Chapter 12

A case study of the production-to-consumption system of sandalwood (*Santalum album*) in South Central Timor, Indonesia

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Common names	Part of the resource used	Management	Degree of transformation	Scale of trade	Geographic range
Cendana, Sandalwood, Hau meni	Resin and wood	Wild	High	International	Medium

OVERVIEW

In Nusa Tenggara Timur province, Indonesia, sandalwood (*Santalum album* L.) is harvested mainly from natural stands. Sought after for its pleasant odour, the wood is used for the production handicrafts, joss sticks and, the main sandalwood product from the region, sandalwood oil, which is exported to be used in perfume and cosmetics industries all over the world. The sandalwood production in Nusa Tenggara Timur province is threatened by an alarming rate of decline in the sandalwood population. Overcapacity of the sandalwood processing industries has stimulated overexploitation by illegal logging activities. In addition, some harvesting methods (e.g., digging up roots because of their oil content) and agricultural expansion have increased the pressure on the resource. There have been limited efforts to develop sandalwood plantations. Local government policies tend to neglect local people's rights to the benefits of the valuable sandalwood and thus discourage them from participating in the maintenance of sandalwood natural regeneration. The local government should stimulate local participation in maintaining natural regeneration of sandalwood by offering more rational benefits to local communities as well as encourage intensive sandalwood plantations in the region.

INTRODUCTION

This case study discusses various aspects of sandalwood (*Santalum album* L.) in Timor Tengah Selatan (TTS) district of Nusa Tenggara Timur (NTT) province, Indonesia. The study is based on analytic reviews of the available references and unpublished reports, as well as field visits to some locations in the district during 1999/2000. The authors also visited various sandalwood oil processing and handicraft factories in Kupang, the provincial capital.

Brief description of the study area

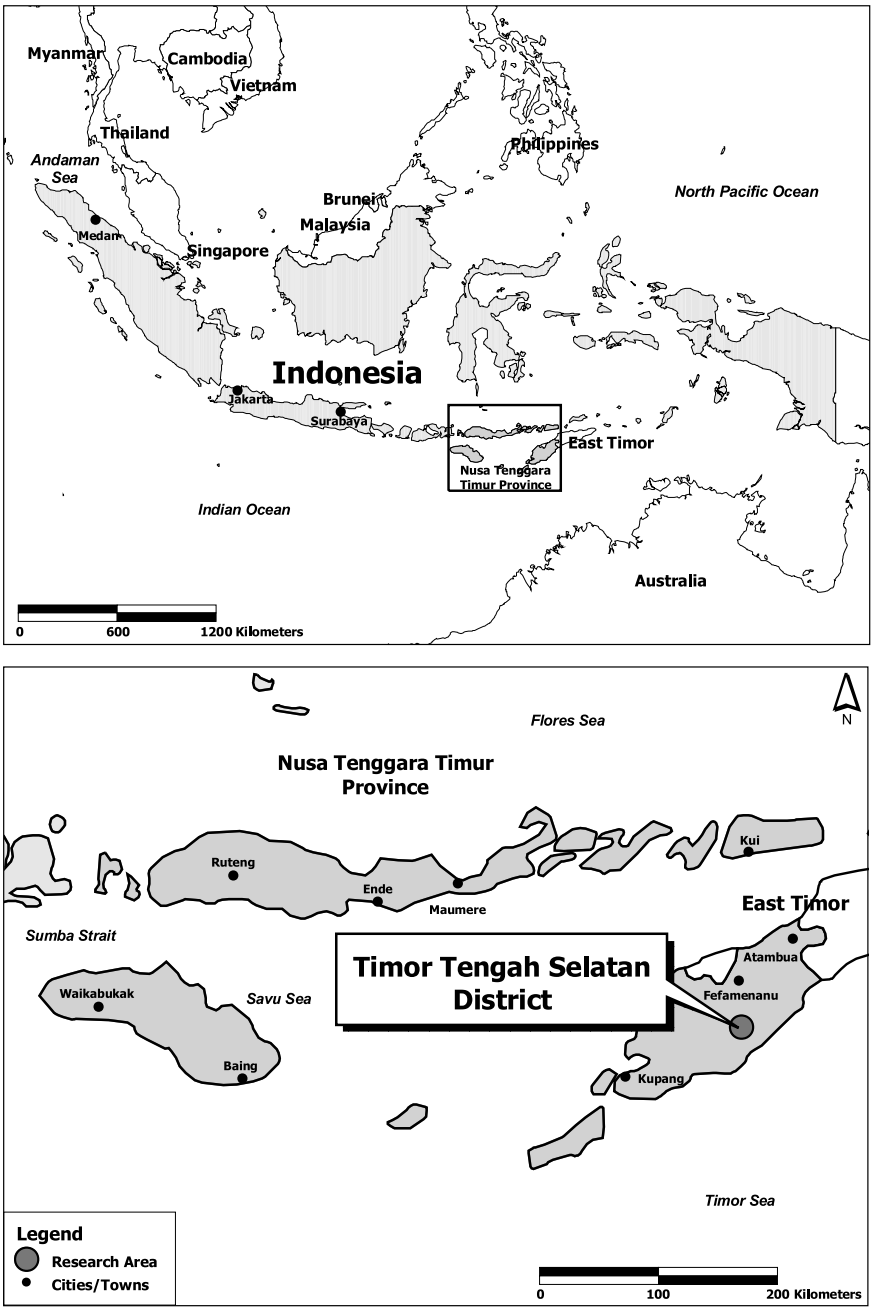
Timor Tengah Selatan is one of 14 districts in NTT Province. The district lies in the centre of Timor Island (see Figure 1). Its capital city, Soe, is located about 110 km from Kupang and is connected by asphalt road to other cities in Timor. The road system in the district is relatively good.

The district is dominated by mountainous topography with an altitude range of 500 m to 2,400 m above sea level (a.s.l.). In the northern area there are three mountains—Mollo, Kekneno and Mutis—ranging in altitude from 1,500 m to 2,400 m a.s.l. In the south, the topography is also hilly, but in general the altitude is lower, about 1,000 m a.s.l. The climate is cool with an average temperature of about 15°C in the evening and 20°C during the day, and the average rainfall is 1,372 mm per annum (Dinas Kehutanan Daerah Propinsi NTT 1974).

Because of the predominantly dry climate, the forests in Timor are dominated by short trees with less dense, curved trunks and relatively thick, low branches. Dominant species are *Acacia leucophloea*, *Eucalyptus* spp., *Cassia fistula*, *Zizyphus mauritana*, *Schleicera oleosa*, and *Albizzia* spp. In areas higher than 1,000 m, on the slopes of the Mutis, Mollo and Miumafo mountains, there are stands of various evergreen non-fire-resistant *Podocarpus* species, among them *Podocarpus umbricatus*, known for its excellent carpentry wood. Below 1,000 m, isolated groups of non-fire-resistant trees are found, notably *Sterculia foetida* (*nitas*), *Callophyllum teysmanii* (*camplong*) and the candlenut *Aleurites moluccana* (*kemiri*). Sandalwood grows mainly in the transitional zone between deciduous monsoon forest and montane forest (600–1000 m). Other species growing within these regions are *kayu kuning* (*Cudranea javanensis*), *soga* tree (*Peltophorum pterocarpum*) and *tingi* (*Ceriops candolleana*), all of which are important sources of natural colouring for the batik industry in Java. Teak (*Tectona grandis*) plantations can also be found in many areas, particularly around Takari.

Agriculture is an important sector in the district. Rice fields are common and can be found along the way from Kupang to Soe, where plenty of water is available. Some other common agricultural products from the district are maize (as a staple food), cassava, sweet potatoes, oranges, mangos, *pinang* (*Areca catechu* L.), *sirih* (*Piper betle* L.) and vegetables such as tomatoes, green cabbage and spinach. Pinang (*Areca catechu* L.) and sirih (*Piper betle* L.) are used particularly for courtesy snacks to welcome guests.

Figure 1. Map of the study site



Source: ESRI Data and Maps 2002.

(*Santalum album*)

THE PRODUCTION-TO-CONSUMPTION SYSTEM

Plant and product characteristics

Sandalwood belongs to the family *Santalales*, subfamily *Santalineae*, order *Santalaceae* and genus *Santalum* (Sumarna 1985). There are various species of sandalwood, but the species *album* is believed to have originated from the Timor region, although it is also found in India. Two varieties of *S. album* are found in the Timor region, i.e,. *S. album* L. var. *album*, which is characterised by small leaves, and *S. album* var. *largifolium,* which has larger leaves (Harisetijono and Suriamihardja 1992). Other sandalwood species are found in Western Australia (*Santalum sygrara/Eucaria spicuta* SPRAG et SUMM), South Australia (*Santalum fresyssianum* MIQ), Eromanga and Hebrides islands (*Santalum homei* SEEM), Sandwich Island (*Santalum freveinetianum* GUND), Marquesas Islands (*Santalum austrocaledonium* VILLB) and Fiji (*Santalum yasi* SEEM) (Karminarsih 1997).

In Timor, the evergreen sandalwood tree (Photo 1) ranges in height from 12 m to 20 m and diameter from 25 cm to 40 cm (although they may reach 55 cm). Branches are usually numerous and irregular (Sipayung 1985; Sumarna 1985). They are rarely found as a single culture, but more often stand distributed in small groups of four to five trees (Sipayung 1985). This tree grows well in regions where the climate is dry. It tolerates 625 mm to 1,625 mm annual

rainfall and temperatures from 10°C to 35°C. The tree occurs at altitudes from 50 m to 1,200 m, but grows best in the higher elevations. Sandalwood prefers soil that has good drainage and it adapts easily to rocky or stony soil with low fertility (Sumarna 1985; Sinaga and Surata 1997).

Photo.1 Sandalwood trees (Photo by D. Rohadi)

Sandalwood is a semiparasitic species; the tree absorbs soil nutrients through *haustoria* roots that stick to other plants, which means that sandalwood trees require host plants from which to grow[5] . Various species reportedly are suitable host plants for sandalwood. During the seedling or sapling period (the first six months), some primary host plants include *Alternanthera* sp., *Desmanthes virgatus*, *Crotalaria juncea, Capsicum frustecens* and *Solanum* sp. The secondary host plants are mainly legume species, including *Acacia villosa*, *Sesbania grandiflora*, *Calliandra* sp. and *Leucaena leucocephala* (Surata 1994).

The tree either regenerates from seed or will shoot from roots or stumps after coppicing, the latter being more frequent although it may take one to three years from the time of cutting or damage to the emergence of new growth. Various bird species, and possibly rainwater, are the main seed dispersers in elevated areas (Sumarna 1985).

Sandalwood use

Sandalwood owes its popularity to its oil content. The oil is extracted from the heartwood of the stem, branches or roots of mature sandalwood trees and exported to the USA, Singapore and European countries, in particular

Switzerland, UK, France and the Netherlands, mainly for the perfume and cosmetics industries (BPEN 1993). The oil from *Santalum album* is in more demand than other *Santalum* species because of its high santalol content (around 80–90%). The mature tree is characterised by thin sapwood (the thickness is less than 2.5 cm) while the diameter of heartwood is more than 10 cm. The oil content varies from 2.5% to 6% depending on the age of the tree, the part of the tree from which the oil is drawn and the tree growth environment. The roots contain oil of higher quality, which has stimulated the current unecological harvesting practice of digging up sandalwood roots, eliminating the possibility of tree regeneration.

Sandalwood is also used, locally and neighbouring islands, for woodcarving and handicrafts such as fans, pens, beads, rosaries and handbags. Sandalwood is highly appreciated in the woodcarving industries in Bali and used for fine arts or sculptures. Some of the wood is exported to Taiwan and re-imported as sandalwood pens.

The sawdust from the handicraft and oil factories in Kupang is used to produce joss sticks, which are used in religious ceremonies, particularly by Hindus and Buddhist (Sumarna 1985). In Timor, sandalwood sawdust is processed into various forms of incense (spiral, prismatic and circular) and mosquito repellents.

Sandalwood has long been used for traditional medicines. Its paste is applied as a lotion to cure headaches. Drinking water in which sandalwood dust and wood have been soaked for a few days may cure *Gonorrhoea virulenta*, and sandalwood mixed with *Myristica argentea* may cure stomach illnesses. Mixed with coconut oil the sandalwood oil may be used as an antiseptic, and if mixed with benzoate acid or borate acid, it may reduce swelling caused by insect bites (Sumarna 1985).

Availability of sandalwood

Sandalwood is the only forest tree that has been completely inventoried in Indonesia. It was the high value of the wood that encouraged the government to carefully record all sandalwood trees. Ormeling (1955) reported that the first inventory of sandalwood was conducted in 1924. Two other inventories were undertaken during the Dutch colonial period in Indonesia but neither was completed, the first because of the outbreak of World War I and the second because of the end of Dutch colonial rule in 1947. The provincial government in NTT province (natural stands of sandalwood in Indonesia occur only in NTT) has since conducted sandalwood inventories approximately every five years. Trees less than 3 m in height are counted and trees with a girth of more than 30 cm and a height of more than 3 m are measured, marked, and observed for signs of attack by pests and diseases. In Table 1 the results of the sandalwood census conducted in Timor and surrounding islands are summarised. Though the accuracy of data resulting from the census is questionable, it is obvious that there has been a sharp decline in numbers over the last 10 years.

Table 1. Summary of sandalwood census in Timor and surrounding islands

Census year	Diameter > 30 cm (no. of trees)	Diameter < 30 cm (no. of trees)	Total (no. of trees)
Before 1966	109,000	150,000	340,000
1965–1968	131,687	375,065	506,752
1973–1976	200,575	325,106	525,681
1987–1988	188,389	395,041	583,430
1997–1998	41,427	209,513	250,940

Sources: Ormeling 1955; Kanwil Kehutanan Propinsi NTT 1989.

Harvesting quantities

The harvesting of sandalwood is conducted following guidelines set forth in an instruction letter issued by the Regional Forestry Office (Dinas Kehutanan Propinsi) to its branch offices (Cabang Dinas Kehutanan) at the district level. The letter states the target for total weight of heartwood to be collected, number of trees to be cut, and total weight of roots harvested. Technical guidance for wood administration, exploitation costs and revenue allocation are also stated in the letter. The instructions are further deliberated by both the district head (Bupati*)* and the branch office head and then disseminated to their subordinates, namely the subdistrict head (Camat*)*, the head of forest rangers (Kepala Resort Pemangkuan Hutan), the village leader (Kepala Desa), the head of the village community (Ketua Rukun Kampung) and the head of the village neighbourhood (Ketua Rukun Tetangga).

The annual sandalwood production is calculated from the following formula:

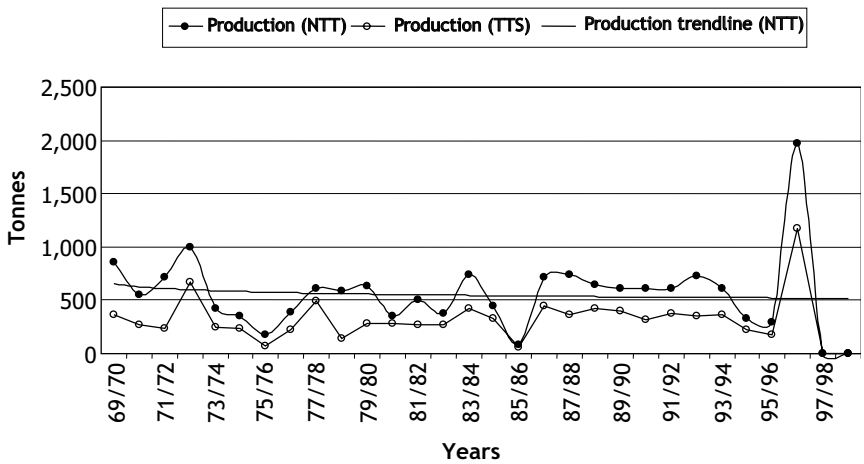
$$\text{Annual allowable cutting} = \frac{\text{total mature trees x average heartwood weight per tree}}{\text{cutting cycle}}$$

From the beginning of the 1970s till the late 1980s, when abundant mature trees were available, the predicted average heartwood weight per tree was 100 kg, and a cutting cycle of 50 years was recommended. The average weight was subsequently revised to 50 kg per tree in 1988 (BanoEt 2000). Research has shown, however, that the average heartwood green weight of stems and branches (excluding root) was only 39.47 kg per tree with a standard deviation of 7.57 kg, while the net dry weight was 29.82 ± 6.89 kg (Susila 1994). It has now become clear that the high estimation of heartwood content per tree has contributed to overexploitation and led to resource depletion, since fieldworkers have tended to fulfil the quota determined by the provincial government. In addition to previously too high annual allowable cutting ceilings, illegal logging practices clearly have also contributed to the overexploitation.

Legal sandalwood production in NTT province has fluctuated significantly, although now the trend is relatively stable at an average of almost 600 tonnes

per year (see Figure 2). There has been no legal cutting since the governor ordered a five-year moratorium from 1998 to 2002 to allow for regeneration and regrowth (Governor Order No. 12/1997). Despite the harvesting ban, the sandalwood oil and handicraft industries have continued to operate, and demand for sandalwood products remains high. To overcome resource scarcity, some factories have moved from producing sandalwood oil to eucalyptus oil, while others have turned to processing illegally cut wood.

Figure 2. Sandalwood production in East Nusa Tenggara province and South Central Timor district



The peak in sandalwood production during the period 1996/1997 (Figure 2) was caused by the government's launching of a 'special operation' preceding the suspension of sandalwood extraction. Called *Operasi Bersahabat,* it was a sweeping operation to collect illegally cut wood from communities. Instead of punishing illegal cutters, the regional government provided compensation for harvesting costs for any collected wood[6]. Once all available stock had been acquired, the provincial government declared the moratorium on sandalwood cutting. Though the operation was meant to collect only already cut wood which had presumably been stored, much of what was collected had been freshly cut. Figure 2 shows that the TTS district has shared, on average, more than 50% of the sandalwood production in NTT province.

Sandalwood plantations

Sandalwood production in Timor is derived mostly from natural regeneration. Efforts to plant the trees in the Timor islands started in the early part of the twentieth century, but have failed to produce successful plantations.

During the Dutch era, people were encouraged to plant and take care of sandalwood gardens for one or two years under the supervision of the Forestry Service. In return, permission was granted to cultivate food crops between the young sandalwood plants (Ormeling 1955). One of the reasons for the plantation failure is said to be a cancer that attacked sandalwood gardens. Husain (1983), however, argued that the disease was not the main cause of the plantation failure, but shifting cultivation with continuous burning, wild grazing and low incentives were. Conditions were even worse during the Japanese occupation, when the necessary maintenance was neglected. The majority of the 208 ha planted between the years 1923 and 1951 failed either partially or completely, and even successful trees were overgrown with *Lantana camara* (Ormeling 1955).

After independence, efforts to cultivate the species were mostly in the form of research trials, demonstration plots or within a framework of community forestry guided by either timber estate companies or the Regional Forestry Office. The total area planted with sandalwood on this island is still not clear. In the late 1980s the provincial government allocated a budget for establishing and maintaining plantations. However, these government initiatives have been limited in scope. The Regional Forestry Office has also established a tissue culture laboratory in collaboration with the Forestry Research Institute in Kupang, but it is still in its preliminary phase.

Processing and industries

Three types of sandalwood industry operate in and around Kupang. They are the processing of sandalwood oil, handicrafts and joss sticks. In 1998, the total wood intake of factories processing sandalwood, estimated from the conversion of total sandalwood products, was around 4,300 tonnes. Although this estimate may be a little bit too high, it is obvious that total sandalwood consumption by the industries was far above the formally reported production. As the total wood collected by Operasi Bersahabat was only around 2,000 tonnes, the gap between wood supply and consumption could only have been fulfilled with illegally cut wood.

The sandalwood oil industry is a major consumer of sandalwood raw material. It uses all wood parts of the tree. Three such factories are operating in Kupang, another in East Timor. The largest and oldest oil-distilling factory is located in Kupang. Established in 1974 this factory has a processing capacity (intake) of about 800 tonnes of wood per annum, but for lack of sufficient raw material it never fulfils that capacity. The average recovery of sandalwood oil in the processing factories is between 2.62% and 2.84%, that is, 1 kg of sandalwood yields 26.2 to 28.4 grams of oil. These numbers are far below those reported in India, where recovery is reported to be around 2.5% for mixed quality and sapwood, and 6% to 8% for the best root. One possible reason for the low recovery is the premature harvesting of the wood. Barret (1985) reported that the oil content (santalol) increases significantly with age. High santalol content also indicates a good quality of sandalwood oil.

The handicraft industry requires high quality wood but in practice also accepts low quality wood. There were 24 handicraft factories officially recorded in 1998, most of them located in Kupang. Only two factories are located in Soe and another two in Atambua. There are no data available on the total amount of raw material used in these factories.

Most of the joss stick factories were established in the last few years, and many of them also produce handicrafts. The 14 joss stick factories operating in 1998 had an annual capacity ranging from 75 tonnes to 900 tonnes per plant and a total capacity of 3,308 tonnes. The factories use sawdust from handicraft and oil processing to produce joss sticks in various forms—spiral, cone and stick—mainly for export to Taiwan, Hong Kong and Singapore. The factories usually mix the sandalwood dust with other wood dust, such as gaharu (*Aquilaria* spp.) and kayu pappi (*Acacia oraria*). During a field visit, it was found that factories use a mix of around 40% sandalwood sawdust to 60% of other wood sawdust.

Trade and marketing

Sandalwood has long been commercially traded, although it is not clear when exactly the practice started. Ormeling (1955) described sandalwood trade in Timor as early as 1400 A.D. It would seem that the first sandalwood traders were Javanese merchants, according to ancient Chinese and Portuguese sources of information. They acted as middlemen who transported the wood from Timor to the western part of the archipelago, to the collecting centres and the entry port of Sriwidjaja in Sumatra, and later to a Malayan harbour. From Malaya it was then shipped to India and China. Husain (1983) reported that the Chinese were trading sandalwood from the Timor islands to Malaya and India as early as the tenth century. They built trade relations with the ruling native chiefs (radjas) who controlled the cutting and sale of sandalwood in the Timor region and bartered the wood for silk, porcelain, beads and gold. Another writer, Widiyatmika (1986) suggests that sandalwood trading may have commenced as early as the third century, when the wood was used as a gift for kings.

During the Dutch colonial period the trade in sandalwood was controlled by the Dutch East Indies Company (Rahm 1957). Since independence, the government has continued to administer the sandalwood resource. The provincial government has established a sandalwood collecting system in the field and sets the selling price through an auction system. The Regional Forestry Office has been appointed the official collector of sandalwood raw material, from felling to the storage depot (Tempat Penumpukan Kayu) in Kupang.

At the lowest level of the chain, the wood administration is in the hands of a forestry field officer (Mandor Tebang), who organises the lumberjacks. The field officer records the specifications of each tree before cutting (height, diameter and estimated heartwood weight) as well as wood production data (stem/root number being cut, length, diameter, and heartwood weight) and exploitation expenses (including the wages paid to

the lumberjacks). The field officer reports to the subdistrict forestry officer (Kepala Rayon Pemangkuan Hutan), who then issues a 'wood transport' document (Surat Angkutan Hasil Hutan Bukan Kayu) indicating the number of stems, quality classes, weight and other records concerning the harvested wood. The wood is then transported to the district storage depot in Soe and on to the depot in Kupang. From the main storage depot in Kupang, the wood is distributed to factories and traders through an auction system. Interisland traders sell the wood to other areas such as Bali and Surabaya. For transport to other islands, another document, called Surat Angkutan Kayu Olahan, is required. This letter, issued by the Regional Forestry Office, states the quantity of the product (pieces), class quality and total weight.

A team chaired by the Economy Bureau of the provincial government (Biro Ekonomi Pemda), determines the selling price for the sandalwood. The team consists of representatives of the Regional Forestry Office, Bureau of Finance, Bureau of Legal Aspects, Regional Office for Trade and Industries, Regional Bank, Regional Tax Office, and Regional Police Office. The price is subject to review every year. Table 2 shows the selling price for sandalwood based on its quality.

Several sandalwood oil, joss stick or handicraft factories are located outside NTT province. In Surabaya, for example, there is a factory that produces sandalwood oil with raw material derived from NTT. In Bali, there are many handicraft centres that sandalwood material from NTT. Factories located outside Indonesia that process sandalwood for various end products include handicraft factories in Taiwan that produce sandalwood pens and perfume industries in France that use sandalwood oil as one of their raw materials. The trade diagram is presented in Figure 3.

Figure 3. Sandalwood marketing chain

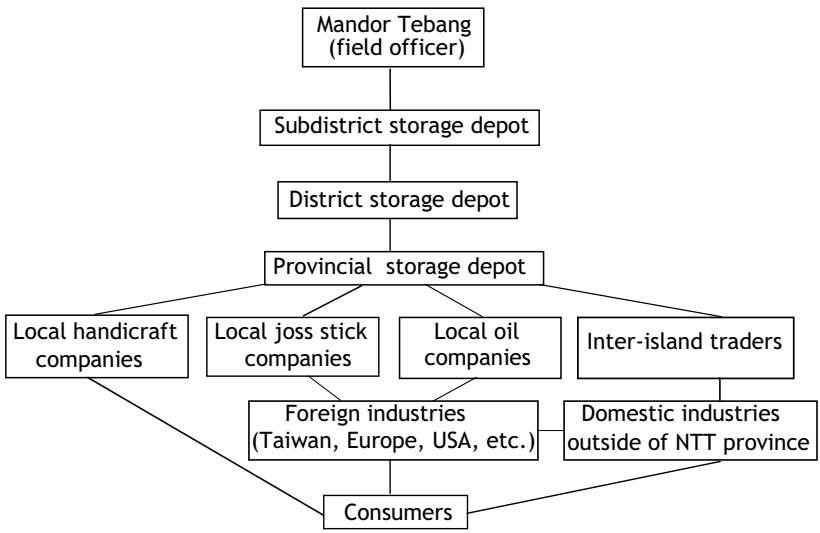


Table 2. Sale price of sandalwood based on quality

Quality Classes	Price (US$/kg)							
	1984/85 (US$1 = Rp1,136)	1985/86 (US$1 = Rp1,136)	1986/87 (US$1 = Rp1,648)	1987/88 (US$1 = Rp1,688)	1988/89 (US$1 = Rp1,773)	1989/90 (US$1 = Rp1,847)	1990/91 (US$1 = Rp1,957	1995/96 (US$1 = Rp2,347)
Special A (diameter > 19 cm)	1.76	2.86	2.06	2.49	3.38	3.90	4.34	7.67
Special B (diameter 8–9 cm)								6.52
Mixed	1.32	0.88	1.21	1.48	1.83	2.17	2.45	3.84
Sap wood								0.43
Twigs								0.21

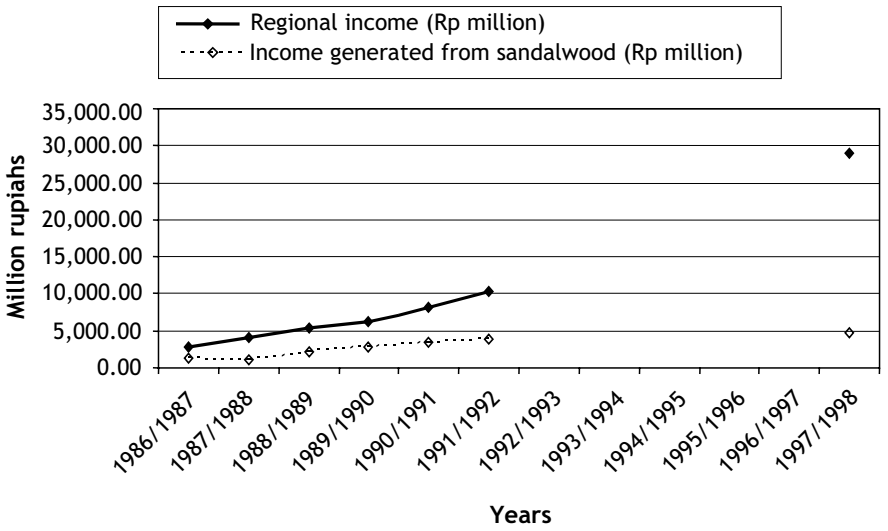
Sources: Ito 1993; Leki 1996.

As mentioned before, sandalwood oil is the main sandalwood product of the region and exports are mainly to the USA, Netherlands and Singapore. During the period 1983 to 1992 the average export volume of sandalwood oil from Indonesia was 12 tonnes per year. The price fluctuated from about US$71 per kilogram to about US$150 per kilogram, the average being about US$114 per kilogram (BPEN 1993).

Contribution of sandalwood to regional income

The exploitation of sandalwood has contributed significantly to regional development (see Figure 4). During 1986 to 1991 sandalwood amounted to about 40% of the annual regional government income derived from economic activities in the region including tax, retribution and other government sources of income, or Pendapatan Asli Daerah (PAD) (Leki 1996). Until 1998 there were 3 sandalwood oil factories, 24 handicraft and 14 joss-stick factories registered in NTT province (Dinas Kehutanan Propinsi NTT, unpublished). The sandalwood industries provide direct employment for almost 1,000 local people and are a source of income generation for many more, particularly the handicraft suppliers.

Figure 4. Contribution of sandalwood to regional income



Policy context

Sandalwood exploitation in Timor has long been practised and used to be controlled by local rulers. As reported by Widiyatmika (1986), historically all sandalwood was owned by a king (*radja*), who would appoint a 'landlord' (*fetor* or *uis pah*) to control the sandalwood production in the region. The landlord then appointed an *adat* chief[7] to maintain and secure the trees, as

well as to conduct ritual ceremonies whenever harvesting took place. The benefits from harvested sandalwood trees were shared as follows: the roots belonged to the *radja,* the stem went to the *fetor,* and the landowner received the branches (Ormeling 1955).

A wage system for sandalwood exploitation was introduced during the Dutch colonial era. Using the local ruler's power, the colonial government provided a certain amount of compensation for harvesting the sandalwood. It is unclear how much compensation the colonial government gave to the local ruler for the harvested wood or how much compensation the local ruler gave to the people who actually collected the wood. It seems, however, that the price was on a downwards spiral, which caused local people to protest and finally to refuse to collect sandalwood. In 1751 the system of compensation was replaced by a tax system. At that time one third of all harvested sandalwood had to be handed over to the local government ('*Swapradja'*). In a way this was just another type of monopoly as the government controlled the trade system and the huge price margin between local farm gate and the destination of trade, Jakarta (Rahm 1957).

After independence, the regional government assumed control of the wood through a series of regulations that controlled all aspects of its management. These regulations controlled sandalwood property rights, resource maintenance, harvesting, marketing and wood allocation. The main points of these regulations are as follows (Rohadi *et al*. 2000):

- All naturally regenerated sandalwood (trees, dead trees and wood) belongs to the regional government. Parties may plant sandalwood on their own land, but their income share from the harvested wood will be only 15%[8] of the total value (Regional Government Regulation, or *Perda,* No. 16/1986 and the Ministry of Home Affairs Decree No. 522.63-433/1988). Landowners should have a land certificate to claim their income from cultivated sandalwood (Governor Decree No. 7/1993). This regulation has been replaced by *Perda* No. 2/1999, decentralising ownership of naturally regenerated sandalwood to the district government. The rules determining sandalwood rights are now unclear and can vary from district to district.
- The Regional Forestry Office will conduct a resource inventory every five years and determine the annual allowable cut for the following year. The allowable cut is determined every year based on inventory data and actual wood production (*Perda* No. 16/1986 and Governor Decree No. 7/1993)
- The local government conducts the harvesting activities, determines the harvesting costs and issues the documents required during harvesting and wood transportation (Governor Decree No. 7 and No. 8/1993). The local government has monopolised all matters regarding exploitation, transportation and marketing of sandalwood.
- The local government determines the wood price and allocates the wood to selected companies (Governor Decree No. 7/1993).
- Revenue from the sale of wood constitutes income for the provincial government. Half of the net revenue is allocated to the district that produced the sandalwood. Half of the district's revenue (or a quarter of the total wood sales) is allocated to the supervision, replanting, and maintenance of the trees (*Perda* No. 16/1986).

- All communities should care, maintain and work towards the sustainability of the resource. Illegal cutting, stockpiling or transportation of sandalwood, as well as intentional acts to damage the trees, are to be prosecuted. The governor has established the co-ordinating Sandalwood Board (Governor Decree No. 53/1992), which comprises a number of government representatives including the heads of district and subdistrict offices, the village head, an Indonesian Army representative and local community leaders.
- Because of the alarming rate of decline in sandalwood, the provincial government ordered a moratorium on the harvest of sandalwood from 1998 up to 2002. This regulation eliminated income contributions the PAD receives from the sale of sandalwood. Similarly, the ban on sandalwood harvesting will diminish export contributions from sandalwood products.

TRENDS AND ISSUES—DEVELOPMENT AND CONSERVATION LESSONS

Why is sandalwood becoming scarce?

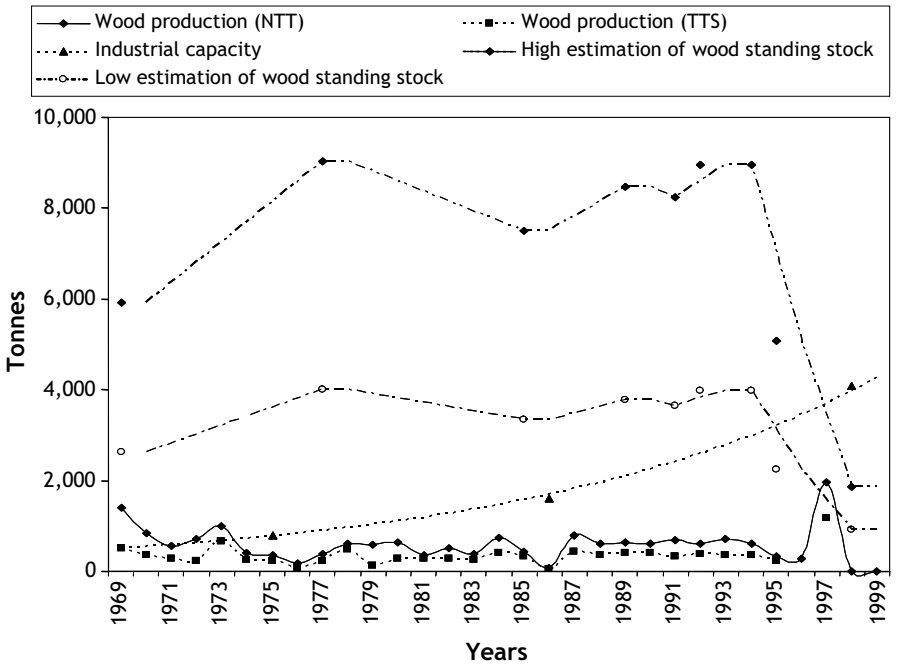
Since independence sandalwood has been controlled by the state. Economic benefits from the sale of the wood received by the local government have been significant. The regulations, however, tend to marginalize community rights to the resource. Because of low incentives for the local people, little effort has been put into sustaining the sandalwood resource. In some cases local people have purposely killed the seedlings so as not to be obliged to maintain the trees in their fields—a striking consequence of the lack of involvement of local people.

Standing stock[9], supply and demand of raw sandalwood in the region as well as annual wood production (formally registered cut) and capacities of the sandalwood industry are presented in Figure 5. While in general wood production during the last three decades has been relatively stable or in a slight decline, the demand for sandalwood, as represented by industrial capacity, has continued to increase. The increasing demand, which far outweighs sustainable production, presumably has forced the overexploitation of sandalwood resources through illegal cutting, particularly so during the middle 1990s, when the remaining wood stock fell to the point that it could no longer fulfil industrial demand.

Clearly, illegal cutting endangers the sandalwood resource. Many opportunists, including local people, government officers and private companies, are involved in the practice, as often reported by local newspapers. The gap between supply and demand, as presented in Figure 5, may give an indication of the amount of illegal wood in the system. Shifting cultivation and wild grazing are other common practices with negative impacts on sandalwood regeneration.

Efforts to increase the sandalwood stock by developing plantations have not been fully implemented. As described previously, the efforts put into plantations were limited to government pilot projects with no significant effort from the local communities to plant trees or maintain seedlings.

Figure 5. Stock, supply and demand of sandalwood in East Nusa Tenggara



Conclusions and recommendations

Sandalwood is an important natural asset for the TTS district and has contributed significantly to the regional income for a long time. It has provided important employment opportunities as well as national export earnings through the sandalwood industries in the region. However, since the government halted further extraction in 1998 to protect the resource from overexploitation, this importance has started, and will continue, to decline. In Indonesia, sandalwood trees are specific to the Timor region, and globally they grow in a relatively limited area. Sandalwood trees could therefore provide a comparative advantage to the TTS district or NTT province if the resource were managed properly. However, current development shows that the sandalwood population in the region is decreasing at an alarming rate. Various factors including illegal cutting, shifting cultivation and grazing cause the current resource scarcity. The root of these problems is ineffective local government policies that tend to neglect community rights and thus discourage villagers from participating in the maintenance of sandalwood natural regeneration. The continued deterioration of the situation results, in the most part, from the imbalance between demand and supply and the limited efforts put into the development of sandalwood plantations.

To recover the sandalwood population in the region, local participation in maintaining the resource is required. More rational benefits should be offered to local communities to attract them to the cultivation and sustainable

Box 1. Harvesting of sandalwood roots

Sandalwood roots contain more oil than other parts of the tree. This phenomenon stimulates destructive harvesting of the roots and hence reduces the possibility of natural regeneration. According to harvesting procedures, only a part of the roots can be harvested two years or more after coppicing if regeneration is take place. The rule is often neglected during illegal harvesting or when it is difficult to fill a particular order.

Box 2. Substitution as a response to scarcity

To respond to the resource scarcity some sandalwood oil companies have had to diversify. They now produce eucalyptus oil, or *minyak kayu putih*, to keep their factories running. Outside Timor, such as in Bali, many handicraft companies use substitute wood species as the raw material and dip the products into a sandalwood oil solution to imitate sandalwood products.

harvesting of sandalwood. Intensive plantations should also be encouraged, particularly with a view to the industries that use sandalwood as a raw material. In a shift from previous practice, which focused on controlling the resource, new government policies should provide proper incentives to support sandalwood raw material production, policies that are more focused on investment in sandalwood plantations.

The sandalwood case is an interesting example of government intervention in resource management. Although regulations and mode of exploitation have changed from time to time, what has remained unchanged is that the people's rights to the resource are still marginalized. Local people receive little in the way of benefits from sandalwood under the existing system, which has consequently resulted in the local people's low level of participation in maintaining sandalwood resources.

ENDNOTES

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5. On field visits some trees were found to grow well without host plants.

6. Operasi Bersahabat may, in fact, well have been a pre-emptive strike by the provincial government against the new central government regulations, which stipulated that the collector or owner should receive up to 80% of the sandalwood value.

7. An *adat* chief is usually a senior village representative dealing with cultural affairs.

8. The income share was increased to 40% with the issue of *Perda* No. 2/1996.

9. See Rohadi *et al.* (2000) for more detailed information on the calculation of the estimated standing wood stock.

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Chapter 13

Damar agroforests in Sumatra, Indonesia: domestication of a forest ecosystem through domestication of dipterocarps for resin production[1]

Hubert de Foresta[2], *Geneviève Michon*[2], *Ahmad Kusworo*[3] *and Patrice Levang*[2]

Common names	Part of the resource used	Management	Degree of transformation	Scale of trade	Geographic range
Damar kaca, White meranti	Resin	Cultivated	High	International	Medium

OVERVIEW

Farmers in the West Lampung Pesisir area in the south of Sumatra, Indonesia, have established forest gardens by introducing damar trees in upland rice swiddens plantations. These damar gardens were established as the wild resource itself was vanishing. While cultivating this forest resource, villagers have achieved the global restoration of a forest in the middle of agricultural lands. Harvest of resin from damar trees represents the main source of household cash income. Furthermore, Pesisir farmers managed to preserve a high level of biodiversity and a whole range of economic products and functions originally derived from the forest. Institutionally, appropriation of the forest resource has entailed a total reorganisation of the traditional tenure system for forest lands and goes along with the increasing importance of land as property and privatisation of this property. During the 1990s, the acceleration of regional development has threatened the agroforests of the area, as they were not recognised by the state and had no legal status. Damar gardens, as a successful forest management strategy developed by local communities, may represent an important support for the development of formal recognition of local people's rights over forest resources.

INTRODUCTION

Driving westward from the peneplain along the Sumatra highway, a mosaic of dry fields and pepper plantations, through the Barisan range, a succession of reddish hills extensively degraded by pioneer coffee growing, one suddenly enters another country: a land of trees that stretches all along the quiet descent to the Indian Ocean. The human mark on this forest landscape is not immediately obvious: some clearings bearing hill rice, a few patches of fallow vegetation. Elsewhere stands a venerable jungle dominated by large trees. The area covers some 100,000 ha divided between a long coastal plain—130 km from the provincial border in the north to the southern Cape Cina in the Sunda Straits which widens from north to south—and a steep hilly and mountainous area rising to a height of over 2,000 m. It stretches over three administrative subdistricts (Pesisir Utara, Pesisir Tengah and Pesisir Selatan) referred to as the Pesisir (Figure 1).

Wherever possible, irrigated rice fields, and associated permanent villages, have been established along the coastal plain, but the rude topography and the relatively low quality of inland soils have limited the possibilities of further permanent agricultural food production. The hills have long remained the domain of a classic agroforestry rotation: mosaics of temporary rice fields and coffee plantations with secondary, fallow vegetation. But for about a century or so this traditional pattern of forest conversion to agriculture has evolved into a complex system of forest redevelopment. Planting valuable fruit- and resin-producing trees in their swiddens, Pesisir farmers have managed to create a new forest landscape entirely tailored to their needs. This forest made by humans, though forming an almost continuous massif, is made up of a mosaic of individually evolved gardens which the farmers have named after the dominant tree species, the damar[4] (Torquebiau 1984; Michon and Bompard 1987; Michon and Jafarsidik 1989).

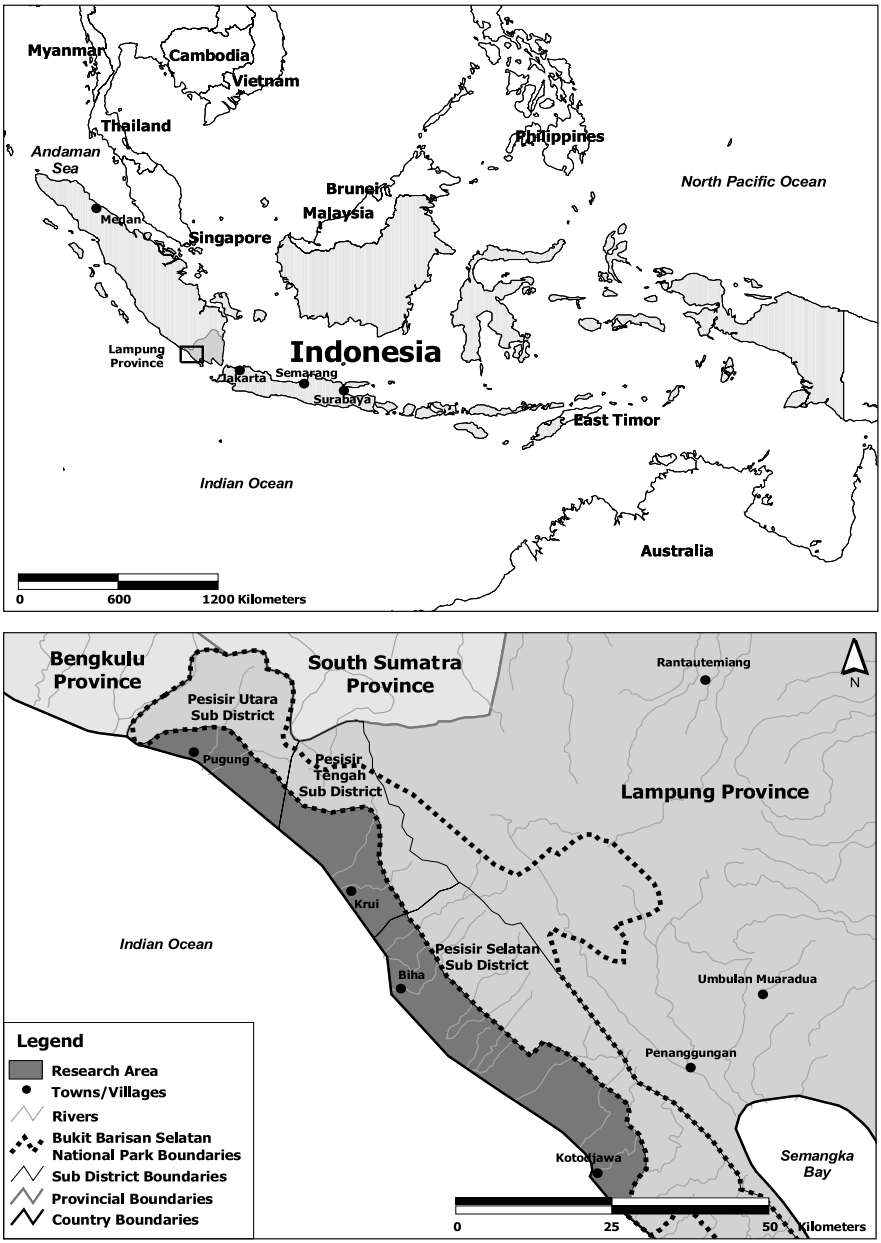
Damar gardens have gradually spread in the Pesisir, and productive gardens presently cover at least 50,000 ha, according to a December 1997 interpretation by the Department of Forestry and International Center for Research in Agroforestry of a Landsat image dated November 1994, completed by ground-checking. The main centre of cultivation is located around the city of Krui, where hills are almost totally covered with a mature damar forest. Yearly damar production was estimated around 8,000 tons in 1984 (Bourgeois 1984) and reached 10,000 tons in 1994 (Dupain 1994). New gardens are still being established in the northern and southern subdistricts. Today, more than 80 percent of the damar resins produced in Indonesia are provided not by natural forests, but by the Pesisir damar gardens. Among the 70 villages scattered along the coast, only 13 do not own damar gardens.

PRODUCTION-TO-CONSUMPTION SYSTEM

The damar garden

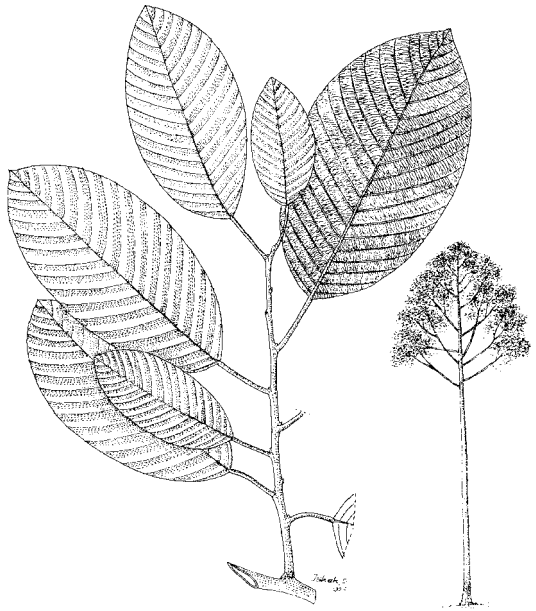
Damar gardens can be analysed as a forest, and indeed, biologically, they constitute a forest in their own right, a complex community of plants and

Figure 1. Location of the research area



Source: ESRI Data and Maps 2002.

animals and a balanced ensemble of biological processes reproducible in the long term through its own dynamics. However, the gardens have been established as agricultural production units on agricultural territory (Michon 1985; de Foresta and Michon 1993).



(*Shorea javanica*)

While damar trees (e.g., *Shorea javanica*) are clearly dominant in mature gardens, representing about 65% of the tree community and constituting the major canopy ensemble, damar gardens are not simple, homogeneous plantations. They exhibit diversity and heterogeneity typical of any natural forest ecosystem, with a high botanical richness and a multilayered vertical structure, as well as specific patterns of forest dynamics.

Plant inventories in mature damar agroforests have recorded around 40 common tree species, and several more tens of associated species, either large trees or treelets and shrubs, liana, herbs and epiphytes. Important economic species commonly associated with damar are mainly fruit trees, which represent 20% to 25% of the tree community. In the canopy, durian and the legume tree *Parkia speciosa* associate with damar trees. In the subcanopy ensembles, *Lansium domesticum* is the major species with, to a lesser extent, mangosteen, rambutan, jacktree, palms like the sugar-palm *Arenga pinnata* or the betel-palm *Areca catechu*, and several water apple species—*Eugenia* spp.—as well as trees producing spices and flavourings (*Garcinia* spp., the fruits of which are used as acid additives in curries, and *Eugenia polyantha*,

Photo 1. Old growth damar agroforests often present impressive tree stands in terms of biomass and volume of timber (Photo by G. Michon © IRD)

the local laurel tree). The last component, 10% to 15% of the tree community, is composed of wild trees of different sizes and types, which have been naturally established and are protected by farmers, either because they do not have adverse effects on planted trees or because of advantageous end uses. These species include valuable timber species (Apocynaceae, Lauraceae, etc). Non-tree species characteristic of a forest ecosystem (Zingiberaceae, Rubiaceae, Araceae, Urticaceae) have colonised the undergrowth of gardens, where they contribute to the maintenance of a favourable environment for the development of seedlings of the upper layer trees.

Management of the garden

Management of mature gardens is centred around the harvest of resin and fruits. Labour allocated to routine garden maintenance is mingled with labour devoted to resin harvest, and the tempo of harvests is determined by labour requirements for wet rice cultivation. Work in the gardens is postponed at the time of the rice harvest or of rice-field preparation, so that tree gardening never competes for labour with subsistence agriculture.

Once established, the damar plantation evolves with minimum human input. The silvicultural process in damar gardens is not conceived, as in conventional forest plantations, as a mass treatment applied to a homogeneous, even-aged population of trees, but aims at maintaining a system that produces and reproduces without disruption either in structural or functional patterns. The main task of the gardener is to regularly introduce young trees in the garden

plot in order to constitute and maintain an uneven-aged pool of replacement trees. In a well-managed garden, the size of the replacement pool ensures the sustainability of the productive stand.

Photo 2. Tapping the damar tree (*Shorea javanica*) in damar agroforest (Photo by H. de Foresta © IRD)

Integration of a forest tree in a farming system: the *ladang* way

Expansion and success of damar cultivation are closely related to swidden agricultural practices (Michon and Bompard 1987; de Foresta and Michon 1994b). It is through the *ladang* (swidden), and through its traditional crop succession structure, that damar trees have been restored to the landscape. In the former dry land cultivation system, *ladang* were opened primarily for rice production, but some did not directly return to fallow. Instead, they were further transformed to coffee and pepper plantations. The first damar trees were introduced in these successional *ladang* gardens, amidst coffee bushes and pepper vines, where they found a suitable environment to establish themselves and further develop. After abandonment of the coffee or/and pepper stand, damar trees were strong enough to grow along with secondary vegetation and to overcome competition from pioneers. The subsequent fallow was a mix of self-established successional vegetation and deliberately planted damar trees, which developed fully until reaching a tappable size some 20 to 25 years after plantation, but no more than 10 years after the last coffee or pepper harvest. Damar plantations soon became a success story. Everyone started to plant seedlings in his own swidden. Through this very simple cropping technique, after two decades, a traditional fallow land had changed into a managed tree

garden that included damar trees as well as other introduced fruit species and self-established trees, bushes and vines.

Economically, the vegetation succession process is of tremendous importance as it is the basis of a succession of harvestable commercial products, thus reducing the unproductive time span of the plantation to some 5 to 10 years. Costs of labour devoted to damar establishment are mingled with those devoted to rice and coffee/pepper cultivation on swidden fields. Cultivation of commercial tree crops does not compete for labour with subsistence agriculture. On the contrary, it allows the maximisation of returns on labour inherent to the swidden system—vegetation cutting and field maintenance—successively through coffee/pepper and trees.

Among the imperatives leading to the initiation of a generalised cultivation process, the main one was probably the growing difficulties encountered in the collection of wild damar, which could closely resemble the conflictual processes regarding access to common property resources encountered today for other forest products (Peluso 1983, 1992; Siebert 1989). In the late nineteenth century, the high increase in resin prices led to intensive and generalised tapping of trees in natural forests. Overcollection entailing the rarefaction of mother trees blocked natural regeneration, whereas the extension of the cultivated territory entailed the rarefaction of the forest itself. Damar trees were spared in the slash and burn process and could easily survive in the modified environment of *ladang* and secondary vegetation, but natural regeneration in these conditions appeared difficult. Some serious conflicts are reported to have occurred between villages as well as within villages concerning access to the remaining damar trees (Levang and Wiyono 1993).

Preserving biodiversity

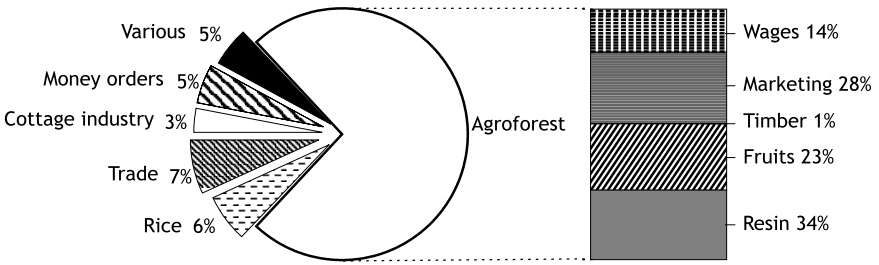
The real appropriation of forest richness and diversity is achieved through the free development of natural processes of diversification and niche colonisation. As in any secondary vegetation dominated by trees, the newly maturing damar plantation provides a suitable environment and convenient niches for the establishment of plant propagules from the neighbouring forests through natural dispersion. It also offers shelter and food to forest animals. In this natural enrichment process, farmers merely select among the possible options offered by the ecological processes: favouring resources, through introducing economical trees and protecting their development, or tolerating non-resources development and reproduction as long as they are not considered as 'weeds'. After several decades of such a balance between free functioning and integrated management, the global biodiversity levels are fairly high. As natural forests below 700 m to 800 m a.s.l. have almost disappeared in the Pesisir, damar gardens constitute the major habitat for many plant species characteristic of lowland and hill dipterocarp forests that would otherwise have disappeared (Michon and Bompard 1987; Michon and de Foresta 1992, 1995). The agroforest also shelters many animal species, including some highly endangered species like the Sumatran rhino and the Sumatran tiger.

Seen from the planter's point of view, while the introduction of economic species in the damar agroforest is intentional, biodiversity reestablishment is 'accidental'. These combined processes, the intentional and the accidental, are essential for several reasons. They restore resources that otherwise would not have been conserved purposefully because they do not appear as important economic resources. These noneconomic resources in turn help support viable populations of pollinators and dispersers that are essential for the long-term survival of commercial tree species, thus allowing the restoration of biological and ecological processes that are crucial for the functioning and reproduction of the agroforest as a commercially productive forest ecosystem.

The economic and social value of damar gardens

Damar trees represent the main source of household cash income (Figure 2), and damar collection is far more lucrative than other agricultural activities in the region (Mary 1987; Levang and Wiyono 1993). Resin is harvested on a regular basis: individual trees are usually tapped from once a month to once every two weeks. A single villager can harvest an average of 20 kg of resin a day. In the central subdistrict villages, average harvests are between 70 kg and 100 kg per family per month. Resin sale represents a regular income allocated to day-to-day expenses such as the purchase of additional foods or the weekly costs of children's schooling. Five days of work in damar gardens are usually enough to ensure a month's subsistence for the whole family (Levang 1989, Levang and Wiyono 1993). For those who do not own permanent rice fields, the damar income also allows for the purchase of some rice and thus complements dry rice culture where it still exists. However, the damar income is usually not sufficient for hoarding.

Figure 2. Origin of household cash income in a damar-based village, Pahmungan



Source: Levang and Wiyono 1993.

The damar activity also generates a series of associated activities: harvest, transportation from the field to the village, stocking, sorting, and transportation to wholesalers in Krui (see Table 1). Harvest, transportation, and sorting are carried out either by the growers themselves or by members of their families, or by specialized agents who are paid employees. Independent entrepreneurs ensure resin stocking in the village. These activities raise significant additional income for the village and allow those who do not own a damar garden to benefit from damar production (Bourgeois 1984; Mary 1987; Levang and Wiyono 1993; Nadapdap *et al.* 1995).

Damar gardens constitute one of the most profitable smallholder production systems in Sumatra (Table 2). They ensure reasonable quality-of-life levels including high school attendance for children, which is given top priority in most villages of the area. In addition, they can be managed—and used accordingly whenever needed—as a safety asset: a garden, or part of it consisting of several selected trees, can be 'pawned' through special agreements called *gadai* (Mary 1987; Lubis 1996) that allow any family to overcome difficult periods without resorting to selling trees or land, which is considered as one of the worse things that might happen to a family.

Indeed, in accordance with an agricultural conception of resource management, damar gardens also represent a patrimony. Arising from a strategy of land property creation, the fruit of labour invested for a distant term, which will mainly benefit future generations, the damar garden constitutes an inalienable lineage property (Mary 1987; Nadapdap *et al.* 1995). In the very particular social and institutional context of the Pesisir, where families are defined mainly by their land assets, this notion of lineage patrimony defines the agroforest not only as the source of living of a household, but also as the land foundation of a lineage.

Damar gardens as a useful forest

Damar gardens fulfil a role equivalent to that of natural forests in the economies of forest villages. Wild resources associated with damar trees support a whole range of gathering activities that are more typically linked with natural forest ecosystems—hunting, fishing, and harvesting of plant products—and provide important complementary subsistence resources for households. These include various noncommercial fruits, vegetables, spices and firewood, as well as other plant material and timber for housing purposes.

Damar gardens also represent, as does any natural forest, a source of products that are potentially marketable commodities at a larger scale: timber, rattan, medicinal and insecticide plants can be harvested for sale whenever needed or if market conditions are considered favourable.[5] As new markets develop, some of the traditional subsistence products have actually emerged as new commodities. Timber presently stands as the major 'new' commodity that might even revolutionise the management of damar gardens (de Foresta and Michon 1992, 1994a; Michon *et al.* 1995a; Petit and de Foresta 1996).

Damar gardens have taken over the essential role traditionally devoted to natural forests in household economy: a place opened to subsistence gathering

Table 1. Main characteristics of the damar resin trade chain inside Indonesia

Agents	Relative profit margins[a]		Activities[b]					
	Trade chain 1[c]	Trade chain 2[d]	Harvest	Stocking	Drying	Sorting	Transport	Processing
Damar grower	70%	70%	xxxx	x	x	o	xxxx	o
Village traders	3%	6%	o	xxxx	xx	xx	xx	o
Krui dealers	1%	none	o	xxxx	xx	xx	xxxx	o
Direct traders	none	6%	o	xxxx	xx	xxxx	xxxx	o
Krui wholesalers	13%	none	o	xx	xx	xxxx	xxxx	xx
Expenses	10%	15%						
Losses	3%	3%						

[a] Expressed in percentage of the resin price in Tanjung Karang or Jakarta.

[b] xxxx = principal activity, xx = often, x = occasionnally, o = never.

[c] Trade chain 1: village traders —> Krui entrepreneurs —> outside trading.

[d] Trade chain 2: village traders —> outside trading.

Table 2. Average production per hectare per year in mature damar agroforest, Pahmungan village, Central Pesisir subdistrict, April 1995

Species	Density trees/ha > 20 cm DBH	Production	Traded	Labour family level	Yearly income (data: 1995) Rp	US$
Shorea javanica (resin)	145	1550 kg	1500 kg	50	1,500,000	682
*Durio zibethinus**	25	625 fruits	600 fruits	10	420,000	191
Lansium domesticum°	15	600 kg	500 kg	10	250,000	114
Parkia speciosa	8	1200 pods	1000 pods	10	100,000	45
Baccaurea racemosa°	7	200 kg	50 kg	2	10,000	5
*Artocarpus cempedak**	6	100 fruits	50 fruits	2	50,000	23
Other fruit trees (6 spp.)°	10	200 kg	50 kg	3	50,000	23
Timber (all species may be used)	250	5 m^3	2.5 m^3	0#	50,000	23
Total labour (man-days)				87		
Average yearly income					2,410,000	1106
Minimum income (no fruiting season)					1,650,000	750
Maximum income (fruit season)					3,570,000	1625

*: production every two years.
°: production every three years.
#: no family labour involved in timber harvesting.

and extractivism and used to fulfil the family's immediate needs. This forest function also appears in some of the social attributes of the gardens, i.e., product exchanges, sharing and donations and free harvesting rights (noncommercial garden products may be collected by anyone who needs and asks for them). This creates important networks of reciprocity that act as a counterpart to mercantile networks created through agricultural activities and helps maintain a social balance between well-endowed people and those without resources.

Damar trade

Resins, which are sticky plant exudates found in various families of forest trees, are among the oldest traded items from natural forests in Southeast Asia. They entered short-distance trade between Southeast Asian islands as far back as 3000 B.C. and were probably included in the first long-distance exchanges that developed with China from the third to fifth centuries (Dunn 1975). Locally, damar served for lighting purposes and for caulking boats. It was traditionally traded as incense, dyes, adhesives, and medicines (Burkill 1935) and acquired a new commercial value by the middle of the nineteenth century with the development of industrial varnish and paint factories. Collection intensified for export trade to Europe and the United States, and then to Japan and Hong Kong. After 1945, however, exports dropped rather sharply as a result of competition with petrochemical resins, which are preferred for most industrial uses.

Nowadays, Indonesia is the only damar-producing country in the world. Damar resins are marketed through both interinsular and export markets. Major end users are low quality paint factories in Indonesia, which use the lowest grades. The best quality damar is reserved for export, mainly to Singapore, where it is sorted and processed, and re-exported as incense or a base for paints, inks, and varnishes manufactured in industrial countries. Other destinations include handmade batik industries and the manufacture of low quality incense (Bourgeois 1984; Dupain 1994; Anonymous 1995).

In the glorious period of intensive harvesting for export, from the beginning of the twentieth century until World War II, the main damar producing areas were the natural forests of southern and western Sumatra, as well as West Kalimantan (van der Koppel 1932). Today, West Kalimantan and South Sumatra still produce some damar, but the main producing area is certainly Lampung, the southernmost province of Sumatra.

Access systems

According to the ancient customary tenure system, forest lands and resources were managed as common property by the local community, unlike irrigated lands for rice production, which were privately owned. Individual claims over economic resources in the communal land were acknowledged for certain species and through certain technical processes. Thus, a wild damar tree could be appropriated by those who first began tapping it; collecting damar from

that tree was then considered their own and exclusive right. However, nobody could claim rights over a piece of unmanaged, pristine forest. Access to land for subsistence and cash cropping was usually gained through clearing a piece of land in the communal forest and cultivating it. Distribution of access rights between the various families consisted of long-term individual usufruct rights. The land itself remained the property of the community. These individual usufruct rights were in fact tacitly maintained long after the crops were abandoned, and the same family could recultivate the land after a fallow period without asking permission. However, customary rights strictly forbade the planting of perennials on these communal forest lands, except for short-lived perennials like coffee or pepper.

As more people developed an interest in damar cultivation, the assembly of community heads, responsible for the customary law, formally accepted the removal of the prohibition against planting perennials in the communal lands, which boosted the spread of the plantation movement and led to drastic land appropriation activities by individuals in the former communal forest domain (Levang and Wiyono 1993). However, land property could only be claimed through tree plantation, and the old tenure system—communal property of the land and usufruct rights—prevailed for unplanted plots.

As the plantation process was conceived in a context of the relative failure of common property systems, its success required the assurance that the planter's children would effectively enjoy the right to harvest the trees, which implied that not only property rights are acknowledged and enforced, but that transmission rights are also secured. The consequence is that created land properties never returned to the community; the commons gradually disappeared. However, the privatisation process remained original as it did not entail promotion of individual control nor fragmentation of the agroforestry domain (Mary 1987; Levang and Wiyono 1993; Michon *et al.* 1995b).

Common property rights and values in the framework of private agroforests

As forest resources and structures have been re-established, common property traditions have been redefined and reinforced in the context of privatisation. Important economic resources such as resin and commercial fruits, as well as land, are effectively individually owned assets. However, on these private agroforest lands many resources are still considered as common property or open access resources. Noncommercial fruits, sap from the sugar palm, bamboos, and special thatching leaves provided by species commonly considered as 'planted' remain at the disposal of the community.

In the same way that the technical appropriation of the forest resource did not fundamentally change the Pesisir landscape, the institutional re-appropriation of the former forest commons through 'controlled privatisation' did not result in a total institutional revolution that erased old values. This maintenance of the communal philosophy in agroforest management is essential. In the way that former common property regulations controlled the permanence of the commons, the new property ethics in the Pesisir ensures that trees and land will be integrally transmitted to future generations.

For village communities the private property legal framework could secure a better bargaining position with external bodies than common property, which is still negatively perceived or easily denied by most state bodies as well as by private companies. The Indonesian administration more easily acknowledges, and compensates for, private claims over land. Privatisation could therefore be used as a political strategy for local communities to protect their resources.

TRENDS AND ISSUES—DEVELOPMENT AND CONSERVATION LESSONS

From extractivism to cultivation

Agroforest establishment in the Pesisir does constitute a true revolution in both the forestry and agriculture contexts. As a forest plantation strategy, the damar agroforest model runs counter to the conventional model of timber estates that are presently being developed. While favoring a selected resource, as estates do, the agroforest allows the maintenance of numerous other resources that otherwise would not have been conserved purposefully, and species that are not direct resources to be restored as well. Moreover, the establishment process allows the restoration of integral biological and ecological processes which are crucial to the overall survival and reproduction of the agroforest as an ecosystem. If encompassed in the framework of agricultural plantation strategies for the development of forest lands, extension of the damar agroforest represents a process of forest conversion that does not go along with economic reductionism. On the contrary, through the restoration of biodiversity in the agroforest, farmers have achieved the restitution of a whole range of economic choices for the present and the future, which appears indispensable in a sustainable development perspective. The agroforest development also represents a successful strategy for agricultural intensification that has helped to set farming system patterns without any disruption in food availability or living standards, while maintaining intact the productive potentialities of the land itself.

Agroforests are *not* natural forests that have been gradually modified through management. They represent an artificial area, which has been created by farmers' communities. They result from a voluntary decision of these communities to re-establish forest resources and to recreate forest structures. Natural forest management in Indonesia, including extractivism, is still a form of exploitation of nature's gift. Agroforest management is beyond that: it is the invention and the achievement of a new form of forest resource management on former natural forest lands.

The need for legal recognition

Damar farmers are caught between two mutually exclusive administrative mechanisms regarding their lands. Part of the damar gardens have been classified as state forest lands, as either Limited Production Forest or Protection Forest. The remaining areas of damar agroforests are 'unclassified' as far as the Forestry Service is concerned; they are not public land and are therefore

sometimes called 'private land'. However, private appropriation by local people is not formally acknowledged as farmers do not hold any official land certificate for either rice fields or damar gardens. In both cases, their legal position is dramatically weak. To forest authorities, they are undoubtedly outlaws. Conducting any agricultural or harvesting activities on forest lands without permission from the Department of Forestry is constitutionally illegal and implies a penalty. Under a 'private' regime, but with no land title, damar farmers may be considered as squatters on empty lands that are reserved for regional development. In both cases, they are highly subject to eviction in order to give way to 'projects'.

Forests, as well as non-forest lands in the Pesisir, represent the last 'wild frontier' in the already highly populated province of Lampung. Because of its proximity to Jakarta and ongoing road development, it is a tempting invitation for private speculators such as estate developers and agro-industries. For the regional authorities, these potential investors represent highly interesting parties. Besides being important taxpayers, which farmers are not, their investments would greatly increase the regional development index and supposedly increase the level of industrial activity in the area (Kusworo 1997).

Since the early 1990s, following completion of logging operations, the provincial authorities have started allocating 'private lands' as well as part of the logged-over forest lands in the three Pesisir subdistricts to two oil palm companies. Local farmers were not informed of these projects and started asking questions when they encountered field teams measuring land, including their damar gardens and even their rice fields. They not always received the correct answer.

Local authorities specified that oil palm would be planted only on 'empty' lands, though local farmers could also be invited to join with their own lands if they wished. They started campaigning to support the project, asking village heads to speak highly of the economic merits of oil palm planting and to ensure farmers' co-operation. But they also specified that no farmer should be compelled to give up his damar land for the company and that no damar tree should be felled without the consent of the owner. One of the companies soon applied its own conception of 'inviting' farmers to join. After a formal convocation conveyed through the subdistrict head, or *camat*, to village authorities, and given the subsequent lack of enthusiasm from damar farmers, it decided to use fake but positive agreements signed by farmers in lieu of true but negative ones, and started clear-felling damar gardens under moonlight!

The joint claims of farmers, nongovernmental organisations and international research institutions asserting that replacing farmers' damar gardens by oil palm estates was neither ecologically nor socially acceptable, and that the way this replacement was about to happen was clearly a classic case of power abuse by economic and political elites, finally succeeded. In December 1996, the Ministry of Forestry asked the first company to suspend its activities and solve the current conflicts with local damar farmers, while in March 1997, the provincial governor asked the second company to halt its activities.

Justice issues

The Pesisir case addresses many justice issues. The main one concerns civil justice. The basic property and use rights of local people over lands and resources they have not only managed, and sustainably managed, but also developed and enriched over centuries are not fully recognised by the state in spite of constitutional facilities that accommodate the acknowledgement and legalisation of such rights. This issue is not specific to the Pesisir; it constitutes the major confrontation area between the state and forest farmers' communities, while revealing the major impediment to the integration of local communities as groups of fully vested citizens into the Indonesian nation. Closure of the damar lands by the state would constitute not only a violation of basic rights but pure theft. Replacing damar gardens by estates, either forest or agricultural plantations, or reserving the damar gardens for any project of conservation or production forestry would obviously constitute a forceful appropriation not only of other people's lands, but also of the fruit of other people's labour.

The second issue is one of economic and social justice. Replacing damar gardens with specialised oil palm or acacia plantation might prove, in the short term and with a partial economic valuation, an economic gain for the region. However, it is uncertain whether this economic gain will be redistributed to the farmers who will, certainly, contribute to this gain through their—underpaid—labour. In terms of equity, the overall economic characteristic of the damar gardens is that the majority of the benefits they provide go to local people: farmers, wage labourers, local trade entrepreneurs. But the income officially derived from the damar activity by and for the district is almost nonexistent: taxes upon the damar resin represent less than 0.1% of the district budget. Industrial plantation estates provide much higher profits—but to a far lower number of people—whereas levies raised by the district through the estates and the related industrial processing units are numerous and substantial. Seen from the point of view of regional administrators, the choice is obvious.

The last issue concerns environmental justice. The damar garden system developed by Pesisir farmers has proven to be an almost perfect ecological substitute for natural forests, in fact probably the best possible one for a diversified production system. Destroying damar gardens to make room for specialised oil palm or acacia plantation would obviously constitute an ecological crime with, among other immediate consequences, the destruction of the specific habitat for many lowland plant species; a significant reduction in the feeding and breeding areas of many endangered mammal and bird species (Sumatran rhino, tiger, tapir, elephant, siamang, hornbills and rapaces); and a drastic increase in soil erosion with consecutive siltation of the Pesisir coast and of irrigation works in the lowlands, not to mention the increase in ecological risks for people as well as for the plantation. An additional consequence is the uncertain ecological sustainability of monocrop plantation over the long term, which has to be compared to the proven sustainability of the damar enterprise over the last 100 years. Crimes of this sort do not result in immediate punishment, but their long-term costs, for locals as well as for the nation itself, are potentially immense.

Which strategy for conflict resolution?

The damar success story has been strongly endangered. Pesisir farmers have been facing urgently threatening choices: either to become labourers on their land as their damar agroforests might be converted to oil palm estates, or to see their rights strongly restricted by zealous foresters who confound damar agroforest with natural forest and thus forget that there are no damar agroforests without damar farmers.

Indeed, culturally, biologically, economically and socially, damar farmers have succeeded in re-appropriating their forest resources. However, what the last few years of threats have shown is that the re-appropriation was obviously incomplete, enough to ensure the long-term sustainability of the system but not enough to protect its short-term survival. To be ensured against forceful conversion, a fifth element is needed that would translate into legal terms the formal and official recognition of the damar farmers' contribution to overall national and regional objectives.

The agroforest situation did not fit any of the existing legal forest categories. In response to this problem, the Minister of Forestry issued a decree in early 1998 that creates a new forest category in Krui. By this decree local communities are now legally and officially recognised as the sole users and sole managers of the state forest area covered with damar agroforests, as long as it stays as agroforest. The area remains state land, so farmers' ownership rights on the land itself are not recognised, but their usufructs rights on damar agroforest, including transmission rights, are now fully recognised (Fay *et al*. 1998; Fay and de Foresta 2001).

The 'agroforest framework' offers a good opportunity to escape the formal forestry context and to devise new forms of association between farmers, foresters, and regional authorities concerning forest resources. Ecologically, economically and socially the agroforest should not be identified with a natural forest, and indeed, as long as this confusion between forest and agroforest is maintained, as long as local practices for management of forest resources in farming systems are ignored, the chances of survival of agroforests as a unique model of integral forest management continue to decrease. Agroforests, once recognised, open a totally new field for negotiations between foresters and local communities, a field favourable to institutional innovations where ancient conflicts might be resolved without one or the other party losing face.

ENDNOTES

1. Modified after Michon, G., de Foresta, H., Kusworo, A., and Levang, P. 2000. The damar agroforest of Krui, Indonesia: Justice for forest farmers. *In*: Zerner, C. (ed.) People plants, & justice: The politics of nature conservation. Columbia University Press, New York.

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4. 'Damar' is a generic term used in Indonesia to designate resins produced by trees of the Dipterocarp family.

5. The most valuable but also less predictable extractive commodity in the damar gardens is rattan. Rattan cane harvest is subjected to the profit/failure dynamics of local buyers. This important economic unpredictability constitutes the main impediment to the development of rattan harvesting into a real garden production.

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Chapter 14

Paper Mulberry (*Broussonetia papyrifera*) in Lao PDR: a successful example of forest product domestication

Catherine Aubertin[1]

Common names	Part of the resource used	Management	Degree of transformation	Scale of trade	Geographic range
Paper mulberry, Posa	Bark	Wild/ Cultivated	Medium	International	Large

OVERVIEW

Paper mulberry, *Broussonetia papyrifera,* is a pioneer species, commonly found in fallow after slash-and-burn cultivation. In Lao People's Democratic Republic (Lao PDR), paper mulberry is cultivated in Sayaboury province as a cash crop, while in Luang Prabang province naturally occurring paper mulberry is harvested from fallow lands. Paper mulberry bark is usually integrated in a trade system of several cash crops, dominated by Thai buyers. It is processed into paper in Thailand and then exported to Japan and Korea. In Luang Prabang, the government's attempt to stop shifting cultivation by allocating only three plots of land for cultivation to farmers has encouraged farmers to intensify exploitation of wild mulberry for extra cash income. This government policy has also stimulated the cultivation of paper mulberry in monocultures, at a cost to the existing agroforestry systems. Paper mulberry production could be improved, for example, by improving grading activities. However, the production in Lao PDR will remain vulnerable to fluctuations as it is controlled by Thai demand. The study of the paper mulberry network, like that of many other forest products, has enabled this research to touch on agricultural and environmental policies and the restrictions on land these policies have introduced for other activities, characterised as traditional. It has also enabled the following of regional and international marketing networks in the country. Paper mulberry provides a good example of successful domestication of a forest product.

INTRODUCTION

Paper mulberry, *Broussonetia papyrifera*, belonging to the *Moraceae* family, is widespread in Lao People's Democratic Republic (Lao PDR). Paper mulberry is a shrubby tree that sprouts spontaneously in swidden fields, after the harvesting of *ray*[2] rice. Paper mulberry is also common in degraded forests and is used more and more often as a plantation tree in forests and fields. Its branches supply the bark that is used in paper production.

Paper mulberry bark has long been used. The French explorer Auguste Pavie related that in 1887 he had attended a parade, in Luang Prabang, organised under a triumphal arch covered with 'cardboard made from mulberry pulp, from a pattern sent specially from Bangkok' (Pavie 1995: 37). Before the introduction of imported sisal and nylon ropes, farmers used to make string and rope from mulberry fibres. Paper production, however, is still limited in Lao PDR. It is the work of a small number of Yao people who draw Chinese characters, constituting the written form of their language, on mulberry paper, for use in religious rituals. Nowadays, paper production is promoted within the context of small development projects, intended to raise the standard of living of mountain people, and on the initiative of handicraft shops for tourists.

Large-scale export started only recently, after the economic opening of the country since 1989, when the communist government began to promote a market economy, and because of a growing demand from Thailand, where the bark is processed into paper pulp for further export to Japan and South Korea. In the latter countries, it is used to process special papers for banknotes, liturgical objects, lanterns, luxury stationery, etc.

The research area

This monograph is based on field studies carried out during the 'forest areas management' research project led by the Institute for Research and Development (IRD) and the Nabong Faculty of Agriculture of the National University of Lao PDR in Sayaboury and Luang Prabang provinces (Figure 1). Sayaboury is a dynamic area because of its commercial relationship with neighbouring Thailand. In Sayaboury province, data were collected in Kenthao and Paklay districts, where paper mulberry is grown as a cash crop. In Luang Prabang, which is a more traditional mountain area of northern Lao PDR, paper mulberry comes mainly from fallow land. The population densities in the two provinces are similar, at around 20 people/km^2.

THE PRODUCTION-TO-CONSUMPTION SYSTEM

Description

Paper mulberry, called *Posa* in Lao and *Salae* in Khamu (the second largest ethnic group in the Lao PDR), grows rapidly and reaches its full mature height at between six months and one year. The ordinary stature of the species is about 3 m and the stem diameter is about 5 cm. At first, the stems are

Figure 1. Map of the study area

Source: ESRI Data and Maps 2002.

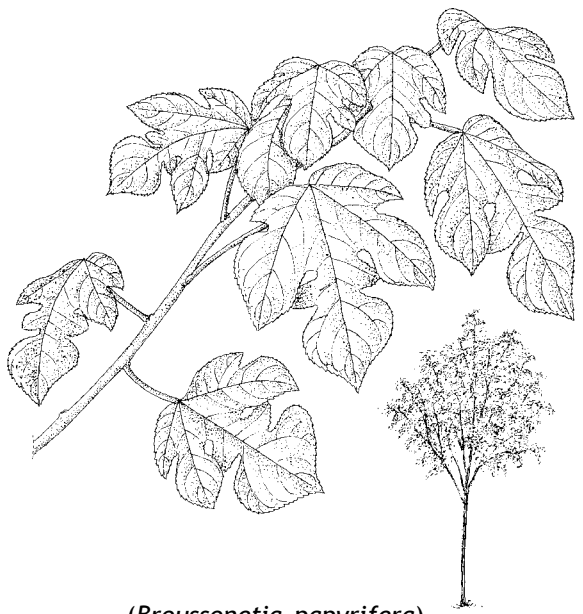
covered with down and then the bark turns smooth and grey. Its leaves are large, with several lobes, and measure more than 20 cm. The red fruits are small (3 cm in diameter) and though reportedly edible not much sought after.

Paper mulberry grows as a pioneer species all over the country. It grows at moderate elevations (500-800 m) in secondary forest and early fallow regrowth following slash-and-burn cultivation. It is traditionally a regeneration species under *ray* requiring a moist forest environment on flat or sloping land (Fahrney *et al*. 1997). Paper mulberry is especially common in northern Lao PDR, particularly in Luang Prabang, and also in the south-eastern province of Sayaboury, where it is now cultivated on a large scale. When domesticated, paper mulberry is grown in managed agro-ecosystems. In Sayaboury, it is cultivated with success as a flood crop along the Mekong riverbanks. Though it is adapted to all kinds of soil, paper mulberry grows particularly rapidly on moist alluvial soils.

The species sprouts spontaneously after burning and has long been considered a weed by foreign agricultural experts. However, paper mulberry trees are much appreciated by farmers because they accelerate the regeneration of soil fertility (thanks to their extensive carbon-fixing root system and their large leaves), along with their rapid growth, resulting in rapid canopy closure, which in turn reduces weeds.

It can be assumed that this is the same variety that grows all over Lao PDR. Male and female flower types occur on separate trees, which are

harvested in the same way. The species propagates through spontaneous germination and sprouts from the base when properly harvested. No serious diseases that affect the tree have been reported.



(*Broussonetia papyrifera*)

Harvesting

The more important part of the production is harvested in March and April, before the wet season. The quality in these months is higher with little moisture (less than 35%), which is reflected in the prices paid for the bark. The second and lesser part of the production (25%) is harvested between October and December, at the end of the wet season. This period is reported to be suitable because the inner bark is easy to strip, easily dried and therefore free of fungal problems when stored.

Paper mulberry can be harvested when the tree is just one year old and then every six to eight months thereafter. The theoretical yield increases until the sixth year and then begins to decrease. If the tree is harvested for commercial purposes, the harvest cycle will be short (six months). If the objective is to occupy an area for reasons of land speculation, the cycle can be very long, more than four years and even then the trees may not be harvested.

Quality paper mulberry must be young, from six months to one year. However, three to four year old paper mulberry bark can be sold at a price that may be 30% to 50% lower. The optimal stem diameter seems to be between 2 cm and 4 cm. Three to five branches are harvested on each tree.

Harvest from fallow lands

In active swidden *ray* fields, studied in Luang Prabang, the stocking density amounts to 300 plants/ha. Farmers do not let paper mulberry grow too long in fallow fields to prevent competition with other plants. It is generally harvested and removed from two to three year fallows after having fulfilled its function as a weed control. Harvesting in swidden *ray* fields is usually carried out in conjunction with other hunting or gathering activities. Farmers harvest from fallow fields belonging to their household or to other villagers. Traditionally, in Luang Prabang province, the harvest of paper mulberry from fields where rice had just been harvested was free for all the villagers. The freedom to harvest paper mulberry from old *ray* has tended to disappear with the reduction of forest areas and the increase in individually owned plots

If properly harvested without damaging the tree (it is not necessary to cut the tree down completely), new shoots will sprout. Harvesting paper mulberry is not detrimental to plant or environment. Paper mulberry is one forest product for which there is no threat of extinction through overexploitation.

Cultivation of paper mulberry

Cultivation has developed following demand. It was implemented by the farmers themselves. They practise selective weeding in order to protect paper mulberry shoots. Then they plant root cuttings for propagation in their *ray*. Today, in Sayaboury province, paper mulberry is mostly planted in fields with significantly higher yields than those recorded in *ray*.

Paper mulberry is still a secondary crop for farmers, and is extensively produced by those who have enough land. It is generally intercropped with fruit trees and trees grown for their shade, like the kapok tree in Sayaboury and teak in Luang Prabang.

Farmers plant root cuttings, which they obtain either directly or through a tree nursery, in June, during the wet season. It is possible to plant seeds but the results are judged less reliable. The proper spacing to obtain longer fibrous fibre is reported to be about 1.5 m x 1.5 m, which represents a planting density of about 5,000 plants/ha. But the planting density depends on the objective of the farmer: weed control, limited competition with rice (3 m x 3 m) or with other trees (4 m x 4 m) or to show and mark ownership of a field (very wide spacing is then possible).

Paper mulberry cultivation requires several kinds of activities: fencing, first-year weeding and stripping. Then, the upkeep consists of weeding two or three times each year and cutting off any excess shoots, leaving only four to five on each tree. Weeding is the most restricting activity because it is labour intensive. In Sayaboury, the fields are weeded in January, May-June and September. A worker can cut and strip between 7 kg and 8 kg of dried bark per day. For one hectare yielding one ton of bark, the theoretical labour requirement amounts to 120 days. In Sayaboury province, each family harvests on average 100 kg of bark per year. Few families own large areas, most have less than 0.5 ha (Pelliard 2000).

Photo 1. Two year old paper mulberry tree in a mulberry paper plantation, Huaphan Province, Viengthong district (Photo by C. Aubertin)

As a rule, the areas under cultivation vary greatly according to market prospects. Farmers can easily change paper mulberry for another crop, and let it grow again spontaneously to harvest it the following year. They can also choose not to harvest if the price is too low. They either keep a standing stock of paper mulberry or give up the activity. The labour force is limited to family members. Both men and women plant, harvest and strip the outer bark from the mulberry trees. There are no particular rituals.

Production in Kenthao and Paklay districts, Sayaboury province

It is estimated that about one third of families in the southern districts of Sayaboury (7,000 families out of 20,500) harvest paper mulberry. The agricultural departments in Kenthao and Paklay districts in Sayaboury province, where we carried out a survey, only register the areas of paper mulberry that are either planted or looked after. It is therefore difficult to gain an understanding of the importance of 'wild' paper mulberry, forming scattered and temporary islands that are not registered. Yet this paper mulberry is also harvested and sold, and represents the main part of the production in other provinces.

In Kenthao district, the increase in cultivation of paper mulberry has followed the general agricultural growth in the area after the economic

opening up of Lao PDR. In 1997, there were 9,099 ha of cultivated lands in Kenthao district. Paper mulberry represented 4.7% of this area and 9% of the 4,718 hectares devoted to cash crops. Up until 1997 the land planted with paper mulberry in Kenthao district had been slowly increasing, but the area has since decreased again by 50% to 203 ha. This might be seen as a consequence of the economic crisis in Thailand in 1998-99, though it did not have any obvious effect in Paklay district, where the areas planted with paper mulberry have increased steadily since 1990. In 1999, the area planted with paper mulberry was twice as large in Paklay as in Kenthao (RDPL 1999).

The quantities reported by the trade department fit neither the areas reported to have been planted nor the yield assessed at the district level nor the statements of the actors who have undergone a downturn in their activities during the 1998 crisis. In Paklay there are huge gaps. In 1999, the quantity officially produced was 585 tons whereas exporters reported to have exported 500 tons and the trade department registered only 219 tons (Table 1).

Postharvest treatment and trade of paper mulberry

After cutting the branches, inner and outer barks are stripped from the woody stems. The inner bark is then separated from the outer bark, which is discarded. This is generally done in the field. The inner bark is hung out in the village to dry in the sun for a day. This step is important to limit mould. In Sayaboury (as in Luang Prabang), mulberry bark is sold in 1 kg bundles with most transactions being recorded in April.

The village first order traders are based in the villages and collect all kinds of products, according to the season. There is generally only one collector in a village, situated by the main road or riverside. These collectors store the paper mulberry in their homes on boards and protected by canvas covers. Once they have collected a given amount, generally more than 1 ton, they inform the exporter who comes to collect it. The farmers, who come from the most isolated villages, must deliver their harvest on foot, in carts or in cultivators. Each collector works principally for one specific merchant. The number of village collectors in Paklay and Kenthao districts is estimated at about 100.

There are no exclusive relations between collectors and traders, so the bark can be sold to the first trader who passes through the field or the village. Thirty percent of the production is directly collected at the central collection centre and 70% is collected in the villages. Farmers from villages close to the border sometimes transport and sell their products in Thailand, without going through a middleman.

Information on prices is circulated one to two weeks before the harvest. Kenthao authorities assert that prices are discussed between Lao traders and the trade department, after which the village leaders are officially notified. This was not the case in Paklay. A farmer sells about 100 kg per year. A trader may buy up to 20 tons and exporters from 10 tons to 1,000 tons. There is at present a concentration trend in the network that benefits the biggest traders, who sell directly to the Thai processors.

Table 1. Paper mulberry production in Kenthao and Paklay districts (Sayaboury province)

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Kenthao District											
Area (ha)				118	118	128	384	427		203	300
Production (t)				117	117	128	460	513		243	360
Yield (t/ha)				1	1	1	1.2	1.2		1.2	1.2
Paklay District											
Area (ha)	10.35	40	124	244	357	360	240	300	450	450	600
Production (t)	7.24	31.5	85	95	324	324	312	390	585	585	780
Yield (t/ha)	0.7	0.82	0.68	0.66	0.9	0.9	1.3	1.3	1.3	1.3	1.3

Source: Statistics of the agricultural departments of Kenthao and Paklay Districts.

Paper mulberry is sent mostly to factories in Sukkothai (1,500 tons of bark was processed in 1997), Uttaradit and Konkhaen (Phoenix factory). Private wholesalers and purchasing companies share the Thai market among themselves according to defined geographic areas. The eastern area comprises Loei and Konkhaen, and the central area Bangkok and Sukkothai. They buy directly from big Lao exporters or from four to five Thai middlemen who control the products crossing the border in Kenthao (Pelliard 2000).

Photo 2. Bark stripping, Huaphan Province, Viengthong district (Photo by C. Aubertin)

Quality of the bark

The product collected in Lao PDR is of medium quality, and competition between first order traders leads to the purchase of bark that is not properly dried. The first trader who arrives in a village rushes to buy the bark. Bark grading requires much attention and is often done too fast by buyers. Thus quality is not properly accounted for in the price.

There are different grading categories. Top quality bark must be as white as possible and without knots or discoloration from fungi. Bark quality depends

mostly on the plantation age and is better when harvested from the secondary stems of young plants, less than three years old, with a diameter of 2 cm to 4 cm. It is essential to store bark in a dry place because mould appears quite rapidly in a moist environment. After one month in storage, about 20% of the bark quality may be lost.

In Thai processing factories, which buy the raw material, mulberry fibres are valued for their length and suppleness and resistance to tearing and creasing. The factories then grade the bark into four categories. 'Super A' grade is exported to Japan, and processed there. Grades 'A' and 'B' are processed either into paper or loose fibres that are compressed for further export to South Korea. Grade 'C' is sold to small Thai handicraft companies, where it is processed by hand.

Box 1. Export routes

There are two main export routes. Mulberry fibres may be sent from Luang Prabang by boat up the Mekong River to Bokeo province, reaching Houayxay and then on to Thailand. Or they may be sent down river to Sayaboury province in the south, down to Paklay harbour and then transferred by truck to the border town of Kenthao. The latter route is used for paper mulberry fibres produced in Kenthao and Paklay districts.

Processing paper mulberry

All Lao paper mulberry production is exported as raw material (in bundles) or as paper pulp. There is no paper processing in Sayaboury and only one paper mulberry processing factory in Luang Prabang, the Pethlama factory. This factory has been in operation since 1988. It buys paper mulberry bark locally and also from the northern provinces of Huaphan, Phongsly and Oudomxay. They semiprocess the bark using two grinders and then export the paper pulp to Thailand.

The most delicate stage is the final grading of the bark. After grading, the bark is cleaned and dried in the factory for the first time. The fibres are then soaked for one night, after which caustic soda or ashes are added and the mixture is stirred and boiled for 6 to 8 hours to bleach and thicken it. Between 50 g and 100 g of caustic soda are needed for each kilogram of paper mulberry bark. The resulting fibre slurry is cooled in cold water for a day. The lumps are then cut and ground. The pulp that is obtained is then dried in the Luang Prabang factory and exported to Thai factories where paper is produced. The Pethlama Company employs 80 workers. Fifty are employed to collect and buy the bark, while the others wash and defibre the pulp.

We did not observe paper processing in Thai factories, but at the head office of the Japanese FORCAP project, south of Luang Prabang on the road to Vangviene. To carry on with paper production, the damp pulp is poured into a fine sieve, often made of wire mesh in a simple frame the size of the sheet

that will be obtained. The standard size seems to be 60 cm x 80 cm. The thickness of the sheet depends on the sieving know-how. The more often the pulp is sifted, the better the quality. The frames are set in the sun to dry for a few hours, then the sheets are separated from the wire mesh and pressed. One kilogram of wet paper mulberry fibres yields 400 g of dried fibres. One kilogram of dried fibres yields 400 g of paper. At the FORCAP project headquarters, seven people can produce about 100 sheets of paper per day.

Prices and incomes

The economic profitability of the product can be assessed at US$1.7per working day per person with a price of US$0.25 per kilogram in 1998 (Phongsavath 1998). Paper mulberry has a higher yield per hectare than rice but a lower yield than maize or kidney beans.

In July 2000, the average family income for two workers in the studied area in Sayaboury province amounted to US$800[3]. More than 70% of the family income is monetary, which is exceptional in Lao PDR and is a result of closeness to the Thai market, which sustains the development of cash crops. With an average harvest of 100 kg of bark, sold at US$0.35 per kilogram, paper mulberry can provide a family with an income of US$35 per year, i.e., about 4.5% of total family income and 6% of their monetary income. The harvest of paper mulberry bark is a supplementary farm activity. Decision-making regarding this activity depends on the need for rice and the market evolution of a set of cash crops.

Mulberry bark processors insist on paper quality. For example, the Luang Prabang factory has instituted three markedly different prices according to raw material quality (US$0.2, US$0.4 and US$0.5 per kilogram). A comparable price difference can be observed in Sayaboury. However, first order traders seem unconcerned about passing on this price difference to the households harvesting mulberry bark. Either they want to increase their margin or they refuse to take on additional selection and grading work. Farmers do not seem to be well informed of these various prices. According to official data, which do not account properly for inflation and exchange rates among the three currencies used (USD, Lao kip, Thai baht), during the years 1997, 1998 and 1999 the price paid to paper mulberry producers varied between US$0.25 and US$0.6 per kilogram. In kips, the price has increased evenly from 500 kips/kg up to 3000 kips/kg. (Pelliard 2000). It is therefore difficult to gain a clear understanding about the evolution of the product price.

In Sayaboury province, in Kenthao and Paklay districts, there is not a big difference between the price paid to the producer (US$0.37) and the free on board (FOB) price at the frontier (US$0.5) per kilogram. The collectors manage to retain a margin of US$0.04 per kilogram of bark, whatever the export price. The adjustment cannot be such that the price paid to the producers is too low, or they are likely to give up harvesting. The adjustment is often to the detriment of the exporters' margins (Table 2).

Table 2. Breakdown of FOB prices in US$ in different districts

Price per 100 kg of dried bark	Kenthao US$	Paklay US$
Price paid to producers in the field	37.50	34.50
Labour force: weighing, loading, grading (paid by exporter)	0.40	0.40
Transport to collection centre (district) (paid by exporter)	0.13	0.13
Price paid to collectors (district)	41.50	38.50
Collector's net profit	4.00	4.00
Transport to border	0.53	2.40
Tax on forest products (3% of price paid to producers in the field)	1.12	1.04
Customs dues (3% of price paid to producers in the field)	1.12	1.04
FOB price	47.00	47.00
Exporter's gross profit	2.20	3.49
Part levied by state company (30%)	0.66	1.05
Exporter's net profit	1.54	2.44

Exchange rate in July 2000: US$1 = 7500 kips
Source: Pelliard 2000.

An export-oriented market

Since 1989, with the economic opening of the country and the promotion of a market economy, the demand has turned a product with local home use into a much sought-after export product. While the development of tourism in Luang Prabang supports the renewal of local consumption of handicraft objects (decorated papers and souvenirs), the traditional use of paper mulberry, the making of fetters for animals, has almost disappeared.

While local agricultural departments are interested in the development of paper mulberry, it is not really a matter of concern for the national agricultural department, perhaps because of the status of paper mulberry. As a forest plant it is close to being regarded as a weed. In Vientiane, paper mulberry has such a poor image that it did not even appear in the last agricultural census (1998/1999) questionnaire and is not included in the list of plants for which the Ministry of Agriculture has issued production forecasts for the 1999/2000 harvest. Only the forestry departments have data on this product. The figures they have are the result of an attempt to centralise the data of all the provinces. They are not made public so that we had to conduct a survey within the departments. The results are unconvincing. They indicate a national total quota of 1,740 tons (collection authorisations given to merchants) for an actual production of 735 tons at the end of 1999. The main producing provinces are those of Sayaboury (quota of 1,500 tons and 60 tons

of production registered) and Luang Prabang (quota of 100 tons and 591 tons of production registered) while, according to our estimates, the production would amount to 1,000 tons in Luang Prabang and 800 tons in Sayaboury.

Paper mulberry appears in the customs' export statistics, but only 508 tons were reported as exported to Thailand in 1998, representing a value of US$150,000. The export price would then be US$0.3/kg, without distinction between paper pulp and the various qualities of dried fibres of lesser value. The export data are therefore more likely to be an underestimate.

Thailand is the main buyer, Japan and Korea then buying high-quality paper from the former. Paper mulberry is no longer cultivated in Thailand, which is more developed than Lao PDR and offers better opportunities to increase the profitability of land and labour. Lao PDR appears as a buffer zone for Thailand and the Lao production is used as a marginal supply, enabling the adjustment of the Thai market to meet international demand.

TRENDS AND ISSUES—DEVELOPMENT AND CONSERVATION LESSONS

Demand for a panel of products

A product destined for export cannot be studied in isolation. Paper mulberry, being exported to Thailand, has always played a supporting role in exchanges and networks that were dominated by cotton some years ago and are now dominated by maize. However, its relative importance has tended to increase against that of other products, following demand.

All the merchants endeavour to meet the Thai demand for products from cotton, maize and peanuts to kidney beans, sesame seeds and Job's tears, among others. Consequently there is no merchant specialising in paper mulberry. As paper mulberry is an export product, it does not concern small retailers who intervene only at a local level.

The local production of paper mulberry in some other areas of Lao PDR is often insufficient or does not fit the demand from Thailand. Lao traders sometimes have to get supplies from the Luang Prabang area to honour their orders. However, paper mulberry depends on trade channels that also concern several other products. Thai traders who deliver products to Luang Prabang may take back a cargo of paper mulberry from Luang Prabang to cover transport costs. For example, a big merchant who supplies Thai products in Luang Prabang (e.g., cement) makes the return journey pay by taking back agricultural products. Likewise, the merchants of the Kenthao area who supply Luang Prabang processing factories with agricultural products look for freight for the return journey.

The demand for a group of products is determined by the Thai local market and above all by the international market, through the processing factories in Thailand. Peanuts and maize are processed for the Thai and international markets, beans are exported to Japan, and paper mulberry is exported to Japan and Korea. The demand is passed on to Thai wholesalers, to Thai retail dealers, and eventually to Lao exporters.

Because of its monopoly Thailand can control the trade in Lao agricultural and forest products, which includes prices and quantities. When prices drop on the Thai market, Lao producers and merchants have some difficulty selling their produce. In 2000, only half of the cotton production was sold in Thailand and the rest had to be stored or an outlet in Luang Prabang found.

A credit-sustained monopoly

Thai domination is all the more important as it controls demand but also supplies credit for all farming activities. The collection of products is often prepaid. This campaign credit is integrated into the production network of cash crops in Kenthao. These funds are used not only to prepare the soil or to buy seed but also for the purchase of building materials or rice for the poorest people. The interest rate, outwardly nonexistent, can then reach 10% per month.

Except two big, independent merchants who have their own capital, Lao exporters obtain credit for the campaign from Thai intermediary buyers. This credit can then be shared among village collectors and farmers. Each actor, from Thai merchant down to local farmer is therefore assured that he or she will be able to carry out commercial transactions (sale or purchase), which is a decisive asset given market instability, inflation and the fluctuations in exchange rates. These campaign credits account for one third to one half of merchants' working capital, the rest being made up from their own capital. It is an important asset for merchants to have this credit granted in Thai bahts, the currency commonly used.

The situation is noticeably different in Paklay, where commercial exchange between traders and collectors is based on trust. The merchants, who have less capital of their own and receive fewer credit facilities from Thai buyers, would rather borrow from the bank to finance the campaign. These merchants prefer to use the Lao kip as currency.

The Lao import-export company

The Thai economic crisis in 1998 unfortunately coincided with the attempt of the government of Lao PDR to win back economic control over profitable businesses. This policy was given up in 1983 when the Lao government stopped the co-operative system and set up a new market mechanism, a kind of transition from socialism to a market economy. But recently a state-controlled import-export society granting a monopoly on the trade of products was set up to master the market and to avoid the fraudulent export of agricultural and forest products. It must be mentioned that, unlike agricultural products, forest products are considered state property. A special tax is levied on their export, theoretically to compensate for the damage done to the national forests and heritage. This 3% tax is also levied on paper mulberry, even if it is produced in plantations and not harvested from the forest.

The State Company, present in Kenthao and Paklay districts, has signed contracts with private exporters for several reasons:

- To control exports: it grants exporters export licenses and buying quotas.
- To collect taxes: 3% of customs dues measured on the price paid to the exporter and 3% taxes on forest products.
- To be able to levy a considerable part of the profits of the traders (30%).

Merchants think of the company as a 'tiger that eats and sleeps'. Indeed it does not: a) grant support or credit, b) intervene in agricultural product networks, c) assist in the search for new markets, or d) help to establish contractual relations with the Thai market. Official agreements on the quantities and prices are, however, claimed for.

The two biggest merchants in Kenthao have not been obliged to sign contracts with the State Company. They are organised in family groups of three to four people who pool their capital and share the profits. However, they must show their accounts and theoretically they pay the same taxes as the other traders but directly to the Trade and Customs Department. Nine merchants in Kenthao and 11 in Paklay have signed agreements.

How to develop the product?

It appears that the paper mulberry network is such that it is near impossible to create a large income before the final processing stage. The margins are limited and marketing is above all favoured by the fact that paper mulberry is integrated into a panel of products that makes the trade structure possible. However, the State Company has found enough interest in the sector to levy taxes on its activities. It is also difficult to interpret the decrease in the number of exporters. Is the sector so profitable that it fosters competition, or, on the contrary, is it possible for only the biggest traders to bear the hazards of the activity, including taxes and the instability of demand? Despite the development of areas devoted to paper mulberry, cultivation and production could stop if Thai demand did not guarantee a minimal price. It is therefore necessary to take into account local dynamics when aiming to support or develop this product. There is a market for paper mulberry: it requires neither specific inputs nor technology and presents good adaptive, ecological qualities in monoculture as well as in silviculture.

The first step forward would be to improve the quality of production. It is possible to improve the sorting of the bark by quality grading through information and an incentive price system. It is essential that the drying process and storage facilities be improved so as to improve both quality and prices.

Another possibility would be to look for new markets. The development of a processing industry would require much investment and training for the workers while the market is questionable. Would it be feasible to bypass high-demand markets such as Japan, controlled for so long by Thailand, with the support of the authorities or of family networks in Lao PDR? How can new trade networks be created? The comparative advantage of Lao PDR, in terms of rural image and ecological production, could possibly open up the development of networks in fair trade and eco-products.

Finally, institutional reform is urgently needed. The State Company should supply actual services as a counterpart of taking in taxes. It could play the part of a professional organisation that would negotiate contracts with potential buyers to stabilise prices and quantities.

Spontaneous domestication

Although paper mulberry does not fit the traditional description of a non-timber forest product (for it is a wood product), it offers a good example of the domestication of a forest plant. This domestication has taken place in Sayaboury province under the influence of strong Thai market demand and as a result of the instability of the prices of the main products, e.g., cotton, which made it necessary to diversify production. Farmers have begun to cultivate paper mulberry in their fields and to encourage its growth in fallows. They have successfully used the banks of the Mekong River and they have turned this forest plant into a riverbank flood crop. The domestication has been carried out rapidly, without the intervention of the agricultural department.

Response to land restrictions

Agricultural and land policies have also exerted some influence on the change process. There is no longer any forest in the district of Sayaboury, and most farmers have turned to a farming system in which cash crops—among them paper mulberry—prevail. In Sayaboury paper mulberry is no longer a *ray* plant linked to shifting cultivation of rice.

The situation is different in the northern provinces of Lao PDR, e.g., Luang Prabang, where mulberry forms part of shifting cultivation systems and where presently land reforms related to shifting cultivation are implemented. The new land allocation regulation aims at abolishing slash-and-burn and at developing the private ownership of land, allocating three plots of land to farmer households (MAF 1999). This raises questions related to mulberry production: Should paper mulberry be planted only in the fields or in the so-called 'production forests'? Can it be exploited as well within agroforestry systems as in 'protected forests'? This is a highly debated issue because it refers to the impossibility imposed on mountain people to preserve their lifestyles (Aubertin 2001) and to the disappearance of paper mulberry as a 'wild' *ray* plant and even as a domesticated plant present in the forest.

Development and domestication of paper mulberry in forest areas, where the market is not widespread, show some similarities with cardamom production in Lao PDR[4]. The redistribution of three plots of land to each household for rice production (existing gardens and rice fields are not included in the lands subject to redistribution) implies a reduction in the land area devoted to rice and a reduction of fertility (due to a short fallow period), resulting in lower rice yields. As a result, harvesting of wild paper mulberry from natural forest has increased in order to obtain cash income to buy rice. Related to the farmers' increased need for cash, we observed in Luang Prabang

that the production of Job's tear, encouraged by the government, did not find a buyer. As a result, farmers have intensified their exploitation of forest products in reserved areas.

Since the harvest of mulberry paper is theoretically forbidden in protected areas, its plantation in the allocated land plots is presented as a means to bring additional income to farmers and to reduce the area under slash-and-burn used for subsistence production of rice. This is the viewpoint of the FORCAP project. The domestication of products comes within the context of the search for perennial species likely to replace rice. Since paper mulberry favours weed control and can be harvested after a few months, several projects suggest that it be planted in two-year fallow rotations, the only ones that are possible with the allocation of three plots to each household. However, intercropping paper mulberry with rice is probably not a real solution to ensure adequate soil fertility for rice each year.

As we have seen, the optimal age for harvesting depends on the objective sought: weed control, rice yield, quality fibre for paper production, or a strategy to obtain land ownership of squatter lands (declared as gardens to evade redistribution of the three plots). Reaching the latter aim implies playing with words. Gardens (*swan)* and rice fields (*na*), when recognised as such, remain the property of the user. If producers manage to convince the institution in charge of land allocation at the district level to recognise that the paper mulberry they grow in fallows or in forests is cultivated in a garden, they evade the condemnation incurred for *ray* and cultivation in protected forests. If the manoeuvre is carried off successfully, these gardens are actually privatised and are not included in the lands to be redistributed. They are added to the family's three plots of land.

Biodiversity and the market

There has been a boom in paper mulberry production in Lao PDR, but it could still disappear at any time. The harvest of wild paper mulberry from fallows is doomed in the very short term because of land policies. The low price, which can be partially explained by the fact that it does not depend on the quality of the product, is no incentive to continue growing paper mulberry or to upgrade its quality, especially since the farmer can very easily give up harvesting it by weeding it out and replacing it with another crop, or it can simply be kept standing. Paper mulberry is only one part of the household income in a very diversified farming economy.

Questions might arise as to the future of such a product, which is dependent on Thai demand and credit, while the government mostly endeavours to hinder the sector rather than to support it by imposing contractual agreements with Thailand.

It may well be delusive to look at paper mulberry from the viewpoint of biodiversity. The trend is towards planting in monoculture outside forests, and no longer associated with the practice of *ray,* paper mulberry does not have the ability to protect forests. By aiming to eliminate shifting cultivation, the government compromises farmers' agroforestry practices and is

encouraging monocultures of mulberry. Paper mulberry plantations do not require chemical inputs for the moment but the intensification process will probably continue.

It is difficult to assess the comparative advantages and specificities of paper mulberry in Lao PDR to explain its development. If there is a comparative advantage of mulberry production in Lao PDR, it is linked to the opportunity costs of land and labour in comparison with Thailand where paper mulberry production is no longer profitable. In Lao PDR, paper mulberry production is not supported by a market that acknowledges its ecological or genetic characteristics. It is supported because Lao PDR acts as a market regulator for Thailand, providing raw materials for use in Thai processing industries. Paper mulberry has become a cash crop like any other and is bearing less and less resemblance to a NTFP.

This case stresses that the development of paper mulberry production, probably like most NTFPs, implies the integration of a whole ecological and socio-economic system into a market economy. Consequently, the actors' interplay, the production conditions and even the botanical variety are no longer the same.

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ENDNOTES

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2. *Ray* is an area where the forest has been cut and burnt for temporary cultivation of rice and other crops. It is the cornerstone of shifting cultivation, a form of agriculture in which soil fertility is maintained by rotating fields rather than crops. New plots are usually cleared by slash-and-burn and cropped until soil exhaustion. The land is then left to regenerate naturally while cultivation is conducted elsewhere.
3. Exchange rate July 2000: US$1 = 7500 kips.
4. See chapter 3 in this volume.

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Chapter 15

Moso bamboo (*Phyllostachys heterocycla* var. *pubescens*) production and marketing in Anji County, China

Fu Maoyi[1] *and Yang Xiaosheng*[2]

Common names	Part of the resource used	Management	Degree of transformation	Scale of trade	Geographic range
Moso, Bamboo, Mao zhu	Stem and shoot	Cultivated	Medium	International	Large

OVERVIEW

This chapter describes the significance, function, characteristics and trends of the bamboo production-to-consumption system in Anji County, China. *Moso* bamboo [*Phyllostachys heterocycla* var. pubescens (Mazel ex J. Houz.) Ohwi] contributes a great deal to the local economy and to farmers' income. With the change from collective to private management rights, the bamboo sector has increased considerably since the 1980s. The establishment of bamboo plantations also had positive ecological effects, as bamboo stands can be established on degraded lands. This has resulted in a decrease in the local people's dependency on natural forests (e.g., for firewood). However, the trend is towards intensification of production, which implies increased use of fertilizers and pesticides. Besides, bamboo plantations are usually monocultures and might compete with remaining natural forests in the area. The government needs to improve institutional support, for example by providing the right incentives to stimulate trade and the processing of higher value products.

INTRODUCTION

China is the richest bamboo producing country in the world, with over 500 bamboo species belonging to 39 genera and 4.21 million ha of bamboo plantations and improved natural bamboo stands (Shidong and Chuande 1998).

The history of bamboo utilisation in China can be traced back 7,000 years to the Neolithic Age, in both the primeval Hemudu Ruins and Liangzhu Ruins of Zhejiang Province where more than 200 woven bamboo articles demonstrating comparatively skilled weaving techniques have been unearthed (Qisheng and Weishan 1997). Anji County has a long-standing bamboo culture. An ancient Chinese work, called 'Shangshu Yugong', stated that, when Taihu Lake came into being, there were many different bamboos growing around it. Anji's bamboos were also recorded in the Tang and Song dynasties. According to a statement by the Ming Dynasty works, there were a lot of bamboos growing in Anji County at that time, stretching over hundreds of miles (Chengye 1993; Zhida 1998).

In modern times, bamboo plays an important role in the social and economic development of Anji. After the political reform of the People's Republic of China, the county government decided to forcefully develop the bamboo industry so as to make it a main source of income for the local economy. In November 1996, the former Chinese premier Li Peng visited the county and referred to it as 'China's bamboo hometown'.

Regional setting

Anji County is located between longitude 119°14' and 119°53' and latitude 30°23' and 30°53'. It comprises 1,886.34 km^2, which includes 44.21 km^2 of freshwater. The county boundary is 343.5 km long. Anji is a middle-income county located in the northwest of Zhejiang province, near the 'economic locomotive' of Shanghai (Figure 1). Having 22,600 ha above 500 m altitude and 9,600 ha of slopes greater than 25°, it can be considered a typical hilly county in eastern China. Its mean elevation is 125 m a.s.l. The highest peak, Longwang Mountain, reaches 1,587 m a.s.l. The average annual temperature is 15.6°C and the average annual rainfall is 1,485 mm, falling within the subtropical region of China. According to the forest inventory carried out in 1998, the forestland in Anji County covers 131,938 ha, of which the forested area amounts to 109,875 ha (69% of the whole county). In this, bamboo forests account for 63,338 ha, or 5 % of the total forested area and 33% of the total land area.

Anji is a beautiful resort with fresh air, green scenery and a lot of old architecture attracting many tourists from home and abroad. After 10 years of hard work, a national park with the Chinese Bamboo Museum has been established in Anji.

Cultural importance

Since the New Stone Age bamboo, above all other plants, has been rooted deeply in Chinese daily life and culture, colouring the lives of the Chinese. Some biological properties of bamboo have been thought of as the ideal embodiment of human characteristics, which have been praised in many Chinese songs, poems and traditional paintings since ancient times. Su Dongpo, the famous poet of the Song Dynasty, is reported to have said, 'There are

Figure 1. Map of the study area

Source: ESRI Data and Maps 2002.

bamboo tiles for shelter, bamboo hats for shading, bamboo paper for writing, bamboo rafts for carrying, bamboo skin for clothing, bamboo shoes for wearing, bamboo shoots for eating and bamboo fuel for fires. Indeed we can not live without bamboo for a single day' (Bamboo Information Centre 1994). Chinese literature, legends and epics also mention bamboo.

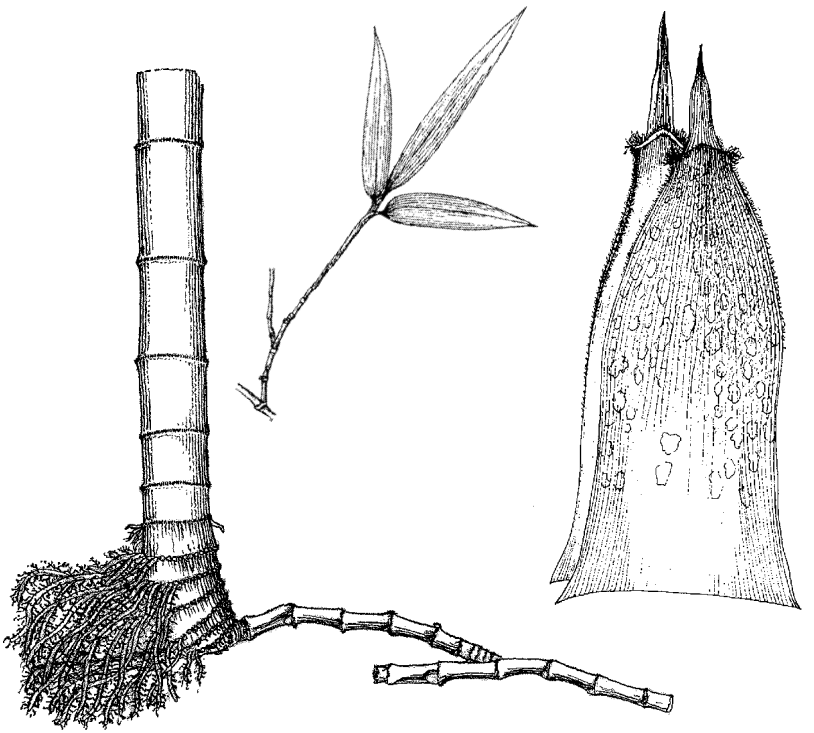
In modern times, the usefulness of bamboo in the daily lives of the Chinese people, especially in the rural areas, has been well eulogised in literature, both scientific and popular. The development of bamboo production has not only achieved extensive social benefits, but has also enriched people's culture, beautified the environment, and is thought to have moulded people's sentiments.

THE PRODUCTION-TO-CONSUMPTION SYSTEM

Resource base

The majority of bamboo stands in Anji County have been in existence for a long time. Bamboo plants are the most important element of the flora in Anji, occurring in many areas from sea level to some 1,500 meters on mountain slopes. The dominant species is *moso* bamboo [*Phyllostachys heterocycla* var. *pubescens* (Mazel ex J. Houz.) Ohwi], a monopodial bamboo, which has been cultivated in the region for centuries. The bamboo area is continuing to

increase. The expansion of the *moso* bamboo area is mainly a result of natural regeneration, whereas other bamboo species are specifically cultivated to meet increasing demands for fresh bamboo shoots on the domestic market.



(*Phyllostachys heterocycla* var. *pubescens*)

The trend in the study area has been one of intensification over the past 10 years. The intensively managed bamboo area increased from 1,000 ha in 1988 to 8,529 ha in 1998. (See Table 1 for characteristics of intensive management.) The management level in Anji County generally is higher than in other regions of China. As a fast growing plant, bamboo consumes substantial quantities of nutrients. It is estimated that, on average, farmers annually apply 200 kg of fertilisers (mainly nitrogen) per hectare to bamboo plantations. Based on data from Table 1 and Table 2 we can calculate that the average labour intensity, including growing and harvesting, was 106 days/year/ha in 1998 for Anji County. The total fertilised bamboo area in 1982 was 2,000 ha, while the high yielding bamboo stands for culms or shoots reached 1,000 ha in the county in 1988.

Table 1. Average yearly input for three types of management intensity

Inputs	Intensive	Normal	Extensive
Fertilizers (kg/ha)	450	225	0
Manure (tonnes/ha)	35	0	0
Labour (days/ha)	225	120	45

Source: Anji Forestry Bureau 1999.

Table 2. Bamboo areas at different management levels of bamboo stands in Anji in 1998

	Intensive management	Normal management	Extensive management
Moso bamboo (ha)	8,295 (16.6%)	20,768 (41.6%)	20,849 (41.8%)
Other bamboo (ha)	4,254 (31.7%)	3,515 (26.2%)	5,657 (42.1%)

Source: Anji Forestry Bureau 1999.

Moso bamboo culms can, in theory, be harvested throughout the year. However, cutting mature bamboo culms during the season of new bamboo growth, especially in April and May, affects the rhizomes, resulting in a loss of sap, which will in turn result in nutrient loss affecting new bamboo growth. If the culms are cut for storage during summer and autumn, they are likely to mould since bamboo culms are rich in sugars and starch during this period and are vulnerable to attack from insects and mildew (fungi). In winter most nutrients are stored in rhizomes rather than culms. In order to meet quality demands and minimize the impact of harvesting on new culm growth, harvest takes place during the following months[3]:

- Winter shoots: Two months, from the beginning of December to the end of January
- Spring shoots: Two months, from the beginning of March to the end of April
- Culms: Four months, from the beginning of October to the end of January.

If bamboo stands are properly managed the impact of the harvest on the bamboo ecosystem is limited. But if young bamboo culms are cut, bamboo stands will be greatly impaired. It is therefore important not to cut young culms. Preferably, one should harvest only the six-year-old culms, because, generally speaking, the rhizomes of six-year-old standing culms will have stopped producing shoots. Thus, if rhizomes are damaged from cutting the six-year-old culms, it will have little effect on the bamboo stands. In summertime the top parts of rhizomes can be used as a vegetable. If possible, the rhizomes of six-year-old bamboo plants, which are very long, are dug up and used as a raw material for arts and crafts (for example, flowerpot and handbag production).

Research has been conducted on factors influencing productivity (such as site conditions, cultivation measures, and the stand composition) and pest control technologies. The extension of these technologies has greatly promoted the cultivation and utilisation of bamboo resources (Maoyi and Jianghua 2000).

Photo 1. *Moso* bamboo culm (Photo by B. Belcher)

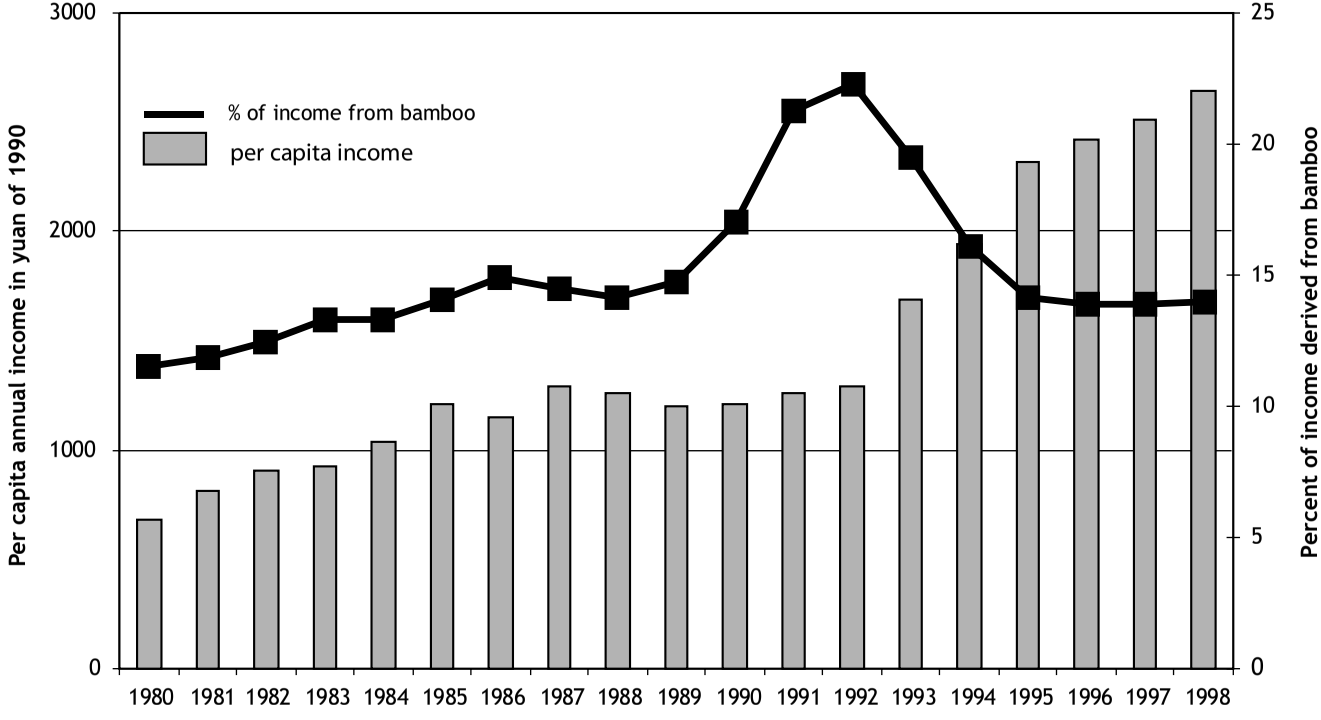
The socio-economic importance of Bamboo

The Anji County forest sector is dominated by bamboo, which represents about 70% of the total forestry output value. The economic importance of bamboo has been increasing steadily since the early 1980s. In 1980, only 8% of the bamboo produced in Anji was processed within the county, while in 1998 not less than 67% was. According to the Anji Forestry Bureau, in 1998 an estimated 64% of county farmers managed bamboo as part of their daily activities. The Anji Foreign Trade Bureau has stated that the total export of bamboo products from the county amounted to US$56.3 million in 1998.

The average total annual household income from subsistence, barter and cash in Anji county in 1998 was US$571. Income from bamboo represented 15% of farmers' average total income in Anji County (Figure 2). This percentage reflects the whole county, thus also those townships and households not involved in bamboo production. Studying a sample of 200 farming families from eight townships in bamboo growing areas, Ruiz Pérez *et al.* (2000) found that bamboo represents 25% of farmers' income (not including semiprocessing at the farm level).

According to a survey of 300 households involved in bamboo extraction, the average number of labourers involved in production per producer-household was 2.5. Farmers in the research area find bamboo to be an interesting option,

Figure 2. Farmer's per capita income and percentage of income from bamboo in Anji



Note: Exchange rate in 1990: US$1 = Yuan4.80

and they frequently participate in its processing either as part-time contracted labourers in factories or by doing some semiprocessing at home, thus adding value to the raw material. The combination of high demand for bamboo and an associated local industry has been one of the major success factors in Anji's rural development. In the last two decades, farmers' per capita net income has multiplied by 3.7 in real terms.

Box 1. Durability of bamboo culms

The high sugar and starch content in the bamboo culm, which is composed of about 50% parenchyma cells and 10% conducting tissues with large diameter vessels, has caused problems in bamboo utilisation because its natural durability is relatively low when untreated (Jiru *et al.* 1995). Although bamboo is one of the strongest structural materials available, it often succumbs prematurely to fungal and borer attacks resulting in heavy damage to structural units. Most of the durability estimates are based on the whole bamboo culm. There is not much systematic test data available on the natural durability of different bamboo species. The natural durability of raw bamboo is low and varies between 1 to 36 months depending on the species, age of culms and climatic conditions. Bamboo is generally destroyed in about one to two years when used in the open and in contact with the ground, while a service life of two to five years can be expected from bamboo under cover and out of direct contact with the ground.

Processing Industry

People have used bamboo for many years because of its excellent features. The strength of bamboo culms, their hardness, straightness, long fibres, light weight, hollowness, range in size, ease of splitting, cutting and working, and transportability make them suitable for multifarious traditional uses. The manufacture of mats and bamboo handcrafts is a cottage industry in Anji County, as well as in other parts of China. The traditional handcrafts industry used to be governed by certain social and cultural norms. Individual groups or castes of people had their own particular skills and thereby became associated with a particular type of handcraft.

At present, the utilisation of bamboo is no longer confined to private use; bamboo handcrafts and bamboo shoots are selling well on both the domestic and international markets. Industrial use of bamboo is also growing. Bamboo fibre is becoming a raw material for pulping, the culm is used in manufacturing high-grade ply-bamboo, bamboo flooring and particle board as well as chopsticks, mats, furniture, baskets, scaffolding and so on. As a food bamboo shoots are a healthy option because they contain 17 amino acids, cellulose and protein, trace elements and vitamins but are low in fat. Based on the consumption of raw materials and the total processing output value in Anji, the most important use is for home furnishings and accessories, followed by food and construction materials and tools.

Before the opening of China to the outside world, the majority of bamboo was used for construction, agriculture and utensils. The bamboo processing industry was outdated. In Anji the bamboo processing industry, which manufactures most of the main bamboo products with the exception of paper, has expanded enormously over the last 20 years, particularly since the reform of the rural industry and the establishment of private bamboo enterprises. The bamboo processing industry grew at an average annual rate of 34.5% for the period 1980–1998. According to the Anji Forestry Bureau (1999), there were 18,900 workers in the bamboo industry in 1998, creating a production value of US$107 million (878 million yuan).[4] Although collective enterprises still represent 33% of the total bamboo industrial output in Anji, most of this growth has come from private and joint-venture enterprises. Establishment of the latter began in the county in 1988. A total of 18 joint-venture enterprises employing 1,200 workers are currently operating, with a focus on production for export markets.

The proportion of raw material used in final products varies. Some of the products and the price component of raw material are listed in Table 3. The added value of the final bamboo products also varies from product to product. The value of one *moso* bamboo culm is about US$0.9. The values of possible final goods of a selection of products are shown in Table 4. Handcrafts represent the highest added value; from one culm up to US$13 worth of handcrafts can be produced. The prices shown will of course fluctuate with market conditions.

Table 3. The cost of raw material as a percentage of the price of end products

Product	Cost of raw material as a percentage of end product price
Chopsticks	44%
Mats	35%
Ply-bamboo and bamboo flooring	21%
Paper	42%
Furniture	25%
Joss sticks	28%
Handcrafts	8–13%

Table 4. Value of final products from one culm

Product	Value of product from one culm (US$)
Chopsticks	2
Mats	2.5
Ply-bamboo and bamboo flooring	4.2
Paper	2.1
Furniture	3.5
Joss sticks	3.2
Handcrafts	7.5–13

The original technology and equipment for mat making and the processing of canned shoots were brought from Japan, Korea and Taiwan. The number of processing steps is no different from that in other areas of China or other countries. Most processing of manufactured bamboo goods is small-scale and labour intensive.

The Anji Bamboo Industrial Association and the *Ph. praecox* Association were established in 1986 and 1988, respectively. Some 125 members belong to the Anji Bamboo Industrial Association, including processors, trade firms, officers and bamboo producers. About 300 bamboo producers belong to the *Ph. praecox* Association. The purpose of the Anji Bamboo Industrial Association is to establish processing standards for bamboo products, release marketing information, stipulate price policies including the unified price of culms and shoots and so on. The *Ph. praecox* Association on the other hand holds training courses, exchanges information concerning markets and technology, provides nurseries from which bamboo seedlings can be purchased and stipulates the price policies for producers.

Photo 2. Selling salted dry bamboo shoots (Photo by M. Ruiz-Pérez)

Trade and Marketing

Bamboo products have been traded from the raw material production area for centuries. Before 1980, however, the main commercial bamboo products were culms and shoots for construction materials, handicrafts, woven products like baskets and food. Since 1980, processing has developed and bamboo mats, flooring and canned shoots have become the main commercial products.

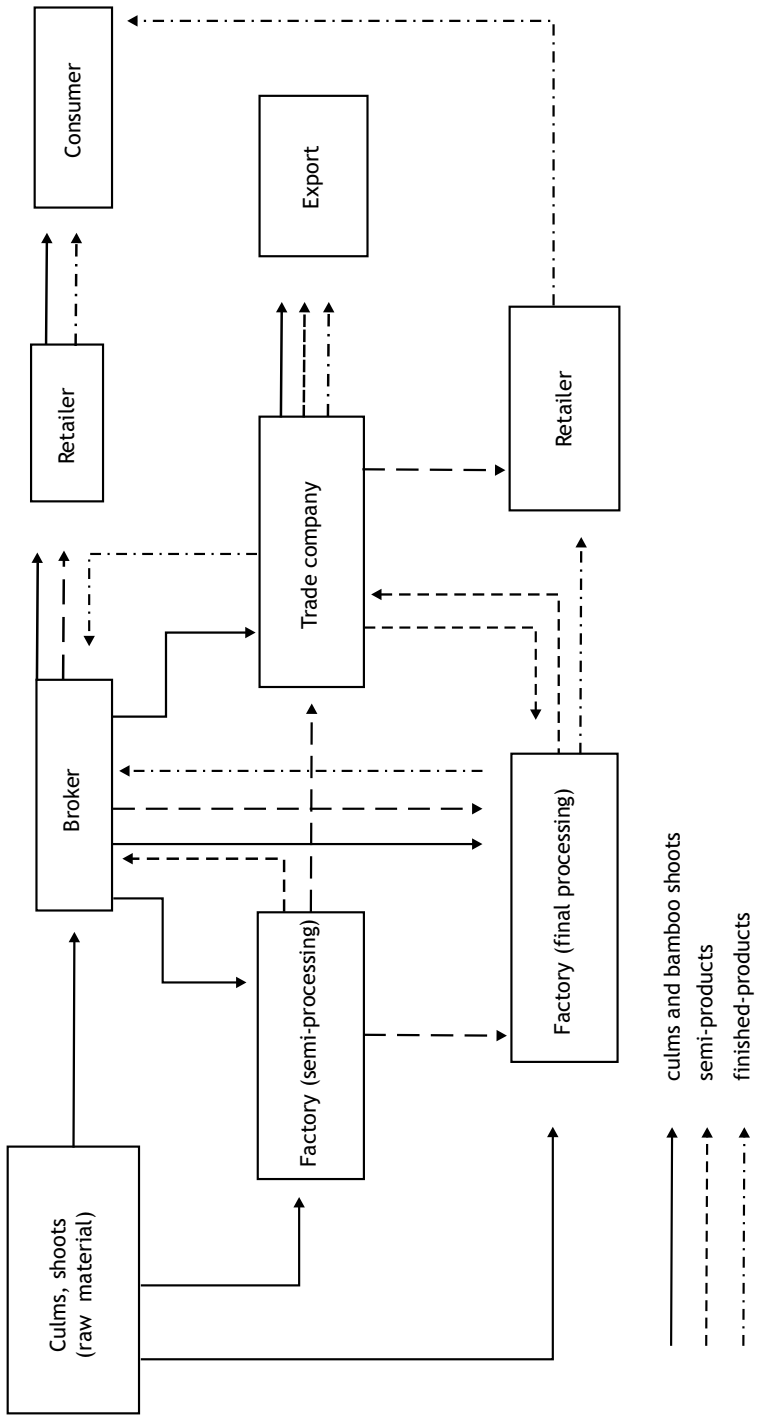
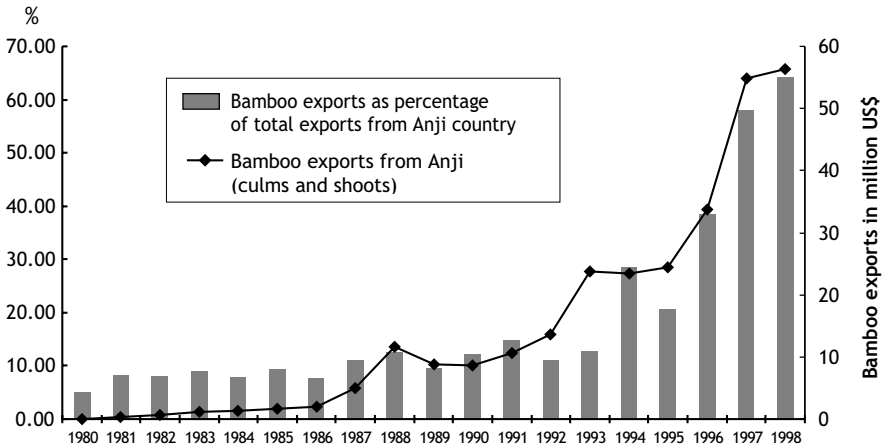


Figure 3. The distribution line of bamboo products

Figure 4. Anji bamboo and total exports



The production to consumption system includes producers, intermediates or traders of raw materials, processors and traders of finished products. Farmers harvest bamboo culms and shoots from bamboo stands, then bundle and skid them to the roadside, where traders and manufactures grade the culms and shoots before delivery to manufactures and markets. Traders may sell the culms or shoots to factories[5]. Bamboo products are then made in factories and finally sold to retail stores. The product flows are shown in Figure 3.

A significant component of Anji's bamboo production is exported to other countries. Bamboo exports have grown almost exponentially since 1980, and their contribution to total county exports has increased in parallel. Most exports are now undertaken through direct arrangements between the producing companies and customers in foreign countries. They amounted to US$56.3 million in 1998, representing 64.2% of the county's total exports in that year, according to the Anji Foreign Trade Bureau. With the development of trade in bamboo products, the price of raw bamboo increased. However, partly because of the economic crisis that occurred in Asia in 1998 the price has begun to decline.

In Anji county more than 20 marketplaces for raw materials like culms and bamboo shoots and just under 100 trade centres for processed bamboo products have been set up. There are 4 special wholesale markets for bamboo products and 2,000 households who participate in trade and transportation of bamboo culms and shoots in Anji. Information gathered during the survey by Anji Forestry Bureau indicates that more than 500 trading places in over 100 cities around the country have been set up by the processing enterprises of Anji County.

Although Anji used to be the county with the highest production of raw materials in China, at present it cannot meet the increasing demands from the processing industry. Processors from the county now import about 5 million *moso* culms from other counties annually.

Policy Environment

In China's planned economy, characterised by generally low productivity, the bamboo sector developed slowly until the mid 1980s. Since then, the national reform has replaced the planned economy with a market-regulated economy. This has created more favourable circumstances for the industry's development, providing growers and enterprises with rights of production and trade, and resulting in increased competition in the bamboo market. In this system, various bamboo management systems such as a sharing system and leasehold system have been fully applied under the guidelines of the market. Transactions in the bamboo sector are now taking place according to market rules.

The government and related industrial societies practice macrocontrol on the bamboo sector, which means the use of financial policies and incentives to encourage the development of high-added-value products and limiting the production of 'outdated' products. The success of Anji County bamboo plantations is attributable to a combination of a tradition of planting bamboo, policy reforms, industrial development and geographical setting. The mountainous and hilly characteristics of Anji have helped to protect most of the land from intensive agricultural development. In 1983 the Household Responsibility System (HRS) was introduced, which changed commune-based management into individual-based management. After this shift many farmers started to get more intensively engaged in bamboo cultivation, based on the traditional experience of farmers in Anji. The original HRS contracts had terms of 30 years, but recently there has been a move to extend the terms to 50 years or more. Since 1983 the majority of bamboo cultivation has been contracted to individual farmers, who currently manage 96% of the total bamboo area.

The introduction of the HRS brought dynamism to a stagnant sector, greatly increasing culm and shoot production, which multiplied by 1.86 and 3.66, respectively, since 1980. Provisions to guarantee inheritance of the contract and to permit subletting were incorporated. Transferability of rights and use of other mechanisms such as the auctioning of allocated land (the collective land-use rights are transacted by auction) have started to be implemented recently.

In practice, bamboo legislation and regulations have yet to be enforced effectively. Moreover, the policy and institutional aspects of the legislation and regulations in relation to bamboo processing and marketing are not clearly defined. As a result, the government is losing revenue every year through uncollected taxes and fees on harvested bamboo. On the other hand, it would be worthwhile formulating a regime of fiscal incentives and tax exemptions for bamboo resource development with the aim of motivating rural people to include bamboo processing in their activities.

At the policy level, one category of issues that needs attention is the efficiency of policy measures such as subsidies intended to directly encourage bamboo cultivation. The evidence that farmers adopt bamboo growing because of its low capital costs and good benefits in the short term suggests the need to re-examine the rationale and effectiveness of the widespread practice of subsidising the cost of bamboo seedling supplies. These subsidies may be

unnecessary because bamboo producers will grow bamboo without subsidised seedlings. Interventions to ensure producers' access to the market may be more effective than subsidies.

Box 2. Bamboo-based tourism

Bamboo-based tourism and ecotourism have developed fast in recent years, with a campaign called 'visit the bamboo farmer's house' addressed to the large number of tourists that come to Anji to see its massive bamboo plantations. This effort is supported by the positive experience of the Anji Bamboo Botanical Gardens and China Bamboo Museum, the largest of its kind in China, established in 1989. The Great China Bamboo Sea, with a centre of 10,000 ha located in the eastern part of Anji County, is famous for its big bamboo culms. The number of tourists visiting Anji reached 1.1 million during the period 1996–97. Of these tourists, 70% visited bamboo related tourist objects. This travel is in addition to bamboo ecotours, which started in 1998.

Demonstration plots and environmental contracts

The local government has realised that it is essential to improve the exploitation and management of bamboo resources for ecological and economic benefits. In the context of the national logging ban following the disastrous floods of 1998, demonstration plots, where mixed plantations are managed, have been established to achieve the new multiple objectives and to study the effects of bamboo management practices on the environment. Some of these demonstration plots are managed by the local government, while others are supported by the national government.

Bamboo resources are managed based on the classification of two parts, i.e., ecological common weal forests and commercial forests. Based on the development plan, 26,600 ha of common weal bamboo forests will be established in the coming years. To implement this new policy, Anji Forestry authorities have signed environmental contracts with farmers for the allocation of new HRS forestland, as well as incorporating environmental clauses into the current forest management contracts. The environmental management contracts are being extended for a further period of 15 years. Farmers are eligible for subsidies of US$9.1/ha/year to compensate for potential benefits they could have derived from the use of their contracted land. The county government set aside US$303,000 to cover this program in 1999 (Anji Forestry Bureau 1999).

Efforts to promote the bamboo sector

Outside intervention from donors and non-governmental organisations has included financial, technical, organisational and political support and advocacy for the bamboo sector. Since the opening of China, institutions like the International Development Research Centre, the Center for International Forestry Research and the International Plant Genetic Resources Institute have co-operated with the Research Institute of Subtropical Forestry (RISF) to provide financial support for the Anji Bamboo Botanical Gardens, which were set up at the beginning of the 1980s. The RISF, as well as the Forestry Institute of Zhejiang, Zhejing Forestry College and Nanjing Forestry University, has undertaken a number of projects from setting up bamboo management demonstrations and preparing technical manuals to train personnel and bamboo farmers to stipulating a standard for the products. The China Bamboo Society and Chinese Industrial Association have also held various academic workshops and meetings to exchange information and techniques. They have also prepared materials to be disseminated through the local media for propagating the bamboo sector, so as to promote the extension of technologies and to enhance the local communities' involvement in bamboo-based activities. The organisations mentioned above have emphasised the importance of bamboo in the local—and even the national— economy and in poverty alleviation, as well as its ecological functions and protection of biodiversity. In addition, the World Bank provided a financial loan for Anji to plant bamboo, which finished in 1999.

TRENDS AND ISSUES: DEVELOPMENT AND CONSERVATION LESSONS

Key issues and problems

The establishment of a market economy in China has been important for the development of the bamboo sector, but there are drawbacks. Farmers have been primarily interested in low technology processing activities that require low inputs (such as the production of mats). They seem reluctant to engage in 'high-tech' processing because it requires more input. This has resulted in an oversupply of 'low-tech' products. Therefore, the local government should try to control development in the processing sector by using a tax policy to limit the development of some products and incentives to encourage the development of high-tech products. Another drawback is the establishment of a market economy where competition between enterprises has resulted in low prices and low benefits or even in financial loss because of a lack of guidance and co-ordination concerning prices and markets. Heavy taxes and fees have also hampered manufacturers' efforts to further develop the bamboo sector. The taxes and fees in Anji County are higher than those of neighbouring counties such as Yuhang and Deiqing. This situation has encouraged some processors to move their factories.

The current foreign trade system has contributed greatly to the export of bamboo products from processing factories. However, because the majority of bamboo-processing factories do not have licences for exporting to other

countries and regions, their products have to go through an export company. And Chinese export companies prefer to export cheap products to increase their profit margins.

Ecological drawbacks

The authorities are beginning to recognise that the success and tremendous growth of Anji County's bamboo sector has come at a cost to the forests. Natural forests in the vicinity of bamboo plantations have sometimes given way to bamboo as a result of conscious efforts to replace them or because of the vigorous natural expansion of bamboo in logged forests. This process has had a negative impact on biodiversity, affecting the few remnants of subtropical forests in the county.

At the same time, intensive management implies maintaining the plantation grounds clear of undergrowth, achieved through manual or chemical weeding and periodic tilling of the land. This increases erosion and results in a monoculture over vast areas, with all of the attendant biodiversity costs and economic and ecological risks. The intensive use of chemicals (pesticides, herbicides, fertilizers etc.) is also affecting the environment. The strong trend towards intensification of the bamboo sector makes it particularly important to study problems and alternatives for more environmentally sound practises.

Conservation and development lessons

With the development of the bamboo sector and the increasing economic importance of bamboo, this sector has received more attention from local communities and governments and investments in the bamboo sector have increased.

The bamboo sector has numerous economic and social benefits: Bamboo serves as a cheap and fast regenerating alternative to wood, its extraction increases the farmer's income, and the bamboo sector provides forest funds and revenue from taxes for the local government. In addition to the socio-economic importance of its multi-use culms and edible shoots, bamboo also has ecological benefits. Because of their evergreen characteristics, thick canopy, close and strong underground rhizome-root systems, bamboo stands perform an important function in soil and water conservation.[6] In Anji County, excessive exploitation does not occur, in part because of the harvesting quota calculated by Anji Forestry Bureau based on the density of standing culms, age structures, area etc. However, some problems occur related to erosion and use of chemicals, as intensified management of bamboo stands can lead to a certain amount of soil degradation.

There is a shortage of agriculture lands but abundant hilly lands and labour resources in the mountainous areas. Further development of the bamboo sector in both forest management and product processing can generate income for local communities providing employment opportunities for the rural and suburban labour surplus. Future efforts to develop the sector should focus on the bamboo farmers, better protection for the forest ecosystem and the adding

of more value. Expansion of the bamboo stands could promote rural economic development, help farmers to fight poverty and further improve the people's living conditions. Meanwhile bamboo stands could increase land productivity per unit and promote sustainable utilisation of land resources. Bamboo plantations can be established on degraded land, which can improve soil characteristics and nutrient content, prevent the loss of soil and water, and stabilise the banks of rivers and lakes. The development of bamboo stands indirectly reduces the pressure on remaining wood resources for fuel wood as bamboo is used as an alternative fuel and also brings in cash earnings that enable farmers to purchase gas for energy.

In China, macroeconomic policies (such as tax and export policies) and sectoral policies affecting the bamboo sector could be improved. The government needs to pay more attention to strengthening institutional support for the bamboo sector and the government-private sector co-ordination, including financing schemes for small enterprises.

ENDNOTES

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3. Other bamboo species, such as *Phyllostachys iridenscens*, *Phyllostachys praecox* and *Phyllostachys meyeri*, may produce bamboo shoots at different times and their harvesting season may last eight months.

4. Exchange rate in 1998: US$1 = Chinese Yuan 8.27.

5. Sometimes traders sell the bamboo directly to retailers or consumers.

6. It was reported that a bamboo stand's capacity for stabilising soil and sand is 1.5 times that of massons pine. Its ability to absorb water is 1.3 times that of the Chinese fir, while its water storage capacity is 30% to 45% higher than that of Chinese fir.

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Chapter 16

The development of the woodcarving industry and the cultivation of *Paraserianthes falcataria* in Bali, Indonesia

***Dede Rohadi*[1], *Pipin Permadi*[2] *and Syarif Hidayat*[3]**

Common names	Part of the resource used	Management	Degree of transformation	Scale of trade	Geographic range
Sengon, Albizia, Belalu	Wood	Cultivated	Medium	International	Large

OVERVIEW

The woodcarving industry in Bali has changed from a traditional religious art into a modern industry with an economic orientation, which is reflected in the diversification of designs. The woodcarving industry involves various scales of business (wood suppliers, home based enterprises, collectors, large producers and exporters) and contributes significantly to regional as well as household income. The development of the woodcarving industry, to some extent, has caused the depletion of several preferred wood species in the area. Some substitute species, imported from other islands, are now being used. In Bali, *Paraserianthes falcataria*, a particularly fast growing species, is being planted in home gardens and plantations and increasingly being used for woodcarving. This species has become popular for the production of mass produced woodcarvings. Woodcarvings are both sold in Bali to tourists as well as exported. Government support has been beneficial, for example in art education, but efforts are needed to maintain the market and to sustain the raw material supply.

INTRODUCTION

Carving and Bali are two inseparable words. This becomes easily apparent when one enters Bali, a small island east of Java. Statues of varying shapes and sizes can be found everywhere in Bali, as gateways and building ornaments,

giving a strong indication of the importance of carving as part of the daily life of the Balinese. In terms of quality and economic importance, woodcarving is perhaps the most developed of all carvings in Bali. It has not only become the art of daily Balinese life, but has also developed into an important business. In terms of quality, Balinese woodcarving shows excellent styles, unique and full of imagination and creativity. In terms of quantity, the number of woodcarvers and the number of the products they are able to produce are high. Kanwil Deperindag Propinsi Bali (2000) recorded more than 6,000 woodcarving producer units employing more than 23,000 woodcarvers and consuming more than 60,000 m^3 of wood in 1999. In 1998, the value of exported woodcarving products from Bali reached US$99.5 million (Biro Pusat Statistik Propinsi Bali 2000).

This chapter is based on interviews in the field and a literature study conducted from May to November 2000. The documented materials (reports, theses, and regional statistics) were obtained from government offices (mainly the regional office of the Ministry of Industry and Trade and the regional office of the Ministry of Forestry) and other published materials. Interviews were conducted with wood suppliers, woodcarvers, traders and some well-known woodcarving artists.

The key informants for this case study

- I Wayan Rugeg. The current Secretary of DEKRANAS, or the National Handicraft Board of the province of Bali, he was hired as a local consultant for this study and recorded data about Tegallalang subdistrict from the subdistrict office.
- Sutrisno. A staff member of the regional office of the Ministry of Industry and Trade in the province of Bali, he was hired as a local consultant for this study and provided most of the data related to the woodcarving industry in Bali.
- I Nyoman Silanawa. A staff member of the regional office of the Ministry of Forestry in the province of Bali, he was hired as a local consultant for this study and provided most of the data related to wood supply and demand in Bali.
- I Ketut Sandiarsa. The director of Sekolah Menengah Industri Kerajinan (SMIK), an industrial craft high school in Sukawati, Gianyar.
- I Wayan Balik Riti. A religious leader (or *Mangku*) in Guwang village, Sukawati, Gianyar, he was the main informant for the story of woodcarving development in Bali.
- I Wayan Sugita. A woodcarver from Banjar Pakudui, Tegallalang village, specializing in carving *garudas*, he is also a producer and collector of 'pop art' woodcarving products.
- I Ketut Udu. A woodcarver from Banjar Pujung, Tegallalang village, he owns a small art shop producing mainly pop art woodcarvings and employing 10 daily workers.
- I Made Ada. A woodcarver from Banjar Pakudui, Tegallalang village, he is a well-known artist specializing in carving *garudas*.
- I Made Sutedja. One of the founders of the first carving school in Gianyar, he owns a gallery in Sukawati.

The study area

The province of Bali is well known for its tourist industry. Tourism currently ranks first in regional income, followed by agriculture and fisheries. Manufacturing, which includes woodcarving, is in fifth place. The district of Gianyar is the centre of the woodcarving industry in Bali. Around 90% of the woodcarving producers in Bali are located in this district. The many galleries and art shops in the district display fine quality woodcarving products and have become a popular tourist destination. The development of the woodcarving industry in the district has had a positive impact on adjacent districts such as Bangli, Klungkung and Tabanan, which now produce significant volumes of semifinished woodcarving products and send them to Gianyar for finishing and marketing. This study focuses on the subdistrict of Tegallalang, which is one of the centres for woodcarving producers in Gianyar (Figure 1). Tegallalang is well known as a producer of mass produced woodcarvings. Woodcarving products are made mainly from species of *Paraserianthes falcataria* and then finished with opaque paints. Most of the people living in this subdistrict are farmers and handicraft producers, including woodcarvers. From the total population of 39,874 people (in 1999) around 15%, or 6,020 individuals, are recorded as woodcarvers (I Wayan Rugeg personal communication).

Brief history of the woodcarving industry in Bali

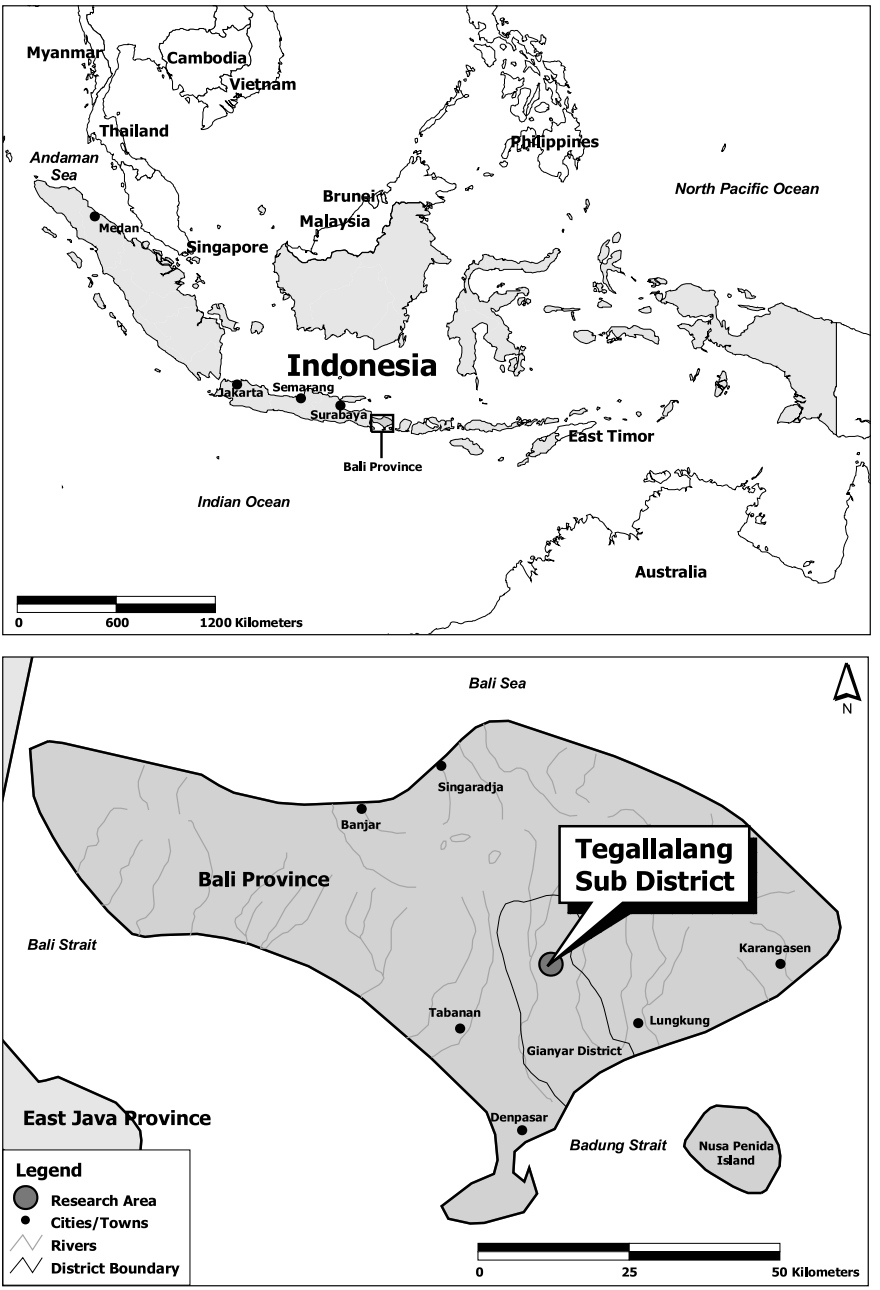
Carving has been a traditional Balinese art form for hundreds of years, practised as part of daily life particularly by those who live in and around Gianyar District. No one knows exactly when and how this carving tradition started, but there is evidence at one historical site, the Elephant Cave *(Goa Gajah)* near Bedulu, Gianyar, that carving has been practised there since at least the ninth century AD. Elaborate Buddhist style stone carvings adorn the entrance to the cave.

From various sources (Kandiyasa 1991; Sudarta 1991; I Wayan Balik Riti personal communication) it is clear that in the past the practice of carving was mostly related to religious traditions. This religious art is found not only in temples but also in Balinese homes in the form of *puras* (small private temples). Because of the traditional religious nature of the carvings and the related traditions that were commonly practised by the community, the old Balinese carving style was dominated by god and goddess figures, as shown nowadays by the collected ancient statues at Pura Beji in Medahan village.

Commercial woodcarving probably started around 1935 (Sudarta 1991). Initiated by the Dutch, Balinese woodcarving products were introduced to European markets. Later on as more European visitors came to Bali, the demand for Balinese woodcarving increased. This new market stimulated the woodcarving business and attracted many new woodcarvers.

The growing market and the influence of Western artists contributed to the development of the woodcarving style in Bali. In 1936, the art organization Pita Maha was established in Ubud, Gianyar, initiated by a prominent Balinese, Bapak Cokorda Sukawati, and supported by the Western artists R. Bonet and Walter Spies (Kandiyasa 1991). This organisation helped Balinese carvers to improve their carving techniques and styles. The group developed the technique

Figure 1. Location of the study area



Source: ESRI Data and Maps 2002.

for detailed anatomical structures and products became more expressive. Styles also developed from previously dominant religious themes into more varied objects related to daily Balinese life. This period was marked by the emergence of some creative and innovative carvers who developed their own individual styles. I Tegelan of Banjar village (Belaluan, Denpasar) was one such carver and the first to introduce the 'elongated style' of sculptures (Kandiyasa 1991). Another, I Tjokot, introduced a carving style that hollows out big tree stumps (which can be more than 1 m thick), including all root parts of the tree, to produce complex mythological characters. Some of the masterpieces of these well-known artists are now part of a collection in Ubud Museum.

Since 1940, woodcarving has become an important economic activity, particularly for the Balinese around Gianyar. Many woodcarving groups were first established here and it is likely that these formed the basis of the woodcarving industry in Bali today. In Kemenuh village, for example, a *sekehe*, or woodcarvers group, was established in 1940. This group, which became a legal co-operative in 1962, supplied its members with wood materials as well as providing assistance with carving techniques and product marketing. Unfortunately, because of political chaos in Indonesia during 1964-1965, the co-operative dissolved in 1964.

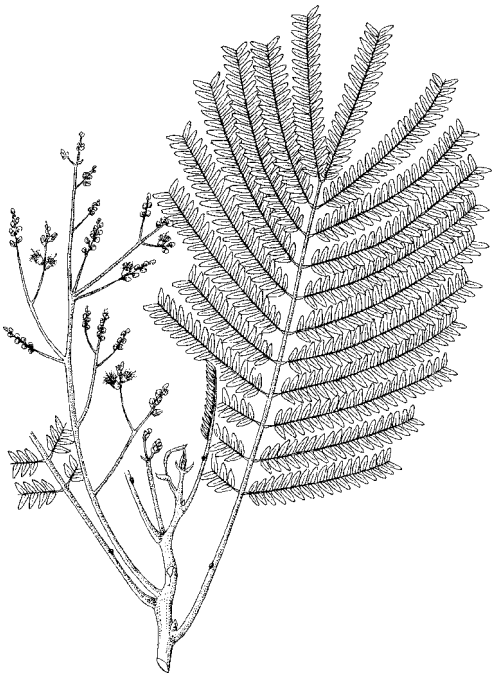
In 1969 a new opportunity arose for the woodcarving industry in Bali when the government of Indonesia declared Bali an Indonesian tourist area by opening Denpasar international airport. Bali was soon flooded with foreign tourists, a new prospective market for woodcarving products. Driven by increased demand from tourists, more woodcarving groups were established in the district of Gianyar. In Kemenuh village, for example, six carving groups sprang up in 1970, which later developed into the handicraft co-operative Dirga Yusa (Sudarta 1991). Similar to the previous pioneering co-operative, this co-operative also provided wood materials, technical and marketing assistance as well as providing its members with a small-loans credit system.

In 1974 the development of the woodcarving industry was noted by a new trend, i.e., mass-produced woodcarvings locally known as 'pop art'. The designs of, for example, animals or fruits are usually much simpler than traditional carvings. This kind of product has attracted many people to the industry, making it possible to produce thousands of woodcarvings per month. As little carving skill is required, mass production provides quick economic returns for carvers. Pop art became quite popular and triggered the development of woodcarving exports from Bali.

THE PRODUCTION-TO-CONSUMPTION SYSTEM

Wood species used

In the past, only a few tree species were used for woodcarving. For carved products related to traditional and religious purposes, *Manilkara kauki* (*Sawo Kecik*) and *Artocarpus heterophylla* (*Nangka* or jackfruit) were the most popular wood species used and are still today the preferred species for the production of ornaments in Pura (I Wayan Rugeg personal communication).



(*Paraserianthes falcataria*)

In 1972, the most popular species for woodcarving were *Manilkara kauki*, *Zhantoxylum rhetza* (*Panggal buaya* (crocodile wood)), *Santalum album* (*Cendana* (sandalwood)), *Diospyros celebica* (ebony), *Wrightia pubescens* R. Br. (bentawas), *Thespesia populnea* Soland (waru lot), *Dalbergia latifolia* Roxb (sonokeling), *Manglietia glauca* L. (manglid), *Michelia alba* DC and *Michelia champaca* L. (*Cempaka*) (Kanwil Kehutanan dan Perkebunan Propinsi Bali 2000b). Sandalwood and ebony are not grown on the island but are imported from places such as East Nusa Tenggara and Sulawesi.

Mandang (1982) recorded around 30 wood species used for carving in Bali in the early 1980s. Important characteristics of the wood that is preferred for carving are texture, colour, decorative grain and being easy to work. Changes in species used for woodcarving have been due mainly to the vigorous developments in the woodcarving industry. Bali is a small island with limited forest resources, and local wood production has simply not been able to keep up with the increasing demand. The island has also developed very fast because of tourism, and changes in the landscape have been considerable. The current forest cover in Bali is only around 25% of the total area (Table 1), some of which is in critical condition with poor vegetation. Most of the forest is in protected areas, while there is only around 8,600 ha of production forest, or 1.5% of the total land area of Bali (Table 2). With such a small area of production forest, wood production is low, and most of the wood used in Bali currently comes from other Indonesian islands, mainly Java.

Table 1. Land use in the province of Bali

Land use	Area (ha)	%
Irrigated crops	86,836	15.42
Estate crops	168,805	29.97
Forest (state owned)	127,271	22.59
Fields	86,711	15.39
Settlements	41,341	7.34
Private forest (plantation)	13,530	2.40
Other	38,798	6.89

Source: Kanwil Kehutanan dan Perkebunan Propinsi Bali 2000a.

Table 2. State owned forest in the province of Bali by function

Forest function	Area (ha)
Protection forest	95,776.06
Production forest	8,626.26
Nature conservation	1,762.80
National park	15,587.89
Recreation forest	5,527.90

Source: Kanwil Kehutanan dan Perkebunan Propinsi Bali 2000a.

The amount of wood consumed in Bali far exceeds production. The amount required for the woodcarving industry alone was more than 60,000 m^3 in 1999 (Table 3). Since 1995, wood production from Balinese production forests has been practically zero. The small amount of wood recorded as coming from production forests between 1996 up and 1999 was derived from confiscated illegal logging. During that period, the amount of illegal logging accounted for around 230 m^3 per year (Kanwil Kehutanan dan Perkebunan Propinsi Bali 2000c). Wood production from private/plantation forests (13,530 ha) is much higher, i.e., 4,451 m^3 in 1999. The fast growing species *Paraserianthes falcataria* dominates private wood production, accounting for 30% of production. In 1999 locally produced wood accounted for around 5% of total wood consumption in Bali, the remainder being imported (Table 4).

The development of the woodcarving industry has triggered an increase in the planting of fast growing species, especially *Paraserianthes falcataria*. The species was first introduced through the land rehabilitation programme, carried out by the Ministry of Forestry in the early 1980s (I Nyoman Silanawa personal communication). At that time, the government distributed *P. falcataria* seedlings to local people for planting in their home gardens. Later on, this wood was found suitable for mass produced woodcarvings. The relatively cheap price as compared to other wood species and its advantageous properties (light, easy to work and takes paint well) has quickly made this species popular with woodcarvers. *Acacia mangium* is another fast growing species increasingly used for carving. This species is similar in appearance to *Tectona grandis* (teak wood).

Table 3. Distribution of woodcarving producers and volume of raw material used in the province of Bali in 1999

Districts	No. of enterprise units	No. of woodcarvers			Volume of raw material used (m^3)
		Men	Women	Total	
Tabanan	96	696	0	696	86
Badung	261	623	15	638	220
City of Denpasar	65	212	14	226	34
Gianyar	5,672	18,051	3,068	21,119	60,027
Klungkung	106	174	59	233	0
Bangli	192	465	142	607	0
Total Bali	6,392	20,221	3,298	23,519	60,366

Source: Kanwil Deperindag Propinsi Bali 2000.

Table 4. Volume of wood supplied to Bali during 1997–1999

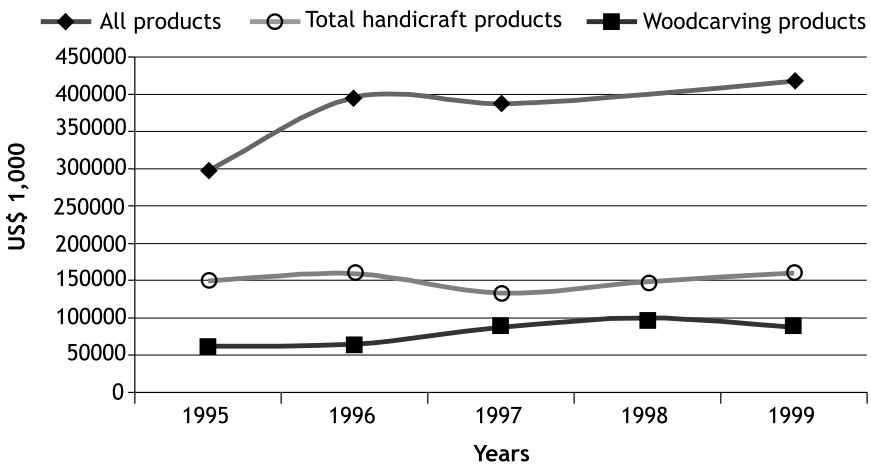
Port	Wood supplied to Bali (m^3)		
	1997	1998	1999
Gilimanuk	56,613	63,630	68,477
Celukan Bawang	34,088	21,428	24,387
Padang Bai	481	154	233
Total	91,182	85,212	93,097

Source: Kanwil Kehutanan dan Perkebunan Propinsi Bali 2000c.

Impacts on regional development and livelihoods

The woodcarving industry has played an important role in the economic development of the province of Bali, particularly the district of Gianyar. Between 1995 and 1999 the average export value of woodcarving products from Bali was around US$79.95 million per year. The highest export value so far was reached in 1998 with around US$99.5 million (Biro Pusat Statistik Propinsi Bali 2000). Over the period of 1995–1999, woodcarvings contributed more than half (53%) to the total value of handicraft exports and 21% to the total value of all exported goods from Bali. There was an increasing trend in woodcarving exports from 1995 up to 1998, from US$61 million to US$100 million. The drop in woodcarving exports after 1998 may well have been caused by the economic recession in Indonesia (Figure 2).

Figure 2. Export of woodcarvings and other products from Bali, 1995–1999



Source: Biro Pusat Statistik Propinsi Bali 2000.

The woodcarving industry provides employment for thousands of people, from wood farmers and traders to carvers, carving traders and exporters. The sector provides income to around 23,500 people in Bali. The Balinese woodcarving sector counts 6,000 units (from home-based enterprises to large carving and export companies) and most of these units are small-scale

Photo 1. Planted *Paraserianthes* (Photo by D. Rohadi)

enterprises engaged in actual woodcarving. There are only about 75 medium to large factories. The Biro Pusat Statistik Propinsi Bali (2000) recorded that these 75 units employed almost 4,000 people, or around 12% of the sector's total workforce.

At the household level, the woodcarving industry provides an important source of income. Farmers who grow trees for woodcarving, wood suppliers, carvers, woodcarving traders and the people who work in the woodcarving galleries or art shops are those who directly benefit from the industry. The income gained varies depending on the products or services they provide and the size of the enterprises.

For tree growers, woodcarving provides an attractive incentive through high prices on logs. A *Paraserianthes falcataria* tree with a diameter of 30 cm to 40 cm would be valued at between US$10 and US$ 20,[4] depending on the distance of the farm to the nearest accessible road. Usually lumberjacks buy standing trees from a farmer. They will then harvest the tree and take it to the nearest sawmill or woodcarving centre. The distance from the stump to the nearest motorable road determines the log transportation cost. A longer distance increases transport costs and consequently reduces the value of the standing tree. Branches measuring 1cm x 1m, of the same species, can fetch US$0.1 (I Wayan Sugita personal communication). This attractive price has encouraged farmers to plant *P. falcataria* on farms around Gianyar as well as in surrounding districts.

The prices of slow growing species are much higher, but not many farmers are interested in planting these species. The price of some wood species based on the field survey are presented in Table 5.

The income from woodcarving varies significantly. A carver who works in an art shop and makes semifinished pop art may make between US$1.5 and US$2.5 per day (I Ketut Udu personal communication), while a skilled woodcarver may get US$7.5 per day (I Made Ada personal communication).

Table 5. Prices of some wood species often used for woodcarving

Wood species	Local name	Dimension (cm)	Price per unit (US$)	Approx. log price per m^3 (US$)
Artocarpus heterophylla	Nangka	35 x 35 x 200	230	470
Michelia champaga	Cempaka	35 x 35 x 200	250	510
Paraserianthes falcataria	Belalu, sengon	∅ 30 x 100	3	50

Assumed recovery factor from log to sawn timber = 50%.
Exchange rate used: US$1 = Rp10,000 (year 2000).
Source: Interview with a wood supplier in Batu Bulan.

The income for a woodcarving artist is more difficult to quantify. I Wayan Sugita, a woodcarver from Pakudui village, Tegallalang, for example, needs three or four days to complete a small *garuda*[5] carving made from *P. falcataria*. The carving then needs another two or three days to be painted by his wife and daughter. Once finished, the statue should sell at a price of US$70. Further up the scale, a well-known artist like I Made Ada could take six months to complete one statue of a 1 m high *garuda,* made from *Swietenia macrophylla,* and priced at US$7,500. Another artist interviewed, I Made Sutedja, never considers how much time he needs to finish his carvings, but he sets a price of between US$8,000 and US$15,000 for each of his pieces.

Photo 2. Women involved in woodcarving production (Photo by D. Rohadi)

Women and children are often involved in the production. They usually work in the finishing stages, such as sanding and painting. Their average income is around US$0.8 to US$1 per day. The wage is rather low compared to the normal daily wage in the area, but they are satisfied as they can work in their homes during what would otherwise be leisure time.

Trade and market

Except for *Paraserianthes falcataria*, wood materials for woodcarving are obtained mostly from other Indonesian islands. There are 20 companies recorded as wood suppliers in Bali, located mostly around Denpasar and the District of Gianyar (Kanwil Kehutanan dan Perkebunan Propinsi Bali 2000c). These wood suppliers sell their wood to retailers located in villages. Sometimes carvers buy their materials directly from the suppliers, especially when they need a specific species or size for a specific piece or product.

P. falcataria, an introduced fast growing species, is at present abundantly available in Bali. Carvers prefer to use this species newly cut, as fresh wood is easier to work with. Lumberjacks often buy the standing tree directly from farmers. A logging team may consist of fewer than five people, who cut and buck[6] the tree and take the logs to small sawmills or directly to carvers.

The marketing channel for fine art woodcarving is usually simple. Skilled carvers sell their products directly in their galleries or art shops. Mass produced woodcarvings have longer trade channels. Carvers who own an art shop often buy semifinished carved products (*putihan*) and smooth, sand and paint the pieces in their shops. Many of these products are for export through cargo companies. There are no figures regarding the number of woodcarving products bought by tourists in Bali, but the volume is quite insignificant compared with exports. It is estimated that less than 5% of the carvings produced are sold locally to tourists.

The prices of products along the marketing chain from the log down to the final product ready for export are difficult to measure. Thousands of designs with high variability in both volume and value make it difficult to find a single, representative recovery factor for calculating the added value on the products.

Government support for the development of the woodcarving industry

The development of the woodcarving industry in Bali has shown remarkable growth from a previously traditional art into a commercial oriented industry. This development has partly depended on the creativity of the Balinese in improving their carving skills, as well as their open attitude toward a dynamic market. Government support, as well as consistent effort on the part of some Balinese entrepreneurs, has also played an important role in the development of the Balinese woodcarving industry. Below we describe some related activities, which originated from the regional government and local associations, that have contributed to the development of the woodcarving industry in Bali.

The carving school

The first recorded effort to formalise carving lessons or instruction took place in 1969 with the establishment of the Dwi Jendra carving school in Guwang village, in the district of Gianyar. I Wayan Balik Riti, one of the founders interviewed during the field survey, explained that the school provided carving lessons for children around 13 years old who had graduated from a six-year basic school. At the time, the lessons were given mainly based on the knowledge and experience of some of the artists. Many of the current well-known wood carvers went through this carving school.

In 1971 the Industrial Regional Office (Inspeksi Perindustrian Rakyat) provided the school with financial aid, buildings and some carving tools. Following the National Meeting of Technical Schools, Dwi Jendra was upgraded to a government owned school in 1974 and moved to Batu Bulan village, closer to Denpasar. In 1978 the level of the school was upgraded to a senior high school and it was renamed Sekolah Menengah Industri Kerajinan (SMIK), an industrial craft high school. In 1985, the school moved again to its current location in the art campus, or Kampus Kesenian Batu Bulan, in the subdistrict of Sukawati. The school has now been extended into three craft schools, consisting of the previous SMIK, the painting school (Sekolah Menengah Seni Rupa) and the dancing school (Sekolah Menengah Karawitan Indonesia). Each school has a director appointed by the Ministry of Education. The curricula of these craft schools are independently designed, although some general subjects such as mathematics, Indonesian, English, history etc. are mandated by the Ministry of Education. To maintain curriculum development, the schools set up an advisory board called the Majelis Sekolah, which consists of representatives from the Ministry of Industry and Trade, the handicraft association Dewan Kerajinan Nasional (DEKRANAS), the trader association Kantor Dagang Indonesia (KADIN) and well-known artists and art shop owners.

SMIK students follow a three-year education program, which is mostly practical (70% of the curriculum). In the first year, all students learn the basic concepts of handicraft making and are introduced to the three main carving materials, i.e., wood, stone and metal. In the second year, students are grouped into three divisions, i.e., woodcarving, stone carving and metalwork, based on their interest and talent. In the woodcarving division, studies are separated further into woodcarving, furniture making and woodturning. I Ketut Sandiarsa S.Pd., the current director of the SMIK, stated that the woodcarving division has always been popular with students. From the current 461 students at SMIK, 198 are studying woodcarving. Almost 90% of the students hail from the District of Gianyar. The director further stated that most of the graduated students have found jobs in art shops and galleries or are running their own woodcarving businesses. About 25% of the alumni went on to become well-known woodcarvers in Bali.

Handicraft board

DEKRANAS is an association of handicraft producers that promotes the development of handicraft industries through activities such as exhibitions and training (carving skills, wood treatment for improving wood durability,

export procedures, entrepreneurship etc.). At the national level the board is usually chaired by the vice president's wife, whereas at the provincial level it is chaired by the governor's wife. According to Bapak I Wayan Rugeg (see box 1), it could be said that DEKRANAS Bali is one of the most active sections in the nation. At least once a year this association holds a handicraft exhibition in Denpasar and always receives great attention from the public. These exhibitions often provide a market opportunity by creating a direct contact between woodcarving producers and domestic and foreign buyers. Financial support comes mainly from the local government (Pemerintah Daerah), the Ministry of Industry and Trade, and handicraft companies.

Small-scale credit

The Village Credit Institution, Lembaga Perkreditan Desa (LPD), offers credit to small businesses. This institution was initiated by the local government, but then managed by local people through the Village Cultural Board (Lembaga Adat Desa). The LPD provides small loans (a maximum of US$3,000) for short periods of three to four months with an interest rate of about 3% per month. This institution runs well since it keeps traditional rules whereby religious ethics maintain the commitment of the debtor to repay the loan. The credit facility is quite helpful for small businesses as they can get financial support quickly and the procedures are easy to follow. The LPD in Tegalalang village for example was established in the mid 1980s with an initial capital of US$200 (Bapak I Ketut Udu personal communication). Currently the LPD runs a total capital of about US$200,000.

Research and development

Government agencies, universities and private companies have been contributing to the research and development of the woodcarving industry in Bali for some time. In the 1970s the Forest Products Research and Development Centre studied the characteristics of wood species used for carving in Bali. The main objective was to understand the preferred characteristics of the wood used and to search for alternative species to substitute for the preferred, but less available species (Mandang 1982). In collaboration with the Indonesian Wood Preservation Association (Asosiasi Pengawetan Kayu Indonesia) and the Bogor Agriculture University (Institut Pertanian Bogor), the institute also disseminated information concerning wood drying and preservation techniques to prevent woodcarvings from suffering drying defects and fungal attacks. The introduction of water repellent to improve dimensional stability of carvings has been embraced, particularly for natural finished woodcarving products.

In 1982, the Land Rehabilitation and Reforestation Institute of the Ministry of Forestry launched the Sengonisasi programme, which provided local people, mainly those living in villages or near forest areas, with seedlings of *Paraserianthes falcataria* to plant on their marginal lands. The species was chosen because of its superior properties: it is fast growing; able to improve soil fertility through its ability to fixate nitrogen; can provide fodder for animals;

can be used as fuel wood; and can be used for carving, mainly mass production. The species is particularly suited to the latter as it is easy to work, light and can be painted with relatively cheap paints. Currently, extensive local plantations of this species can be found in the District of Gianyar and the surrounding areas. The wood is now in high demand for carving, which has in turn encouraged local people to extensively plant this tree on their farms. During our field survey we saw many plantations of this species in Tegallalang and the surrounding areas.

The development of the woodcarving industry in Bali has resulted in the overexploitation of some species. While species such as *P. falcataria* are fast growing, some others are slow growing and therefore less attractive as a plantation species. *Zanthoxylum rhetza* and *Manilkara kauki* are two examples of the native slow-growth wood species that currently are becoming scarce because of high demand, particularly for high quality woodcarving products. The Forest Tree Seed Institute (Balai Perbenihan Tanaman Hutan), an institution under the Directorate General of Land Rehabilitation and Social Forestry, is now taking the lead in the cultivation of these two species. Supported by the Finnish agency Finnida, the institution is collecting and testing the seed qualities of the two species from various provenances in Bali and the surrounding islands. Once promising seeds have been selected, the institute will establish plantation trials involving community participation near West Bali National Park.

TRENDS AND ISSUES—DEVELOPMENT AND CONSERVATION LESSONS

The development of the woodcarving industry in Bali shows how market opportunities have changed the style of woodcarving from community carving mostly dedicated to traditional and religious objects to commercial production with an economic orientation. It also shows how wood as a raw material is used to produce goods (carved products), with the process of material transformation giving benefits to a large group of local people. Currently, the industry plays an important role as a source of regional as well as household income. It contributes to and is simultaneously supported by the development of the tourism industry in the area. The industry also has been encouraging local people to plant trees to supply wood.

Changing wood species and designs

The species used for carving have changed over time in response to market opportunities as well as the increasing scarcity of previously used species. Overexploitation of some preferred slow growing species such as *Manilkara kauki* and *Zanthoxylum rhetza* has resulted in a decline of these species. Slow growth and the availability of substitute species probably are the main reasons why plantation efforts for these species remain low. With other fast growing species such as *Paraserianthes falcataria*, however, market opportunities of mass produced carved products has stimulated local people to plant the trees in their home gardens.

Similar to wood species being used, the carving styles have changed significantly in response to the market. Pop art has been vigorously developed and is now the dominant woodcarving product exported from the region. Compared to the Balinese woodcarving tradition, pop art demands little skill, effort or time. It is, however, the craftsmanship of the traditional Balinese woodcarvers that distinguishes the Balinese woodcarving from that of other countries, giving it a special position on the international market. Young artists are encouraged by economic motivation and want products that will give quick economic return. If this development goes too far it could make Balinese woodcarving lose its identity and with that its good name and strong position in the woodcarving market. Thus, though the pop art designs and themes are very much market oriented, in the long term the trend to mass production could lessen the comparative advantage of woodcarvings from Bali. However, there are many woodcarvers in Bali who maintain the classic carving tradition, and it is expected that this adherence will have a positive impact in the long term on the market for Balinese woodcarvings.

Developing the woodcarving sector

The willingness of woodcarvers to work together through rural organisations and their open attitude towards market dynamics have contributed to the development of the woodcarving industry in Bali. There is also a positive impact from cultural (*adat*) traditions on running the rural organisations; there are, for example, traditional sanctions that would boycott an entire family business if a credit were not repaid. Government support in the form of financial aid through the Lembaga Perkreditan Desa, providing education for the younger generation, promotion through exhibitions and research and development have also contributed to the growth of the woodcarving industry in Bali.

In order to maintain the development of the woodcarving industry in Bali, as well as to reduce negative ecological impacts on the environment, consistent effort is required. Some proposed recommendations are:

- To maintain the market through promotional efforts such as making available more informational booklets and brochures and organising periodic woodcarving exhibitions.
- To support the Lembaga Perkreditan Desa in its efforts to be an effective village financial institution. The LPD could be extended to other districts.
- To maintain the quality of woodcarving designs and themes. Classic styles or fine art carving are important and should be maintained as a quality benchmark of Balinese woodcarving. Artists and educational institutions should be provided with incentives for maintaining or developing these woodcarving styles.
- To invest in plantations, particularly of slow-growth wood species. This could be implemented in areas where sufficient land is available, e.g., in the West Bali region. Collaboration between research institutes, Balai Perbenihan Tanaman Hutan and local organisations to establish plantation plots is recommended.

ENDNOTES

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3. Forestry and Nature Conservation Research and Development Center, Jln. Gunung Batu No. 5, Bogor, Indonesia. E-mail: syarif.hidayat@mailcity.com

4. Exchange rate used: US$1 = Rp10,000.

5. *Garuda* carvings are the most popular type of woodcarving produced in Tegallalang. A carved *garuda* illustrates Prince Rama sitting on the *Jatayu* knight, a bird knight from the story of Ramayana. There are various sizes and carving qualities (detail and structure of the carving).

6. Bucking is cutting the tree stem into specific lengths. The stem may be cut into 1 m, 2 m or 3 m length depending on the market order.

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