damage to roads through large-scale logging activities as a problem that affected communities. This, however, was not an issue with the chainsaw milling operations.

Table 6: Timber operations imposing costs as reported by households

Costs	Percentage of respondents	
	Large-scale logging and milling	Chainsaw logging and milling
No cost	45.7	48.4
Damage to crops (and livestock)	32.5	40.2
Forest degradation, negative environmental impacts	9.0	12.5
No idea/don't know	7.3	2.0
Litigation	7.0	0.0
Damage to road	5.0	0.0
Accidents with large trucks	4.8	0.0
Conflict, vandalism, breakdown of law and order	0.0	7.6
Accidents with chainsaw operations	0.0	2.3

Extent of involvement and economic reliance on logging and milling operations

About 8% of households interviewed were directly involved in chainsaw milling operations, while about 4% were involved in conventional logging and milling operations. Where chainsaw activity was identified, it was primarily reported as a secondary source of income (only 1 of 15 respondents relied on it as a primary occupation).

For the interviewed individuals who worked in large-scale logging and milling operations, their monthly incomes from logging activities varied with the type of jobs undertaken and ranged between Ghanaian Cedis 100,000 and 1,200,000 (£ 6–70; US$ 12-140), median 200,000 or £ 11; US$ 22 per month).

Incomes earned in chainsaw milling activities were comparatively higher than the incomes of the employees from the large-scale logging activities (Table 7). However, income from the large-scale logging operations were on a monthly basis involving relative consistency and security, and therefore may place participating households in a more financially secure position than those whose income originates from chainsaw milling. Average annual income for those interviewees working in chainsaw operations is Ghanaian Cedis 3,645,000 (US$ 416). This compares to a median annual income of Ghanaian Cedis 2,400,000 (US$ 275) for those interviewed and working in the large-scale operations.

Table 7: Reported income from survey respondents

Earnings of respondents	Number of respondents	Median Income (Ghana Cedis)	Median income (US$)
Monthly earnings of respondents from large-scale logging	9	200,000	22
Annual earning of respondents from large-scale logging	9	2,400,000	260
Respondent earnings from chainsaw activity the last year	22	3,645,000	394
Estimated annual income from chainsaw operations as reported	18	2,850,000	308
Reported annual income from primary occupations from those involved in chainsaw operations	18	5,000,000	540
Reported annual income from all households interviewed	293	2,000,000	216

Attributes of individuals working in logging and milling

About 60% of the people involved in chainsaw milling operations were farmers, similar to the percentage of the overall sample. There was no association between livelihood assets and current involvement in chainsaw operations, nor was there a significant association between current involvement and access to credit. Those involved in chainsaw operations were just as likely to participate in formal, traditional or religious associations as those from the overall sample. And they were no more, or less, likely to be involved in local government, to be close to the chief, or close to the assemblyman. When the age distribution of those involved in chainsaw milling operations was examined in relation to the age distribution of the overall sample, it was found to be similar, as was the age distribution of those working in large-scale logging and milling operations. Thus, it can be concluded from the relatively small sample considered here that there is no evidence these two occupations are favoring the young over the old, or any other subset of rural society.

Suggestions for making chainsaw milling more socially sustainable

The majority of households interviewed were broadly supportive of legalizing chainsaw milling operations (Table 8). Their suggestions for making it more socially sustainable included allocation of concessions with associated monitoring established, making employment opportunities more regular, and requiring operators to pay taxes. About 15% were supportive of the ban on chainsaw milling.

Table 8: Suggestions for making chainsaw milling more socially acceptable

Household suggestions	Percentage of respondents
Give concessions and monitor operations	38
Regularize employment opportunities	15
Ban operations but give permits for communities to use	15
Ensure farmers get compensation for crop damage	12
Let operators pay taxes	7
Organize operators into associations	6
Plant trees	5
Provide education to increase livelihood opportunities	5

Conclusions

A large number of rural households in the forest areas surveyed feel that they receive no benefits from large-scale logging and milling operations. Despite heavy reliance on these industries for their supply of local lumber, residents are expecting more. This is particularly true for large-scale operations. Several factors may play a role in influencing rural household views about the industry's failure to meet their expectations. First, it may be a lack of transparency in the procedures for delivering benefits to the communities from forest resources.

Social Responsibility Agreements are negotiated between the timber companies and the local governments, as represented by the District Assembly and the Chief. Where the details of the agreements are not clearly communicated to the members of the community, it is difficult for people to associate benefits with the large-scale logging and milling operations that take place in their forest, even when contributions such as schools, market buildings or street lighting have been funded by the timber companies.

Similarly, revenues that are transferred to local governments through the local Chief from the Forestry Commission as a result of timber sales may not be transparent to the community. The large proportion of people indicating that they receive no benefits from chainsaw operations suggests that if the business were to be regularized, it would be necessary to review the benefit-sharing agreements to ensure that people are aware of the benefits that the community derives from the operations. Lack of transparency in relation to such benefit sharing agreements can result in feelings of frustration over ownership of trees on farms, and may explain farmers' willingness to illegally sell their trees directly to chainsaw operators, allowing them to capture some direct income. Variations recorded in perceptions of benefits from the lumber trade may relate to regional differences in the effectiveness of landowners (i.e., chiefs) in negotiating with the Forestry Commission and industry representatives for benefits.

It is interesting to note that household reliance on chainsaw lumber varied by region. In Ashanti, households were sourcing lumber from sawmills more frequently than in other regions. Although the Ashanti region has a relatively high density of mills, the presence of mills alone doesn't explain the household sourcing patterns. The majority of sawmills produce lumber for the export market and tend to deal with bulk rather than individual or household sales. Most of the saw-mills do not supply the local retail market. Further, the lumber that

is produced by sawmills for local markets can not compete with chainsaw lumber in terms of price (i.e., lumber sawn using a chainsaw is sold at a much lower price than that sawn at a mill). Rather, results suggest that where forest resources have been degraded, households are more reliant on lumber from sawmills than from chainsaw operators. Very few chainsaw firms are operating in degraded forest areas because of the low availability of preferred timber species, and this may explain a heavier reliance on lumber from sawmills.

The transportation of lumber from district or regional markets to villages was frequently cited by respondents as a difficulty faced in obtaining lumber for construction. Although some efforts have been made to encourage the development of local lumber markets, for the most part these efforts have not yet been successful. Difficulties in sourcing lumber appeared to be the most frequent cited problem for households in the Brong Ahafo region, along with transportation difficulties, fear of arrest and fines, and cumbersome permit processes. Variations across regions in relation to the intensity of policing efforts may explain differences in perception. More research is needed to confirm the main factors behind the variation.

The costs of logging and milling operations for rural households appear to be felt more acutely than the benefits. Damage to crops and livestock was cited most frequently, both in the case of large-scale operations and in chainsaw operations. For large-scale operations involving the removal of raw timber "off-reserve," logs are often skidded over long distances, frequently causing damage to crops. For chainsaw operations, the damage is primarily associated with felling activities.

Negative environmental impacts, including forest degradation, were cited by a large proportion of respondents as a cost of timber operations. Including the felling and skidding damage already mentioned, impacts on the forest resource base are also recognized. Chainsaw operators regularly fell trees that are below the legal size limit, cut and mill tree species from all timber classes (i.e., those with high, medium and low demand), and harvest over-exploited and threatened species. Although more lumber appears to be taken from "off-reserve" sources, the statistics related to Forestry Commission confiscation of lumber suggests that "on-reserve" offences are as frequent as those occurring "off-reserve."

Conflicts, vandalism and the breakdown of law and order are costs rural households associate with chainsaw milling. This is felt more broadly by the general society in Ghana, and is especially true for people working in law enforcement and forest management. Conflicts are also associated with large-scale operations, though these were identified specifically as being in the form of litigation costs. Many farmers have faced difficulties when taking logging companies to court to get compensation for crop damage. Litigation issues also arise in relation to disputes over the boundaries between different communities' lands.

Taken together, logging and milling operations employed members of about 12% of the households interviewed. Given that the study was conducted within the forest zone, one might expect higher levels of employment. Those few who are employed by the large companies benefit from job security and a predictable income; however, the numbers of jobs available are few. Large-scale operators have no obligations to employ locally when working in a particular zone. In contrast, survey results suggest that chainsaw operations employed twice as many local people as the large-scale operations. The median income from chainsaw milling was greater, but job security was low and there was high variability in the number of opportunities for earning from this activity. Chainsaw milling is primarily used to supplement income rather than as a primary source of income. Relative to large-scale operations, it appears that opportunities in chainsaw milling are more widely dispersed across forest zones.

From this study it is clear that local communities would welcome policies that ensure a regular supply of legal timber for domestic use. There is also potential for greater commitment from

communities toward sustainably managing existing timber resources, especially if they could experience benefits from effective regulation of the forest resource.

There is desire among some policy makers, politicians, and resource managers to support the legalization and regulation of chainsaw milling, but there is also fear of increased corruption, which has already negatively impacted on the sector. There is a need to understand the nature and dynamics of corruption in chainsaw milling in order to devise appropriate interventions and standardize the industry. Weak forestry institutions currently cannot enforce policies and legislation effectively. Weak social norms lead to forest abuse that goes unpunished by other stakeholders. It is these governance and societal weaknesses that underlie the problems of corruption and illegality in the forest sector, especially with regards to chainsaw milling.

In addition to weak institutions, some policies introduced by the Ministry of Lands, Forestry and Mines may be contributing indirectly to the problem of chainsaw milling and its associated corruption. For example, resource allocations through the timber utilization contract and competitive bidding procedures mean that only registered timber companies have the ability to obtain trees. In both authorized large-scale operations and chainsaw milling there are opportunities for corrupt practices to influence access to the resource.

The current government policy for dealing with the problem of chainsaw milling in Ghana appears to be one of a continuously enforced ban on such operations. This is to be accompanied by the creation of alternative livelihood schemes to absorb illegal chainsaw operators, mobilize chainsaw operators to establish and operate mobile forest mills that are easier to regulate; implement an effective log-tracking system; and strictly enforcing the law banning chainsaw operations. Contrary to this approach, the general public supports lifting the ban, mainstreaming chainsaw operations through re-introduction of limited permits to registered groups of local timber traders and their chainsaw operators, and thus ensuring a consistent and affordable supply for the domestic market.

Logging and milling activities in the forest zone bring a variety of costs and benefits to rural households, which vary regionally. A large number of households are broadly supportive of legalizing and regulating the chainsaw milling industry, with the expectation that controlling the industry would reduce the negative environmental impacts of milling, provide farmers with a mechanism for being compensated for crop damage, and contribute to a consistent supply of quality lumber for local markets. If chainsaw milling is to become socially, environmentally and economically acceptable in Ghana, it will be necessary to address issues related to transparency, corruption, institutional weakness and forest policies related to timber resource allocation.

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Capturing Opportunities in Forest Harvesting and Processing to Benefit the Poor in Papua New Guinea

Anda Akivi,
Eco-Forestry Coordinator
Papua New Guinea

Introduction

Papua New Guinea (PNG) comprises the eastern part of New Guinea island, the Bismarck Archipelago, the North Solomons and many smaller islands. Forests cover an estimated 67 % of the land area or 30,601,000 ha (FAO 2005). Much of this forest is inaccessible due to the mountainous nature of the terrain. Papua New Guinea is one of the world's most important reservoirs of biodiversity, containing an estimated 7–8% of world species bio-diversity. There are 15-20,000 species of plants, 700 species of birds and 250 species of mammals within the country, of which many are endemic.

Economic and social indicators

In addition to this wealth of biodiversity, PNG is rich in other natural resources. Apart from the extensive tropical forests and maritime fisheries, there are significant mineral deposits including gold, copper, oil and natural gas. There are

large areas of arable land which could be developed for agriculture and there is scope for an expanding tourism sector. The rugged terrain and high costs of developing infrastructure, however, have hampered natural resource exploitation, while ongoing political instability has undermined investor confidence.

By mid-2006, it is estimated that the population reached 5.85 million, but population density remains low at less than 11 people per square kilometer. Estimates of the adult literacy rate (those over 15 years of age who can read and write) range between 55% and 65%.

From the mid-1990s until the early years of the 21st century, PNG's economic and social development levels were poor. Real GDP remained broadly unchanged from the early 1990s onwards. Activity in the private sector was virtually stagnant and social indicators were deteriorating. In 2003, real GDP per capita was US$ 650, and had been contracting for a decade. It is estimated that 40% of the population lived on less than US$ 2 a day, up from 25% in 1996. Formal employment had risen by only 1.5% since 1996. Those living in rural areas were poorer than urban dwellers in monetary terms, but rural people tend to be landowners and ample subsistence opportunities exist for the rural population.

Although most Papua New Guineans are landowners, the focus of international aid in Papua New Guinea has been the alleviation of poverty. The principal development partners are the Australian Government, the Asian Development Bank and the European Union. Within this context, the European Union has taken an interest in natural resource management, particularly in the context of rural development.

With an improvement in global commodity prices, the current outlook is brighter. Inflation is projected to remain at 1–2% annually. The government's Medium Term Development Strategy harmonizes development priorities for 2005–10 with the Millennium Development Goals. The Medium Term Development Strategy seeks to:

- Establish good governance;
- Promote export-driven growth in agriculture, forestry, fisheries and tourism; and
- Accelerate rural development and poverty reduction.

Role of the forest sector

Forest industry plays a key role in the PNG economy, with timber comprising more than 95% of export sales. A majority of forest land is held through customary land tenure by local communities, informally considered to be the landowners. Under traditional management, there has been limited clearing of forested land. Papua New Guineans are diverse in culture with more than 800 separate tribal languages, but their relationship with the land is consistently strong.

The State has negotiated logging permits with customary landowners, allowing large foreign companies to exploit more than three million hectares of the total forest area. Under these agreements, customary land holders expect to receive cash royalty payments, and the communities expect to have roads, aid posts and other amenities built and staffed. In practice, these arrangements have not always worked out well. The gap between expectations and actual delivery has been wide. Logging operations are accused of practicing unsustainable, industrial logging that primarily exports round logs with limited benefits accruing to the communities. Figures are debated and recent numbers are not yet available, but deforestation rates have been estimated at 1.5% (approximately 450,000 ha) per year.

There is an increasing awareness of the damage occurring through unsustainable commercial logging, and communities are seeking alternatives over which they have more control. "Eco-

Forestry", as community-based forest management is known in PNG, is intended to present local communities with such an alternative. The objectives of Eco-Forestry are:

- long-term conservation of the forest resource and eco-systems by establishing sustainable natural forest management; and
- provision of sustainable income to landowners.

Eco-Forestry management practices allow communities to utilize their forest resources in a modest, sustainable manner to enhance their incomes and living standards, while ensuring that their forest resources continue to be available for future generations. Methods of utilization include cutting, milling and further processing of timber on a selective basis. Eco-Forestry may also include replanting of trees in depleted areas, collection of non-timber products, and development of ecotourism. The essential principles of Eco-Forestry activities are that they depend on local forest resources, they are sustainable, they improve local living standards and they are under the control of the local people.

Islands Region Environment and Community Development Program

The European Commission (EC) provided a significant boost to the practice of Eco-Forestry in PNG by supporting the Islands Region Environment and Community Development Program (IRECDP), from 1995 onwards. When the IRECDP closed in 2001, it had achieved a number of important results. Thirty-two communities had established small-scale saw-milling operations that brought significant benefits, including improved houses, newly constructed schools and other public buildings, and improved income from timber sales. Some communities invested part of the proceeds of their saw-milling enterprises into other productive activities within the communities. The program also promoted the Eco-Forestry movement among a number of non-government organizations within PNG.

However, the IRECDP suffered from a number of weaknesses. First, the program was nominally under the administration of the Department of Environment and Conservation (DEC), which had very limited capacity for implementing or monitoring activities. Thus, there was no government framework within which the principles of Eco-Forestry could be learned, supported and replicated. Second, the program operated primarily in the islands and had little impact on the mainland, though later projects were established in Madang and Morobe. Third, certain aspects of the methodology turned out to be unsustainable.

This lack of sustainability can be attributed to the program, not the communities, retaining responsibility for the logistical arrangements of selling sawn timber, and delivery of fuel and spare parts. When IRECDP support faltered, the communities had not yet developed sufficient capacity to assume management of these aspects of their businesses. As a result, production levels declined rapidly after 2001.

The Eco-Forestry Program

The Eco-Forestry Program was intended to build upon the achievements of IRECDP. According to the financing agreement, the Eco-Forestry Program was expected to facilitate "a systematic introduction of Eco-Forestry in Papua New Guinea" at the national level, and at the local level it was to "improve the Eco-Forestry approach developed by the IRECDP."

Like IRECDP, the Eco-Forestry Program was originally designed to be managed from Kimbe, West New Britain and to continue for five years. It included three components: the field and marketing components were both based at program headquarters, while a policy component was based in Port Moresby. Unlike IRECDP, the Eco-Forestry Program has been administered by the Forest Authority of PNG, with a total budget of Euro € 7.5 million (approximately US$ 10 million).

Purpose and overall objective of the Eco-Forestry Program

The stated purpose of the Eco-Forestry Program is to enhance the economic welfare of the people of PNG through community-based sustainable forest management. The program aims to enable landowners to benefit sustainably from their forest resource. The program outlines eleven procedures to ensure that resource management meets certain basic standards for sustainability of the forest resource. The program aims for the community to be able to use the benefits generated through forest management to develop other enterprise options. However, the question arises on the sustainable management of forest resources by succeeding generations, as a 20-year cycle of harvesting is traditionally required.

According to project documentation, the Eco-Forestry Program and its predecessor, the IRECDP, have demonstrated that community-based forest management can enhance the welfare of communities in various ways. These include self sufficiency through the construction of aid posts, class rooms, and meeting halls as a result of income derived from community-owned and milled timber. Income from the sale of timber has even been used to subsidize the health expenses of community members. Funds generated by the program activities have also been used to fund the development of income-generating agricultural enterprises, such as coffee, cocoa, vanilla and oil palm.

Project documents recognize that the sustainability of the above forest management programs remains inconclusive. Traditional forest management and utilization practices are, in theory, low impact. Harvest cycles are forty years or more. What typically happens is that as operations move further from the more accessible routes, the work involved in extracting timber becomes more labor-intensive and eventually ceases. By the time this happens, the communities have often attained most of their immediate objectives of becoming cash-crop producers, thus relying less on timber extraction. Consequently, the community feels less urgency to sell its forest resources, which are then better conserved and protected against exploitation by outsiders.

Results expected compared to actual experience

Below are the six expected results from the Eco-Forestry Program, with narrative on what the actual experience has been.

1. Relevant actors are aware of the ecological and productive potential of the forest resources.

Communities seem to have adopted the ecological standards of Eco-Forestry readily. Expectations of the productive potential of forests are high, but given the size of the resource available, the expectations can usually be met. In the projects undertaken by the Eco-Forestry Program, the sustainable production cycles actually exceeded the capacity of the community to exploit the resource.

It should be noted that the criteria and indicators for sustainable forest management are often not sufficiently monitored in large timber projects in PNG. There has been considerable work done on assessing the sustainable harvest cycles of PNG forests, but this knowledge has yet to be incorporated into large-scale logging management schemes. The evidence suggests that PNG forests are not particularly productive, and that harvesting cycles should be longer, or harvest rates lower, than in the neighboring Indonesian forests of Borneo, for example. This issue has not been adequately addressed by the Eco-Forestry Programme to date, but it is generally perceived that the relatively low volumes removed under the Eco-Forestry Programme are in line with sustainability principles.

2. Development, testing and promotion of economically, environmentally and socially sustainable options for Eco-Forestry.

The program developed six Eco-Forestry options. Two of these, the Walindi and Multifor schemes, relate to the original objective of managing the natural forest. The other four, reforestation (REFOR), ecotourism, downstream processing and non-timber forest products (NTFP), were peripheral options that were addressed, but never developed or tested in a meaningful way.

The Walindi scheme has experienced problems with financial viability due to limited available resources, factors relating to the level of education and literacy of community members and difficulties resulting from cultural differences.

The Multifor scheme was developed to address some of the financial shortcomings of the Walindi scheme by increasing available forest area, thereby increasing the supply of timber which would then allow mechanical harvesting and extraction. The Eco-Forestry Program has implemented two Multifor projects. The first involves the Ruti community in the Baiyer River Valley, Western Highlands Province. In this case, the community secured two semi-portable mills that were placed on site with the assistance of the program. They also acquired a D7 bulldozer, tractor, bench saw and a 250 KVA generator to power downstream processing operations. Training was conducted in both the field and classroom. A forest inventory was completed, and a Forest Management Plan was developed.

The second Multifor-based project is a cluster of Walindi-based projects in West Pomio, a remote area of East New Britain. Most of these projects were originally developed under IRECDP. The clustering strategy is an attempt to consolidate timber output to meet the requirements of export sales orders. In the past there were problems with the transport of timber to sales points. To address this, buffalo were introduced in 2005, which significantly improved transportation arrangements. Buffalo have since been introduced in other Walindi projects, and their use has been successful where the animals are used and cared for properly. This is a significant advance over previous technology, and a major achievement cited by the program.

On paper, the Walindi and Multifor schemes are financially viable, but this viability has not always been demonstrated in practice. However, the wider social and economic benefits experienced (service buildings constructed, clean water supplies built, long-term conservation, capital for alternative agriculture, etc.) are seen to far outweigh the marginal financial viability.

The other four options have not been developed by the program, but outsourced to other stakeholders. The development of ecotourism is a branch of the tourism sector. The forestry sector's contribution is generally the management of natural forests and foresters often are not trained for tourism activity management. This aspect of the program was therefore outsourced to Maniho Na Dari, an NGO involved in the promotion of ecotourism in PNG.

The reforestation project, including establishment of nurseries, developed from trainings conducted on community nursery development in 2004, involving communities from the Highlands and Mamose regions of PNG. The medium- to long-term viability of this activity is still uncertain. There is a need to establish a stream of benefits to the community from this model before the planted trees mature, which is not expected for at least 15 years. Waiting for 15 years before any income can be realized is for the most part unsustainable at the community level. Present models which involve compensating the community to plant trees on their own land also have not been successful in the past. Carbon sequestration payments linked to reforestation provides a possible avenue for income generation and should be explored further by the government as a priority. If this is seen as a viable option, a key task is the establishment of institutional arrangements for benefit sharing.

Downstream processing is a good option for PNG, but not for community-based timber producers who do not possess adequate processing capacity. This should be developed at a medium-scale level (Multifor), where professional wood manufacturers have the capacity to produce high-quality certified timber products for export.

Using NTFPs for income generation is another option. Eagle wood and other forest products provide significant opportunities. These are currently being undertaken in specialized projects. The private sector could assist, especially if the opportunity for profitable returns exists. It should also be understood that there is the potential for over-exploitation of these products if production is not sustainably managed.

3. Standards for Eco-Forestry are further developed.

An Eco-Forestry policy for PNG was produced through a long participatory process. This was necessary, as the PNG Forest Policy and Forest Act developed in the early 1990s do not address the community management of forests. The Eco-Forestry policy has been approved by the National Forests Board, but not yet endorsed by the Minister of Forests for consideration by the National Parliament. Consequently, a code of practice has not yet been drawn up and institutional arrangements still need to be put into place. It is hoped that the Eco-Forestry policy will be enacted by parliament and then actively implemented.

4. Eco-Forestry integrated in the training programs of existing institutions.

The Eco-Forestry Program developed sawmill and chainsaw manuals to support training of project personnel in the field by field trainers. Some 455 people were trained as trainers. These field trainers are a significant resource who will be able to support projects on a commercial basis.

The Small Business Development Corporation (SBDC) has developed two training modules, including training manuals specifically targeting small-scale forest enterprises. A cadre of 17 certified trainers has been trained who can be hired for instruction. So far they have delivered nine courses. The marketing office has worked in conjunction with the Eco-Forestry Program business development officer to achieve this result, and it is cited as a major success of the program.

5. Landowners can market their products from Eco-Forestry.

There have been mixed results on this point. Landowners can now market their own products, but improvements could still be made to market products more efficiently. Due to the mixed objectives of the marketing component, landowners are confused over the costs of marketing and are far from competent in selling timber. Much energy goes into trying to maximize short-term profits, rather than developing sustainable long-term trade for the benefit of all

involved. Trust between landowners is in short supply, and the Eco-Forestry Program's role in this respect has been questionable.

There is a small group of overseas buyers who know the PNG market and will buy any certified timber produced of reasonable quality. Producers could sell as much timber as they produce, but they are currently not meeting even minimum quality standards, nor are they supplying finished products in sufficient quantities to develop a steady trade.

Other aspects of marketing have received more attention, such as promoting lesser-known species or developing newsletters to inform potential buyers. Unfortunately, based on results to date, it does not appear that these efforts are directly helping the producers. It also appears that these activities have been poorly targeted, with many projects initiated but few completed or effectively followed through. This is at least partly due to the slow performance of the field component, which only started to produce timber in late 2004.

6. Community development activities supplementing Eco-Forestry projects are encouraged and supported.

Good progress has been made on supporting community-based forest businesses. Training modules have been developed, and this training could easily be mainstreamed through the use of business schools and certified trainers. The same approach is being developed with sawmill trainers. Trainers are already in the villages and various projects have led to partnerships with trainers who supervise production while taking a percentage of the profit as payment for ongoing training. Sustainable forest management is more difficult to teach and training in this has been less developed to date. This management knowledge needs to be incorporated into training modules and tested. Other areas requiring more training and capacity building are enterprise management and marketing techniques.

The communities themselves have ensured that their immediate needs have been met. Aid posts, classrooms, village halls and churches have been built. The secondary development of agricultural enterprises can also be seen as a positive result. Much remains to be done, but a base has been established from which a new institutional framework could be confidently established.

Summary of observations

- The program has contributed to its objectives in that some communities are receiving benefits from their own forest resources, and in general their well-being has been enhanced by their involvement in Eco-Forestry projects. The major contribution of the program has been to demonstrate the potential success that communities with a sufficient quality of resources and commitment can achieve through the Eco-Forestry approach. There is also no doubt that an indirect benefit not listed in the project documents is also being achieved. Deforestation is simultaneously being mitigated through this approach. Personal communication with those active in the field suggests this, but hard figures comparing vegetation changes in Timber Authority (TA) areas and community-controlled forests are not currently available to confirm this.
- The Eco-Forestry approach is not intended to produce financially significant results at the national level. In this respect, it is not a substitute for industrial logging in terms of contributing to the national treasury. The immediate impact of wholesale adoption of Eco-Forestry by communities would result in a deficit in the national accounts. However, if this analysis accounted for the costs of resource depletion, the balance might weigh

in favor of Eco-Forestry as a long-term strategy over industrial logging as it is currently being practiced in PNG.

- Industrial-scale logging in PNG often does not bring significant benefits to landowners because prices of logs are often manipulated and kept artificially low by deceit and political compromise. While traditional financial analysis might favor industrial logging over Eco-Forestry, the constant and sustainable stream of benefits provided by Eco-Forestry seem a preferable option from the perspective of landowning communities.
- It is difficult to claim that the Eco-Forestry Program is generating impacts at the national level. While real results are emerging at the local level, the widespread adoption of the Eco-Forestry approach is some time away. The impact is currently localized and limited in time, as some benefits appear to exist for a limited period until the community becomes wealthier and takes up other cash crop alternatives to Eco-Forestry. However, forest resources remain intact and in the hands of the community, thereby supplying ongoing benefits to many stakeholders both within the community and beyond its borders.
- There continues to be resistance to the advance of Eco-Forestry as a practical concept. Large-scale logging companies have employed consultants to undermine the value of benefits perceived by the public. So far this misinformation campaign has been successful, in that the establishment of the Eco-Forestry Branch within the PNG Forestry Administration has been delayed - despite board-level approval. Supportive elements within the PNG Forestry Administration are struggling to overcome this resistance.
- The program has coordinated with other stakeholders, notably NGOs, to promote the benefits of Eco-Forestry, but this effort is being undermined by others who do not wish to see Eco-Forestry succeed.

Conclusion

Participation in Eco-Forestry projects engenders self-sufficiency and empowers communities by enabling them to derive benefits and services from their own forests as well as assuming responsibility for forest management. Indirect benefits of Eco-Forestry include aid posts, and classrooms, capital for agricultural investment and cash for supplies.

Eco-Forestry potentially offers rural communities a viable alternative to industrial logging. Eco-Forestry also meets the objectives of the government's Medium Term Development Strategy and is strongly supported by various sections of government. However, there is also strong resistance within the forest industry and their proxies in government.

The Eco-Forestry Program has produced some good examples of activities that provide a stream of economic and social benefits to communities, especially in remote areas. On the other hand, while there is evidence that Eco-Forestry can be financially viable, further evidence and experience is needed to reaffirm this. The evidence from early projects is inconclusive, but suggests that the projects do deliver a stream of benefits to the communities and provide a viable alternative to industrial logging. There is also emerging evidence that Eco-Forestry activities are being used to build capital, to launch agricultural enterprises and to derive income from land clearing.

Challenges do remain, however. The Eco-Forestry Program has led to an Eco-Forestry policy, but not, as yet, a viable institutional framework. Furthermore, despite early successes, including a proliferation of good ideas and awareness-raising around Eco-Forestry products, the Eco-Forestry Program Marketing Component failed to successfully increase the capacity of the community to organize and manage the sale of timber at the community level.

The Eco-Forestry Program has been effective in developing capacity in communities and has probably played a key role in raising awareness of Eco-Forestry and the potential of Eco-Forestry in the country, although this process has not necessarily been efficient. Ongoing capacity building is needed.

The roles of various stakeholders beyond the program will remain important. The private sector will play a key role in the further development of community-based forest management. International buyers are already buying certified sawn timber from Eco-Forestry Program producer groups. They would buy many times what is presently available if supply and quality were more reliable. NGOs are already playing a significant role in Eco-Forestry development. They will continue to do so despite a precarious operating model and limited capacity. The European Union and other donors benefit from carbon sequestration and conservation derived from improved natural forest management and increased forest resource security, which Eco-Forestry provides to community-owned forests.

Community reforestation schemes show promise, but unless a steam of benefits can be generated immediately, they are unlikely to be supported by the communities themselves in the medium term. In particular, reforestation schemes funded under the carbon sequestration component of the Clean Development Mechanism of the Kyoto Protocol may provide a vehicle to mobilize income for reforestation schemes, increasing their viability.

References

FAO, 2005. *Global Forest Resources Assessment 2005: Progress towards sustainable forest management*. FAO Forestry Paper 147, FAO, Rome.