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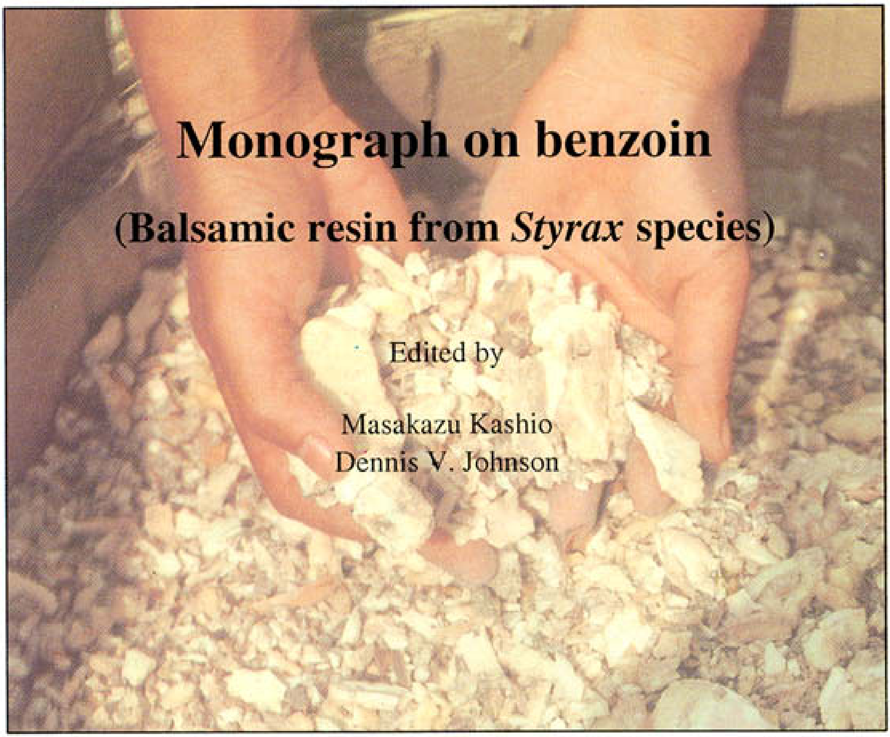

Monograph on benzoin

(Balsamic resin from *Styrax* species)

Edited by

Masakazu Kashio
Dennis V. Johnson

Food and Agriculture Organization of the United Nations
Regional Office for Asia and the Pacific
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Foreword

The Lao People's Democratic Republic (Lao PDR) is a land-locked, mountainous, and forest-rich country in continental Southeast Asia. The Lao forestry sector is one of the main export revenue earners, comprising 40 percent of total export value in 1996. The forest cover has, however, been reduced by excessive shifting cultivation, in which 1.8 million people are engaged. The pressure on forests is also increasing due to the growing demand for forest products in neighbouring countries such as Thailand and Viet Nam.

During 1989-1991, the Lao government with FAO assistance reviewed its forestry sector through the Tropical Forest Action Plan exercise and in 1992 the government adopted a new forestry policy, including the development of non-wood forest products (NWFPs).

In response to the government request, FAO formulated and implemented a project under the Technical Cooperation Programme, "Improved benzoin production (TCP/LAO/6611)", from 1996 to 1998. Lao or Siam benzoin, a balsamic resin derived from *Styrax tonkinensis*, is one of the traditional NWFPs that possesses potential for improvement to benefit rural people and enhance high-value, low-volume exports, highlighting the role of NWFPs in poverty alleviation and sustainable management of forests.

This TCP project undertook a series of studies and produced many valuable technical documents, but their distribution was limited. Thus, FAO felt it worthwhile to produce a comprehensive monograph of benzoin based on these documents in order to share the information in a wider arena.

My thanks are due to Dennis Johnson, who edited the original documents, and Masakazu Kashio, FAO Forest Resources Officer, who formulated and backstopped the project, and consolidated the scattered information into this monograph.

I hope that this publication will serve as a useful reference for resource managers and specialists seeking opportunities to improve the management of *Styrax* species and increase the effective production, processing, marketing and utilization of benzoin.

R.B. Singh
Assistant Director-General and
Regional Representative for
Asia and the Pacific

Acknowledgements

FAO would like to note with appreciation the work of Khongsak Pinyopusarerk, Project Team Leader and silviculture expert; Manfred Fischer, Associate Professional Officer of the project; John Coppen, marketing and processing consultant; Prachoen Sroithongkham, benzoin tapping consultant; and Masakazu Kashio, FAO Forest Resources Officer; as the authors of the original documents used in this publication.

FAO would also like to acknowledge the valuable contributions of the Lao counterparts in the Department of Forestry (DoF), Ministry of Agriculture and Forestry (MoAF), especially Sianouvong Savathvong, Chief, Luang Prabang Provincial Forestry Section. Kamphone Mounlamai, National Project Coordinator, Sommay Souligna, Field Manager, and many other DoF foresters who were assigned to the project, played key roles in the project implementation. The continuous support of Onechanh Boonnaphol, Chief of Provincial Agriculture and Forestry Office, Luang Prabang, MoAF, is much appreciated. Latsamy Vongsack (Mrs.), Director of the Food and Drug Quality Control Centre, and her staff were always cooperative in chemical analysis of benzoin.

A note of appreciation is due to other individuals who directly or indirectly supported this project. Boon Thong, former village headman, Sichanh, present village headman, and other villagers in Ban Kachet have been always very cooperative. In FAO, the strong support of Peer Hijmans, FAO Representative, Roger Eijkens, Forestry Officer in the FAO Office in Vientiane, and Masahiko Hori, FAO Project Operations Officer in Bangkok, is highly appreciated. Wanida Subansenee (Mrs.) and Yanyong Kangkarn of the Thai Royal Forest Department served as FAO consultants in benzoin tapping and processing. Renaud Costaz, a consultant for the European market, contributed to the project. Special thanks are given to Diederik Koning, Co-Director of the EU Micro Projects Luang Prabang Phase II, for his kind commitment to follow up the field trial work after the termination of the project.

Editorial notes

Original documents referred to:

Chapter 1 is derived from *Introductory Remarks for the National Workshop on Improved Benzoin Production,* 12-14 May 1998 in Luang Prabang, by M. Kashio with his additional writing, and the report *Gum Benzoin: Its Markets and Marketing and the Opportunities and Constraints to Their Improvement in Lao PDR.* July 1997, by J.J.W. Coppen.

Chapter 2 is derived from the above report by J.J.W. Coppen (July 1997).

Chapter 3 is derived from the report *Physical and Socio-Economic Conditions of Benzoin Production in Northern Laos,* 1997, by M. Fischer, and *Vientiane and Luang Prabang, Lao PDR, Back-to-office Report*, January 1994, by M. Kashio.

Chapter 4 is derived from the reports *Technical Cooperation Project: Improved Benzoin Production in Lao PDR. First Mission Report,* 1996, *Second, Third and Fourth Mission Reports,* 1997, *and Fifth Mission Report,* 1998, by K. Pinyopusarerk.

Chapter 5 is derived from the report *Lao PDR Improved Benzoin Production, Monograph Report,* 1998, by P. Sroithongkham. This report was prepared to consolidate several benzoin tapping and processing consultant reports by W. Subansenee, Y. Kangkarn, and P. Sroithongkham himself.

Chapters 6, 7, 8 and 9 are derived from the report by J.J.W. Coppen (July 1997).

Chapter 10 is derived mainly from *The Proceedings of the National Workshop on Improved Benzoin Production,* 12-14 May 1998 in Luang Prabang, edited by M. Fischer and K. Pinyopusarerk, with some inputs from the report by J.J.W. Coppen (July 1997).

Use of the terms *Siam benzoin* and *Lao benzoin*:

Siam benzoin and Lao benzoin refer to the same product from *Styrax tonkinensis*. The former name is used almost universally outside Lao PDR when it is necessary to distinguish benzoin of Lao origin from that produced in Indonesia (Sumatra benzoin). The name originates from the previous importance of Thailand (old name Siam) as an international exit point for benzoin. The latter name is used for the benzoin specifically produced in Lao PDR. Both terms are used in this publication.

Spellings for the names of provinces:

There are many different spellings of the names of provinces even in officially released government documents. To be consistent in their uses in this publication, the following spellings have been adopted. The spellings in the parentheses show other spellings often seen.

- Luang Prabang (Luangprabang, Luangphrabang)
- Phong Saly (Phongsaly, Phongsali)
- Houaphan (Houaphanh, Houa Phan, Houa Phang)
- Oudomxay (Oudomxai, Oudomsai)
- Xieng Khuang (Xiengkhuang, Xiang Kwang)
- Luang Namtha (Luangnamtha)

Abbreviations

ADI	Acceptable daily intake (an indicator of food safety)
C & F	Cost and freight (import prices)
CIF	Cost, insurance and freight (import prices)
DAFO	District Agriculture and Forestry Office
ECU	European currency unit
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FOB	Free on board (export prices)
GDP	Gross domestic product
HS	Harmonised System
IUCN	International Union for Conservation of Nature and Natural Resources
JECFA	Joint FAO/WHO Expert Committee on Food Additives
NWFP	Non-wood forest product(s)
PAFO	Provincial Agriculture and Forestry Office
ppm	Parts per million
SITC	Standard International Trade Classification
TCP	Technical Cooperation Programme
UAE	United Arab Emirates
WHO	World Health Organization

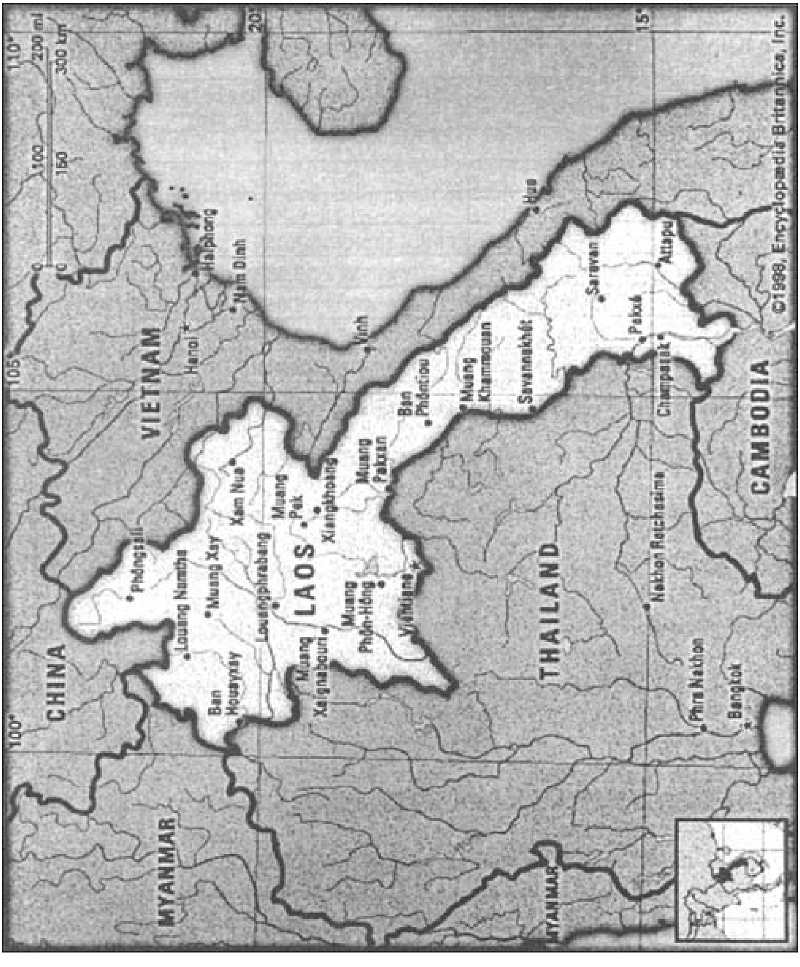
Exchange rates

The annual average exchange rates between US dollar and Lao kip are given below.

Year	Annual average exchange rates (1 US dollar to Lao kip)
1994	717
1995	816
1996	935
1997	1,257
1998	3,282
1999	7,067
2000	7,809
2001 (Jan. – Oct.)	8,843

Source: the Foreign Exchange Department of the Lao National Bank.

Map of Lao PDR



CONTENTS

Tables

Figures

Photographs

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Chapter 1. Introduction

1.1 General background

The Lao People's Democratic Republic (Lao PDR) is a land-locked country with an economy that is overwhelmingly agrarian in character. Approximately 85% of the 4.3 million people live in rural areas with agriculture as their main occupation and about 65% of GDP is derived from agriculture and forestry. About 300,000 families (1.8 million people) are engaged in shifting cultivation, a practice that seeks to meet family subsistence needs and provide some cash income. Shifting cultivation brings with it, however, certain serious environmental and social problems.

Lao PDR is the major producer of Siam or Lao benzoin, a balsamic resin obtained from the *yan* tree (*Styrax tonkinensis*), which is native to Southeast Asia. Annual production of Siam benzoin, one of the two types of commercially produced benzoin, is around 50 tonnes. In some years Lao PDR is the sole producer of benzoin, although Viet Nam is believed to intermittently produce much smaller amounts.

The second type of commercial benzoin, Sumatra benzoin, is derived from two other *Styrax* species: *S. benzoin* and *S. paralleloneurum*, both also Southeast Asian trees. Indonesia, specifically north Sumatra, is the only producer of Sumatra benzoin. The scale of production of the two types of benzoin is very different. Annual production of Sumatra benzoin is of the order of 1,000 tonnes. This production figure for Sumatra benzoin is based on Indonesian export data. It is important to note that some of this benzoin contains damar, which is used in the manufacture of benzoin block. The actual figure for genuine benzoin could be as low as half this, i.e. about 500 tonnes.

Benzoin is used chiefly for incense purposes and in the flavouring, fragrance and pharmaceutical industries. The higher quality Siam benzoin is used mainly in the manufacture of fine fragrances.

Production of benzoin in Lao PDR is centered in the mountainous, northern provinces of Luang Prabang, Phong Saly, Houaphan, and Oudomxay, where *Styrax tonkinensis* trees are managed within the shifting cultivation cycle. The shifting cultivators in Luang Prabang, Phong Saly and Oudomxay provinces extract the resin from trees during the dry season. Luang Prabang is the chief province for benzoin production; there are some 3,000 ha of styrax forests above 700 m elevation in two districts of the province.

Benzoin production, integrated into the shifting cultivation cycle, forms an agroforestry system combined with upland rice cultivation. For example, the villagers of Ban Kachet in Nam Bak district of Luang Prabang province apply a rotation of 11 years, producing upland rice in the first year and benzoin during the following 10-year fallow period. This type of land use can maintain forest ecosystems and offers an excellent rehabilitation method for degraded forests damaged by shifting cultivation. In other villages, however, a shorter rotation period of 5-7 years is applied. Under this regime soil degradation has been inferred from a decline in rice yields.

Although benzoin production in Lao PDR is relatively small, at least in comparison with that in Indonesia, it provides a welcome source of cash income to the people who collect it. Benzoin also makes a small contribution to the national economy through foreign exchange earnings.

1.2 FAO technical assistance through a project

A brief introduction to the background of the project is appropriate. As forestry specialists are well aware, the tropical forests of the Asia-Pacific Region are being threatened by a continuous process of degradation and deforestation. Lao PDR is one of the countries that has been affected by this process through the 1980s and 1990s.

In October 1989, the Lao government drew international attention to major problems in its forestry sector — a serious environmental crisis and further impoverishment of rural communities and people living around or inside the forests, in particular in watershed areas affected by intensive practices of shifting cultivation.

In response to a request by the Lao government, FAO reviewed the forestry sector through a Tropical Forestry Action Plan (TFAP) exercise during 1989-1991. A set of recommendations was submitted to the government, along with several forestry project proposals. Many donors began to formulate projects based on these proposals. The government also requested FAO to formulate forestry projects, in particular in the field of watershed management and non-wood forest products (NWFPs).

Recognition by the Lao government that problems of shifting cultivation needed to be addressed, and that promotion of non-wood forest products could contribute to finding a solution, highlighted the benefits that would derive from improved benzoin production.

This recognition facilitated the commencement of project formulation work in July 1992. An FAO review of the country's NWFP resources concluded that the improvement of benzoin cultivation, processing and marketing should be one of the top priority subjects. Following the preparation of a draft project proposal on benzoin, a second mission was carried out in January 1994, in close collaboration with the Department of Forestry (DoF). The mission studied benzoin production systems combined with shifting cultivation practices in the field, and identified a suitable project site at the village of Ban Kachet in Nam Bak. The site was chosen because soil degradation, related to declining upland rice yields, was being experienced — and there was easy access to the village by road.

After the addition of information collected in the field, the project document was finalized by DoF with support from FAO in March 1994. The project identified two key issues: 1) how to provide effective alternative income sources to shifting cultivators; and 2) how to reduce the negative impacts of shifting cultivation. The project also identified the need for a broad rural development concept to improve benzoin production, processing and marketing.

Thus, a project funded by the FAO Technical Cooperation Programme (TCP), "*Improved Benzoin Production (TCP/LAO/6611)*," was initiated and operated from July 1996 to June 1998. The following were three objectives of the project:

1. to introduce better and innovative techniques of: a) cultivation and harvesting (either through natural regeneration or plantation cultivation); and b) extraction, processing and purification of benzoin resin (technical aspects);
2. to develop the domestic trade of benzoin resin, and develop international marketing strategies and mechanisms (institutional aspects); and
3. to promote agroforestry and rural development through a benzoin utilization programme in the country (socio-economic and environmental aspects).

The project achieved many things in pursuit of these objectives. However, much work still remains in the hands of Lao government officials, including DoF foresters, as well as villagers, benzoin traders, researchers, and other NWFP-related project staff to meet challenges of the future.

1.3 Major activities and outputs

The project implemented many activities during its 2-year implementation period. These ranged from the improvement of silvicultural treatments, tapping methods, and agroforestry trials, to a socio-economic survey, benzoin market studies, study tours and chemical analysis of benzoin samples. These were all new activities that had not been conducted before. There have been some interesting results from these activities, and more are expected from the on-going follow-up and future activities.

A variety of technical advances, including those relating to silvicultural treatments, tapping methods, genetic improvement work, selection of high yield elite trees, healthy and resistant characters against pests and diseases, seedling propagation in nurseries, and socio-economic and benzoin marketing survey results, were presented at a workshop held in May 1998, and publicized in its proceedings in July 1998. A number of recommendations were also made at the workshop and these are detailed in Chapter 10 of this monograph.

Two subjects meriting special attention are processing and marketing of benzoin – the most crucial factors in determining the future of Lao benzoin and how much it can contribute to improving the economic situation of Lao villagers. Experts contracted to the project conducted a series of studies on the benzoin markets in Lao PDR, Indonesia, Singapore and France. Benzoin samples have been analyzed at the Food and Drug Quality Control Centre in Vientiane to facilitate improvement of tapping methods, grading systems and quality control. Results of these studies are incorporated into this publication. Project study tours to Viet Nam, Singapore and Indonesia provided vital information to the participants. Unfortunately, the project period of 2 years was not long enough to fully achieve the initially targeted objectives. However, the Lao government is keen to follow up the project activities.

Outputs from the project are mostly in the form of English-language documents. Some of them have been translated into Laotian for the benefit of the Lao people. In principle, the documents are government property, although the government has placed them in the public domain. In reality, however, it is not easy for non-governmental people to obtain copies. There is, however, recognition of the importance of sharing the information generated and the experience gained by the project. This is the reason for this publication, *Monograph on Benzoin*.

The project has opened a new horizon for Lao benzoin and shown what can be done and should be done in the future. It is hoped that this publication will enable anyone concerned and/or interested to assess new opportunities and continue efforts to achieve the final project goals. By attaining greater appreciation in the international market, benzoin production in Lao PDR can provide a good opportunity for off-farm employment and an income source for rural communities. It will not be an easy task, but this should not deter efforts to develop benzoin resources and process benzoin resin for new and expanding markets.

Both FAO and the Lao government have ranked NWFP development as a top priority in conjunction with rural development for environmentally sound, economically viable, and socially acceptable forest resources management and utilization.

Photo 1.1 The project village, Ban Kachet.

Chapter 2. Description of gum benzoin

2.1 Terminology

Apart from the distinction already made between Siam benzoin and Sumatra benzoin, there are two English terms used to describe the resinous product from styrax trees: *benzoin* (or *gum benzoin*, although use of the word *gum* is strictly incorrect since benzoin is not a water-soluble polysaccharide) and *gum benjamin*. The latter term is used as the description in Singapore's trade statistics and is the designation employed by many Singaporean traders. Since Singapore is the major international trading centre for benzoin, the term *gum benjamin* is often used elsewhere in trade.

In common usage in Indonesia benzoin is known as *kemenyan*. In Indonesian trade statistics, however, benzoin is misleadingly called *frankincense,* a term usually applied to the resinous exudate from *Boswellia* spp. of Arabia and Africa. It is possible that this use of the term *frankincense* derives from benzoin of Indonesian origin that was traded by the Arabs, who regarded it as a form of frankincense, at least 700 years ago.

In Malaysia, benzoin is called *kemenyan* or *kemayan*. Malaysian trade statistics use the term *gum benjamin.* In Thailand it is known as *kamyan* or *kumyan* and in Lao PDR it is called *kam nhan*, *nyan* or *yan*.

2.2 Appearance

Benzoin appears in international trade in several forms. Most Siam benzoin exported from Lao PDR is in the form in which it is collected from the tree, after it has been cleaned and graded. It consists of hard, usually cream-coloured/pale orange pieces, which if broken reveal a milky white colour. The benzoin is quite pale in colour when freshly collected but darkens gradually during storage to a sandy-orange colour. During handling and transport from its collection to the point of export, larger pieces are inevitably broken down to smaller ones and a significant proportion of dust and siftings is produced. Some benzoin which finds its way to Bangkok through Thai traders living near the border with Lao PDR, and which is used in the preparation of traditional medicines (but also occasionally exported), is formed in larger, dark brown lumps with a glassy appearance.

Sumatra benzoin similar in appearance to the Siam benzoin described above is traded (often known as *almonds*), and with the same sort of grades, but there are also substantial quantities of darker, dirtier, lower grade material. Even more common is a semi-processed form of block benzoin which generally contains pieces of damar embedded in a matrix of low grade benzoin. The use of damar is an important feature of the production of block benzoin and accounts for the large differences in volume between exports of benzoin from Indonesia to Singapore (the major initial destination) and subsequent exports of benzoin out of Singapore. Occasionally, pure benzoin almonds are used in the production of block benzoin, instead of damar.

2.3 Chemistry

The chemical compositions of the two types of benzoin account for their sensory characteristics and determine the uses to which they are put. There are both similarities and differences in composition and this means that although they are both used for flavour and fragrance purposes, they often go into different parts of the markets. Both contain mixtures of organic acids and esters, along with numerous other – mostly minor – components, and both can be described as *balsamic* in odor. However, in Siam benzoin the chief constituents are benzoic acid and its esters (such as coniferyl benzoate, benzyl benzoate and cinnamyl benzoate), while in Sumatra benzoin the major constituents are cinnamic acid and its esters (such as coniferyl cinnamate and cinnamyl cinnamate). Vanillin is present in both types of benzoin and gives rise to its familiar vanilla odor (most readily detected in the Siam type).

Using samples of benzoin obtained from regional fieldwork, qualitative analyses were carried out at the laboratories of the Royal Forest Department, Bangkok. The results illustrate the similarities in composition of the two types of benzoin, but by separating and detecting the cinnamates in the Sumatra type it was also possible to distinguish them. The results are discussed in more detail later (Chapter 8, section 8.1.3 and **Appendix 2**). They also confirm the presence of damar in some of the semi-processed block forms of benzoin.

2.4 Plant sources

Benzoin comes from tree species of the genus *Styrax* in the family Styracaceae. *Styrax* contains about 130 species of trees and shrubs occurring in tropical to temperate climates. Three centres of distribution are described: southeastern Asia, southeastern North America to South America, and a single species in the Mediterranean.

Siam benzoin is obtained from *S. tonkinensis* (Pierre) Craib ex Hartwiss. Sumatra benzoin is collected from two species: *S. benzoin* Dryand. and *S. paralleloneurum* Perkins (sometimes spelled *paralleloneurus*). The latter two species are cultivated for benzoin production in different parts of Indonesia and are said to produce benzoin of different qualities; the two types are not separately identified in trade however.

Two varieties of *S. benzoin* occur in Peninsular Malaysia, var. *benzoin* and var. *hiliferum* Steenis. Neither is tapped for benzoin on a commercial scale. In China, *S. tonkinensis*, *S. hypoglauca* Perk. and *S. cascarifolia* are tapped but the products, though used domestically, are not believed to enter world trade.

Photo 2.1
Flowers of *Styrax tonkinensis*
(at the tapping trial plot in Ban Kachet. 13 May 1998)

Photo 2.2 Fruits of *Styrax tonkinensis*
(at the tapping trial plot in Ban Kachet. 13 May 1998)

Chapter 3. Traditional benzoin production within its village context

3.1 Benzoin production

3.1.1 Location and scale of production

Production of Lao benzoin takes place in the mountainous northern provinces of Lao PDR. Traditionally, Luang Prabang, Phong Saly, Houaphan and Oudomxay provinces have been the main production centres, but in recent years the production in Oudomxay has declined due to alternative sources of cash income available to the farmers. Very small amounts of benzoin may be produced in the northern parts of Xieng Khuang province bordering Houaphan.

There are no national data on benzoin production. Incomplete provincial data are available, but it is not possible to establish their reliability. Part of the problem is because some data come from Department of Commerce sources and others from Forestry Division sources. In the case of the Department of Commerce, benzoin shipments which pass through Luang Prabang City, for example, are registered with the trade office and reported for Luang Prabang province. Benzoin produced within the province and exported directly to China through northern routes therefore goes unrecorded, whereas benzoin which passes through Luang Prabang City but originates from another province will be recorded. Unofficial trade across the Thai border, and perhaps some into Viet Nam, represent production which is unrecorded in any location. To make the task of acquiring national data even more difficult, there is no mechanism in Vientiane for consolidating data acquired provincially.

Given the above limitations, Table 3.1 shows official, albeit incomplete, production of benzoin for Luang Prabang and Houaphan provinces for the period 1986-96.

Table 3.1 Benzoin production in Lao PDR, by province, 1986-1996 (tonnes)

Year	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Total	48.7	41.6	42.7	35.6	18.0	19.0	15.9	15.0	36.0	30.0	25.0
Of which:											
Luang Prabang	28.7	21.6	24.7	19.6	-	-	0.9	-	21.0	15.0	13.0
Houa-phan	20.0	20.0	18.0	16.0	18.0	19.0	15.0	15.0	15.0	15.0	12.0
Phong Saly	na	na	na	na	na	na	na	na	na	na	na

Sources: Department of Commerce, Luang Prabang;
Forestry Division, Houaphan

The absence or near absence of data for Luang Prabang for the period 1990-1993 is inexplicable, and no information is available for Phong Saly. Therefore it is impossible to make any meaningful estimate of total national production using official figures or to identify trends.

Based upon anecdotal information from benzoin traders and others, it seems clear that Luang Prabang, Phong Saly and Houaphan provinces are the three principal sources. The best estimate that can be made for their shares of total production are as follows:

Luang Prabang	15-20 tonnes
Phong Saly	15-20 tonnes
Houaphan	10-15 tonnes
Total	40-55 tonnes

3.1.2 Production and shifting cultivation

Benzoin production is integrated into the traditional practice of shifting cultivation. There is no cultivation of styrax as a long-term tree crop. Typically in Lao PDR, land where *S. tonkinensis* occurs naturally is cleared and upland rice is planted in the first year of the cycle. Local people use the name *yan* to refer to *Styrax* spp. and recognize two types: *black yan* and *white yan.* Commercial benzoin is produced only from *black yan*.

It is unclear if white yan represents a different species of the genus *Styrax.*

After the rice crop is harvested, the styrax seedlings produced as a result of natural regeneration are allowed to grow during the fallow period. When the trees are large enough to yield benzoin, they are tapped for several years before the cycle starts again and the land is cleared.

Traditionally, the shifting cultivation cycle is around 10-12 years or longer and tapping begins at about the 7th or 8th year (or earlier), allowing up to four years or more of production. In recent years, however, pressure on land caused by population increase, and the concentration of people around urban centers and in areas close to road or river access, coupled with government restrictions on forest clearing, has resulted in a shorter cycle. In those cases where the cycle is reduced to 7-8 years, tapping may only take place during the final 1-2 years. In some areas, the fallow period is reduced to only 4-5 years when the styrax trees are too young and small to tap. This reduction in cycle length means that not only are fewer trees likely to be tapped, but yields of benzoin from those are getting less. Therefore, the supply base for benzoin is becoming less secure, adding to the problems of a population which is inexorably looking towards other, less arduous forms of cash income than collecting benzoin.

In two districts of Luang Prabang province, a form of enrichment planting of styrax is practised. Under this system, during the first year of shifting cultivation styrax seeds are sown directly with three or four seeds per hole. Seeds are collected from 7-8-year-old trees which are reserved as seed sources and not tapped. After the styrax seeds are sown, the field is then burned. It is said that the heat produced by burning promotes seed germination. After the burning, farmers plant upland rice. Upland rice is planted in the first year only; from the second year onwards styrax trees only are grown. Weeding and cutting of climbers is done periodically to promote styrax tree growth. Benzoin tapping begins when the trees reach 7 years of age, and a DBH of 12-14 cm. All large trees are tapped. It is said that trees which have a larger crown can produce more benzoin.

Cuts are made in the bark of benzoin trees during October–December, around the end of the rainy season. Benzoin is harvested during March-April (sometimes up to May) in the following year. Yields are reported to be around 0.4-0.6 kg per tree or 160-240 kg per ha, assuming 400 trees per ha. Benzoin is classified into three grades on the basis of the size of the pieces.

Under this production system, farmers tap the trees and then cut them down as part of the land clearing for the next shifting cultivation cycle. Styrax wood is used as fuel.

A variation of the system described above consists of broadcasting large quantities of styrax seed (5 kg per ha) in the cleared field by hand. A month later the field is burned and upland rice planted. The styrax and rice seeds germinate at almost the same time, i.e. within 7-10 days. The density of styrax trees is 500-600 per ha. No thinning operations are carried out. When the trees are 7 years old, the farmers decide which trees should be tapped, depending upon their size. An estimated 50 styrax trees per hectare per year are tapped.

3.1.3 Village case studies

A survey was conducted in two benzoin tapping villages in Nam Bak district of Luang Prabang province. One of the villages, Ban Kachet, is easily accessible; the other, Ban Sang La Dtai, is quite remote. Socio-economic as well as bio-physical data were collected, with special attention paid to benzoin and other non-wood forest products. Both formal and informal data collection techniques were used. Results of these two surveys are described below in sections 3.2 and 3.3.

3.2 Ban Kachet village

3.2.1 Biophysical conditions

3.2.1.1 Geographical location

Ban Kachet is located in a mountainous area in the north-western part of Luang Prabang province, about 130 km north of the provincial capital, Luang Prabang, and 27 km southwest of the district capital Nam Bak. Ban Kachet village is situated at an elevation of about 750 m; the elevation of the village lands range from 400-900 m. There are no official figures available, but the total village area is estimated at approximately 1,000-1,200 ha.

3.2.1.2 Topography

The village land is mountainous, with moderate to steep slopes. Ban Kachet's housing area is situated on a hill saddle and is one of the few wider, relatively level spots. The parent material of the hills is mainly weathered clay stone and silt stone. The effective soil depth depends on the geographic site.

The village area is part of the Nam Ou (Ou River) watershed; the Nam Ou is the largest tributary of the Mekong River. Several streams run through the Ban Kachet area, most of them intermittent. The Nam Mong (Mong River) is the only perennial stream relatively close to the village. The other streams draining the village area serve as its tributaries. The Nam Mong flows westwards into the Nam Khan (Khan River) that enters the Nam Bak at Nam Bak town. Due to the topographic conditions paddy cultivation is impossible.

3.2.1.3 Climate

The only available climatic data come from the Luang Prabang Meteorological Station which is at an elevation of 305 m. The climate in Ban Kachet is similar except that air temperatures are lower due to the higher elevations. Assuming a decrease in air temperature of 0.6°C per 100 m increase in elevation, the average annual temperature in Ban Kachet can be expected to be 0.5-3.0°C lower than in Luang Prabang.

The climate can be described as wet/dry monsoon tropical climate. The mean annual rainfall is 1,400 mm. The annual weather pattern is characterized by two main seasons. The rainy season starts from late April to early May and ends in late October and accounts for 90% of the annual precipitation. The total annual rainfall can vary from a little more than 1,000 mm to almost 2,000 mm. The onset of the monsoon rains varies considerably, creating high risks to those crops established early.

The mean annual temperature is 25.3°C. December is the coolest month (mean 20.4°C) and the warmest months are May and June (28.7°C). During the cool season the minimum temperatures can drop below 15°C. During the hot and dry season just before the rainy season in April-May, the maximum temperatures can reach 40°C. The mean annual relative humidity is 76%. The average rain-fed cropping season at the elevations of Ban Kachet area is about 8 months.

3.2.1.4 Soils

Soil analysis was carried out at a plot which was cultivated with upland rice the previous year. Although the survey area was rather small, the results give at least some indications of the general soil conditions in the area.

In response to the soil parent material and varying slope conditions, the soil properties can be expected to show considerable variation. The prevalent soil texture is clay-loam with a higher portion of loam in the upper soil layers. Organic matter (carbon and humus) is at a medium to high level and thus a sufficient amount is available (> 2.0%).

The soil is acidic; most samples showed a pH (in H_2O) below 4.5. Base saturation is very low. As is typical of soils in this region, available phosphorus is low. With the exception of potassium the other cations (calcium, magnesium and sodium) are at a low level.

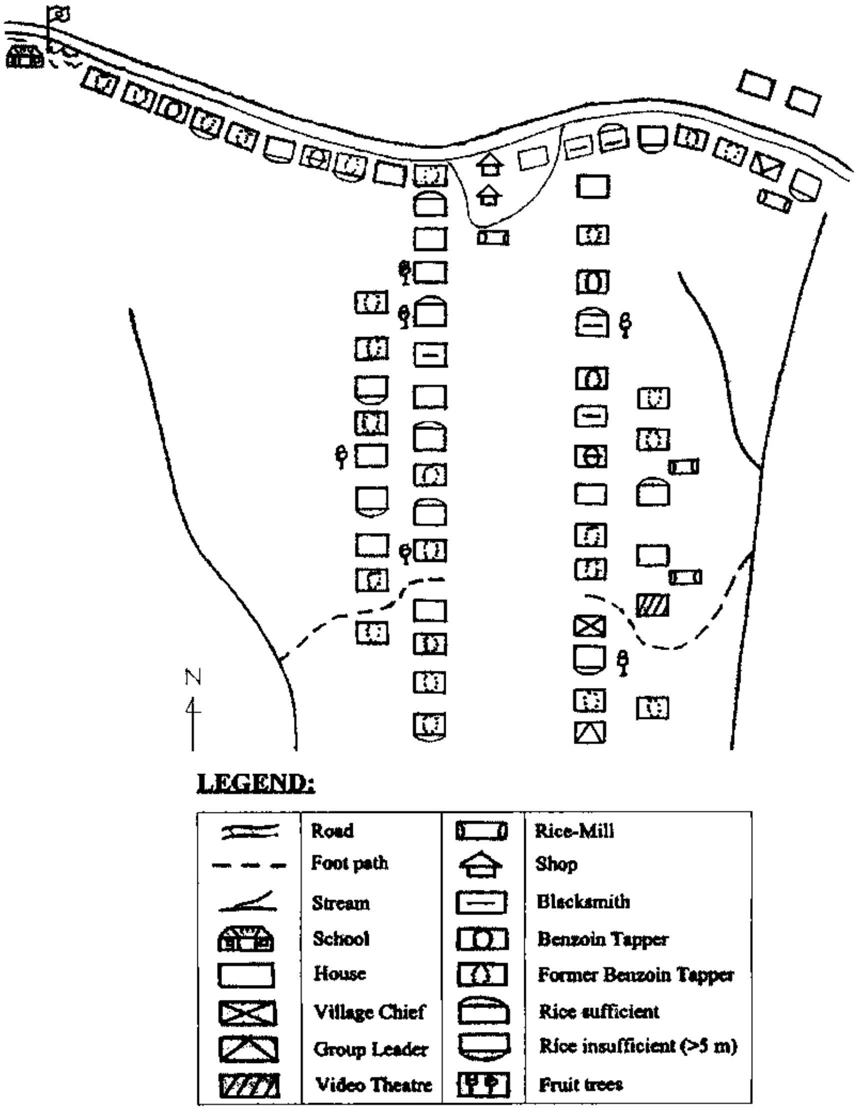


Figure 3.1 Map of Ban Kachet

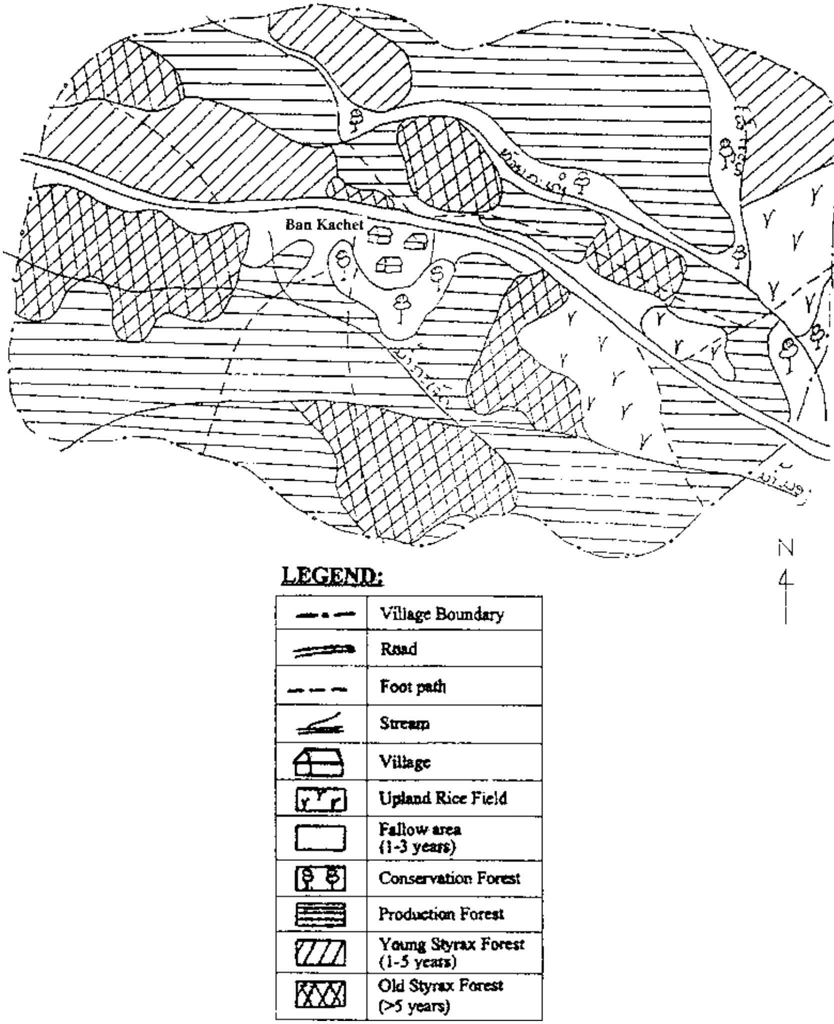


Figure 3.2 Ban Kachet – Land Use

3.2.1.5 Vegetation and land allocation

The status of the vegetation is mainly influenced by the practice of shifting cultivation, i.e. rotational slash and burn cropping. After a 1-year cultivation period, pioneer species develop. With the increasing length of the fallow period the vegetation develops towards a forest cover. As a result, most of the forests in the village area are secondary forests in different stages of succession, but generally no older than 15-20 years.

More mature forests can be found in the areas which are described as *Conservation Forests* in the village land use map. These areas are mainly preserved for religious reasons.

Land allocation was carried out in 1996. Each family received a limited number of plots which will lead to a shorter fallow period. Styrax trees need a fallow period of at least seven years to start producing benzoin. This is, however, not assured on the allocated plots. On the remaining area it is envisioned that older forests will develop. But the older the forests get, the less competitive is the pioneer species *S. tonkinensis*. In forests approaching 15 years of age, styrax trees will begin to disappear. Moreover, old styrax trees (>13 years) barely produce benzoin.

3.2.2 Socio-economic conditions

3.2.2.1 Village history

About four generations ago the first 11 families arrived in the area of Ban Kachet and settled there. All of them came from Houai Fa village, about 3 km away from Ban Kachet. Since then the population has continued to increase. With the exception of one family which moved to Ban Kachet in 1995, the increase in the number of residents is due to the natural population growth within the village.

3.2.2.2 Demography

In May 1997 the population of Ban Kachet consisted of 381 people living in 62 households (64 families). The average number of people per household is about six. The percentage of males is 54% (206 persons), slightly higher than females 46% (175 persons). With the exception of two Lao Loum women who married village residents, all village inhabitants belong to the Khamu ethnic group (Lao Theung).

Table 3.2 shows the population divided into five age groups, their absolute numbers and percentages.

Table 3.2 Age distribution in Ban Kachet, Nam Bak district

Age group	Numbers	Percentage
0-6	56	15
7-15	98	26
16-30	126	32
31-50	75	20
50 +	26	7
Total	**381**	**100**

Due to the high number of children, the percentage of active labour force (16-60 years) is low, 48% (182 persons). This can be considered a limiting factor for the land area which can be cultivated by a family. However, older children and elders still contribute labour to the family. More than 40% of the population are 15 years old or younger, which indicates a high population growth. This will have consequences for future natural resource management and it can be expected that land will become scarce in the village area. Only 7% of the population are more than 50 years of age. The reason for this is not known. It could be higher birth rates, lower child mortality or high adult death rates.

Ban Kachet has four female-headed households. One of the main constraints for them is a lack of labour available for the cultivation of their land. There are six drug addicts in Ban Kachet, all middle aged (five men, one woman). The men became addicts while they were soldiers during the war. The addiction of a family member is a serious burden to the family economy.

3.2.2.3 Village organization and education

As is usual in Lao PDR, the village is run by a chief elected directly by the villagers. The village is subdivided into three sub-groups, each headed by a group leader. Beside these representatives, the village has a council of elders with three members. The two groups should not be regarded as competing structures to rule a village; cooperation between them is the rule. Representatives of national organizations like the Lao Women's Union or the Youth Union are also present in Ban Kachet.

Ban Kachet has had a school since 1970. It was established through the initiative of the villagers themselves who built it and initiated teaching activities. The present teacher attended primary school for three years and lives in the village. Besides a basic government salary the teacher receives additional support from the village. The first two grades are taught in the village. For grades three and four, the pupils have to go to Song Cha village which is 12 km away. The school of Song Cha village has a dormitory which the parents have to pay for their children's lodging. For grade five and higher the children have to go to the district capital, Nam Bak, which is 27 km away.

A total of 36 children from Ban Kachet attend school: 26 pupils attend the first grade and nine the second grade. Just one pupil attends the fifth grade in Nam Bak town. In total, 13 girls go to school. Assuming that children from the age 6 to 15 should theoretically attend school within the district area (in Ban Kachet 98), just 37% do. The main reasons are 1) long distance to schools above second grade; 2) costs of sending children to school; 3) the labour of older children is needed within the family.

3.2.2.4 Health and nutrition

The most common health problems are diarrhoea, malaria and coughs. From June to August, the expenses for medicine are significantly higher than during the rest of the year. This is the rainy season when malaria is prevalent. The nearest health station is 9 km away in Song Cha village; the closest hospital is in Nam Bak town.

A total of 10 households have sufficient rice to eat over the entire year. For six households a rice shortage starts already in late January or early February. As the time since the previous rice harvest lengthens, more households have to buy or borrow rice. If they have to borrow money from a money lender, the interest rate is 200%. Money borrowed from relatives is free of interest. During the months of rice shortage the villagers shift to other food to fill their dietary gap. These mainly consist of tubers like taro, sweet potatoes, yam, which are either grown in the upland fields or collected in the forest. The most serious period of rice shortage is from June to September. In October the rice harvest season begins and rice shortage is over.

In years when rice is plentiful, taro, yams and sweet potatoes are usually used to feed animals. Wildlife and other products from the forest play an important role in the food supply of the villagers, particularly during the periods of rice shortage.

3.2.2.5 Infrastructure

Roads and markets: Considering the average situation in northern Lao PDR, Ban Kachet is easily accessible. It is directly located on the sealed road leading from Luang Prabang to Oudomxay. This is one of the major trading routes leading from China southwards to central and eastern Lao PDR.

The distance to the district capital, Nam Bak, is 27 km (fare cost of 1,000 kip by pick-up truck), to Oudomxay 66 km (2,000 kip) and to Luang Prabang 130 km (4,000 kip). The closest market is Ban Pak Mong (20 km, 500 kip), which is at an intersection on the way from Luang Prabang to Oudomxay and further to China, as well as to the north-east route to Houaphan province and Viet Nam. The most important market is Oudomxay; Nam Bak town is second in importance.

Water: Ban Kachet has three water sources. However, the water supply is one of the infrastructural shortcomings. During the dry season the water sources close to the village are inadequate. The villagers consider water-supply as the most urgent development problem for Ban Kachet.*

* This constraint was overcome in 2000 by the water supply construction project funded by a Japanese company, STEM, under the technical assistance of the Lao Red Cross.

3.2.2.6 Land tenure

Land allocation was carried out in Ban Kachet in 1996. According to government regulations, every family received four plots of land for cultivation. Several areas which are traditionally used and cultivated were not allocated. This resulted in a situation in which after land allocation the farmers had less land available for cultivation than before. Moreover, farmers stated that they already had problems with declining soil fertility. One reason for this may be an over-utilization of the limited number of cultivation areas. It seems questionable that the land allocated to the villagers can sustainably provide sufficient food. If this observation is unfortunately right, the clearing of additional forestlands will be inevitable.

Until recently there were no problems with encroachment of other groups into the village area. During the last few years, however, a land conflict has arisen with people from a neighbouring Hmong village. This is an indication of increasing land pressure in the Nam Bak district.

Unlike other non-wood forest products, the benzoin producing styrax trees are traditionally individually owned. Forty-one families (64%) own some styrax forests. The size of the area ranges from 1 to 3 ha. All the other forest products can be gathered by the one who finds them first or who indicates by placing a sign that a claim is being laid on them.

The land use map drawn by the villagers of Ban Kachet (Figure 3.2) is the result of 1) the practice of shifting cultivation system with its fallow cycle and 2) the land allocation in 1996. The area available for cultivation by the villagers (upland rice field and fallow area) represents about half of the village area. During the fallow period, styrax forests dominate a large part of the area. The remaining area is mainly production forest and, to a limited extent, protection forest. Areas used for community and religious purposes, e.g. cemetery or ghost forest, are part of the protection forest. The production forests can be considered as village forests but are under district administration and provincial authorities. Extraction of timber is only allowed for house construction in the village. The use of the other forest products is permitted without fee or restriction.

3.2.3 Economic activities

3.2.3.1 Sources of cash income

The ranking of the main sources of cash income for men and women is given in Table 3.3. NWFPs play a major role as a source of cash income. Both sex groups register cardamom of highest importance, followed by livestock, paper mulberry, benzoin and broom grass. Agricultural products like rice, sesame or chili are economically of less importance, indicating a high level of agricultural subsistence production. With some exceptions the ranking of men and women is similar. Obviously, for women many more products are of economic value than for men. The most significant difference is that women give importance to more agricultural products (ginger, sweet potatoes, taro) and NWFPs (bamboo shoots).

The villagers are very well aware of the possibility to gain a higher price for their products by selling directly to customers or traders in the respective market places. Gaining a higher trade margin by direct selling is mainly a matter of individual calculations and the availability of means of transport.

Table 3.3 Ranking of main sources of cash income in Ban Kachet for men and women

Rank	Men	Women
1	Cardamom, livestock	Cardamom
2	Paper mulberry, broom grass	Benzoin, livestock
3	Rice	Paper mulberry, broom grass
4	Sesame	Mak kha[1]
5	Benzoin	Mak khaen[2], bamboo shoots
6	Chili	Rattan seeds, rattan
7	Rattan seeds, mak kha	Chili, sesame
8	Mak khaen	Ginger, rice
9		Sweet potato, taro, vegetables

Notes: 1. *Alpinia malaccensis*
2. *Zanthoxylum rhetsa* or *Z. limonella*

Labour requirements per month, divided between men and women, are shown in calendar form in Table 3.4. The highest labour demand occurs around the middle and end of the year, which is the time for weeding, harvesting and collecting NWFPs. The calendar does not show significant differences in the perception of labour needs between men and women, but it underlines the interrelationship of the villagers with the natural environment, i.e. upland fields, fallows and forests. A large proportion of the raw materials for their daily life comes directly from those environments.

A calendar of expenses and income, separately for men and women, is given in Table 3.5. It seems that women have a great number of different sources of income and expenses. In particular the income side of the women's group calendar includes more products than the one for the men's group. Again it is evident that forest and fallow products are important for cash income generation.

The income from the most important NWFPs (e.g. cardamom, benzoin, paper mulberry, and broom grass) occurs at the time when there is, apart from some vegetables, hardly any other sources of income. This is also the time when the supply of rice is declining and often people have to borrow money or sell livestock to fill the gap in the rice supply. The income from NWFPs functions as a buffer in this sense. With the exception of expenses for festivals, the families spend their money mainly on rice, medicine, clothes and tools. There is no tradition of producing their own clothes.

3.2.3.2 Agricultural production

Shifting cultivation is the traditional means of agricultural production and production patterns are very much subsistence-oriented. In May 1997 the total area cultivated by the 62 households of Ban Kachet amounted to 174 ha. This represents the area which was allocated to the village in 1996. As previously mentioned, each household received four plots for cultivation according to their available labour force. On average a household received around 2.75 ha.

The main agricultural crop is rain-fed upland rice (glutinous rice). Local varieties are grown. The yield per ha of upland rice varies from 0.6-1.2 tonnes with an average of 1.0 tonne, depending very much on the length of the previous fallow period. The length of the fallow period determines the nutrient status of the soil as well as how much of the weed growth will be shaded out; the latter determines the amount of labour input necessary for weeding. The Khamu people are aware of this fact. They look for a forest area with trees that are not too large, but with limited undergrowth. Before the land allocation, the average fallow period was 7-9 years. Because of the biophysical conditions, there is no irrigated land in the Ban Kachet area.

Table 3.4 Calendar of activities and labour input for men and women

Men (High ◄──► Low)	Internat. calendar	Khamu calendar	Women[1]
Build new houses; New Year Festival (western)	1	2	Building new houses; Making knives; Searching for new cultivation areas
Prepare tools; Slash fallow	2	3	Slash fallows; Harvest broom grass, paper mulberry, benzoin and bamboo shoots
Harvest benzoin, broom grass, ginger; paper mulberry	3	4	Harvest benzoin and paper mulberry; Fencing; Build new houses
Harvest benzoin, broom grass and ginger; Burn fallow fields	4	5	Burn fallows; Clear fallows; Fishing
Rice sowing; Fencing; Grow chili and ginger	5	6	Clear fallows; Grow rice, corn, taro, chili, ginger; fishing
Weeding; Fishing; Hunting	6	7	Grow rice and sesame; Weeding, Fishing
Weeding; Hunting	7	8	Weeding; Harvest cardamom; Hunting
Harvest cardamom and rattan seeds; Tap benzoin; Grow tobacco	8	9	Weeding; Tapping benzoin; Harvest cardamom, rattan seeds and corn
Tap benzoin; Harvest cardamom, chili and rattan seeds	9	10	Tapping benzoin; Making baskets; Starting home gardens;
Home gardens; Prepare rice storage; Tap benzoin; Harvest rattan	10	11	Tapping benzoin; Making baskets; Home garden work; Harvest rice; Hunting
Harvest rice and sesame	11	12	Harvest rice, mak khaen, sesame and chili; Hunting
Rice transport; Charcoal making ──►	12	1	New Year; Preparations for the building of houses; Make charcoal; Garden work; Hunting

Note: The Khamu calendar differs from the international calendar by six weeks (earlier).

[1] Among women, no assessment of the level of labour input was made.

Table 3.5 Calendar of expenses and income for men and women

Men		Internat. calendar	Khamu calendar	Women	
Expenses	Income			Expenses	Income
Western New Year Festival		1	2	Knives & axes	Ginger, bamboo shoots & poultry
	Paper mulberry & broom grass	2	3	Food	Broom grass, bamboo shoots & paper mulberry
		3	4	Lao Loum New Year	Paper mulberry, broom grass, bamboo shoots & benzoin
	Paper mulberry, benzoin & broom grass	4	5	Salt, food, alcohol & cigarettes	Rice, paper mulberry, vegetables & benzoin
		5	6	Rice	
Medicine & rice		6	7	Rice	
Medicine & rice		7	8	Medicine & rice	Cardamom
Medicine & rice	Cardamom & rattan seed	8	9	Medicine, rice & clothes	Rattan seeds, cardamom
	Cardamom & rattan seed	9	10	Rice	Rattan seeds & mak kha
Household tools	Mak kha, mak khaen & rattan seed	10	11	Clothes & food for Khamu New Year Festival	
Household tools	Chili & sesame	11	12	Alcohol, cigarettes & biscuits	Chili, mak khaen & sesame
		12	1		Sweet potatoes & chili

An indication of the usual crops cultivated in Ban Kachet, divided into cash and subsistence crops, is given in Table 3.6. Every product is for sale as long as the well-being of the family is assured. In particular corn and root crops are important during the period of rice shortage.

Table 3.6 List of subsistence and cash crops (unranked)

Subsistence crops (mainly)	Cash crops
Upland rice (glutinous)	Ginger
Corn	Sesame
Taro	Pumpkin
Sweet potato	Chili
Cassava	Sweet potato
Eggplant	Cucumber
Long bean	
Job's tear	
Sugar cane	

3.2.3.3 Forest products

Table 3.7 presents a ranking of forest/fallow products according to their importance for subsistence use. Bamboo is by far the most important product; a number of bamboo species yield edible shoots that serve to broaden the nutritional base. In addition, bamboo canes are used for various purposes such as house construction and producing handicrafts like baskets or mats. Rattans have similar uses but are not as important.

The main uses of wood are for fuelwood and for construction. Despite its soft characteristics, the wood from styrax trees is used for both purposes. Styrax wood is locally used for house construction, mainly because of its resistance to insects. Fruits and roots of *mak kha* (*Zanthoxylum rhetsa)* are used for food and are also sold. The same is true of broom grass, but with more emphasis on selling.

Table 3.7 Ranking of forest products according to their importance for subsistence use in Ban Kachet

Rank	NWFP
1	Bamboo (shoots and canes)
2	Rattan (food and canes)
3	Wood (fuelwood, construction)
4	Mak kha
5	Broom grass

The management of the village forest area is the responsibility of the village forester in cooperation with the village headman. The village forester is selected by the district forestry service together with the village headman and receives two weeks training per year.

In addition to the NWFP traders who regularly visit Ban Kachet, there are also villagers acting as middlemen. They acquire products from the collectors and sell them to other traders either in the village or in Nam Bak town. The collection and processing of most of the NWFPs is carried out by women, children and older people. If more physical strength is needed, such as for tapping and harvesting of benzoin, men do the job.

Wood extraction is only allowed for house construction within the village and is limited to a certain quantity per family. As a source of cash income, wood does not play a role in the economic life of the villagers.

An overview of the most important forest and fallow products in Ban Kachet is presented in Table 3.8. A detailed interpretation is given below.

The amount of income generated from forest and fallow products varies from family to family. The range is 50,000-150,000 kip per year depending on the magnitude of the harvest, prices and available labour. It is difficult to assess the proportion represented by these products on the entire family income. In general, the poorer the family the greater the share of family income coming from forest and fallow products. At the maximum it is estimated to reach 50%.

Table 3.8 Most important forest and fallow products

Lao name	Scientific plant name	English name	Importance for sale	Importance for self consumption	Farm gate price
Njahn (or yan)	*Styrax tonkinensis*	Benzoin	XX(X)	–	up to 5,000 kip/kg
Mak naeng	*Amomum ovoideum*	Cardamom	XXX	(X)	up to 7,500 kip/kg
Bpo sa	*Broussonetia papyrifera*	Paper mulberry	XXX	(X)	400-800 kip/kg
Sang	*Bambusa* spp.	Bamboo	XX	XXX	Depends on the product
Wei	*Calamus* spp.	Rattan and rattan seeds	X	XX	Depends on the product seeds 600 kip/kg
Mak khaen	*Zanthoxylum rhetsa*	–	XX	(X)	800 kip/kg (dried)
Mak kha	*Alpinia malaccensis*	–	XX	XX	500-700 kip/kg
Khaem	*Thysanolaena maxima*	Broom grass	XX	X	800 kip/kg

Benzoin

Although more than 60% of the households own some styrax forest, benzoin does not have the importance for the villagers that it formerly had. This trend is the same in the other benzoin producing areas in Lao PDR. At the time of the survey, there were only five households in Ban Kachet which were continuing to actively tap; 25 households had recently stopped tapping because of the low benzoin prices. They could restart tapping if the prices become more attractive.

However, this downturn in benzoin tapping should not lead to the conclusion that it is not worthwhile to promote benzoin and its production. Many families, in particular the poor ones, depend considerably on the cash income generated by the sale of benzoin. Furthermore, the recent movements on the benzoin market indicate a positive price development.

An aspect which can seriously affect benzoin production in the future is the decreasing length of fallow periods on upland fields caused by increasing land pressure and the current way of land allocation to local people.

Other forest products

Cardamom (*Amomum ovoideum*)**:** At the time of the survey, cardamom was the most important non-wood forest product for income generation in Ban Kachet. One person can harvest up to 6 kg per year, depending on the season. Two kinds of cardamom, white and red, grow in the area of Ban Kachet. White cardamom grows more on moist soil, yields less but receives higher prices than red cardamom. The white variety is mainly used for medicinal purposes. Red cardamom has lower soil requirements but its yield is greater.

The harvest of cardamom occurs between late August and early October. Harvesting can be done individually or collectively. In the case of collective harvest, the head of the village announces the day of the harvest. After harvest the seeds are initially dried for a few hours, peeled and then given a final drying of 2-3 days.

Traders are mostly interested in white cardamom, but its availability is limited. Normally the villagers mix white and red cardamom for selling. Since it is easy to distinguish the varieties, the traders are aware of the mixing that takes place. Cardamom starts producing fruits when it reaches three years of age and then produces fruits every second year. In Ban Kachet cardamom is only gathered from the forest; it is not cultivated.

Paper mulberry (*Broussonetia papyrifera*) **bark:** The production of paper mulberry bark has increased significantly in recent years. In Ban Kachet its economic importance is comparable to that of benzoin. Mulberry bark is the raw material traditionally used to produce a type of wrapping paper used for all kinds of products. Currently, a large portion of the bark is exported to Thailand where it is processed into high quality paper and sold to other countries, mainly Japan. The smaller local production of paper is, in addition to its traditional uses, often sold in various forms to tourists.

The raising of paper mulberry is possible in two ways: in plantations or in the forest. People in Ban Kachet grow mulberry in the forests under a low intensity system. The prices the growers received for the bark in 1997 ranged from 500-800 kip/kg, depending on the grade. Paper mulberry is one of the most promoted products in Luang Prabang province and Ban Kachet seems to have a good potential for expanding its production.

Bamboo and rattan: Bamboo is probably the most important forest/ fallow product. The large number of bamboo species allows ample uses, with more emphasis on subsistence use. Several finished and semi-finished bamboo products (mats, baskets, thatch etc.) are made and, to a limited extent, sold. A similar statement can be made for rattan. The uses vary from construction material to shoots as subsistence food and for sale. Rattan seeds are a recognized source of cash income in Ban Kachet, bringing 600 kip/kg.

Mak khaen *(Zanthoxylum rhetsa)***:** *Mak khaen* is a tree fruit seed used as a condiment. Very little labour is needed for its harvest; in that sense it is an interesting product for the people of Ban Kachet. One tree yields about 5 kg of seeds; trees start bearing fruit at the age of 5-6 years. To harvest the fruit the tree is felled; for that reason mak khaen is becoming increasingly rare. After fruit harvest the seeds are removed and dried.

Mak kha (*Alpinia malaccensis*)**:** Both the fruits and the root of this herb can be used. The fruits are mainly collected and sold to Chinese traders; the villagers themselves do not use the fruit. The root is both for subsistence use as a spice, and sold, bringing 50 kip/kg. The plant shoots are a local food item. *Mak kha* is common in the village area and easy to find. About one third of the villagers collect the fruits during harvest season in October. Post-harvest processing consists of cooking and drying.

Broom grass (*Thysanolaena maxima*)**:** Broom grass (*Khaem* in Lao) represents a fallow plant more than a classic NWFP, but it plays an important role as a source of cash income. The harvest period extends from January until March. The 1997 farm-gate price for broom grass was 800 kip/kg; in Nam Bak it was 1,200 kip/kg.

3.2.3.4 Horticulture and livestock

All families cultivate home-gardens. However, the garden size is always extremely limited, as are the number and quantity of plants that are cultivated. Due to the location of Ban Kachet on a mountain saddle, it is difficult to increase the home garden area close to the village. The most common garden plants are ginger, pumpkin, eggplant, chili, long bean, cucumber and job's tears.

Six Ban Kachet families cultivate fruit trees on a very small scale (a few trees per garden). The following fruit trees can be found: tamarind, orange, papaya, peach, mango, pomelo, jackfruit, banana, guava and coconut.

Livestock, in particular larger animals such as cattle or buffalo, are an indicator of wealth. Animal diseases are frequent and at the village level there is no animal health volunteer. There is much disease and death, especially among chickens and pigs. The small number of chickens in April 1997 was caused by an epidemic. Cattle and buffalo graze freely in the areas around the village; pens are uncommon. Pigs also roam freely in the village.

3.2.3.5 Off-farm activities

Trade: Business activities are limited in Ban Kachet. Two shops offer a limited variety of necessities for daily life. One family acts as a trader for agricultural and forestry products on a relatively larger scale than the others. Three rice mills offer their services and evening entertainment is provided by one family which shows video films.

Handicrafts: Most of the goods produced by the villagers such as baskets, mats and woven bags are largely for subsistence use. Trade in these products is little developed; selling occurs sporadically. Five men are skilled as blacksmiths.

There are a number of raw materials or semi-finished products with existing marketing possibilities. Most of these are collected from the forest or fallow fields and sold to traders who regularly visit the village. The production and selling of roofing material (thatch) of bamboo and rattan leaves and of the grass *Imperata cylindrica* has reached the level of a cottage industry in Ban Kachet, mainly because of its easy access for traders.

Wage labour: It is not uncommon for men to seek employment when there is minimal work to do on their own farms. Traditionally they are hired by farmers from neighbouring villages, mainly those belonging to the Hmong ethnic group.

3.2.4 Family living standards

Three different economic groups were identified in Ban Kachet and they can be characterized as follows.

The first group is made up of the very poor families which have a limited labour force. The general reasons for their status are: 1) there are children who are too young to work with their parents and to contribute to the family labour needs; 2) the family is headed by a widow; or 3) drug addiction of the father. The general consequence of one or more of these reasons is rice insufficiency for several months per year.

Because these families have no available savings, only a small investment in livestock is possible. The risk of raising animals can be taken only for a few chickens and one or two pigs.

The main source of cash income is from NWFPs. Because benzoin collection requires male labour, tapping is uncommon within the poorest families of Ban Kachet, if they own styrax forests at all. The second important income sources are from certain agricultural and horticultural products like chili or sesame. Some individuals in very poor families hire themselves out as labourers in other villages.

Poor families represent the second economic group in Ban Kachet. The majority of families in this economic group presently or formerly tapped benzoin. All other characteristics of the poor family group are between the two extremes described above and below.

Moderately wealthy families comprise the third economic group. Besides the parents, older children contribute labour to the family's activities. Members of some families may have other occupations such as policeman, trader or shop owner. Under those circumstances, cultivating upland areas is not of such high importance to families in this group. Moderately wealthy families have sufficient money or sell some livestock to buy the rice needed in the periods of rice shortage. One family has no upland cultivation area at all.

Livestock is of higher importance than in the very poor and poor groups. Beside poultry and pigs they own buffalo, cattle and goats. NWFPs still play a role in the family economy, but they are not as important as for the less fortunate families. Benzoin is tapped by only one moderately wealthy family.

Families in this economic group have alternatives in earning cash incomes. Working with NWFPs, apart from trading, is not attractive enough for them.

3.3 Ban Sang La Dtai village

3.3.1 Physical conditions

3.3.1.1 Geographical location

Ban Sang La Dtai is much more difficult to reach than Ban Kachet. It is located about 15 km northwest of Nam Bak town and far from any road. From Nam Bak town it takes one day travelling by boat or foot to reach Ban Sang La Dtai. The distance from Ban Kachet is 16 km in a northern direction.

The elevation of the village area ranges from 450 m to more than 1,000 m above sea level. The village itself is located at about 900 m. The exact boundaries and extent of the land area the village owns are not known. The district administration plans to start land allocation soon. Part of the process will be the demarcation of village boundaries.

3.3.1.2 Topography and climate

The topography and climatic conditions are very similar to those of Ban Kachet and for that reason are not repeated here. The main difference in terms of climate is a lower average temperature due to the higher elevation.

With regards to soils, the basic conditions are assumed to be similar to Ban Kachet, but no data are available. The main differences are due to human activities. Because the fallow period is considerably longer in Ban Sang La Dtai, the average soil fertility is assumed to be higher.

3.3.2 Socio-economic conditions

3.3.2.1 Village history

Ban Sang La Dtai is an old village like Ban Kachet. In the late 1960s, due to its exposed location, Ban Sang La Dtai suffered from heavy bombing during the Viet Nam War. For that reason the villagers decided to move to a safer area downhill. In 1971 most of the families came back and re-established the village.

3.3.2.2 Demography

In May 1997, the population of Ban Sang La Dtai was 154 people in 28 households (23 families). The average number of people per household is 5.5, similar to Ban Kachet. The sex distribution is also similar: 55% (84 persons) are male and 45% (70 persons) female. A total of 58 individuals (38%) belong to the active labour force of the village: 28 women and 30 men. All inhabitants belong to the Khamu ethnic group (Lao Theung).

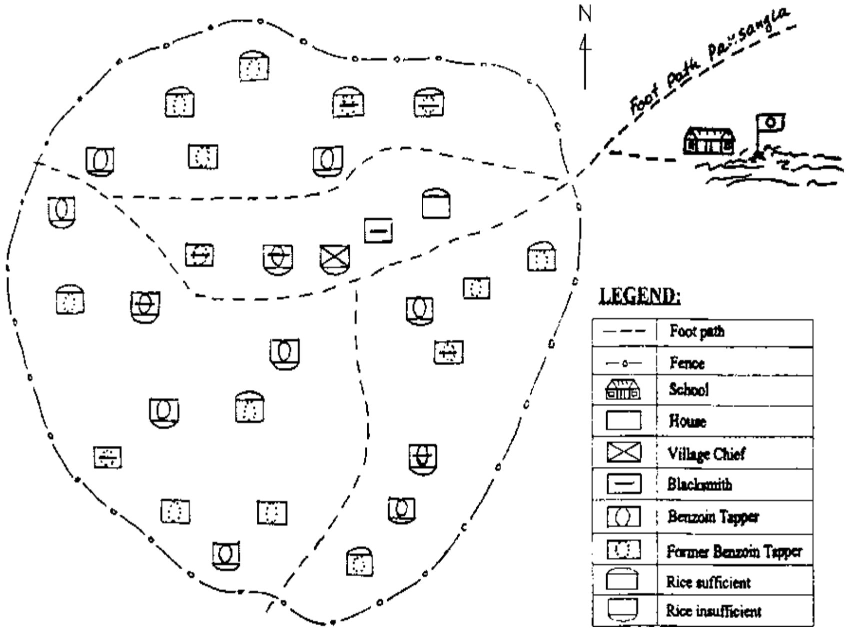


Figure 3.3 Map of Ban Sang La Dtai

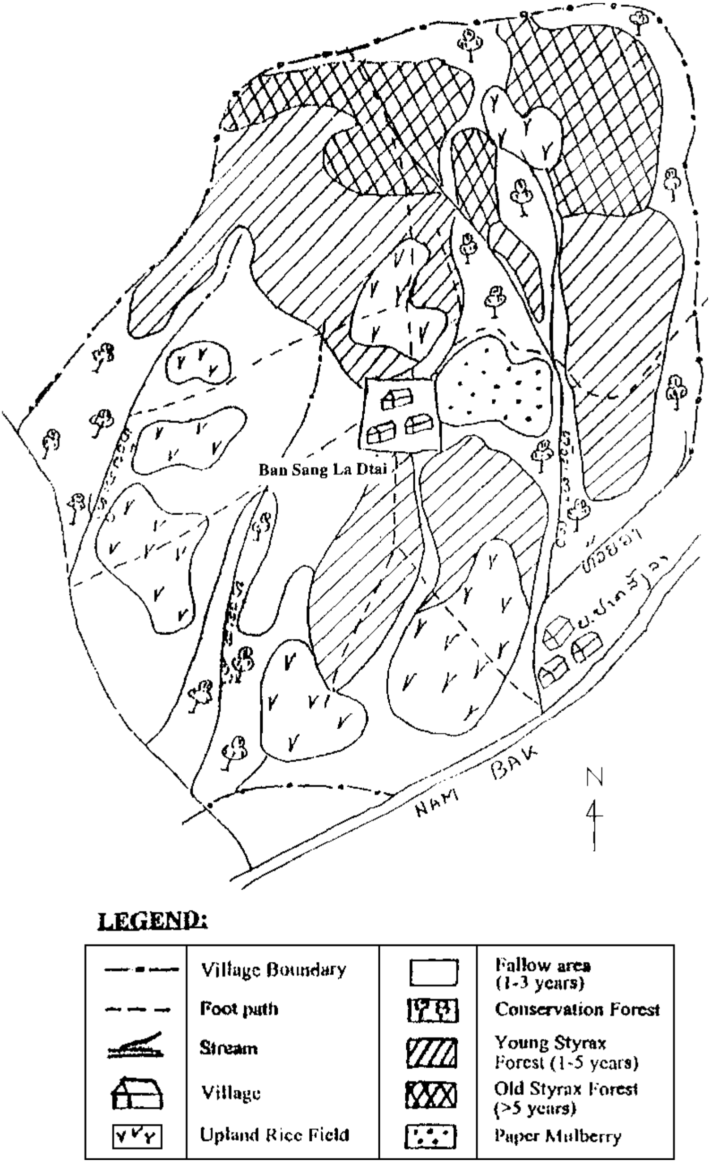


Figure 3.4 Ban Sang La Dtai – Land Use

3.3.2.3 Village organization and education

The village organization is similar to Ban Kachet. However, because of its considerably smaller size, it is not subdivided into groups.

The existing village school teaches children in the first four grades. To attend classes beyond the fourth grade, children have to go to Nam Bak town.

3.3.2.4 Health and nutrition

Eleven households (40%) suffer from rice shortages from June or July until October. The other families have sufficient quantities for the entire year. This represents a higher level of rice sufficiency as compared to Ban Kachet.

The most common health problems are malaria, diarrhoea and red-eye disease. The nearest available health service is located in Nam Bak town.

3.3.2.5 Infrastructure

Accessibility: There is no road access to Ban Sang La Dtai. The only way to reach the village overland is by a footpath from the next village of Ban Pak Sang La, which is situated at the Nam Bak (Bak River). From there to Ban Sang La Dtai it takes about 2-3 hours, depending on the season. Ban Pak Sang La can be reached from Nam Bak town either by boat (3-4 hours) or on a footpath (6 hours).

Markets: Unlike Ban Kachet, there are no direct marketing possibilities. Since the village is difficult to reach, no traders visit there to buy commodities. Some traders do come to Ban Pak Sang La to collect goods. However, the main market for buying and selling goods is Nam Bak town.

As a result of the difficult transport conditions, the marketing of agricultural products is limited to commodities which are light in weight and easy to transport, such as cardamom, benzoin, mak kha, mak khaen, mulberry bark, broom grass, sesame and chili.

Water: There are seven sources of water in the village area. The closest stream is 10 minutes walking distance.

3.3.2.6 Land tenure and use

Land allocation has not yet taken place, although it is planned for the near future. Land is still managed in the traditional way without legal land tenure. Initially, the elders decide about the land area to be given to each family. The general pattern is that a family receives 0.5 ha for each family member who can provide labour. Once a family has received land it becomes their individual land. The decision about clearing for agriculture is made by the family, but the fallow period should not be less than 5 years.

Each family owns a number of different small plots (ten or more). Each year one area is cleared, burned and cultivated. The fallow period is therefore at least 10 years, allowing the soil to regain its fertility.

Pressure on the land is relatively low; land is available and land conflicts are uncommon. It is possible to bring under cultivation new land which is not being used by another family. However, medium-term fallows are preferred because of the lower labour input necessary as compared to older areas stocked with larger trees. As in Ban Kachet, styrax forests are owned individually, whereas other forest products are free for the taking to anyone living in the village area.

The land use patterns are the same as in Ban Kachet; however, land use is not as intensive in Ban Sang La Dtai. The relatively large area of Conservation Forests and fallow land is one indication of low intensity. Unlike in Ban Kachet, paper mulberry is cultivated separately on a plantation close to the village.

3.3.3 Economic activities

3.3.3.1 Sources of cash income

Table 3.9 presents a ranking of the sources of cash income. There are strong similarities to the results from Ban Kachet. The importance of non-wood forest products is very pronounced. Compared to Ban Kachet, NWFPs are even more important, whereas agricultural products are less important.

Cardamom ranks first, as it does in Ban Kachet, whereas benzoin is more important than in Ban Kachet, ranking second. Heavier agricultural products (rice, taro, ginger) and more perishable products (vegetables) are ranked lower. This is a consequence of the remoteness of the village, difficult transport conditions, as well as the large forested areas surrounding Ban Sang La Dtai.

Table 3.9 Ranking of the sources of cash income from agricultural and forest products

Rank	Product
1	Cardamom
2	Benzoin
3	Paper mulberry, broom grass
4	Mak kha
5	Mak khaen, bamboo shoots
6	Rattan seeds, rattan
7	Chili, sesame
8	Ginger, rice
9	Taro, vegetables

The calendar of the income sources is shown in Table 3.10. Once again, the situation is very similar to Ban Kachet. Income from selling the most prominent NWFPs (cardamom, benzoin, paper mulberry, broom grass) comes during the portion of the year when there are scarcely any other income sources.

Table 3.10 Calendar of income sources

Calendar-Months		Income sources
International	Khamu	
1	2	Poultry, bamboo shoots, ginger
2	3	Broom grass, paper mulberry, bamboo shoots
3	4	Benzoin, paper mulberry, bamboo shoots, broom grass
4	5	Benzoin, vegetables, paper mulberry, rice
5	6	
6	7	
7	8	Cardamom
8	9	Cardamom; rattan seeds
9	10	Mak kha; rattan seeds
10	11	
11	12	Sesame; mak khaen; chili
12	1	Chili, sweet potatoes

The calendar for labour input is shown in Table 3.11. The activities listed closely coincide with those from Ban Kachet. The level of labour input reflects differences. The labour input needed between the fifth and sixth month (International Calendar) is much higher in Ban Kachet than in Ban Sang La Dtai. This is the period when weeding is the primary work. One explanation for this difference is more vigorous weed growth in Ban Kachet than in Ban Sang La Dtai because its shorter fallow period retains more weed seeds in soils. The remaining differences are not pronounced enough to be able draw conclusions from them.

3.3.3.2 Agricultural production

Agricultural production patterns in Ban Sang La Dtai are similar to those of Ban Kachet, but the subsistence level is more pronounced. Selling of agricultural commodities such as sesame, chili, sweet potatoes, ginger, cucumber and rice is common. Table 3.12 shows the division of crops for sale and subsistence.

Table 3.11 Calendar of Labour Inputs

Calendar-Months		Level of labour input
International	Khamu	Low => Medium => High
1	2	Build house; Knife production, Searching/selecting fallow for cultivation
2	3	Slash fallows; Harvest paper mulberry, broom grass, & bamboo shoots
3	4	Harvest benzoin & paper mulberry; Building house; Fencing
4	5	Burning fallows; Fishing
5	6	Clearing fallows; Growing rice, corn & chili; Fishing
6	7	Growing rice, Weeding; Fishing; Growing sesame
7	8	Weeding; Harvest cardamom; Hunting
8	9	Weeding; Harvest cardamom and rattan seeds; Tap benzoin
9	10	Tap benzoin; Harvest corn, mak kha & rattan seeds
10	11	Tap benzoin; Making baskets; Harvest rice; Hunting
11	12	Harvest rice, mak khaen, sesame & chili; Hunting
12	1	Khamu New Year festival; Build rice store

Table 3.12 Subsistence and cash crops

Subsistence crops (mainly)	Cash crops
Upland rice (glutinous)	Sesame
Taro	Chili
Corn	Sweet potatoes
Cassava	Ginger
Pumpkin	Cucumber
Job's tears	
Eggplant	

The fallow period in Ban Sang La Dtai ranges between 10 and 15 years. Upland rice yields per ha vary between 1.0 and 2.0 tonnes which is considerably higher than in Ban Kachet, most probably because of the longer average fallow period.

The villagers confirmed that opium production was undertaken until a year ago, when it was banned by the district authorities.

Every family has a home garden in which the above mentioned vegetables are produced, but in a limited manner. Fruit trees are uncommon in Ban Sang La Dtai.

Regarding livestock, ten households own one or more buffalo and cattle are frequent. The number of pigs and poultry per family is considerably higher than in Ban Kachet. The general livestock situation is better than in Ban Kachet.

3.3.3.3 Forest products

Larger diameter wood is available in more remote and steep slope areas and supplies are adequate. Just as in Ban Kachet, wood is not of economic relevance for the villagers.

The NWFPs collected, their uses and processing are very similar to Ban Kachet. As mentioned above, they are more important as sources of cash income than in Ban Kachet and benzoin tapping is of greater importance. The villagers sell the marketable NWFPs at the neighbouring village of Ban Pak Sang La.

Benzoin: Until 1995 almost the entire village tapped benzoin (26 of 28 households). Since then, 15 households have abandoned tapping, mainly because of the fall in prices in recent years. Nevertheless, the 40% of the families still tapping is comparatively high.

There are at least five reasons to explain why the intensity of benzoin tapping has remained relatively high in the village. First, a lack of alternative sources of income (beside other NWFPs); second, sufficiently mature styrax forests are available; third, high yields (benzoin production at this elevation is high); fourth, benzoin storage is not a problem; and fifth, comparative ease of transport.

Benzoin tapping has a tradition going back many generations. Every family owns some styrax forest. Nine households each own about 10 ha of styrax forest and five households about 4 ha each. At the time of the survey 11 families were tapping benzoin.

Because the fallow period in the area of Ban Sang La Dtai is considerably longer than in Ban Kachet, trees aged up to 15 years are also tapped. The maximum tapping life of a tree is 7-8 years. However, at about age 13, productivity is said to decrease considerably.

The nearest styrax forest to the village is about two hours walking distance. The highest yield of benzoin per family in 1997 was 10.5 kg.

3.3.3.4 Off-farm activities

In the village, off-farm activities are limited. Seven men work part-time as blacksmiths and three women produce woven bags for use within the village.

Due to the remote location of the village, the people of Ban Sang La Dtai have very little to do with producing semi-finished products such as thatch, as is the case in Ban Kachet. There are no trading activities and wage labour is uncommon.

3.3.4 Family living standards

The general family living standards described for Ban Kachet are also valid in Ban Sang La Dtai. However, there is not such a pronounced differentiation among the families. Since off-farm activities are limited, all families are active in upland agriculture and gain most of their regular cash income from collecting and selling NWFPs. According to the economic classification criteria used for Ban Kachet, the majority of the families in Ban Sang La Dtai fall into the second group, i.e. poor families.

Benzoin tapping is not so clearly related to any economic group as it is in Ban Kachet. Since few alternatives to earn money are available, somewhat better-off farmers also tap benzoin. Apart from individual economic considerations, the availability of sufficient male labour is one important factor favouring benzoin tapping.

3.4 Conclusions: the village context of benzoin production

Benzoin and other NWFPs are essential components of the livelihood systems of rural populations in northern Lao PDR. NWFPs provide raw materials for a range of purposes for subsistence use and for sale. For the poorer segments of the population they offer one of the few possibilities for earning cash. This income is important because it allows villagers to bridge the annual period of rice deficiency and improve their diet.

Because this income source is so important, it is worthwhile to examine closely the following: 1) other NWFPs which are already being used by the people in the villages, but have not been commercialized; 2) the potential for the cultivation or management of interesting NWFPs; some products such as *mak khaen* are becoming scarce; 3) possibilities of further processing of NWFPs at the village level, which is currently limited to cleaning and sorting.

The situation described in Ban Sang La Dtai is characteristic of benzoin production conditions in northern Lao PDR. The majority of the benzoin-producing villages are similar in being isolated and remote.

Ban Kachet has a development asset due to its good road infrastructure. For that reason the possibilities for off-farm activities are significantly higher, as well as opportunities to sell agricultural products and NWFPs.

However, the increasing land pressure in the area of Ban Kachet may be a consequence of this better accessibility.

The overall objectives of land allocation are to control shifting cultivation and reduce pressure on forest resources. However, the cultivation practices of villagers have not changed despite the reduced land area available. This situation carries with it the risk of unsustainable land management.

Other development problems facing Ban Kachet and Ban Sang La Dtai, and villages in northern Lao PDR in general, are: 1) increasing population pressure; 2) poor health and nutrition conditions; 3) poor education opportunities; 4) lack of support services for agriculture, horticulture and livestock production; and 5) limited job opportunities outside agriculture.

Photo 3.1 Project work in the field with villagers of Ban Kachet.

Chapter 4. Improved silviculture of Styrax tonkinensis

4.1 Review of *styrax tonkinensis* silviculture

This review is based on published literature as well as consultations and field visits to Lao PDR in 1996 and 1997.

4.1.1 A brief account of the species

Styrax tonkinensis is a deciduous tree up to 25 m tall and 30 cm in diameter with a clear bole for about two-thirds of total tree height. The bark is generally gray, smooth, and 6-9 mm thick when young, but becomes brown and rough with longitudinal fissures with age. Trees are light branching, with branches more upright towards the top. Young trees have a dense crown which occupies up to two-thirds of tree height.

Trees reach sexual maturity at 4-5 years of age. Flowering and fruiting times vary with location. Flowering usually occurs in May to June (sometimes until July), and fruit matures from September to November. When fully mature, each tree produces up to 40 kg of fruit per year. Each 2-3 kg of fruit contains 1 kg of seed. There are 8,000-9,000 seeds per kg.

The natural distribution of *S. tonkinensis* in Lao PDR encompasses the northern provinces of Phongsaly, Luang Namtha, Oudomxay, Luang Prabang and Houaphan, between latitude 20-22°N and longitude 101-105°E. The distribution also extends into the northern provinces of Viet Nam. In Lao PDR it occurs predominantly at 800-1,600 m elevation. Mean annual rainfall over most of its distribution ranges from 1,500 mm to 2,200 mm with only a few dry months. Mean annual temperature is from 15°C to 26°C. *S. tonkinensis* is light demanding; in open, burned-over areas it often occurs in the upper story.

The extension of the natural range of the species owes a great deal to human activities and its pioneer characteristics – the demand for light and its regular production of large quantities of viable seeds. It may occur in almost pure stands over many hectares. Many stands occupy sites previously cleared for shifting cultivation. Fire promotes and accelerates seed germination.

4.1.2 Natural regeneration

S. tonkinensis regenerates well in gaps, providing the undergrowth is not too heavy, as saplings are sensitive to competition. After this establishment phase, young trees will grow rapidly and dominate the site. In Viet Nam, when harvesting styrax forest for wood, 50-100 styrax trees per ha are left to provide seed. Some treatments (e.g. clearing undergrowth) may be carried out to promote seed germination and seedling growth. Additional seed is sometimes sown. Local people carry out periodic maintenance to retard the invasions of weeds, especially bamboo.

In Lao PDR, natural regeneration of *S. tonkinensis* is a function of the shifting cultivation cycle, but without any systematic silvicultural treatments. Old regrowth styrax forest is cleared and burned at the end of the dry season. Upland rice is sown at the beginning of the rainy season, normally in April or May. The styrax fruits, which fall during the clear felling, germinate in the rainy season and the dense seedling growth is thinned to about 500-600 stems per ha during weeding. It is harvested 4-6 months after sowing, depending upon the variety. Rice is grown for only a single season because the yield declines significantly if it is replanted in the following season. The harvested rice crop is chiefly for subsistence with any surplus bartered for other goods such as salt and kerosene. After the harvest, the plot is left untended and becomes very dense with a diversity of undergrowth competing with the styrax trees. In Nam Bak district, Luang Prabang province, benzoin tapping from styrax trees is initiated in year 6-7 and continues for 3-4 years or until production declines. The whole stand is then cleared and another cycle of regeneration begins.

Until less than a decade ago, the age at which old regrowth forests were cleared for rice cultivation was greater than 10 years, sometimes up to 14-15 years. This tradition has changed in recent years due to rapid population growth and the pressures exerted by villagers who need land for rice cultivation. Now more often, styrax forests are cleared at a much younger age and before the trees reach their full potential age for benzoin production, i.e. 7-8 years old. Often stands as young as 5 years old are cleared. This results in the loss of an important source of household income from benzoin tapping. However, in more remote areas, this change is less predominant.

4.1.3 Silvicultural systems

A comprehensive review of the silvicultural systems of *S. tonkinensis* in northern Lao PDR and Viet Nam was compiled by Pinyopusarerk (1994). The review revealed that there are no structured systems employed in Lao PDR; most styrax stands are the result of natural regeneration subsequent to the shifting cultivation cycle. In Viet Nam, silvicultural practices have been well developed and large areas of plantations have been established. However, assisted natural regeneration is also practised, though to a lesser degree.

4.2 Plantation silviculture in Viet Nam

Viet Nam is the only country known to be carrying out large-scale planting of *S. tonkinensis;* over 20,000 ha have been established. Silvicultural practices in Viet Nam have been documented by Lam Cong Dinh (1964), Le Quang Dang (1966), Hoang Chuong (1974), Doan Van Nhung *et al*. (1978), Nguyen Ba Chat (1979) and Anon. (1983). These authors describe techniques ranging from seed collection and handling, nursery propagation to field establishment and management. The following discussion of practices in Viet Nam is based upon the above citations.

4.2.1 Seed collection

Seed is not collected from the ground but picked from the tree because fallen fruit has poorer germinative capacity. In general the seed harvest period is from October to November. Ripe fruit is characterized by: 1) a silvery colour with pale white spots on the outer coat; 2) splits at the top of the fruit; and 3) a dark brown seed coat.

4.2.2 Seed storage

Storage of *S. tonkinensis* is not required if fresh seed is to be sown. If seed sowing is not anticipated within a few months after the collection, proper storage must be followed to preserve viability. Maintaining the moisture content of the seed at 30% has been recommended. The simplest method is to put the seed in running water or store it in a mixture with wet sand (1:1 ratio) and place the mixture under shade with good ventilation. Seed may be stored under this condition for up to 1 year by turning the mixture once a month and keeping the mixture moist by frequent spraying with water.

4.2.3 Planting stock

Plantations are sometimes established by direct sowing of five to seven seeds into a prepared hole. The germinated seedlings are thinned to leave only one plant per hole. However, this method is uneconomic and a lot of seed is wasted.

Planting with nursery-raised tubed seedlings is a more common practice in Viet Nam. Seeds are sown onto germination beds, which are kept continually moist during the germination period. Fresh seeds germinate within 2 weeks. Germinated seeds are transplanted, when the cotyledons have fully unfolded, into tubes containing loamy forest soil and river sand (1:1 ratio). They are protected from full sunlight until the first two seedling leaves appear. The seedlings should be kept in the nursery for three months before out-planting in the field.

Planting stock prepared from seedlings raised in nursery beds for 10-12 months is sometimes used for plantation establishment in Viet Nam. Seedlings 1-1.5 m tall and 1-2 cm in diameter at the root collar are removed from nursery beds at planting time. The stem is cut off 3-5 cm above the root collar and some of the lateral roots are trimmed from the tap root.

4.2.4 Field planting

Regardless of the type of planting stock used, site preparation follows the same routine. Ground vegetation is cleared, left to dry and burned. A strip of vegetation 10 m wide is retained around mountain ridges if the slope is 25-30°. Furthermore, if the slope is more than 100 m in length, additional 5-10 m wide strips of vegetation are retained, with spacing of 50-100 m, following the contours.

Various initial planting densities are used in Viet Nam, depending on the site quality, planting stock and demand for wood. These densities are: 1) 1,600-2,000 stems per ha where the soil is fertile, well drained and not subject to erosion; 2) 2,000-2,500 stems per ha if the soil is relatively fertile and well drained but may be subject to erosion; and 3) 2,500-3,300 stems per ha in cases where soil fertility is low and there is poor drainage or erosion anticipated. The high density is also suitable where the demand for fuelwood and small wood is high.

4.2.5 Maintenance and care

4.2.5.1 Weeding

In the first two years, styrax plants are ideally kept free of weed competition by regular removal of adjacent ground vegetation. For older plantations, maintenance generally consists of clearing climbers and unwanted surrounding vegetation on an as-needed basis.

4.2.5.2 Fertilizer

The main objective of fertilizer application is to promote early growth and a uniform plantation tree population. Nitrogen fertilizer should be applied immediately after out-planting to help the new seedlings establish themselves within the shortest possible time. The recommended application rate is 60 g N of fertilizer per tree, divided into three applications of 20 g each.

4.2.5.3 Thinning

Thinning forms part of the routine management in styrax plantations because of the high initial stocking rate at establishment. Two to three thinnings may be required before the plantation reaches the minimum rotation age of 10 years. Final stocking density is generally 600-800 stems per ha.

4.2.6 Growth

S. tonkinensis is fast growing and under favorable conditions can attain annual height increments of 3 m during the first three years. A mean height of 18-25 m and DBH of 20-24 cm are obtainable at 10 years (Thai Van Trung, 1975). Such growth would give a wood yield of about 150 m^3 per ha based on final stand densities of approximately 600-800 stems per ha.

4.2.7 Insect pests

A defoliator, *Fentonia* sp. (Lepidoptera: Notodontidae), is reported to damage thousands of hectares of *S. tonkinensis* plantations in Viet Nam (Le Nam Hung, 1990). Control by chemical sprays has been recommended during the outbreak. An unidentified stem borer has also been observed on many trees growing in Nam Bak district, Luang Prabang province of Lao PDR.

4.3 Potential for genetic improvement

There are indications that genetic variation in *S. tonkinensis* may exist. Benzoin production has been observed to vary with the individual tree and according to elevation (Druet, 1924; Lam Cong Dinh, 1964). Trees growing at higher elevations are reported to produce more benzoin than those growing at lower elevations. Furthermore, styrax cultivators in Lao PDR and Viet Nam have observed that more benzoin is obtained from trees having dark brown, thick and rough bark than trees having light-coloured, thin and smooth bark. It is not known whether this difference is related to elevation, or if it is simply a matter of differences between small and large trees.

There have been no systematic studies of the genetic variation in *S. tonkinensis*. The only evidence of such an attempt appears to be in a report on a small provenance trial in Viet Nam (Nguyen Thai Ngoc, 1989). That study, however, compared only three sources from a narrow range in Viet Nam and did not show significant provenance differences. In light of the observed variation in yield of benzoin between different individual trees and elevations, it is appropriate that a systematic assessment be made to confirm such a variation if it exists. Given the availability now of effective and rapid methods of chemical analysis, and relevant precedents provided by research on other species, there is a real possibility that varieties of *S. tonkinensis* with high yields of high quality benzoin could be quickly developed through a tree improvement programme.

Improved production of benzoin through identification of superior seed sources and improved silvicultural management techniques will provide a variety of benefits. Villagers will be better off economically. Increased benzoin production per individual tree means that the land area required to produce the same quantity of benzoin is less, thus allowing more land area for cultivation of subsistence and cash crops over an extended period, and reducing the pressure on villagers to open up more natural forests.

An improvement programme for any tree species is, however, costly to implement, takes a long time to obtain meaningful results, and requires a continuing commitment of skilled staff. Therefore, careful consideration must be exercised before embarking on a potentially costly tree improvement programme. In particular, the benefits and costs of such a programme must be clearly analyzed.

4.4 Provenance trials

Two provenance trials, each consisting of 12 seed sources, were established in Nam Bak district in July 1997, the first at Ban Kachet (800 m) and the second at Ban Thali (400 m).

4.4.1 Layout and experimental design

4.4.1.1 Site preparation

The Ban Kachet trial site was cleared of ground vegetation without burning in May 1997. The plot was used to plant one crop of upland rice in the 1996 season. Marking out of the trial was done as follows: 1) block corners were marked with large wooden posts (15 cm diameter); 2) plot corners were designated with small wooden posts (10 cm diameter); and 3) planting positions were established with bamboo sticks.

The Ban Thali site was cleared of brush and burned at the end of May and early June. This was followed by marking out in a similar fashion to that for the Ban Kachet trial.

Both trials were fenced with three strands of barbed wire to keep out livestock.

4.4.1.2 Experimental design

The experimental designs for the two provenance trials were based on 12 provenances in four replicates, 25 (5 x 5) trees per plot and 3 x 3 m spacing. The total area of each trial was 1.5 ha.

Different experimental designs were employed. The area at Ban Thali permitted all replicates to be kept together in one rectangular block. A latinized row-column design (Williams and Talbot, 1993) was used for this site. The 12 provenances were arranged in two rows of six plots each, and the four replicates were staggered on top of each other (see Figure 4.1).

For the trial at Ban Kachet, due to the steep, mountainous terrain, it was not possible to keep all four replicates together in one rectangular block. As a result, a decision was made to use a row-column design (Williams and Talbot, 1993) where the first three replicates were kept together and separated from the fourth replicate. In this plot, the 12 provenances in each replicate were arranged in three rows of four plots each (see Figure 4.2).

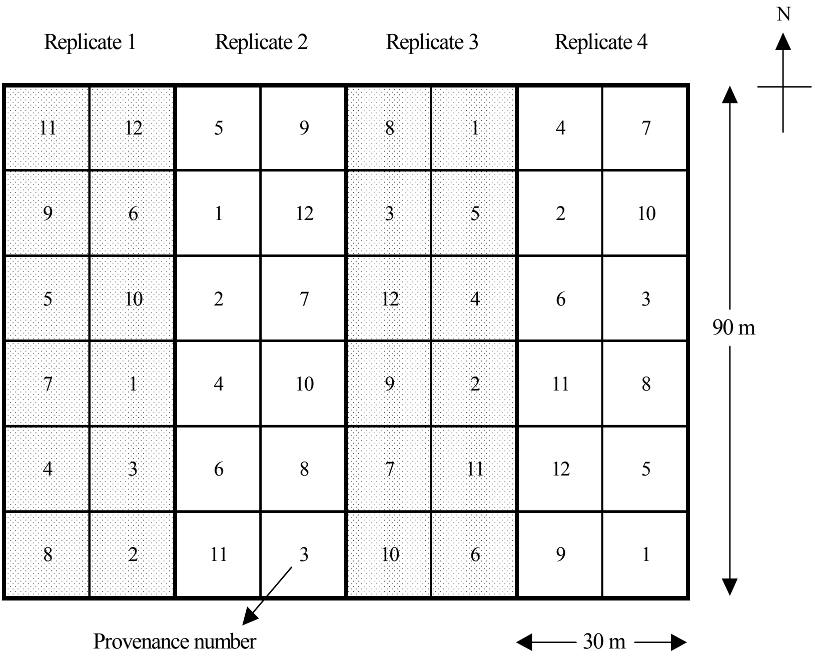


Figure 4.1 Field layout of *S. tonkinensis* provenance trial at Ban Thali

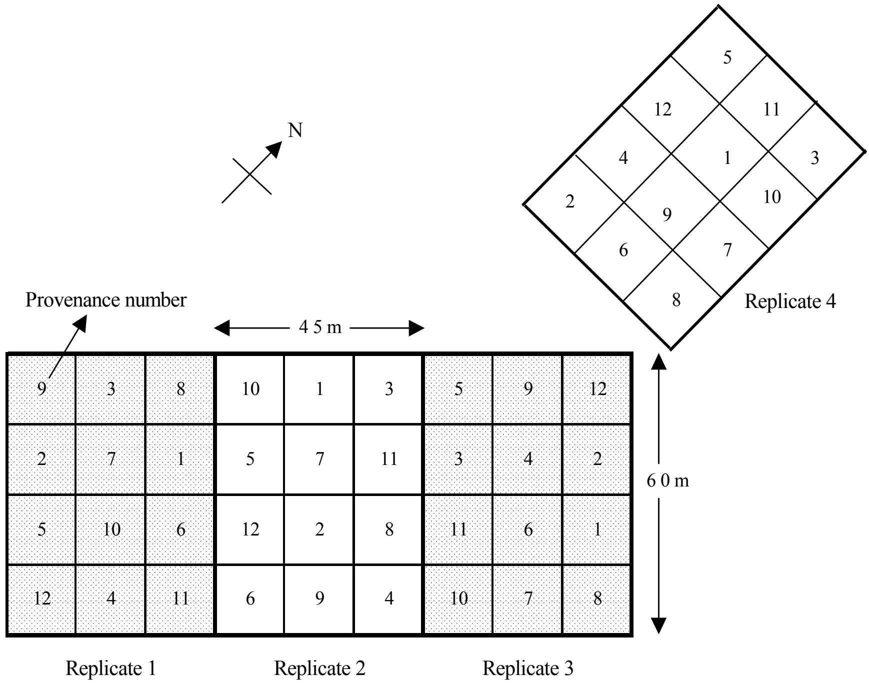


Figure 4.2 Field layout of *S. tonkinensis* provenance trial at Ban Kachet

4.4.1.3 Field planting

The Ban Kachet trial was planted on 1-2 July, and a few days later the Ban Thali trial on 5-6 July 1997. Seedlings were planted in pre-dug holes 25 cm deep and 25 cm wide. The weather was overcast with light rain throughout the whole planting period.

Planting was carried out under close supervision, starting with one replicate and worked through all the 12 plots (seedlots) before beginning the next replicate. Seedlings in one plot were planted before commencing the next plot. All plots in the same replicate were planted on the same day. Two replicates were planted in one day.

A starter-dose of fertilizer (NPK 16:20:0), 50 g for each plant, was applied within one month of planting. The fertilizer was dug in 15 cm from the plant on both sides across the slope. Fertilizer application is aimed at uniform establishment of seedlings at the initial stage.

Dead or badly desiccated plants were replaced with surplus stock of the same provenance. Crickets (*Brachytrupes portentosus*) were observed to nip the stem of a few plants. An initial survival check 10 days after planting indicated that the replacement of dead plants would be minimal.

4.4.1.4 Post-planting care

Fire protection

Dry grasses and other herbaceous plants were cut and removed from the experimental area at the beginning of the dry season. The trial at Ban Thali was deemed to require possibly extra care during the dry season; firebreaks are recommended for this site. Controlled burning was not recommended, as the styrax plants were still too young.

Weeding

Three weedings were anticipated in the first two years. Subsequently, the frequency of weeding was to be on an as-needed basis.

4.4.1.5 Characters to be measured

Provenance trials are generally long-term in nature and require at least one half to two-thirds of the species rotation to obtain reliable results. The *S. tonkinensis* provenance trials were planned to run for seven years during which two types of data would be collected: 1) growth (height and stem diameter); and 2) benzoin production. The frequency of measurements is provided in Table 4.1.

Height refers to the total tree height to the nearest 1 cm at the 6-month and 1-year measurements, and to the nearest 10 cm from year 3.

Diameter at breast height refers to the stem diameter taken at 1.3 m from ground level and is measured to the nearest 0.1 cm.

Table 4.1 Characters and frequency for measurement in *S. tonkinensis* provenance trials

Character	Time table of measurement
Growth	
- *Height*	1. July 1997 (initial height, 2 weeks after planting) 2. January 1998 (6 months after planting) 3. July 1998 (1 year) 4. July 2000 (3 years) 5. July 2002 (5 years) 6. July 2004 (7 years)
- *Diameter at breast height*	1. July 1998 (1 year after planting) 2. Thereafter in conjunction with height measurements
Resin production	
- *Tapping*	1. September 2002 (about 5 years) 2. September 2003 (about 6 years) 3. September 2004 (about 7 years)
- *Harvest*	1. March/April 2003 2. March/April 2004 3. March/April 2005

Benzoin yield for each tree will be measured with a reliable scale to the nearest 1 g. The best tapping method, which will be based upon results from processing research, will be employed, otherwise the Lao traditional tapping method will be used. The same tapping intensity (i.e. number of cuts) will be made in each tree. A qualified laboratory should be contracted to carry out chemical analysis of the benzoin. It is possible that the chemical constituents may vary among the trees within and between provenances.

A data collection form was designed for the *S. tonkinensis* provenance trials. The form was organized in such a way that the data for each plot of 25 trees fits on a single page. Additional data from subsequent measurements can be updated on the same data sheet corresponding to each respective plot.

The origins of the seed planted in the trials are given in Table 4.2.

Table 4.2 Details of provenances of *S. tonkinensis*

Prov. No.	Country	Province	Town/ District	Sub-district	Village and mountain range	Latitude (N)	Longitude (E)	Elevation (m)	No. of trees	Age of stand (years)
1	Viet Nam	Yen Bai	Yen Binh	–	–	21°35’	105°00’	100	10	7
2	- do -	Phu Tho	Thanh Son	–	–	21°13’	105°11’	50	10	9
3	Lao PDR	Luang Prabang	Nam Bak	Phu Kur	Ban Kachet - Ban Huai Pha	20°34’	102’°22’	700-800	8	8
4	- do -	- do -	- do -	Nam Sud	Ban Pong - Ban Muan - Ban Moklamtan	20°28’	102°15’-102°18’	800-900	24	9
5	- do -	- do -	- do -	Nam Miang	Ban Saen Khan - Ban Pak Miang	20°40’	102°20’-102°23’	600-700	15	10
6	- do -	- do -	Muang Ngoy	Sam Sum	Ban Sam Sum - Ban Sum Phu	20°58’	102°41’	700	16	10
7	- do -	- do -	- do -	Sam Muen	Ban Sam Muen - Ban Huai Si	20°54’	102°49’	880-1,000	15	9
8	- do -	Houaphan	Xam Nua	–	Ban Sa Loei	20°15’	104°03’	920	5	10
9	- do -	- do -	Xam Tai	–	Ban Sa Kan	20°00’	104°30’	700	3	8
10	- do -	- do -	Houa Muang	–	Ban Na Siu	20°10’	103°49’	900	4	6
11	- do -	Luang Namtha	Muang Long	–	Ban Nang	20°50’	100°50’	930	19	20
12	- do -	Oudomxay	Muang La	–	Buam Som/Phu Ngam	21°00’	102°25’	850	6	8

4.4.1.6 Early results of provenance trials

The survival rates of seedlings in the trials varied among provenances and between planting sites.

Table 4.3 summarizes the survival of the provenances at both sites three months after planting. The trial at Ban Kachet (the higher elevation site) had less than 10% mortality while that at Ban Thali (the lower elevation site) suffered approximately 30% mortality.

All 12 provenances in the Ban Kachet trial had a good-to-excellent survival rate, with provenance means ranging from 82-99%. It is interesting to note that a local provenance (No. 3 Ban Kachet) had one of the two lowest survival rates (mean 83%). The other poor surviving provenance, No. 5 Nam Miang (82%), was also from Nam Bak district. Although the trial was fenced with three strands of barbed wire, village goats had managed to slip through causing some deaths amongst the plants.

At Ban Thali, all three provenances from Nam Bak district (Nos. 3, 4 and 5) had very poor survival rates (54-68%). Other poor surviving provenances included Phu Ninh, Viet Nam (No. 2). The best provenances in terms of survival were those from Houaphan province (Xam Nua, 84%, Xam Tai, 90%). It should be noted that barbed wire on the western side of the experiment (Replicate 1) was stolen twice over two months. Before the missing barbed wire could be replaced, many plants on that side had been damaged by cattle and this might have resulted in a higher mortality in Replicate 1. Nevertheless, overall survival at Ban Thali (72%) was poorer than that at Ban Kachet (92%).

Crickets were observed to bite off the stem of newly-planted seedlings at both trial sites, causing some plants to die.

Table 4.3 Mean survival rates of *S. tonkinensis* in provenance trials at Ban Kachet and Ban Thali assessed 3 months after planting

Prov. No.	Provenance	Ban Kachet					Ban Thali				
		Rep 1	Rep 2	Rep 3	Rep 4	Mean	Rep 1	Rep 2	Rep 3	Rep 4	Mean
	Viet Nam			(%)					(%)		
1	Yen Bai	100	100	96	100	99	64	76	84	80	76
2	Phu Tho	88	96	96	92	93	44	56	56	68	56
	Luang Prabang										
3	Phu Kur, Nam Bak	88	92	88	64	83	52	56	52	56	54
4	Nam Sud, Nam Bak	88	100	92	88	92	60	68	72	60	65
5	Nam Miang, Nam Bak	80	80	92	76	82	52	68	72	80	68
6	Sam Sum, Muang Ngoy	92	92	92	92	92	80	84	52	72	72
7	Sam Muen, Muang Ngoy	88	96	96	100	95	64	88	84	88	81
	Houaphan										
8	Ban Sa Loei, Xam Nua	92	96	88	100	94	76	92	72	96	84
9	Ban Sa Kan Xam Tai	96	96	100	100	98	76	96	88	100	90
10	Ban Na Siu, Houa Muang	96	96	88	88	92	32	52	88	84	64
	Luang Namtha										
11	Ban Nang, Muang Long	100	100	96	100	99	76	88	84	76	81
	Oudomxay										
12	Buam Som, Muang La	76	92	100	88	89	56	76	72	80	71
	Mean	**90**	**95**	**94**	**91**	**92**	**61**	**75**	**73**	**78**	**72**

Table 4.4. Mean survival, height and height increment at 6 months after planting of *S. tonkinensis* in provenance trials in Nam Bak, Luang Prabang

Prov. No.	Provenance	Ban Kachet						Ban Thali					
		Survival		Height		H. increment		Survival		Height		H. increment	
		(%)	Rank	(cm)	Rank	(cm)	Rank	(%)	Rank	(cm)	Rank	(cm)	Rank
1	Yen Bai, Viet Nam	62	8	64.0	9	13.5	12	31	6	81.8	3	41.4	3
2	Phu Tho, Viet Nam	52	10	58.5	10	14.4	11	12	11	65.9	9	37.3	5
3	Phu Kur, LP	48	11	55.7	12	24.1	9	9	12	59.1	11	35.1	7
4	Nam Sud, LP	65	6	71.2	7	28.4	8	22	9	63.5	10	29.4	11
5	Nam Miang, LP	35	12	57.0	11	31.3	6	25	8	73.1	8	32.3	9
6	Sam Sum, LP	55	9	74.1	6	33.9	5	17	10	56.2	12	23.4	12
7	Sam Muen, LP	75	5	96.2	2	37.0	3	54	3	89.3	2	37.4	4
8	Xam Nua, HP	79	3	84.0	4	28.8	7	55	2	81.3	4	33.9	8
9	Xam Tai, HP	87	2	97.2	1	34.3	4	63	1	99.7	1	35.7	6
10	Houa Muang, HP	77	4	86.0	3	48.4	1	44	4	79.4	5	52.6	1
11	Muang Long, LN	91	1	77.6	5	22.3	10	38	5	74.2	6	32.0	10
12	Muang La, OX	64	7	66.5	8	37.9	2	30	7	74.1	7	49.2	2
	Mean	**65.8%**		**74.0 cm**		**29.5 cm**		**33.3%**		**74.8 cm**		**36.6 cm**	
	s.e.d	7.3		8.3		8.5		9.1		7.4		7.8	

A general observation on height growth in the provenance trials found clear differences among provenances. The fast-growing provenances appeared to be those from Houaphan province. All three provenances from Nam Bak and two provenances from Viet Nam were among the slower growing seed lots. With a few exceptions, the provenances which had good survival also tended to grow well. The first height growth measurement of the trials was carried out at age 6 months after planting in January 1998. The result of this measurement is shown in Table 4.4.

The latest findings of the provenance trials are described in **Appendix 5**.

4.5 Agroforestry trial

One agroforestry trial using the alley-cropping system was established at Ban Kachet. Rice and peanuts were inter-planted between rows of styrax seedlings.

Soil samples collected from the experimental plot were analyzed by the Soil Survey and Land Classification Centre in Vientiane. The soil texture is loam to clay loam, very acidic, pH (H_2O) 4-4.5. The top 10 cm of the soil is moderately high in organic matter but very low in available phosphorus.

Survival and growth of the styrax plants in the agroforestry trial were poor, with more than 30% of plants being found dead or severely damaged. Crickets, village goats and poor root development of the seedlings were reported to have contributed to the high mortality. In order to maintain a full coverage of styrax trees in the trial, direct sowing of five or six seeds into each empty planting hole was carried out. Where styrax seedlings survived new seeds were sown at 20-25 cm away from the seedlings. Seed was collected from the current crop and sowing was completed in November 1997. The development of the old and new seedlings was assessed in February or March 1998.

The upland rice crop was also performing poorly and the yield was very low. According to the comments of villagers at Ban Kachet, inadequate site preparation and late sowing of rice seed may be the key factors contributing to the poor performance of the rice crop. Preparation of the experimental site was behind schedule due to a shortage of casual labourers because Ban Kachet villagers were busy working in their own farms. As a result, the experimental site was not burned after ground vegetation was slashed.

The first peanut crop, which was harvested in September 1997, was reported to be satisfactory. The second peanut crop was sown at the end of October.

The latest situation of the agroforestry trial is described in **Appendix 5**.

Photo 4.1 Natural regeneration of *Styrax tonkinensis* in the rice field under shifting cultivation at Ban Kachet.

Photo 4.2 The provenance trial at Ban Kachet.
(Approximately 18 months after planting)

Photo 4.3 The agroforestry trial plot at Ban Kachet. The small trees seen in the near front are young styrax seedlings in the provenance trial plot.

Photo 4.4 A mature styrax tree in a naturally regenerated stand, Ban Kachet.

Chapter 5. Tapping methods and improvement

Two lines of research were pursued with respect to tapping methods and improved benzoin production. Firstly, the relationship between tree size and benzoin production was investigated; secondly, tapping methods used in Lao PDR and elsewhere in Southeast Asia were studied.

5.1 Tree size and benzoin production

Benzoin tappers in Lao PDR believe through casual observation that several factors affect resin characteristics. For example, it is often said that trees having dark, thick and rough bark produce the most benzoin. However, bark characteristics generally change with age and growth of the tree. It is natural for young trees to have smooth and light-coloured bark that becomes rough and darker with age. It is also claimed that tapping cuts positioned on the upper part of the stem secrete more resin than those lower down. These first-hand observations may well be true, but there are no substantiating published scientific research results.

Field research was conducted to attempt to answer the following questions:

1) Is there a relationship between the size of the tree (based on stem diameter) and benzoin production?
2) Is there a correlation between bark thickness and stem diameter?
3) Is there a relationship between benzoin yield and the height of tapping cuts on the stem?

5.1.1 Trial plot

A 1-hectare plot of styrax trees located opposite Ban Kachet village on the higher side of the road at an elevation of 800 m was selected for the studies. The study plot consisted of 348 trees that had regenerated in 1991, and represented a 6-year old tree stand. Benzoin tapping of the trees had been going on for 2-3 years. The study ran from May 1997 to April 1998.

5.1.2 Sample collection and methodology

After the undergrowth was cleared, 60 styrax trees were selected for the experiment. The DBH of selected trees was measured using a ribbon tape; diameters ranged from 8 cm to 23.9 cm. The 60 trees were grouped into 13 diameter classes as shown in Table 5.1.

Table 5.1 Size classes of styrax trees studied

DBH class	DBH range (cm)	No. of trees
1	< 9.0	2
2	9.0 – 9.9	5
3	10.0 – 10.9	5
4	11.0 – 11.9	5
5	12.0 – 12.9	5
6	13.0 – 13.9	5
7	14.0 – 14.9	5
8	15.0 – 15.9	5
9	16.0 – 16.9	5
10	17.0 – 17.9	4
11	18.0 – 18.9	5
12	19.0 – 19.9	4
13	> 20.0	5

The bark thickness at 1.3 m height from the ground was also recorded for each tree, at the time of taking the DBH measurement.

The standardized traditional Lao tapping method (Type 5) (see section 5.3.3) was used to tap each selected tree for benzoin at the end of September 1997. The method was modified from the general local method to a standard for future research. Each cut was 7.5 cm wide and

6 cm long with the lower part of the cut bark remaining attached to the tree; the beating treatment was not carried out.

On each tree, a single tapping cut was made at 1-m intervals up to 5 m above ground level. All the cuts faced north in order to reduce the influence of the tapping direction, if any. Therefore, apart from comparing the yield of resin between trees of different diameter classes, it was also possible to determine whether resin yield varied at different positions on the stem.

Careful harvesting of the benzoin was carried out at the end of March 1998 (5-6 months after tapping). The traditional Lao method was followed, using a forest knife, bamboo basket and bamboo ladder. The harvested product was weighed and simple qualitative characteristics (size, colour and purity) recorded on a tally sheet. Some samples were sent to the Food and Drug Quality Control Centre in Vientiane for chemical analysis.

The harvesting data were analyzed to determine any differences in yield according to DBH class and height of the tapping cuts.

5.1.3 Results

The styrax tree and benzoin yield data from each tapping cut at five different height levels of the 60 trees are tabulated in Table 5.2.

Examination of the benzoin yield data recorded for each of the 60 trees indicates that out of the five largest trees only two (ID Nos. 31 and 57) produced significant amounts. Of the remaining three largest trees, one did not produce benzoin at all and the other two produced only small amounts, i.e. 8.7 g and 9.6 g.

Table 5.2 Benzoin yield at different tapping heights of 60 representative styrax trees

No.	Tree ID No.	DBH (cm)	Bark thickness (mm)	Benzoin yield (g) 1 m	2 m	3 m	4 m	5 m	Total (g)
1	214	8.3	2.0	0	0	0	0	0	0
2	177	8.5	2.0	0	0.9	0	2.3	0	3.2
3	173	9.2	2.5	0	0	0	0	0	0
4	204	9.4	2.0	0	0	0	0	0	0
5	283	9.6	3.5	0	0	0	0	0	0
6	324	9.8	3.0	0	0	0	0	0	0
7	76	9.9	3.0	2.0	2.8	3.5	2.5	1.8	12.6
8	198	10.1	2.5	0	0	0	0	0	0
9	297	10.3	2.0	1.8	0.8	1.4	1.4	0	5.4
10	278	10.5	3.5	11.2	4.5	6.2	1.5	1.0	24.4
11	229	10.7	4.0	0	0	0	0	0	0
12	207	10.9	3.5	2.5	2.2	4.3	0	0	9
13	153	11.1	3.0	0	0	0	0	0	0
14	303	11.3	2.5	1.4	0	0.6	0	0	2
15	193	11.5	3.5	7.7	0	4.7	4.6	0	17.0
16	215	11.7	2.5	0	1.5	4.4	2.6	0	8.5
17	163	11.9	3.5	0	0	0	0	0	0
18	335	12.1	3.0	0	0.6	0	0	0	0.6
19	282	12.3	3.0	2.0	1.6	0	0	0	3.6
20	66	12.4	3.5	0.4	0	0	0	0	0.4
21	200	12.7	2.5	0	0	0	0	0	0
22	249	12.8	3.0	1.9	1.3	0	0	0	3.2
23	105	13.1	4.0	0	0	0	0	0	0
24	87	13.3	3.0	4.3	2.3	2.6	2.2	1.0	12.4
25	69	13.5	3.5	0	5.2	6.7	2.3	4.1	18.3
26	158	13.7	3.5	2.5	0	0	0	0	2.5
27	218	13.9	2.0	0.7	5.0	9.9	8.8	4.6	29.0
28	264	14.1	4.0	0	1.9	0	0	0	1.9
29	70	14.3	4.0	2.0	0.9	2.4	0	2.2	7.5
30	55	14.5	4.0	2.3	12.3	7.4	6.3	10.2	38.5
31	10	14.7	4.0	0	0	0	0	0	0
32	123	14.9	3.5	2.0	3.2	7.8	6.3	7.0	26.3
33	117	15.1	2.0	1.4	5.6	4.8	7.7	5.7	25.2
34	257	15.3	3.5	0.6	2.1	2.3	2.2	0	7.2
35	2	15.5	5.0	0	0	0	0	0	0
36	58	15.7	4.0	9.0	7.5	10.0	4.4	6.3	37.2
37	75	15.9	4.5	2.7	3.7	7.9	16.4	14.4	45.1
38	243	16.1	3.0	1.3	0	3.2	3.4	1.7	9.6
39	7	16.5	3.5	8.7	6.8	9.1	10.3	3.0	37.9
40	261	16.6	3.0	4.4	7.3	3.7	5.8	6.0	27.2
41	102	16.7	4.0	3.1	0	8.2	0	2.8	14.1
42	39	16.9	3.5	11.1	8.5	7.5	3.8	8.9	39.8
43	16	17.5	4.5	1.4	4.5	0	1.6	1.3	8.8

Table 5.2 contd.

No.	Tree ID No.	DBH (cm)	Bark thickness (mm)	Benzoin yield (g) 1 m	2 m	3 m	4 m	5 m	Total (g)
44	227	17.7	6.5	0	0	1.9	1.1	1.5	4.5
45	126	17.8	5.5	0	4.3	3.7	0	4.3	12.3
46	122	17.9	5.0	5.2	11.1	23	10.7	17.6	67.6
47	196	18.0	5.0	0	0	0	0	0	0
48	269	18.0	2.5	9.5	4.0	3.3	0	5.5	22.3
49	112	18.1	3.5	0	0	0	0	0	0
50	27	18.6	4.5	9.2	7.2	7.8	7.6	7.5	39.3
51	114	18.8	5.0	7.6	2.4	8.6	1.8	14.0	34.4
52	34	19.2	4.5	0	4.5	2.3	2.6	1.5	10.9
53	30	19.5	5.0	0	2.5	4.1	3.3	2.6	12.5
54	51	19.5	5.5	4.6	8.9	15.3	18.8	10.8	58.4
55	271	19.6	5.0	8.7	16.4	4.0	13.7	6.7	49.5
56	32	20.5	6.0	3.2	0	3	0	3.4	9.6
57	31	21.0	6.0	1.5	3.1	6.3	2.6	11.8	25.3
58	240	21.2	5.0	0	0	0	0	0	0
59	57	21.6	5.0	0	3.1	10.0	8.4	8.9	30.4
60	61	23.9	5.5	0	1.3	2.8	4.6	0	8.7
Total benzoin (g)				137.9	161.8	214.7	171.6	178.1	864.1
No. of trees with benzoin				33	36	36	31	30	44
Benzoin yield per notch (g)				4.2	4.5	5.9	5.5	5.9	19.6

A total of 16 out of the 60 trees did not produce any resin regardless of the height of tapping cuts. It is interesting to note that most of these 16 trees were from the small DBH classes, i.e. <13 cm.

A plot of bark thickness against stem diameter of the 60 trees is shown in Figure 5.1. It shows a positive correlation between bark thickness and stem diameter.

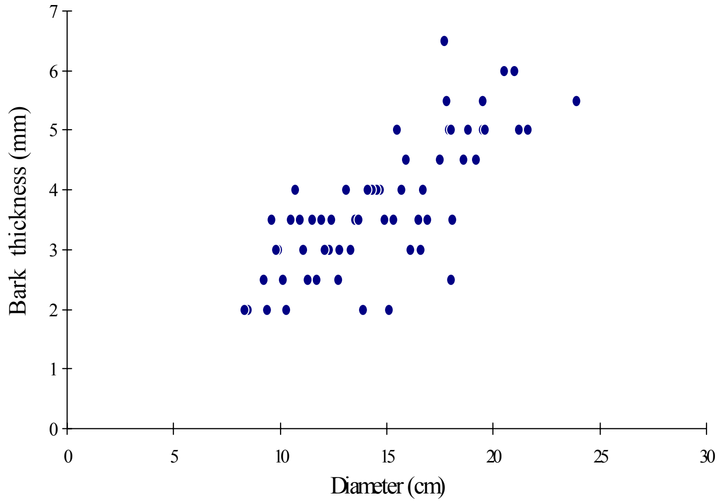


Figure 5.1 Plot of bark thickness against stem diameter of styrax trees in a 7-year-old regrowth forest at Ban Kachet village, Nam Bak district, Luang Prabang province

An analysis of variance was performed by treating DBH classes as one treatment factor and height of the tapping cuts as another. Analysis of the output is shown in Table 5.3.

Table 5.3 Analysis of variance (ANOVA) of mean benzoin yield of 13 DBH classes at 5 different tapping heights

Source of variation	Df	MS	F[1/]
DBH class	12	87.15	6.28*
Tapping height	4	15.76	1.14
DBH class × Tapping height	48	7.10	0.51
Residual	235	13.87	

[1/] * = significant differences at P<0.05 level

The results from the analysis of variance show that benzoin yield varied significantly between diameter classes while the differences in yield between tapping heights were not statistically significant.

Mean benzoin yields recorded for 13 DBH classes at five tapping heights are shown in Table 5.4.

Table 5.4 Mean benzoin yield (g) obtained for 13 DBH classes and 5 tapping heights in a study of relationship between tree size and resin yield

DBH Class	Height of tapping notches (m)					Mean Total (g)
	1	2	3	4	5	
1	0.0	0.5	0.0	1.0	0.0	**1.5**
2	0.4	0.6	0.7	0.5	0.4	**2.5**
3	3.1	1.5	2.3	0.6	0.2	**7.7**
4	1.8	0.3	1.9	1.4	0.0	**5.5**
5	0.9	0.7	0.0	0.0	0.0	**1.6**
6	1.5	2.5	3.8	2.7	1.9	**12.4**
7	1.3	3.7	3.5	2.5	3.9	**14.8**
8	2.7	3.8	5.0	6.1	5.3	**22.9**
9	5.7	4.5	6.3	4.7	4.5	**25.7**
10	1.7	5.0	7.2	3.4	6.2	**23.3**
11	3.4	2.7	3.9	2.9	5.5	**18.5**
12	3.3	8.1	6.4	9.6	5.4	**32.8**
13	0.9	1.5	4.4	3.1	4.8	**14.7**
Mean	**2.1**	**2.7**	**3.6**	**2.9**	**3.0**	

Benzoin yields were greater with increased DBH class. Yields were particularly low where DBH was smaller than 13 cm (DBH classes 1-5). The highest yields were recorded for DBH class 12 (19.0-19.9 cm), a mean of 32.8 g. The yields obtained for 5 trees in the largest DBH class (>20 cm) were surprisingly low, mean 14.7 g.

Although the yield of benzoin did not differ significantly between tapping cuts at different heights, it was the lowest at 1 m. The mean benzoin yield increased from 2.1 g at 1 m to a peak of 3.6 g at 3 m. The yield, however, declined when the tapping cuts were higher on the stem. The mean values recorded at 4 m and 5 m were 2.9 g and 3.0 g respectively, which were higher than those obtained at 1 m and 2 m.

5.1.4 Conclusion

Results obtained from studying the relationship between tree size and resin production demonstrate that small trees are likely to produce less benzoin than larger trees. Trees having a DBH less than 13 cm were found to be unsuitable for tapping.

There was no direct comparison of the resin yield in relation to bark thickness of the tree. However, given that bark thickness is correlated positively with tree diameter, it would be reasonable to assume that trees with thick bark are likely to produce more benzoin than those with thin bark.

The results, however, did not support the popular claim by villagers that benzoin yield is greater at higher tapping positions on the tree. Although yields increased with an increase in the height of tapping cuts from 1 m to 3 m, further increase in the height showed a decline in benzoin production.

5.1.5 Recommendations

The overall productivity of the trees in the experimental plots was extremely poor when compared to that observed for the trees tapped by villagers in adjacent areas. Therefore it was recommended that this study be repeated in another season to verify the results. The Lao traditional tapping method (without any modification) should be used for the trial. As with the first study, five cuts at 1-m intervals up to 5 m above ground level should be made on each tree.

Diameters of all the remaining trees in the study plot should be re-measured for benzoin tapping in a future season to obtain more information. Trees that were used for benzoin tapping in the previous season could also be included.

The tapping results, however, do confirm that more benzoin is produced at higher (but not the highest) positions on the stem. But the results raise more questions than answers. It was expected that the lower portion of the stem would produce more benzoin because the diameter is larger, and bark is thicker and rougher than the upper portion. This aspect of benzoin production is worthy of further investigation.

The latest findings of the relationship between tree size and benzoin production trial are described in **Appendix 5**.

5.2 Tapping methods

5.2.1 General tapping methods

In Lao PDR, styrax trees are tapped for the first time at 6-7 years of age. In general, the trees are felled when they reach about age 10, the exact age depending upon the demands of the shifting cultivation rotation being followed by farmers. The trees are tapped during September and November, when they are bearing fruit and the leaves are dying (the trees are deciduous). At that time, the bark is easy to cut. About 1-3 weeks after tapping, the styrax tree will close the tapping cuts with benzoin, but sap and resin will continue to be secreted. During the cooler, dryer winter season, the resin will dry and become hard and fragile. It is at this stage that the benzoin can be collected.

In Southeast Asia, three general methods are employed for benzoin tapping and these are described below.

5.2.2 Malaysian tapping

There are two Malaysian tapping methods. The first consists of tapping the trunk about 40 cm above the ground. Using a sharp knife, a triangular cut 15-20 cm long is made with the triangle pointing downwards. Three such triangles are cut into the tree bark at the same level, to a depth of about 2 mm. The bark and wood are removed from each cut and the resin begins to secrete. Resin is collected every 3 months.

The second Malaysian tapping method also employs triangular-shaped cuts pointing downwards, but is somewhat different from the first. In this method, three lines having three cuts each are made, one above the other. The first line is 40 cm from the ground, the second is at 80 cm and the third at 120 cm. As in the first Malaysian method, resin is collected every 3 months.

5.2.3 Indonesian tapping

Trees of *Styrax benzoin* and *S. paralleloneurum* are the source of Sumatra benzoin. The Indonesian method of tapping uses three tools. A hoop-shaped knife is used to rub and clean off the bark. Styrax trees in Indonesia are very old (about 60 years of age) and the bark is thick. Next, a wedge, the second tool, is inserted between the bark and wood to make the tapped area into a semi-parabola for collecting the resin. After that the bark around the tapped area is beaten. Resin is collected about 3-4 months after tapping. A semi-parabola knife (tool 3) is used to cut along the tapped area to open the bark before collecting the resin. The resin is generally of good quality and classified as Grade A. After another 3-4 months, a further quantity of resin is collected from the tapped area (Grade B). Finally, a third collection is made after another 3-4 months (Grade C).

5.2.4 Laotian tapping

A forest knife is used to cut the bark, making an incision about 5-10 cm in length, without damaging the cambium. Usually, however, the wood is injured. The knife is then twisted to open the bark before allowing it to close. Tapping occurs at about 50 cm from ground level. There are three lines cut into the bark, to the right, front and left. Village benzoin tappers also climb the trees using a fixed bamboo pole with a rope to serve as a ladder. In this manner, tapping can be done up to a height of 10 m. In some locations, the bark surrounding the tapped area is beaten to stimulate resin flow.

5.3 Tapping trials

The purpose of this study was to develop suitable benzoin tapping methods taking into account both quantity and quality, as well as the costs, equipment and time requirements.

The three main objectives of the experiments were: 1) to compare the yields of benzoin using different tapping methods; 2) to examine benzoin harvesting practices; and 3) to increase benzoin yields in terms of quantity and quality.

5.3.1 Trial plot

A trial plot suitable for the tapping methods experiment was established in the forest a short distance from Ban Kachet, Nam Bak district, Luang Prabang. The 1.2 ha plot was rectangular in shape and at an elevation of 670-690 m. The styrax trees occurring in the plot were the result of natural regeneration and were mixed with other tree species. There was dense undergrowth. The average canopy height was 9-10 m. Shifting cultivation had been practised on the site in 1989. Styrax trees of 7-8 years old and sufficient size were suitable for resin tapping.

The trial plot was established towards the end of 1996 (Kashio, 1997; and Subansenee, 1997). Undergrowth was cleared to make tapping easier. Then 160 styrax trees with DBH greater than 12.0 cm were selected for the experiments.

5.3.2 Sample collection

The 160 styrax trees were numbered and measured for DBH and height. The DBH range was 12.4-23 cm, with an average of 16 cm. The maximum tree height was 18 m and the minimum 11 m; the average was approximately 14 m. For efficient monitoring of the experiment, the locations of all study trees were recorded in a sketch map of the plot with individual numbers. The experiment lasted from May 1997 to April 1998.

5.3.3 Methodology

The 160 selected styrax trees were divided into eight groups of 20 trees each; one group for each of the eight tapping methods to be studied. A Microsoft Excel program was used to categorize the trees to ensure as even a distribution as possible in terms of tree size (DBH), to reduce the bias. Tree height was not considered in forming the groups as it was assumed to be less important in relation to resin production.

To avoid any confusion in the field, the 160 trees were clearly identified by tying a ribbon in different colours assigned to each of the eight groups.

Each tree was tapped at four different levels. The first tapping level was 50 cm from the ground. The second, third and fourth were at heights of 1 m, 1.5 m and 2 m, respectively. The north face of the tree was tapped. The date was established when each tree was to be tapped. The area to be tapped was marked and outlined using an indelible marker and a hard plastic template of the appropriate shape. The bark thickness of every tree was also measured.

The eight different tapping methods used in the study are described below.

Type 1. Malaysian Method A

The trees were tapped with a triangular-shaped cut pointing down as shown in Figure 5.2. The cut was 7.5 cm wide to a depth of about 2 mm inside the woody part of the tree (the cambium was, therefore, totally removed). A V-shaped, 5 x 5 cm galvanized metal sheet was fixed in the bark to direct the resin flow into a tin can attached to the trunk of the tree.

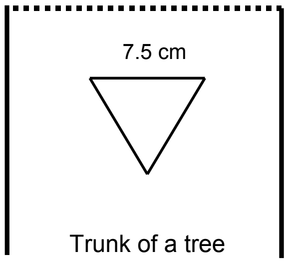


Figure 5.2 Malaysian Method

Type 2. Malaysian Method B

The same tapping method as Type 1, except that the bark around the tapping area was beaten to stimulate resin flow.

Type 3. Malaysian Method C

Again the same method as Type 1, except that cuts were made in the cambium layer only, not into the wood.

Type 4. Malaysian Method D

The same method as Type 3 above, except that the bark around the tapping area was beaten to stimulate resin flow.

Type 5. Standardized Traditional Lao Method A

This method was modified from the traditional method locally practised to standardize the research. Cuts were made in the shape of a rectangle, measuring 7.5 cm wide and 6 cm long (Figure 5.3). The bark was loosened to open the upper part and form a pocket. The lower bark was left attached and served as a receptacle to collect the resin.

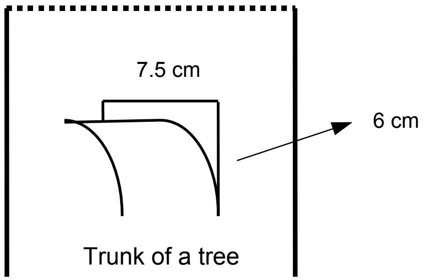


Figure 5.3 Standardized Traditional Lao Method

Type 6. Standardized Traditional Lao Method B

The same method as Type 5, except that the bark around the tapping area was beaten to stimulate resin flow.

Type 7. Standardized Traditional Indonesian Method

This tapping method was adapted to be suitable for the research. A chisel was used to cut the bark in a straight vertical line 7.5 cm in length (Figure 5.4). Next, the chisel was inserted between the bark and the cambium at a depth of 3 cm. Then a rectangular-shaped cut measuring 7.5 x 3 cm was made on the left side of the tapping area only. This created a pocket between the bark and the wood to collect the resin produced.

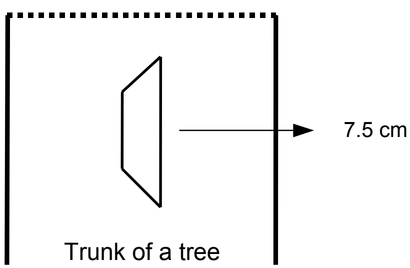


Figure 5.4 Standardized Traditional Indonesian Method

Type 8. V-shaped Method

The tapping was done using a V-shaped cut, each side of the V measuring 7.5 cm in length and 2.5 cm in width (Figure 5.5). After making the cut, a 5 x 5 cm piece of zinc sheet was attached and bent into a V-shaped to direct the flow of benzoin into a tin can positioned at the bottom of the V and nailed to the trunk.

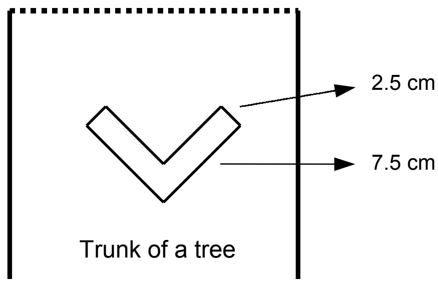


Figure 5.5 V-shaped Method

5.3.4 Initial observations

After tapping for 1-2 months, a study of the flow characteristics of the resin was made by observing each tapped area. At that time, some trees tapped by the V-shaped Method (Type 8) were harvested to increase the trial yield.

5.3.5 Harvesting

Benzoin was collected in March 1998 when it was dry, 5-6 months after tapping. A forest knife was used to remove the resin in each of the eight trials. The benzoin was weighed and each piece evaluated qualitatively. Results were recorded for each tree on a tally sheet for later analysis of the quality of the benzoin derived under each tapping method.

Three product characteristics were considered with respect to quality: size, colour and purity. These were adapted from the report by Coppen

(1997) and considered the percentage of the product according to the following categories. The results were recorded on a tally sheet.

Size of pieces:	Grade 1: > 60% larger than 12 mm
	Grade 2: 30-60% larger than 12 mm
	Grade 3 < 30% larger than 12 mm.
Colour of pieces:	Grade 1 > 60% light in colour
	Grade 2 30-60% light in colour
	Grade 3 < 30% light in colour
Purity of pieces:	Grade 1 > 60% clean
	Grade 2: 30-60% clean
	Grade 3 < 30% clean

5.3.6 Analysis

The pieces of benzoin were packed in vacuum bags and sent to a laboratory for chemical analysis.

Analysis of variance (ANOVA) was conducted to determine the differences in the benzoin yields between tapping method. The final results were used to answer the following questions:

1) How efficient are each of the eight tapping methods in terms of the quantity of benzoin produced? After consideration of the tapping and harvesting period, and tools used, the most promising method can be identified for adoption and further development.

2) Is more resin produced by tapping into the wood (e.g. Type 1), or by tapping only into the cambium layer (e.g. Type 3)? The results will also answer the question as to whether the benzoin is coming primarily from the cambium or a combination of wood and cambium. Tapping depth can be adjusted accordingly.

3) Is more resin produced as a result of beating the bark around the tapping area (e.g. Type 2) as compared to not beating the tapping area (e.g. Type 1). Tapping practices can again be adjusted accordingly.

5.3.7 Results and observations

Table 5.5 shows the yields obtained using the eight tapping methods.

The following observations can be made.

1) The comparatively lower yields using the Malaysian tapping method could be improved upon. Instead of nailing the tin can to the tree to catch the resin, it could be attached more easily with wire. Another problem with the tin cans was that in some instances they filled with rainwater, which might have negatively affected the benzoin production. The collection system and perhaps also the yield would be improved by use of a plastic or ceramic container that would drain off water but hold the resin.

2) The immediate areas of the tapping cuts in the Malaysian methods (Types 1-4) and the V-shaped Method (Type 8) were examined. Small spots of black fungus were found on the wood surrounding the cuts. After one week of tapping no trace of benzoin, sap or oil was observed. However, in some of the cuts that included beating the bark (Types 3 & 4), there were traces of resin at the edges of the cuts that may later have developed into benzoin.

3) In the Standardized Traditional Lao Method A and B (Types 5 & 6) it was noted that the bark pouches contained large amounts of moisture. On the exposed cambium and wood surfaces, a light, clear resin was present, especially in those locations that had been beaten with a chisel or other tool where a large amount of crystalline resin had formed into larger resin drops. The drops were sticky to the touch which is a test for benzoin. However, in some areas of the cut where the bark had peeled away or contracted, the underlying wood surface was dry and there were no traces of resin crystals. These differences could represent a critical factor in the production of benzoin in the future.

Table 5.5 Yields of benzoin, and quality, from tapping trials in the 8-year old regrowth styrax forest at Ban Kachet

Tapping method	Benzoin quantity			Benzoin quality[1]								
	No. of benzoin notches	% benzoin notches	Yield (g)	Size[2]			Colour[3]			Purity[4]		
				1	2	3	1	2	3	1	2	3
1. Malaysian A	18	22.50	12.8	29	57	14	0	100	0	0	86	14
2. Malaysian B	7	8.75	11.4	0	100	0	0	100	0	0	100	0
3. Malaysian C	22	27.50	26.7	44	56	0	0	89	11	0	44	56
4. Malaysian D	22	27.50	50.8	63	25	12	0	75	25	0	88	12
5. Lao A	31	38.75	65.7	70	30	0	20	80	0	10	80	10
6. Lao B	21	26.25	25.1	29	57	14	0	100	0	0	83	17
7. Indonesian	56	70.00	102.3	50	50	0	0	88	12	0	75	25
8. V-shaped	34	42.50	86.0	55	36	9	9	73	18	0	64	36

[1] **Quality:** Percentage of product quality proportion in each item.
[2] **Size:** Grade 1: > 60% bigger than 12 mm; Grade 2: 30-60% bigger than 12 mm; Grade 3: < 30% bigger than 12 mm.
[3] **Colour:** Grade 1: > 60% pale; Grade 2: 30-60% pale; Grade 3: < 30% pale.
[4] **Purity:** Grade 1: > 60% clean; Grade 2: 30-60% clean; Grade 3: < 30% clean.

4) A preliminary observation suggests that the Standardized Traditional Indonesian Method (Type 7) may be the most time-efficient. This method produced the highest benzoin yield, apparently due to the tight coverage of the resin in the pocket of styrax bark. However, Type 7 may require additional harvesting time and may also be limited in terms of tapping height as compared to the traditional Lao method (i.e. up to 10 m; see section 5.2.4); not the standardized Lao method used in the trials. In the Lao methods (Types 5 & 6) a wider tapping cut was made to allow a longer time for resin flow. But with the traditional Lao tapping the time requirement for cutting may be shorter and more efficient and it may be possible to tap to the higher level using only a single cut with the forest knife. The benzoin from the traditional Lao method may also be harvested more easily, but the quality of the product is lower than from the Indonesian tapping method. Both the Indonesian and Lao methods, however, may be carried out more efficiently in terms of tapping and harvesting than the methods which involve peeling off the bark (Malaysian and V-shaped).

5.3.8 Observations on resin flow

Characteristics of resin flow were studied by closely observing the conditions at the site of the tapping cuts over a 2-month period. Observations included data on any possible environmental effects on the quantity of benzoin produced, as well as on the quality of the product, i.e. size of pieces, colour, purity and dust. Through direct observations and field interviews the following provisional conclusions were reached.

1) Based upon observations made two months after tapping, along with analysis of the benzoin produced, it was concluded that the resin resulting from the trials is of the same quality regardless of tapping methods employed. It was also confirmed that the flow of resin is not from the wood, but from the area between the bark and the cambium.

2) It was observed that in the Standardized Lao Tapping Method, about 7-15 days after tapping, there was some transparent gum or oil, along with water appearing at the surface of the cut. The oil was resinous and sticky. On some cuts, the resin had formed into sizable pieces, but in other instances there was no resinous covering of the cut. In these cases, the water mixed with the resin had apparently quickly evaporated leaving a dry surface. It appears that when larger pieces of resin were present, water evaporation had occurred slowly when the weather was cool and dry; the resin was hard, brittle and ready for collection.

3) From the general observations made, it can be assumed that the tree draws nutrients from the xylem and from the leaves during the photosynthetic process, leading to the formation and flow of resin. Sap is drawn through the phloem in the cambium, which is between the wood and bark. When the bark is injured, sap is secreted and flows around the wound; clear liquid is visible at this stage. After 7-15 days the sap forms drops of resin. The size of the individual resin drop is increased if more sap is secreted. During the winter months the water in the resin drop evaporates and the residual resin becomes harder until, finally, it takes on the familiar characteristics of benzoin. The whole process takes 3-5 months.

4) In comparing the tapping methods in the experiment to the traditional Lao method, the villagers were not satisfied with the experimental tapping results. This was especially true in the case of the Standardized Lao Method because of the low resin production. It was assumed that the traditional villagers method, where the bark is cut and the knife is twisted to widen the cut, is more damaging to the bark and causes more resin to be secreted. At the same time, the cells in the bark do not become dry. A statistical analysis must be carried out to provide reliable results.

5) In the experiments with the Malaysian tapping methods (Types 1-4), resin production was low. Very few of the tin cans were found to

contain resin because the small amounts secreted remained attached to the tree. It was evident that the Malaysian method is not suitable for styrax trees in Lao PDR. It is possible that in this method the size of the cut is too large, because in the V-shaped cut (Type 8) experiment, more resin was produced than in any of the experiments with the Malaysian method. The optimal size of the tapping cut may have an important effect on benzoin yield.

6) Using tin cans to collect resin was found to be impractical. Because of the 1-2 month duration required for resin formation, the can becomes a trap for insects, rainwater and dirt, thereby lowering the quality of the resin. Another disadvantage is the additional labour required to attach the can to the trees.

5.3.9 Observations on harvesting

Resin was harvested carefully at the end of March 1998. Experimental yields were low and only small quantities of resin had accumulated in the tin cans. A considerable proportion of the benzoin was still on the trees and had not flowed into the cans; this was particularly true using the Malaysian methods. The use of a tin can for collecting the benzoin is unlikely to be practical and the traditional method of collecting it directly from the tree is preferable.

Harvesting was carried out using a forest knife, bamboo basket and, as needed, a rope ladder. The villager removes or digs the benzoin out of the bark using a forest knife and places the pieces of resin in a bamboo basket. In the trials, however, the quantities of benzoin produced were low and the production from the four tapping-height positions on each tree was harvested together. Benzoin from each tree was placed in an individual sample bag to be weighed and the quality assessed (size, colour and purity). These data were entered on a tally sheet.

To harvest benzoin under the Indonesian tapping method a forest knife was used to cut the upper and lower parts of the bark pocket. The bark was then removed and the resin collected.

After recording the yields from each tree, all the benzoin from a particular tapping method was combined and kept separate from that derived from each of the other methods. A single sealed bag containing all of the benzoin harvested under each trial was clearly labeled and sent to the Food and Drug Quality Control Centre in Vientiane where the chemical analysis of the benzoin was carried out. Since France is the principal market for Lao benzoin, there are advantages in following the French Pharmacopoeia monograph for *Benjoin du Laos* where appropriate. The following analyses were to be done: 1) thin layer chromatography (TLC); 2) loss on drying; 3) alcohol-insoluble matter; 4) total ash; and 5) total acids. Although the TLC is not included in the *Benjoin du Laos* monograph, it is simple to do and is very useful in comparing the chemical composition of the production under the different tapping systems (see Chapter 8, section 8.1.3 and **Appendix 2**).

5.3.10 Data analysis

Quantitative and qualitative data derived from the tapping trials were shown in Table 5.5. The results of statistical analysis of the quantitative data are given in Tables 5.6 and 5.7.

Table 5.6 Analysis of variance (ANOVA) of resin yield from the tapping trials

Source of variation	Df	MS	F[1/]
Tapping method	7	59.0646	3.544*
Replication	19	23.3704	1.402*
Residual	133	16.6644	

[1/] * = significant differences at P<0.05 level

Table 5.7. Duncan's new multiple range test of yield from the tapping trials

	Type 2	Type 1	Type 6	Type 3	Type 4	Type 5	Type 8	Type 7
Type 7	**4.55***	**4.48***	**3.86***	**3.78***	2.58	1.83	0.82	
Type 8	**3.73***	**3.66***	3.04	2.96	1.76	1.01		
Type 5	2.72	2.65	2.03	1.95	0.75			
Type 4	1.97	1.90	1.28	1.20				
Type 3	0.77	0.70	0.08					
Type 6	0.69	0.62						
Type 1	0.07							
Type 2								

* = significant differences at P<0.05 level

The following observations can be made:

1) Although the replications (tree size) in the experiments had a significant effect on resin yield, the analysis of variance (Table 5.6) shows the significant effect of tapping methods on resin yield. Clearly, the different tapping methods result in different quantities of benzoin being produced.

2) Table 5.5 shows that the best tapping method in terms of the number of tapping cuts which produced resin was the Standardized Traditional Indonesian Method (Type 7). Of the total of 80 tapping cuts, 56 (70%) were found to have resin. The next best methods were the V-shaped Method (Type 8), 34 cuts (43%) and the Lao Method A (Type 5), 31 cuts (39%). All four Malaysian methods gave a poor response to tapping, 9-28%.

3) The results obtained for total resin yield (Table 5.5) by tapping method correlate with the number of tapping cuts which produced resin. The highest yield was from the Standardized Traditional Indonesian Method (Type 7), and amounted to 102.3 g. This was followed by the V-shaped Method (86.0 g) and the Lao Method A (65.7 g). Of the four Malaysian methods all but one, i.e. the Malaysian D (Type 4), produced very little resin. It should be noted however that there was a large

variation among the 20 trees within each tapping method and care should be taken in interpreting the results. Nevertheless, the Indonesian, V-shaped and Lao A methods are clearly the best in terms of quantity of benzoin produced. Any one of these three tapping methods could be adopted to improve production in Lao PDR.

4) Given that a number of trees in the experiments yielded no resin at all, comparing the mean differences among the eight tapping methods may not give clear results. However, analysis of the means does confirm that the Malaysian tapping methods as a group yielded less resin than the other methods. Only the Malaysian Method D (Type 4) gave a reasonable yield although, in fact, there was only a small amount of resin in the tapped area; most of the resin came from beyond the cuts under the bark which had been beaten when the cuts were made. Nonetheless, it is clear that as a group the Malaysian tapping experiments were the least productive.

5) In the Malaysian tapping experiments, making the tapping cuts into the wood rather than just into the bark had no significant effect in terms of resin production. There was no difference in resin yields related to the depth of the tapping cuts. This confirms that resin is secreted from the bark alone.

6) Beating the bark around the tapping cuts did not stimulate sap flow or increase resin yield. In fact, this treatment had an adverse effect as shown by comparing yields between the Malaysian A (Type 1) and Malaysian B (Type 2) and between the Lao A (Type 5) and Lao B (Type 6). It is possible that the bark beating was excessive and caused too much damage. It was observed that the bark of these trees was dried out and in some instances new bark was developing and covering the tapping cut. The dead bark in the cutting area produced no resin. However, a more moderate degree of bark beating may be a way to increase resin production.

7) The low resin yields make it difficult to compare the differences in quality (size, colour and purity) among tapping methods. Never-

theless, it appears that the size of the resin drops was dependent on harvesting techniques rather than tapping techniques. Resin harvest is a tedious task and there is a high incidence of breaking the resin drop when it is removed from the tree. Visual observation and analysis of the data in Table 5.5 suggest that there are no significant quality differences among the eight tapping methods.

5.3.11 Preliminary trial to increase yield

About 1-2 months after the initiation of tapping, a study of the characteristics of resin flow was carried out by observing each tapped area. At that time, some trees tapped by the V-shaped Method (Type 8) were harvested to increase the trial yield.

Results of the study to increase the production are shown Table 5.8 and the analysis of variance (ANOVA) in Table 5.9.

Table 5.8 Benzoin yield from experiments to increase resin production in the V-shaped tapping method trial (grams)

DBH class	No treatment to increase production	Removal of resin to increase production
1	17.7	0.0
2	0.0	0.0
3	3.1	3.3
4	6.4	2.1
5	0.0	1.7
6	1.8	25.8
7	0.0	0.0
8	0.0	14.4
9	7.2	0.0
10	0.0	2.5
Mean	**3.62**	**4.98**

Table 5.9 Analysis of variance (ANOVA) of yield from experiments to increase resin production in the V-shaped tapping method trial

Source of variation	Df	MS	F[1/]
Treatment	1	9.2480	0.1438[ns]
Replication	9	9.8333	
Residual	9	64.3147	

[1/] ns = not significant differences at P<0.05 level

The experiment showed that removal of accumulated resin after 1-2 months, as compared to leaving the secreted resin in place for harvest at the end of the tapping season, was not significant in terms of overall benzoin yield. Nevertheless, visual observation did reveal that some new resin was secreted after removing the pieces blocking the tapping cut and cleaning it, indicating that it may be possible to achieve some increase in production by this practice. At the very least this may mean that it is possible to harvest some hardened resin after 1-2 months and the remainder at about 5-6 months. It remains to be seen if it would be efficient to harvest benzoin more than once from a tapping.

5.3.12 Recommendations

1) The tapping experiments demonstrated clear differences among tapping methods. Three methods – the Indonesian, V-shaped and Lao A – all showed satisfactory results in terms of resin production. It was not possible, however, to determine the optimal tapping method among them. Other factors such as the time required to tap and ease of application were not assessed but also must be taken into account. It is recommended that testing of the Indonesian, V-shaped and Lao A methods be repeated, taking into account factors such as the time and ease of application.
2) Tin cans should not be used with the V-shaped Method.
3) The size of the V-shaped tapping cuts should be reduced.

4) As noted previously, the overall yield of resin in the tapping trials was low compared with that observed on nearby non-experimental trees tapped by farmers. Undergrowth in the trial area was removed to facilitate access. Cutting of the undergrowth vegetation below the styrax trees exposed them to more direct sunlight and heat, and this may have caused the tapping cuts to dry out. It is recommended that the effect of undergrowth clearing be investigated.

5) Trying to stimulate sap flow by beating the bark around the tapping cut should be re-examined. In order to avoid severe damage to the bark, which appears to be detrimental, rubber hammers could be used to gently beat the bark.

6) It was observed that removing resin from the tree 2-3 months after tapping resulted in new flow of the sap and an increase in resin yield of some trees. Thus, it may be possible to promote new resin flow by removing the resin already formed 2-3 months after tapping by the V-shaped Method.

7) There is some uncertainty with regard to the optimum time of resin tapping. Discussions with some benzoin collectors indicated that early tapping (in July) is best suited for large trees while late tapping (in August-September) is good for small trees. Some consideration should be given to this factor.

8) If sustainable yield from styrax trees is to be achieved, it is necessary to study the optimal number of tapping cuts per tree which do not cause serious harm to the trees and yet assure that tapping can continue for successive seasons. In addition, a tapping rotation that provides optimal yields should be determined.

9) The orientation aspect of the tapping cuts on the tree may influence yield, due to the effects of sunlight and leafiness of the tree. One side of the tree may be leafier than another and the exposure down-slope may be different from the exposure up-slope. These site factors of

individual trees may influence their resin production and should be examined in any further trials.

The results of the additional studies carried out in 1999 and 2000 have given some answers for the above recommendations, Nos. 1, 4 and 5. They are briefly explained in **Appendix 5**.

Photo 5.1 The tools used in benzoin tapping and harvesting operations by the villagers in Ban Kachet.

Photo 5.2 Benzoin tapping operation with the traditional Lao method in Ban Kachet.

Photo 5.3 Resin flow on the stem of a styrax tree tapped by the Standardized Traditional Lao Method (Type 5).

Photo 5.4 Indonesian tools used in benzoin tapping.

Photo 5.5 Malaysian Method and resin flow.

Photo 5.6 Indonesian Method and resin harvesting.

Photo 5.7 V-shaped Method and resin flow.

Photo 5.8 Harvesting benzoin from a notch under the Standardized Traditional Lao Method.

Chapter 6. Markets and end-uses of benzoin: competition from other supplying countries

The following discussion provides as much information as could be gleaned from field interviews and from published literature. In most cases it was impossible to quantify accurately the amounts of benzoin used in the different segments of the market or in the particular end-uses. Some companies were willing to disclose the approximate quantities of benzoin they use or trade, but since they represent only a few of many such companies it would be misleading to attempt to use them to extrapolate on the volume of usage. Some *typical* usage levels of benzoin as a food additive are found in the literature but without knowing the total consumption of the particular products in question it would, again, be misleading to try and use them to calculate overall benzoin consumption. Even if one did, it would still leave the question as to how much was Siam benzoin and how much was Sumatra benzoin.

One has to resort to trade statistics – for all their deficiencies – to get some quantitative idea of markets and this is done in Chapter 7.

In the source countries, consumption is vastly different in Lao PDR and Indonesia. Use of Siam benzoin in Lao PDR is minimal. A small amount is used for incense purposes in Buddhist temples. In Indonesia, it is not possible to quantify domestic consumption of Sumatra benzoin, but if available production data are to be believed it could be considerable.

6.1 Pharmaceuticals

6.1.1 Pharmacopoeia preparations

Benzoin has well-established uses in both allopathic and traditional forms of medicine. Several national pharmacopoeias – including the British, Chinese, French, Italian, Japanese, Swiss, Thai and US – describe specifications and tests for benzoin and these are examined in more detail in Chapter 8. Some specify either Siam or Sumatra types while some include both. The titles of the monographs in the French/Swiss and Italian Pharmacopoeias are *Benjoin du Laos* and *Benzoino del Laos*, respectively.

In the form of a tincture (i.e. a solution in alcohol) benzoin is used as an inhalant with steam for the relief of cough, laryngitis, bronchitis and upper respiratory tract disorders. The British Pharmacopoeia (1993a) specifies the use of Sumatra benzoin in Benzoin Inhalation and Compound Benzoin Tincture (the latter known as Friars' Balsam in the UK). Preparations of the two are shown in Table 6.1.

Table 6.1 Benzoin inhalation and compound benzoin tincture

Benzoin Inhalation		Compound benzoin tincture	
Sumatra benzoin	100 g	Sumatra benzoin	100 g
Storax	50 g	Storax	100 g
		Aloes	20 g
Ethanol (96%)	to 1000 ml	Ethanol (90%)	to 1000 ml

The US Pharmacopoeia (1994) also describes a Compound Benzoin Tincture, although it does not specify which type of benzoin is to be used. In addition to the ingredients stipulated in the British version, another natural resin, tolu balsam (derived from trees of the genus *Myroxylon* in Central and South America), is included. The Swiss Pharmacopoeia (1995) describes a simple benzoin tincture using Siam benzoin (*benjoin du Laos*).

Other official and proprietary preparations contain benzoin. These include lotions for the prevention and treatment of cold sores, and a Compound Podophyllum Paint (British Pharmacopoeia, 1993a) which consists of podophyllum resin (derived from the roots of the May apple herb, *Podophyllum peltatum*) and Compound Benzoin Tincture; this is used for the treatment of warts. In most of these, Sumatra benzoin is used. The Italian Pharmacopoeia describes Ondroly-A as a mouthwash for dental disorders; it includes benzoin tincture and menthol in its ingredients.

6.1.2 Other medicinal preparations

In Indonesia, benzoin extract (from Sumatra benzoin) is used in Purol®, a well-known antibacterial powder used to freshen and soothe dry skin and ameliorate skin allergies.

In the form of over-the-counter herbal medicines, which are finding increasing use in Western society, benzoin (probably the Sumatra type) is employed in cough and cold remedies and for the topical treatment of itching skin rashes, wounds and ulcers. An ointment containing witch hazel and benzoin is used for treating hemorrhoids. In aromatherapy, benzoin is regarded as soothing and relaxing for tired muscles and can be used either in the form of a massage oil or as an additive to bath water. The Body Shop chain of shops sells a skin lotion containing lavender oil, sandalwood, vetivert, patchouli and benzoin.

Benzoin is believed to be widely used in Chinese medicines. The Chinese Pharmacopoeia (1992) states that benzoin preparations in the form of pills or powders are used to restore consciousness, activate the flow of blood and relieve pain. Typical indications for their use are loss of consciousness due to strokes, infantile convulsions and chest pains. The benzoin specified is that from *Styrax tonkinensis*.

In Bangkok, several pharmacies where benzoin is used in traditional Thai and Chinese medicines were visited during the regional fieldwork. Examples of two prescriptions are given in **Appendix 4**.

Sumatra benzoin is used a little in traditional *jamu* medicines in Indonesia (said to be asthma products) but no other information is available.

6.2 Fragrances

6.2.1 Incense use

In volume terms, the greatest use of benzoin – the Sumatra type – is for incense purposes. Most commonly, small or crushed pieces of the raw benzoin in block form are simply placed on an open fire, either in the house or in the place of worship. It is used by several of the major religions, including Moslems and Hindus, and in Chinese temples, and accounts for the fact that the Middle East, North Africa, parts of Asia and the Indian sub-continent are important export destinations for Sumatra benzoin. It is also used in the Catholic and Orthodox churches and is often formulated with other natural fragrance materials such as frankincense, myrrh and storax (derived from *S. officinale*, the sole Mediterranean species of the genus).

The use of benzoin for incense purposes by the large Muslim population in Indonesia is impossible to estimate but could be great. It is said to be especially used in Central Java for ceremonies requiring incense.

One other popular retail outlet for benzoin in Indonesia which involves burning it in the home employs modern packaging and marketing. Ratus Dedes®, a small sphere about the size of a golf ball, consists of a mixture of crushed fragrant herbs and tree barks, as well as benzoin. The user sprinkles pieces of it on an open fire to create a fragrance, either to fill the whole room or over which a woman hangs her hair (marketing is aimed at young women).

Extracts of Sumatra benzoin are used to produce fragrances for joss sticks. Sometimes the fragrance formulation is traded internationally and sometimes the joss sticks themselves are exported. India uses fragrances containing benzoin and other natural oils and resins in the manufacture of *agar batti.* Although most imports of benzoin into Malaysia are of block benzoin for direct use as a source of incense, one fragrance compounder purchases benzoin extract for the production of joss stick perfumes. A little benzoin extract *goes a long way*, however, and in the case of Malaysia, less than 100 kg of extract are purchased per year.

6.2.2 Formulated fragrances (other than for incense)

The better grades of benzoin are extracted and used in the manufacture of fragrances which are then compounded and employed in a wide range of end-products. These include personal health care products such as toilet soap, shampoo, body lotion and cream, bath oil, aerosol and talcum powder, and household and other products such as liquid soap, air freshener, fabric softener, washing detergent and other cleaning agents.

Although there is occasional overlap in end-use, such as shampoos, the more expensive Siam benzoin is generally used for fragrances at the higher end of the market, i.e. fine fragrances (perfumes and colognes) and the more expensive soaps. Siam benzoin has a pleasant, rounder, softer fragrance than that of Sumatra benzoin, which is somewhat bitter and harsher on the nose. Extracts of Sumatra benzoin also tend to be darker than those of Siam benzoin and for those products where this is not acceptable (and where the higher price of Siam can be tolerated), Siam benzoin is used in preference. However, Sumatra benzoin should not be regarded simply as a less expensive substitute for Siam benzoin – it may be selected on its own merits for use in perfumes. The Siam type is used to impart a sweet, *oriental* note to the fragrance, while the Sumatra type is used more in *spicy* and *floral-balsamic* fragrances. A few perfumers believe some Sumatra benzoin is adulterated with vanilla to pass it off as the Siam type.

Although benzoin contributes its own fragrance to the final, formulated product, one of its important functions is to serve as a fixative for the other fragrance materials, i.e. it increases the tenacity and prevents loss of the middle and top notes of the more volatile components.

6.3 Flavours

6.3.1 Food

Benzoin's principal role in foods is as a flavouring agent. The presence of substantial amounts of cinnamates in Sumatra benzoin accounts for its use in the manufacture of chocolate flavours, since cinnamates are also present in cocoa and their compatibility facilitates production of the flavour and improves its properties. The flavours are used in chocolate bars, ice cream, milk products, syrups and other products. The level of incorporation in the flavour is around 0.1%, while the flavour may represent up to 4% of the final product.

Benzoin is used as a flavouring in baked goods, especially those containing vanilla or cassia, where it also serves to *fix* the other flavours and increase their spiciness. It is especially popular in Denmark and Sweden for this purpose. It is also employed as a glazing agent and tinctures of benzoin are used to confer a luster to chocolate eggs. In syrups it is used to produce turbidity.

In Japan, where it is approved for use, benzoin is employed as a chewing gum base. Some use levels for *Benzoin resin* in foods have been reported and these are shown in Table 6.2.

Table 6.2 Use levels for benzoin resin in foods

Baked goods	139.50 ppm
Frozen dairy	75.56 ppm
Soft candy	93.23 ppm
Confection, frosting	1.00 ppm
Gelatin, pudding	93.28 ppm
Non-alcoholic beverages	51.58 ppm
Alcoholic beverages	49.87 ppm
Chewing gum	54.62 ppm

Source: Burdock, 1995

Burdock (1995) also states that Siam benzoin is used in preference to Sumatra benzoin for food flavouring (but must first be de-acidified). It is difficult to reconcile this statement with the views expressed by others that Sumatra benzoin has greater use because of the price-sensitive nature of the flavour industry.

In the United States, benzoin is approved for food use. A tentative specification exists for benzoin as a food additive (FAO, 1992); the main parts of it are identical with the 1994 US Pharmacopoeia monograph on benzoin (see **Appendix 3**). Like all food additives, benzoin is subject to periodic scrutiny by the Joint FAO/WHO Expert Committee on Food Additives to assess its safety. The most recent statement of the JECFA (FAO, 1996b) reaffirms the position given at their 21st session, 1977 (WHO, 1978), namely, that no toxicological data were available and therefore no ADI (acceptable daily intake; an indicator of food safety) was allocated. Although there has never been any suggestion that benzoin poses a health hazard when used in foods, the absence of toxicological data means that it is not included in the permitted list of Codex Alimentarius. If favourable data were forthcoming, and benzoin was included in the Codex, this might open up new markets for benzoin. Conversely, if data indicating harmful effects were submitted, this would have an adverse effect on benzoin. In the absence of any information indicating that this is so, however, this remains speculation.

6.3.2 Tobacco

In Indonesia, an important outlet for Sumatra benzoin is in flavouring tobacco. It is still used by some people in Central Java in its raw form – by mixing with tobacco when making their own cigarettes – but it finds wider use in the production of *Manila* flavour. This is used by cigarette companies in the manufacture of Kretek cigarettes (which also contain the well-known clove flavour). Use of benzoin in this way is unique to Indonesia since another ingredient of the *Manila* flavour is coumarin, a substance banned in most other countries. Total consumption of the flavour has been estimated by one industry source at about 250 tonnes, of which 5% is benzoin, i.e. about 12 tonnes. Another tobacco flavour uses benzoin in mixture with tolu and Peru balsams.

Benzoin is also used by the tobacco industry in China and possibly, also, in Viet Nam.

6.4 Other uses

Minor applications of benzoin include its use as a glazing agent in polishes and wood finishes. One company in the UK produces a formulation from an alcohol extract of block benzoin and seed lac. This is sold in 1 litre or 5 litre plastic bottles to the furniture trade. It is used particularly for traditional furniture. Sales of the product have increased in recent years, reflecting the fashion for this type of furniture, but purchases of benzoin are still very small – just a few tonnes per year by this company – compared with consumption in the major end-use industries.

One brief reference in a report of the Ministry of Forestry (MoF), Indonesia, states that benzoin is used by the porcelain industry.

6.5 Competition from other supplying countries

6.5.1 Indonesia

6.5.1.1 Scale of production

The problem of quantifying actual Indonesian production of benzoin (as distinct from Sumatra benzoin of commerce, most of which contains damar) was alluded to in Chapter 1, section 1.1. Two widely varying estimates of production illustrate the divergence of views.

An official report (Anon., 1993) gives annual production of benzoin for the years 1990-93 as shown in Table 6.3.

Table 6.3 Gum benzoin production in Indonesia[a], 1990-1993 (tonnes)

1990	1991	1992	1993[b]
4,416	4,431	4,454	5,782

Notes: *a*: North Tapanuli, North Sumatra
b: At July 1993
Source: MoF, 1993

It is not clear how these estimates were arrived at, and unless there is a far higher consumption of benzoin in Indonesia than is thought to be the case, it is difficult to believe that the figures can be so high.

Jafarsidik (1986), in contrast, states that total production of benzoin in 1986 was about 470 tonnes, of which 420 tonnes was from Tapanuli, an order of magnitude lower than the Ministry of Forestry estimate. The source of the data for this second estimate is not stated.

Using the figure of approximately 1,000 tonnes given in Chapter 7, section 7.3.2 for average annual exports from Indonesia, subtracting something for the presence of damar in that figure, and then allowing for domestic consumption, it is possible that real production of benzoin could be of the order of 500-1,000 tonnes, a figure close to Jafarsidik's, at the lower end of the range.

Based on a detailed forest inventory (Anon., 1993b), the area of benzoin trees has been estimated at about 17,500 ha. If a benzoin yield of just over 300 g per tree is assumed, then three trees would yield 1 kg of benzoin, i.e. three million trees would be required to produce 1,000 tonnes of benzoin. If a density of 300 stems per hectare is then assumed, 1,000 tonnes of benzoin would require an area of 10,000 ha of trees (and 4,000 tonnes would require 40,000 ha).

6.5.1.2 Location of production

Collection of benzoin in Indonesia occurs in the Tapanuli region of North Sumatra, mainly in the highlands above 1,000 m to the west and south of Lake Toba. Some production is from wild trees but many families plant styrax to provide a source of cash income. Seedlings from mixed stands are transplanted to sites where little or no seedlings occur to provide villagers with a high density and wide range of sizes of benzoin trees.

A network of internal trading exists. Agents purchase different types of benzoin from centers in or near the forest areas such as Tarutung. The *almonds* type is usually bought in mixed size form and is then sold to larger traders, exporters or processors in Medan or Pematang Siantar, who clean and sort it. Producers of block benzoin in Pematang Siantar either export it themselves or sell to other traders in Medan who export it.

6.5.1.3 Method of production

The trees are tapped during the flowering season, typically between June and September. Prior to tapping, the bark is scraped to remove moss and lichens. Vertical cuts 2-3 cm in length are made, about 30 cm apart, so as to penetrate the wood. On smaller trees, a single line of cuts is made but this increases to two or three on larger trees. Tapping extends to as high as 5 m on the large trees using a similar system of climbing them as that used in Lao PDR. The first tapping is made on trees 7-10 years old and continues annually for some years after. Replanting is recommended when the trees reach 25 years of age.

Harvesting of the benzoin takes place 3-4 months after tapping. Average yields of benzoin are said to be about 0.1-0.5 kg per tree; a good tree produces about 1 kg (Anon., 1993b). A vigorous, medium-size tree produces 0.5 kg *kasar* (white coloured) and 0.5 kg *juru* (dark coloured) (Watanabe *et al*., 1996).

The methods used in Indonesia for preparing block benzoin have been described elsewhere (Anon., 1993b) and are the same as those used in Singapore.

6.5.1.4 Grades and qualities

In Sumatra, more resin appears to run down the tree, rather than being trapped between the cut bark and the stem, than is the case in Lao PDR, and this results in a large number of different types and qualities of benzoin. Darker, dirtier grades are produced, which do not have Lao equivalents. Sorting yields the following types (Anon., 1993b):

- *Mata besar* (*big eye*) - first quality

- *Mata halus* (*soft eye*) - second quality, 1-2 cm, yellowish white
- *Jurus/jurir* - brown with yellowish white pieces, mixed with bark and dirt
- *Tahir* - similar to *jurus*
- *Barbar/Laklak*
- Dust - produced from the other grades

Note: Dust and *laklak* are usually mixed with *jurus* and *tahir* before sale.

The grading terms for benzoin almonds of commerce are comparable with the Lao ones, i.e., they are graded according to size: Grade 1 for the larger pieces and Grade 4 for dust/siftings. It is presumed that they are derived from the *mata besar* and *mata halus* types.

Styrax paralleloneurum is said to produce the best quality benzoin but in lower yields than *S. benzoin*. Watanabe *et al*. (1996) state that benzoin quality also depends on how it exudes from the tree: *kasar* has a white colour and is sold at a higher price than the coloured *juru*. Benzoin which has congealed on the bark is called *tahil.*

6.5.2 Viet Nam

Historically, Siam benzoin produced in Viet Nam was being exported to Europe along with that from Lao PDR at the beginning of the 20th century. Production was mainly in the northern provinces and continued into the 1950s; thereafter it has declined, apparently because the price is not sufficiently attractive to induce the people to tap the trees.

6.5.2.1 Scale of production

Exports from Viet Nam of what appears to be benzoin are discussed in Chapter 7. The volumes are small (1-12 tonnes annually) and do not necessarily represent indigenous production. Some benzoin enters Viet Nam from Houa Phan Province, Lao PDR, and is re-exported. Before 1990, when the state import-export company NAFORIMEX had a monopoly on benzoin trade, they claimed to export up to 40-50 tonnes per year, mainly to France. Since then, other companies have been allowed to export benzoin, which has reduced NAFORIMEX's share. They exported none in 1996 because the price of benzoin from Lao PDR was too high. In addition, a ban on exploiting the protected forest areas where *S. tonkinensis* grows has contributed to the decrease in domestic production.

6.5.2.2 Location of production

The natural distribution of *S. tonkinensis* extends from the northern parts of Lao PDR into neighbouring Viet Nam to the northwest of Hanoi. The only area where benzoin collection is still practised is just west of Viet Tri in Vinh Phu province. There is large-scale planting of *S. tonkinensis* for pulp – over 20,000 ha have been established – but no attempt seems to be made to fit benzoin tapping into the rotation. Presumably, the trees are considered too young for tapping for a year or two prior to felling (or yields are too low).

6.5.2.3 Grades

NAFORIMEX buys mixed benzoin from Lao PDR and then cleans and separates it into seven grades based on size and colour. Grade 1 consists of pale coloured pieces larger than 4 cm. The lower grades are increasingly smaller and darker, until the bottom grade is dust and siftings. Any larger pieces which have suffered from heat and compacted together are also assigned a low grade.

6.5.3 People's Republic of China

It is reported that benzoin is produced in Yunnan Province but no details are known. Plant sources were indicated in Chapter 2, section 2.4. Sophisticated flavour and fragrance industries are developing in China and if benzoin is being produced it seems likely that it is all consumed domestically to meet the needs of an increasingly consumer-oriented and fashion-conscious market.

Chapter 7. International trade

7.1 Introduction

In contrast to domestic consumption, which is not well documented, information on international trade *is* recorded, although there are some limitations in its coverage. Allowing for the inherent deficiencies of trade statistics, useful information on the size and scope of trade in gum benzoin can be obtained.

Before examining specific data four points should be made. First, un-official trade, benzoin which does not pass through customs points, does not appear in trade statistics. Some Siam benzoin from Lao PDR enters Thailand in this way and the same may be true for some benzoin shipped into China and Viet Nam.

Second, the data are only as good as the customs' returns allow. If the exporter chooses not to describe his shipment as gum benzoin (or gum benjamin) then it clearly will not be recorded as such and the official returns will underestimate exports. Occasionally, items are misclassified which can result in either inflated or deflated figures. These instances can often be identified by knowing that the origin or destination cited cannot possibly be one relevant to the commodity in question. Use of the mis-leading term *Resin of frankincense* in Indonesian trade statistics is a potential pitfall when examining Indonesian exports; it can also result in errors in the statistics of importing countries.

Third, and most important, gum benzoin may not be separated in the trade statistics of the country concerned. If it is a major item, then it is usually recorded, but otherwise it is included with similar commodities under a general heading or a *not elsewhere specified* heading. This is the case for member countries of the European Union in the Eurostat statistics and for other countries such as Japan, China, Hong Kong, Philippines, South Korea, Bangladesh and Myanmar. In the English version of the

Chinese *Customs Statistics Yearbook 1995*, for example, import data are separated in the gums and resins section for lac, gum arabic, tragacanth, olibanum/myrrh/dragon's blood, asafoetida and pine resin. *Others not elsewhere specified* (which for 1995 amounted to 14,700 tonnes) acts as a catch-all for other gums and resins; 38 tonnes under this heading came from Lao PDR.

Lao PDR appears as a country of origin under the *Other natural gums and resins* heading in Eurostat data. In the case of Thai imports of gums and resins, gum benzoin is separated, but there are two other headings in which benzoin could be included if it were only described in general terms in the documentation: *Natural resins, unmodified* and *Other natural gums and gum-resins*. In both cases, imports from Lao PDR are generally the most important (although a major proportion of this is assumed to be damar). Calculation of unit values for imports from Lao PDR under these headings confirmed that a low-value item such as damar predominates in the data.

Fourth, and finally, the statistics do not distinguish between the two types of benzoin, Siam and Sumatra, nor between the different forms in which they are traded (e.g. pure almonds *vs* semi-processed block benzoin *vs* extracts and resinoids), and this makes it impossible to quantify accurately the movements of the different types in international trade. Even exports from Indonesia include some very small amounts of Siam benzoin, since it is known that this is imported into Indonesia for extraction and subsequent re-export. The fact that block benzoin is produced in Indonesia, and is included in the export data, makes an analysis of that country's production particularly difficult, since only a part of the total export figure represents real benzoin (i.e. resin from *Styrax* spp.).

Despite the above comments, valuable information can be derived from published trade statistics on benzoin and these are discussed following a brief explanation of trading channels.

7.2 Overview of international trade

7.2.1 Trading channels

Although some Sumatra benzoin is exported directly from Indonesia to the final destinations, most is exported to Singapore. Here, the importer either re-exports it without any material change apart from possible re-packaging, sells it on to other Singaporean traders, or subjects it to some form of processing (the products of which are mostly exported). For Siam benzoin, too, not all exports from Lao PDR go direct to the end-user country, and although the quantities involved are much smaller than for the Sumatra type, both Thailand and Singapore are sometimes intermediate destinations for it.

For both types of benzoin, therefore, much is to be gained by examining export statistics for these intermediate destinations, as well as those for the primary producers, where they exist.

Once the benzoin reaches its final destination it is either sold on to other, smaller traders, processed (extracted) by the same company which imports it, or sold on by the importer to other companies who process (extract) it. These companies either use the extract for their own purposes or sell it to other end-users at home or abroad.

7.2.2 Classification of benzoin

In trade statistics, if benzoin is specifically recorded it appears within the gums and resins category of commodities. Most countries use the Harmonised Commodity Description and Coding System (usually known as the Harmonised System) of the Customs Cooperation Council, in which a numbering hierarchy groups commodities according to type, and becomes increasingly more specific as the number of digits increases. A few countries show the SITC number (Standard International Trade Classification, Revision 3) of the United Nations alongside the HS number. The classification numbers and nomenclature used by the countries whose statistics are analyzed below are shown in Table 7.1.

Table 7.1 Gum benzoin - Trade classification and descriptions

	HS number	SITC number	Description
Indonesia	130190130	-	Gum benjamin
	130190250	-	Resin of frankincense
Thailand	1301900027	-	Gum benzoin or benjamin
Singapore	130190100	2922910	Gum benjamin
Saudi Arabia	13019030	-	Benzoin
India	13019004	-	Benjamin ras
	13019005	-	Benjamin cowrie
Malaysia	130190400	292290400	Gum benjamin

7.3 Export data - Primary source countries

7.3.1 Lao PDR

Export data were obtained for Lao PDR but it is impossible to judge their reliability or completeness. Destinations are not specified and it was only possible to obtain a reasonably long time series in terms of volumes exported. Figures for the ten years 1987-1996 are shown in Table 7.2.

Table 7.2 Gum benzoin - Volume of exports from Lao PDR, 1987-1996 (tonnes)

1987	1988	1989	1990	1991	1992	1993	1994	1995	1996[a]
70.0	12.0	16.0	27.0	36.6	30.0	40.0	47.5	51.3	32.8

Note: *a*: Provisional
Source: Statistics Division, Ministry of Commerce, Vientiane

The volumes involved do appear to be in line with rough estimates made by traders and others in Lao PDR.

Limited data were obtained from Lao Customs which include value, as well as volume figures (Table 7.3). It should be noted that the quantities involved are significantly less than the figures in Table 7.2 suggest. The unit values are consistent, although lower than what might have been expected from the prices of the different grades of benzoin as stated by Lao exporters.

Information provided by the Ministry of Commerce, Vientiane, for the first 9 months of 1996, gives the export of benzoin from Vientiane municipality as 17.9 tonnes, valued at US$ 189,738 (equivalent to US$ 10.60/kg).

Table 7.3 Gum benzoin - Volume, value and unit value of exports from Lao PDR, 1993/94-1995/96[a] (tonnes; 1,000 US$; US$/kg)

	1993/94	1994/95	1995/96
Volume	25.15	26.62	28.35
Value	193.65	206.72	221.86
Unit value	7.70	7.77	7.83

Note: *a*: Statistical year October-September
Source: Customs, Vientiane

7.3.2 Indonesia

Exports of benzoin from Indonesia by destinations, for the period 1987-1995 are shown in Table 7.4 in volume terms and in Table 7.5 in value terms. In an attempt to distinguish different types of benzoin which might be destined for different countries, unit values for each destination were calculated and these are also shown in Table 7.5. Note that from 1996, unfortunately, benzoin is not separated from other unspecified gums and resins in the trade statistics.

The data (Table 7.4) show that annual exports of benzoin in the 9-year period varied between around 800 tonnes and 1,300 tonnes (but block benzoin is included in these figures), with an average of 1,010 tonnes. As indicated above, most (93% on average) is shipped to Singapore. Other, minor, but reasonably regular, destinations include Malaysia, Taiwan, Japan, Switzerland, France and the USA.

Table 7.4 Gum benzoin[a] - Volume of exports from Indonesia by destinations, 1987-1995[b] (tonnes)

	1987	1988	1989	1990	1991	1992	1993	1994	1995
Total	**1,331**	**1,157**	**975**	**884**	**1,126**	**806**	**825**	**830**	**1,156**
Of which to:									
Singapore	1,324	1,099	881	773	1,062	735	781	755	1,058
Malaysia	-	7	36	27	17	39	7	17	24
Taiwan	-	21	30	-	13	-	12	16	25
Japan	-	~	~	1	8	6	12	6	12
Hong Kong	-	2	-	16	-	-	-	-	-
India	-	-	-	59	-	~	11	8	10
Pakistan	-	-	-	-	16	-	-	-	-
UAE	-	20	-	-	-	-	2	-	-
Kuwait	-	-	16	-	-	-	-	-	-
S. Arabia	-	-	-	~	1	9	-	~	~
Switzerland	3	4	1	3	3	6	-	4	2
France	1	2	6	2	4	3	-	1	1
UK	-	-	-	-	-	~	-	17	20
Netherlands	1	1	-	-	-	-	-	5	-
Spain	-	-	-	1	1	~	~	~	~
USA	2	1	2	2	1	2	-	1	3
Suriname	-	-	3	-	-	5	-	-	-

Notes: *a*: Apart from occasional, small amounts which are classified as *gum benjamin,* most is classified as *Resin of frankincense*.
b: Data for 1996 do not separate r*esin of frankincense* from *other, unspecified gums and resins.*
-: indicates nil; ~: indicates figures less than 0.5 unit.
Source: Indonesia Foreign Trade Statistics

Table 7.5 Gum benzoin[a] - Value and unit value of exports from Indonesia by destinations, 1987-1995[b] (1,000 US$; US$/kg)

	1987	1988	1989	1990	1991	1992	1993	1994	1995
Total value[c]	**1,486**	**1,279**	**1,262**	**1,062**	**1,671**	**1,184**	**1,207**	**1,399**	**1,380**
(Unit value)[d]	**(1.12)**	**(1.11)**	**(1.29)**	**(1.20)**	**(1.48)**	**(1.47)**	**(1.46)**	**(1.68)**	**(1.19)**
Of which to:									
Singapore	1,424	1,197	1,140	911	1,554	1,002	1,125	11	1,123
	(1.08)	(1.09)	(1.29)	(1.18)	(1.46)	(1.36)	(1.44)	(1.54)	(1.06)
Malaysia	-	4	27	9	12	32	11	10	23
	-	(0.54)	(0.73)	(0.33)	(0.70)	(0.82)	(1.62)	(0.61)	(0.96)
Taiwan	-	9	13	-	6	-	6	11	24
	-	(0.43)	(0.45)	-	(0.44)	-	(0.51)	(0.68)	(0.94)
Japan	-	~	1	12	17	15	21	12	27
	-	(7.40)	(8.81)	(9.92)	(2.14)	(2.31)	(1.71)	(1.98)	(2.21)
Hong Kong	-	7	-	39	-	-	-	-	-
	-	(3.54)	-	(2.51)	-	-	-	-	-

Table 7.5 contd.

	1987	1988	1989	1990	1991	1992	1993	1994	1995
India	-	-	-	41	-	2	38	29	37
	-	-	-	(0.70)	-	(15.78)	(3.59)	(3.74)	(3.85)
Pakistan	-	-	-	-	11	-	-	-	-
	-	-	-	-	(0.67)	-	-	-	-
UAE	-	-	-	-	-	-	2	-	-
	-	-	-	-	-	-	(0.91)	-	-
Kuwait	-	-	5	-	-	-	-	-	-
	-	-	(0.31)	-	-	-	-	-	-
S. Arabia	-	-	-	1	12	15	-	9	2
	-	-	-	(7.03)	(15.99)	(1.55)	-	(27.08)	(14.00)
Switzerland	22	35	12	23	16	52	-	40	21
	(8.52)	(8.72)	(8.30)	(8.26)	(5.79)	(8.46)	-	(9.67)	(9.84)
France	17	8	37	8	28	44	-	5	3
	(11.52)	(4.21)	(6.50)	(3.82)	(7.27)	(14.52)	-	(4.74)	(4.17)
UK	-	-	-	-	-	~	-	72	81
	-	-	-	-	-	(6.08)	-	(4.23)	(4.00)
Netherlands	3	9	-	-	-	-	-	32	-
	(5.28)	(8.75)	-	-	-	-	-	(6.47)	-
Spain	-	-	-	2	8	2	4	5	6
	-	-	-	(3.96)	(13.63)	(14.23)	(14.87)	(12.27)	(13.84)
USA	21	7	18	16	8	13	-	6	34
	(8.41)	(5.69)	(8.82)	(6.87)	(5.41)	(7.55)	-	(11.85)	(11.03)
Suriname	-	-	8	-	-	8	-	-	-
	-	-	(3.16)	-	-	(1.60)	-	-	-

Notes: *a*: See Table 7.4
b: See Table 7.4
c: FOB value recorded in source data in US$
d: Calculated using exact figures for volume and value from source data rather than those rounded to nearest tonne and 1,000 US$
Source: Indonesia Foreign Trade Statistics

Annual exports have been valued at 1-1.6 million US$ (Table 7.5) but it is more instructive to look at unit values. Exports to Europe and the United States are significantly more valuable in value terms than those to Singapore, Malaysia and Taiwan. There are occasionally what appear to be abnormally high or low unit values. These may or may not be genuine but more significance is given here to the consistency of the values for a particular country, and their relative comparison with other countries, than to their absolute magnitude. Based on known usage, the higher grades go for fragrance, flavour and pharmaceutical uses, while the lower grades are destined, on the whole, for incense purposes. Therefore small but higher value quantities of benzoin extract are included in the statistics. A leading Indonesian producer and world-wide exporter of benzoin extract was an information source. Customers for these extracts include the multinational flavour and fragrance companies, who undertake compounding and sell the formulated products to the end-users, which include their own overseas branches and subsidiaries. This accounts for the appearance of benzoin in the statistics of Switzerland, for example. Since 1990, Spain has been a regular destination for high value benzoin (or its extracts) but the intended end-use, or user, is not known.

Indonesian trade statistics give a breakdown of exports according to port of exportation and the data for benzoin are shown in Table 7.6 for the period 1988-1995.

Belawan, the port of Medan, is seen to be the principal port of export, accounting for 91-98% of exports between 1988 and 1993. However, its share has dropped significantly in the mid 1990s: to 72% in 1994 and 60% in 1995. The balance of trade in 1994-1995 has been taken largely by Batu Ampar, which is understood to be a newly developed port on Batam Island, just south of Singapore.

7.4 Import data - Secondary source countries

Before discussing exports from secondary source countries, their imports of benzoin are examined to see how well they match up with recorded exports from the primary producers. In the case of Thailand, it is of interest to see what is officially recorded as entering the country from Lao PDR, and in the case of Singapore, to see how well Indonesian export data correlate with Singapore's imports from Indonesia and whether other sources are recorded (e.g. Lao PDR or Viet Nam).

Table 7.6 Gum benzoin[a] - Volume of exports from Indonesia by port of exportation, 1988-1995 (tonnes)

	1988	1989	1990	1991	1992	1993	1994	1995
Total	**1,157**	**975**	**884**	**1,126**	**806**	**825**	**830**	**1,156**
Of which shipped from:								
Sumatra:								
Belawan	1,057	938	829	1,107	771	773	600	690
Palembang	58	-	-	-	-	-	-	-
Panjang	30	-	-	-	-	-	-	-
Padang/Tl. Bayur	5	2	-	-	-	-	-	-
Jambi	5	-	-	-	-	-	-	-
Batu Ampar	-	-	-	-	-	52	126	439
Medan (air)	~	-	~	~	1	~	~	~
Java:								
Tg. Priok	1	35	-	18	30	-	7	5
Surabaya/Tg. Perak	-	-	54	-	3	-	14	21
Semarang/Tg. Emas	-	-	-	-	-	-	83	1
Jakarta (air)	~	-	~	1	~	-	-	~

Note: *a*: See note *a*, Table 7.4
Source: Indonesia Foreign Trade Statistics

7.4.1 Thailand

Volume and value/unit value data for imports into Thailand for the 10 years 1987-1996 are shown in Tables 7.7 and 7.8, respectively. Value data were converted from Thai Baht to US$ using published historical exchange rates.

Table 7.7 Gum benzoin - Volume of imports into Thailand by origins, 1987-1996 (tonnes)

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Total	**7**	**~**	**-**	**-**	**~**	**~**	**~**	**-**	**~**	**~**
Of which from:										
Lao PDR	6	-	-	-	-	-	-	-	-	-
Indonesia	1	~	-	-	-	-	-	-	-	-
China, PR	-	-	-	-	~	-	~	-	-	-
Japan	-	-	-	-	-	~	-	-	-	-
UK	-	-	-	-	-	-	-	-	~	-
USA	-	-	-	-	-	-	-	-	-	~

Source: Foreign Trade Statistics of Thailand

Table 7.7 is interesting for what it does not show as much as for what it does. Imports from Lao PDR only appear for 1987 (6 tonnes) and yet exports of benzoin from Thailand for the same period (see Table 7.10), which are presumed to be of Lao origin, are recorded up to 1995. Apart from Indonesia, imports from all other sources were less than 0.5 tonnes.

The differences in unit value for the imports from Lao PDR and Indonesia (Table 7.8) reflect the differences in price between Siam and Sumatra benzoins. Imports from Japan, the UK and the USA appear to be processed products.

Table 7.8 Gum benzoin - Value and unit value of imports into Thailand by origins, 1987-1996 (1,000 US$; US$/kg)

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Total value[a]	**38**	**~**	**-**	**-**	**~**	**~**	**~**	**-**	**8**	**~**
(Unit value)[b]	**(5.91)**	**(0.40)**	**-**	**-**	**(0.47)**	**(26.34)**	**(0.50)**	**-**	**(27.27)**	**(7.41)**
Of which from:										
Lao PDR	38	-	-	-	-	-	-	-	-	-
	(6.80)	-	-	-	-	-	-	-	-	-
Indonesia	~	~	-	-	-	-	-	-	-	-
	(0.38)	(0.40)	-	-	-	-	-	-	-	-
China, PR	-	-	-	-	~	-	~	-	-	-
	-	-	-	-	(0.47)	-	(0.50)	-	-	-
Japan	-	-	-	-	-	~	-	-	-	-
	-	-	-	-	-	(26.34)	-	-	-	-
UK	-	-	-	-	-	-	-	-	8	-
	-	-	-	-	-	-	-	-	(27.27)	-
USA	-	-	-	-	-	-	-	-	-	~
	-	-	-	-	-	-	-	-	-	(7.41)

Notes: *a*: CIF value in Baht converted to US$ using following average exchange rates: 25.723 (1987), 25.294 (1988), 25.702 (1989), 25.585 (1990), 25.517 (1991), 25.400 (1992), 25.319 (1993), 25.150 (1994), 24.915 (1995), 25.323 (Jan.-Nov. 1996)

b: Calculated using exact figures for volume and value from source data rather than those rounded to nearest tonne and 1,000 US$

Sources: Foreign Trade Statistics of Thailand; International Financial Statistics, IMF

7.4.2 Singapore

Volumes of imports into Singapore for the 10 years 1987-1996 are shown in Table 7.9.

Table 7.9 Gum benjamin - Volume of imports into Singapore by origins[a], 1987-1996 (tonnes)

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Total	**64**	**12**	**33**	**8**	**17**	**15**	**17**	**7**	**61**	**98**
Of which from:										
Thailand	56	6	6	-	3	-	12	-	-	-
India	-	3	24	-	13	13	-	-	-	-
USA	-	-	-	-	-	-	-	-	46	20
France	-	-	-	-	-	-	-	-	5	-
Pakistan	-	-	-	-	-	-	-	-	-	61
Malaysia	-	-	-	-	-	-	-	-	-	8
Others	8	3	3	8	1	2	5	7	10	9

Note: *a*: '-' does not necessarily indicate nil, but that the particular destination is not specified in the source data; it may be included in *Others.*
Source: Singapore Trade Statistics

It is immediately evident that Indonesia is never cited as a country of origin for Singaporean imports, despite the fact that it is overwhelmingly the major source, and this results in completely misleading figures for total, officially published imports. The volumes recorded are incompatible with Singapore's exports (see below). Although the Singapore Trade Development Board was unable to explain this, it is believed to be due to a protocol negotiated between the two countries during the late 1960s which allows certain commodities (including rubber and pepper as well as benzoin) to be imported into Singapore from Indonesia without being recorded in Singapore's trade statistics.

Figures for all of the source countries shown in Table 7.9 represent re-exports. The years for which Thai imports are recorded agree with those given below for Thai exports into Singapore (Table 7.10), although the volumes are slightly different, more so for 1987. This mismatch between a country's apparent imports from one source and the recorded exports from that source into the country is not uncommon, and not always easily explained. Some discrepancies arise because exports shipped at the end of one year are not recorded by the importing country until the following year. There may also be differences in the heading under which the item falls in the exporting and importing countries.

In view of the deficiencies in the Singaporean import data, values and unit values are not presented here, although they indicate that imports from Thailand, for example, which are likely to be Siam benzoin, are more highly valued than those from India, Pakistan and Malaysia.

7.5 Export data - Secondary source countries

7.5.1 Thailand

Exports of benzoin from Thailand, and destinations, for the period 1987-1996 are shown in Table 7.10 (volume) and Table 7.11 (value and unit value).

Table 7.10 Gum benzoin - Volume of exports from Thailand by destinations, 1987-1996 (tonnes)

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Total	**10**	**17**	**6**	**11**	**14**	**3**	**8**	**18**	**6**	**-**
Of which to:										
Hong Kong	1	6	2	7	12	3	-	-	-	-
Singapore	5	5	2	-	~	-	8	-	-	-
Malaysia	-	-	-	-	-	-	-	15	-	-
Indonesia	-	-	-	-	-	-	-	-	6	-
Germany	3	4	2	3	1	-	-	1	-	-
France	1	2	-	1	1	-	~	2	-	-

Source: Foreign Trade Statistics of Thailand.

Exports were erratic, varying from nil in 1996 to 18 tonnes in 1994. The 10-year annual average is approximately 9 tonnes. Hong Kong and Singapore are both likely to be intermediate destinations. The Indonesian figure for 1995 is presumed to be Siam benzoin intended for extraction and so also represents an intermediate destination.

The high unit value of exports to Germany and France suggests that they include a high proportion of the top grades of Siam benzoin.

Table 7.11 Gum benzoin - Value and unit value of exports from Thailand by destinations, 1987-1996 (1,000 US$; US$/kg)

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Total value[a]	**87**	**163**	**42**	**91**	**111**	**1**	**11**	**56**	**47**	**-**
(Unit value)[b]	**(9.04)**	**(9.67)**	**(7.60)**	**(8.41)**	**(7.89)**	**(0.50)**	**(1.37)**	**(3.17)**	**(8.14)**	**-**
Of which to:										
Hong Kong	4	39	6	30	76	1	-	-	-	-
	(3.98)	(6.90)	(3.47)	(4.36)	(6.37)	(0.50)	-	-	-	-
Singapore	24	31	10	-	~	-	4	-	-	-
	(5.33)	(5.99)	(6.17)	-	(3.42)	-	(0.50)	-	-	-
Malaysia	-	-	-	-	-	-	-	3	-	-
	-	-	-	-	-	-	-	(0.22)	-	-
Indonesia	-	-	-	-	-	-	-	-	47	-
	-	-	-	-	-	-	-	-	(8.14)	-
Germany	38	68	24	44	14	-	-	13	-	-
	(13.23)	(15.20)	(12.22)	(14.82)	(14.02)	-	-	(16.42)	-	-
France	21	24	-	17	20	-	8	40	-	-
	(17.08)	(16.28)	-	(16.75)	(20.26)	-	(15.35)	(19.98)	-	-

Notes: *a*: FOB value; see note *a*, Table 7.8
b: See note *b*, Table 7.8
Source: Foreign Trade Statistics of Thailand

7.5.2 Singapore

The volume of exports of gum benjamin (gum benzoin) from Singapore, and destinations, for the 10 years 1987-1996 are shown in Table 7.12.

Annual exports have varied from around 2,800 tonnes (1987) to just over 4,000 tonnes (1996). The annual average is 3,600 tonnes. Since 1990, the source data give both total exports and domestic exports, the latter therefore giving an indication, in the case of benzoin, of the amounts which are processed in Singapore (into block or extract). From 1991 to 1995, the proportion of benzoin exported in processed form was 51% of total exports; it rose slightly to 54% in 1996.

The volumes of benzoin exported are clearly much greater than the exports from Indonesia suggest. Recorded exports to Singapore averaged 940 tonnes for 1987-1995, compared with Singapore exports for the same period of 3,500 tonnes. This can be explained, however, by the considerable amounts of damar which are used in the preparation of block benzoin, as well as the higher moisture content of the latter compared with benzoin almonds.

The destinations listed in Table 7.12 have been grouped according to geographical region and several features are evident. Most significantly, the data support the statements made by the various traders which were visited during the mission, namely, that the major markets are in the Middle East, India and North Africa, where the benzoin is used for incense purposes. Saudi Arabia is the biggest single market, and may re-export to some smaller Gulf states, but the United Arab Emirates also take significant quantities. In Africa, Djibouti serves as an entrepôt; Morocco, Tunisia and Egypt are other prominent importers. In West Africa, Nigeria is important. In the Indian sub-continent, India and Sri Lanka import large amounts of benzoin, and in Asia, Malaysia is by far the biggest importer. France, Germany and the UK are the biggest markets in Europe.

Table 7.12 Gum benjamin - Volume of exports from Singapore by destinations[a], 1987-1996 (tonnes)

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Total[b]	**2,827**	**3,499**	**3,945**	**3,134**	**3,826**	**3,873**	**3,739**	**3,659**	**3,411**	**4,063**
Domestic[c]	**na**	**na**	**na**	**80**	**1,945**	**1,987**	**1,910**	**1,882**	**1,731**	**2,187**
Difference	**na**	**na**	**na**	**3,054**	**1,881**	**1,886**	**1,829**	**1,777**	**1,680**	**1,876**
Of which to:										
S. Arabia	819	872	904	662	858	835	735	746	708	869
UAE	135	141	174	145	196	161	328	442	428	268
Kuwait	114	249	120	25	-	-	-	-	36	36
Oman	16	9	21	24	25	16	18	-	12	-
Yemen	-	-	-	15	43	115	129	73	105	160
Yemen, Dem.	-	-	-	17	20	-	-	-	-	14
Jordan	-	-	-	-	74	131	-	37	-	-
Djibouti	283	317	457	340	646	374	405	505	235	366
Ethiopia	-	-	-	-	-	135	36	93	72	162
Morocco	114	209	187	166	165	180	212	176	123	167
Tunisia	84	110	279	195	158	90	117	54	221	118
Egypt	-	180	50	120	59	182	-	144	-	98
Algeria	-	-	-	-	-	-	72	54	-	-
Nigeria	32	26	92	95	89	106	164	36	103	102
S. Africa	-	-	-	-	-	-	-	-	24	37
Other Africa[d]	77	97	94	73	56	90	105	52	-	162

Table 7.12 contd.

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
India	318	378	434	456	370	511	317	260	244	350
Sri Lanka	146	147	205	171	219	223	354	245	285	308
Pakistan	39	29	51	63	51	40	58	38	48	36
Bangladesh	-	-	149	-	-	-	-	-	-	193
Malaysia	248	278	237	204	318	212	368	362	390	307
Taiwan	88	79	90	92	133	104	20	12	39	22
Japan	33	33	49	20	23	12	14	16	22	8
Viet Nam	-	-	-	-	-	-	-	15	20	-
France	80	124	89	88	51	56	73	78	90	72
Germany	26	36	108	41	71	64	53	64	62	79
UK	50	40	54	47	51	40	22	33	15	10
Netherlands	-	4	4	3	12	13	21	13	-	-
Italy	5	6	4	3	4	3	17	-	-	-
Greece	15	18	14	12	12	13	-	-	9	12
Denmark	-	-	-	-	41	40	-	-	-	-
USA	43	38	14	16	19	47	30	26	14	-
Others[e]	62	79	65	41	62	80	71	85	105	107

Notes: *a*: '-' does not necessarily indicate nil, but that the particular destination is not specified in the source data; it may be included in *Other Africa* or *Others*.
b: Total exports comprise domestic exports and re-exports (but exclude transshipment cargo on through bills of lading or through airway bill).
c: Domestic exports are those of Singapore origin and comprise *primary commodities grown or produced in Singapore and goods which have been transformed, that is processed in Singapore, including those with imported materials.*
d: Includes Benin, 19 tonnes (1987) and 26 tonnes (1988); Sudan, 26 tonnes (1987) and 40 tonnes (1988); and Libya, 38 tonnes (1989), which are specified in source data. Other source data are recorded simply as *Other countries, Africa.*
e: Includes Hong Kong, 5 tonnes (1991); Lebanon, 10 tonnes (1994); and Venezuela, 16 tonnes (1996).
Source: Singapore Trade Statistics

The data in Table 7.12 have been condensed in Table 7.13, which shows the destinations grouped into regions. The percentage of total exports for each year taken by each region is also given.

The Middle East is seen to account for about one third of Singapore's exports of benzoin, with Africa accounting for between a quarter and one third.

Table 7.13 Gum benjamin - Volume of exports from Singapore, and destinations by region, 1987-1996 (tonnes; %)

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Total	**2,827**	**3,499**	**3,945**	**3,134**	**3,826**	**3,873**	**3,739**	**3,659**	**3,411**	**4,063**
Of which to:										
Middle East	1,084	1,271	1,219	888	1,216	1,258	1,210	1,298	1,289	1,347
	(38%)	(36%)	(31%)	(28%)	(32%)	(32%)	(32%)	(35%)	(38%)	(33%)
Africa	590	939	1,159	989	1,173	1,157	1,111	1,114	778	1,212
	(21%)	(27%)	(29%)	(32%)	(31%)	(30%)	(30%)	(30%)	(23%)	(30%)
Indian sub-	503	554	839	690	640	774	729	543	577	887
continent	(18%)	(16%)	(21%)	(22%)	(17%)	(20%)	(19%)	(15%)	(17%)	(22%)
Asia	369	390	376	316	474	328	402	405	471	337
	(13%)	(11%)	(10%)	(10%)	(12%)	(8%)	(11%)	(11%)	(14%)	(8%)
Europe	176	228	273	194	242	229	186	188	176	173
	(6%)	(7%)	(7%)	(6%)	(6%)	(6%)	(5%)	(5%)	(5%)	(4%)
USA	43	38	14	16	19	47	30	26	14	-
	(1%)	(1%)	~	~	~	(1%)	(1%)	(1%)	~	-
Others	62	79	65	41	62	80	71	85	106	107
	(2%)	(2%)	(2%)	(1%)	(2%)	(2%)	(2%)	(2%)	(3%)	(3%)

Source: Table 7.12

The value of benzoin exports from Singapore for each of the destinations in Table 7.12 is shown in Table 7.14.

Table 7.14 Gum benjamin – Value[a] of exports from Singapore by destinations[b], 1987-1996 (1,000 US$)

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Total[c]	**3,431**	**4,110**	**4,265**	**3,457**	**4,235**	**3,878**	**4,173**	**4,231**	**4,754**	**5,205**
Domestic[d]	**na**	**na**	**na**	**94**	**2,011**	**1,867**	**1,830**	**2,022**	**2,327**	**2,896**
Difference	**na**	**na**	**na**	**3,363**	**2,224**	**2,011**	**2,343**	**2,209**	**2,427**	**2,309**
Of which to:										
S. Arabia	1,055	1,068	1,153	721	1,075	888	892	896	890	972
UAE	317	340	268	251	314	271	568	439	569	401
Kuwait	75	184	90	23	-	-	-	-	35	40
Oman	37	22	29	47	40	18	32	-	22	-
Yemen	-	-	-	17	26	116	125	88	133	223
Yemen, Dem.	-	-	-	18	15	-	-	-	-	19
Jordan	-	-	-	-	54	99	-	27	-	-
Djibouti	222	216	327	242	429	219	270	352	181	369
Ethiopia	-	-	-	-	-	97	24	64	66	117
Morocco	120	206	204	198	181	170	183	168	116	174
Tunisia	57	71	192	140	137	59	73	37	225	123
Egypt	-	313	27	68	29	95	-	69	-	74
Algeria	-	-	-	-	-	-	43	37	-	-

Table 7.14 contd.

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Nigeria	25	17	62	72	50	69	114	25	84	85
S. Africa	-	-	-	-	-	-	-	-	34	55
Other Africa[e]	55	77	79	54	50	85	86	50	-	165
India	348	422	495	503	416	431	339	403	531	685
Sri Lanka	110	108	160	130	193	191	284	282	337	378
Pakistan	32	16	31	44	30	28	38	28	33	33
Bangladesh	-	-	27	-	-	-	-	-	-	30
Malaysia	185	217	169	142	254	145	318	403	511	490
Taiwan	80	73	156	130	244	133	49	43	162	83
Japan	52	46	93	37	39	20	20	25	49	18
Viet Nam	-	-	-	-	-	-	-	18	20	-
France	257	270	231	218	124	179	244	238	346	244
Germany	72	87	173	146	157	209	178	211	167	231
UK	146	112	135	123	154	101	64	128	66	30
Netherlands	-	21	15	17	36	45	81	47	-	-
Italy	37	39	29	19	28	18	33	-	-	-
Greece	23	29	24	20	19	25	-	-	20	26
Denmark	-	-	-	-	21	23	-	-	-	-
USA	73	91	42	34	39	68	47	47	26	-
Others[f]	55	65	52	45	81	77	67	107	130	140

Notes: *a*: FOB value in S$ converted to US$ using following average exchange rates: 2.1060 (1987), 2.0124 (1988), 1.9503 (1989), 1.8125 (1990), 1.7276 (1991), 1.6290 (1992), 1.6158 (1993), 1.5274 (1994), 1.4174 (1995), 1.4109 (Jan.-Nov. 1996)

b: See note *a*, Table 7.12

c: See note *b*, Table 7.12

d: See note *c*, Table 7.12

e: Includes Benin, US$12,000 (1987) and US$18,000 (1988); Sudan, US$17,000 (1987) and US$25,000 (1988); and Libya, US$32,000 (1989), which are specified in source data. Other source data are recorded simply as *Other countries, Africa*.

f: Includes Hong Kong, US$31 000 (1991); Lebanon, US$18 000 (1994); and Venezuela, US$18 000 (1996)

Sources: Singapore Trade Statistics; International Financial Statistics, IMF

The total value to Singapore ranged from US$ 3.4 million in 1987 to US$ 5.2 million in 1996. Saudi Arabia remains the major market in value terms, but India, which was third behind Djibouti in volume terms, is the second biggest market in value. The relatively high value of exports to France (and other European destinations) compared with the modest volumes involved are particularly notable. The value data in Table 7.14 are summarized by region in Table 7.15.

Table 7.15 Gum benjamin - Value of exports from Singapore, and destinations by region, 1987-1996 (1,000 US$; %)

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Total	**3,431**	**4,110**	**4,265**	**3,457**	**4,235**	**3,878**	**4,173**	**4,231**	**4,754**	**5,205**
Of which to:										
Middle East	1,484	1,614	1,540	1,077	1,524	1,392	1,617	1,450	1,649	1,655
	(43%)	(39%)	(36%)	(31%)	(36%)	(36%)	(39%)	(34%)	(35%)	(32%)
Africa	479	900	891	774	876	794	793	802	706	1,162
	(14%)	(22%)	(21%)	(22%)	(20%)	(20%)	(19%)	(19%)	(15%)	(22%)
Indian sub-continent	490	546	713	677	639	650	661	713	901	1,126
	(14%)	(13%)	(17%)	(20%)	(15%)	(17%)	(16%)	(17%)	(19%)	(22%)
Asia	317	336	418	309	537	298	387	489	742	591
	(9%)	(8%)	(10%)	(9%)	(13%)	(8%)	(9%)	(12%)	(15%)	(11%)
Europe	535	558	607	543	539	600	600	624	599	531
	(16%)	(14%)	(14%)	(16%)	(13%)	(15%)	(14%)	(15%)	(13%)	(10%)
USA	73	91	42	34	39	68	47	47	26	-
	(2%)	(2%)	(1%)	(1%)	(1%)	(2%)	(1%)	(1%)	(1%)	-
Others	55	65	52	45	81	77	67	107	130	140
	(2%)	(2%)	(1%)	(1%)	(2%)	(2%)	(2%)	(2%)	(3%)	(3%)

Source: Table 7.14

It can be seen by comparing the percentages of total exports taken by the different regions in volume (Table 7.13) with those in value terms (Table 7.15) that although Europe only accounts for around 5-6% of Singapore's benzoin exports in quantity, this share increases to around 14-16% in value terms. Conversely, in most years Africa has accounted for approximately 30% of exports but this drops to around 15-20% when considered in value terms.

Unit values have been calculated for each of the destinations and these are shown in Table 7.16 (individually) and Table 7.17 (by region).

Table 7.16 Gum benjamin - Unit value of exports from Singapore by destinations, 1987-1996 (US$/kg)

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Total[a]	**1.21**	**1.17**	**1.08**	**1.10**	**1.11**	**1.00**	**1.12**	**1.16**	**1.39**	**1.28**
Domestic[b]	**na**	**na**	**na**	**1.18**	**1.03**	**0.94**	**0.96**	**1.07**	**1.34**	**1.32**
Difference	**na**	**na**	**na**	**1.10**	**1.18**	**1.07**	**1.28**	**1.24**	**1.44**	**1.23**
Of which to:										
S. Arabia	1.29	1.22	1.28	1.09	1.25	1.06	1.21	1.20	1.26	1.12
UAE	2.35	2.41	1.54	1.73	1.60	1.68	1.73	0.99	1.33	1.50
Kuwait	0.65	0.74	0.75	0.93	-	-	-	-	0.96	1.10
Oman	2.31	2.48	1.37	1.95	1.60	1.15	1.79	-	1.82	-
Yemen	-	-	-	1.10	0.61	1.01	0.97	1.21	1.27	1.39
Yemen, Dem.	-	-	-	1.04	0.75	-	-	-	-	1.37
Jordan	-	-	-	-	0.73	0.76	-	0.73	-	-
Djibouti	0.79	0.68	0.71	0.71	0.66	0.58	0.67	0.70	0.77	1.01
Ethiopia	-	-	-	-	-	0.72	0.67	0.69	0.91	0.72
Morocco	1.05	0.98	1.09	1.19	1.09	0.94	0.86	0.96	0.95	1.04
Tunisia	0.67	0.64	0.69	0.72	0.86	0.65	0.62	0.69	1.02	1.04
Egypt	-	1.74	0.53	0.57	0.49	0.52	-	0.48	-	0.75
Algeria	-	-	-	-	-	-	0.60	0.69	-	-
Nigeria	0.77	0.67	0.67	0.76	0.57	0.65	0.69	0.69	0.82	0.83
S. Africa	-	-	-	-	-	-	-	-	1.41	1.49
Other Africa[c]	0.72	0.79	0.85	0.73	0.90	0.95	0.73	0.97	-	1.02
India	1.09	1.12	1.14	1.10	1.12	0.84	1.07	1.55	2.18	1.96
Sri Lanka	0.75	0.73	0.78	0.76	0.88	0.86	0.80	1.15	1.18	1.23
Pakistan	0.82	0.57	0.61	0.69	0.58	0.71	0.65	0.74	0.69	0.91
Bangladesh	-	-	0.18	-	-	-	-	-	-	0.16
Malaysia	0.74	0.78	0.71	0.70	0.80	0.68	0.86	1.11	1.31	1.60
Taiwan	0.91	0.92	1.74	1.42	1.83	1.27	2.44	3.55	4.14	3.77
Japan	1.57	1.40	1.90	1.85	1.71	1.64	1.41	1.55	2.24	2.21
Viet Nam	-	-	-	-	-	-	-	1.18	1.02	-
France	3.21	2.18	2.60	2.48	2.44	3.19	3.35	3.06	3.85	3.39
Germany	2.76	2.43	1.60	3.57	2.22	3.27	3.36	3.29	2.69	2.92
UK	2.92	2.80	2.51	2.62	3.03	2.53	2.93	3.87	4.37	3.05
Netherlands	-	5.22	3.72	5.70	2.99	3.45	3.86	3.63	-	-
Italy	7.41	6.54	7.31	6.25	6.95	6.14	1.93	-	-	-
Greece	1.55	1.60	1.72	1.70	1.59	1.94	-	-	2.27	2.19
Denmark	-	-	-	-	0.51	0.57	-	-	-	-
USA	1.70	2.39	3.00	2.13	2.04	1.45	1.57	1.81	1.86	-
Others[d]	0.89	0.82	0.80	1.09	1.25	0.95	0.94	1.26	1.24	1.31

Notes: *a*: See note *b*, Table 7.12
b: See note *c*, Table 7.12
c: See note *d*, Table 7.12 and note e, Table 7.14
d: See note *e*, Table 7.12 and note f, Table 7.14

Source: Calculated from Tables 7.12 and 7.14 (using exact figures for value rather than those rounded to nearest 1,000 US$).

Table 7.17 Gum benjamin - Unit value of exports from Singapore, and destinations by region, 1987-1996 (US$/kg)

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Total	**1.21**	**1.17**	**1.08**	**1.10**	**1.11**	**1.00**	**1.12**	**1.16**	**1.39**	**1.28**
Of which to:										
Middle East	1.37	1.27	1.26	1.21	1.25	1.11	1.34	1.12	1.28	1.23
Africa	0.81	0.96	0.77	0.78	0.75	0.69	0.71	0.72	0.91	0.96
Indian sub-continent	0.97	0.99	0.85	0.98	1.00	0.84	0.91	1.31	1.56	1.27
Asia	0.86	0.86	1.11	0.98	1.13	0.91	0.96	1.21	1.58	1.75
Europe	3.04	2.45	2.22	2.80	2.23	2.62	3.23	3.32	3.40	3.07
USA	1.70	2.39	3.00	2.13	2.05	1.45	1.57	1.81	1.86	-
Others	0.89	0.82	0.80	1.10	1.31	0.96	0.94	1.26	1.23	1.31

Source: Calculated from Tables 7.13 and 7.15

Looking first at regional differences in unit values (Table 7.17), the figures are highest for Europe and the United States, confirming that a greater proportion of high grade benzoin and/or extract is going to these regions. Unit values are lowest for Africa.

Closer inspection of the data (Table 7.16) reveals further differences within a region. In Europe, for example, apart from 1993, Italy's imports have had a consistently and significantly higher unit value than those of the other countries, presumably indicating that less lower quality benzoin is being imported which would have had the effect of lowering the overall unit value. The lower unit value for Greece indicates, perhaps, that the benzoin is intended mainly for incense use in the Greek Orthodox Church.

In Asia, Malaysian imports of benzoin are used mainly for incense purposes and this is reflected in lower unit values than those for Taiwan and Japan. Figures for India are higher than those for other countries in the Indian sub-continent and this may be a reflection of the strong fragrance and flavour industries in India and their requirements for suitable, higher quality benzoin.

7.6 Import data - Other countries

Where they were available, import data for a few of the major destinations, as indicated by the Singapore exports, were examined and these are discussed briefly below.

7.6.1 Saudi Arabia

Volumes of imports into Saudi Arabia for the years 1991, 1992 and 1994 (the only years available) are shown in Table 7.18.

Table 7.18 Gum benzoin - Volume of imports into Saudi Arabia by origins, 1991-1994 (tonnes)

	1991	1992	1993	1994
Total	**707**	**539**	**na**	**561**
Of which from:				
Indonesia	370	145	na	174
Singapore	231	238	na	205
USA	-	75	na	-
Malaysia	63	-	na	-
Others	43	81	na	182

Source: Saudi Arabia. Foreign Trade Statistics

The total volumes indicated in Table 7.18 appear to be reasonable when compared with total exports from Indonesia and Singapore but individual figures for the two countries agree poorly with those in Table 7.18. In the case of Indonesia (Table 7.4), there appears to be severe under-recording of exports to Saudi Arabia. This is even greater than Table 7.18 indicates because Indonesia is included as a country of origin for Saudi imports of frankincense; this represents benzoin and not genuine frankincense. Conversely, Singapore's exports to Saudi Arabia (Table 7.12) are much higher than those shown in Table 7.18. One explanation may be that in the case of imports from Singapore, some of which represent re-exports (without further processing) from Indonesia, Saudi data refer to the country of origin.

7.6.2 India

Indian imports of benzoin for the period 1990/91-1995/96 are shown in Table 7.19 (by volume). In the Indian trade statistics, benzoin (benjamin) is separated into *benjamin ras* and *benjamin cowrie* and these terms are retained in Table 7.19. An Indian trade source states that *benjamin cowrie* refers to benzoin almonds, while *benjamin ras* is block benzoin. However, this would suggest that unit values should be higher for *benjamin cowrie*, when in practice calculated values (not presented here) are very similar for the two types.

The volumes of annual imports shown in Table 7.19 are very erratic, varying from about 90 tonnes up to 280 tonnes, and there must be some question over their accuracy. The total figure of 182 tonnes from Myanmar is extremely doubtful. Levels of imports from Singapore are much lower than the Singapore export data indicate (Table 7.12) and this is not compensated for by high imports from Indonesia. Deliberate misrepresentation of benzoin to avoid import duties may be an explanation.

Table 7.19 Gum benjamin - Volume of imports into India by origins, 1990/91-1995/96[a] (tonnes)

		1990/91	1991/92	1992/93	1993/94	1994/95
Total		**138**	**129**	**86**	**144**	**281**
Ras		**110**	**121**	**31**	**37**	**194**
Cowrie		**28**	**8**	**55**	**107**	**87**
Of which from:						
Indonesia	Ras	9	18	2	12	13
	Cowrie	1	-	2	12	26
Singapore	Ras	101	103	29	25	49
	Cowrie	26	8	53	50	11
Myanmar	Ras	-	-	-	-	132
	Cowrie	-	-	-	45	50
Malaysia	Ras	-	-	-	-	-
	Cowrie	-	-	-	-	-
Italy	Ras	-	-	-	-	-
	Cowrie	-	-	-	-	-

Note: *a*: Statistical year runs April to March
Source: India. Foreign Trade Statistics

7.6.3 Malaysia

Malaysian imports are shown in Table 7.20 (by volume) and Table 7.21 (value and unit value).

As with Saudi Arabia, Malaysian imports from Indonesia are much higher than Indonesia's export statistics indicate, while imports from Singapore are much lower than the Singaporean export data show. Again, the answer may lie in the Indonesian origin of Singaporean re-exports.

The figures for unit value (Table 7.21) confirm the low quality of the benzoin imported into Malaysia.

Table 7.20 Gum benjamin - Volume of imports into Malaysia by origins[a], 1987-1996 (tonnes)

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996[b]
Total	**267**	**298**	**301**	**315**	**306**	**340**	**326**	**264**	**299**	**109**
Of which from:										
Indonesia	182	206	154	186	261	282	301	244	290	96
Singapore	76	79	141	121	40	47	21	17	7	4
India	9	13	4	3	5	11	4	2	2	7
Nepal	~	~	1	-	-	-	-	-	-	-
China, PR	-	~	1	~	-	-	-	-	-	-
Myanmar	-	-	-	4	-	-	-	-	-	-
Italy	-	-	-	-	-	-	-	1	-	-
Denmark	-	-	-	-	-	-	-	-	-	2

Notes: *a*: In addition to the countries listed, Tanzania (1987,1990), Viet Nam (1988), Hong Kong (1988, 1989, 1990), Japan (1989), Taiwan (1989), UK (1989), Egypt (1989) and Iran (1990) supplied small (< 0.5 tonne) or very small (<< 0.5 tonne) volumes. Apart from Viet Nam, these are all likely to represent re-exports

b: Provisional (at April 1997). Final figures to be published October 1997

Source: Malaysia. External Trade Statistics

Table 7.21 Gum benjamin - Value and unit value of imports into Malaysia by origins, 1987-1996 (1,000 US$; US$/kg)

	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996
Total value[a]	**174**	**199**	**200**	**204**	**196**	**277**	**347**	**292**	**404**	**129**
(Unit value)[b]	**(0.65)**	**(0.67)**	**(0.66)**	**(0.65)**	**(0.64)**	**(0.82)**	**(1.06)**	**(1.11)**	**(1.35)**	**(1.18)**
Of which from:										
Indonesia	77	88	79	104	163	242	325	274	390	116
	(0.42)	(0.43)	(0.51)	(0.56)	(0.63)	(0.86)	(1.08)	(1.12)	(1.34)	(1.21)
Singapore	90	97	110	85	27	21	14	14	10	6
	(1.18)	(1.23)	(0.78)	(0.70)	(0.68)	(0.45)	(0.67)	(0.82)	(1.31)	(1.31)
India	8	13	7	4	5	14	8	3	4	4
	(0.87)	(1.03)	(1.96)	(1.26)	(1.03)	(1.30)	(1.88)	(2.08)	(2.61)	(0.60)
Nepal	~	~	2	-	-	-	-	-	-	-
	(1.67)	(3.46)	(3.21)	-	-	-	-	-	-	-
China, PR	-	~	2	~	-	-	-	-	-	-
	-	(1.43)	(1.47)	(0.54)	-	-	-	-	-	-
Myanmar	-	-	-	11	-	-	-	-	-	-
	-	-	-	(2.96)	-	-	-	-	-	-
Italy	-	-	-	-	-	-	-	1	-	-
	-	-	-	-	-	-	-	(1.17)	-	-
Denmark	-	-	-	-	-	-	-	-	-	2
	-	-	-	-	-	-	-	-	-	(1.27)

Notes: *a*: CIF value in Ringgit converted to US$ using following average exchange rates: 2.5196 (1987), 2.6188 (1988), 2.7088 (1989), 2.7049 (1990), 2.7501 (1991), 2.5474 (1992), 2.5741 (1993), 2.6243 (1994), 2.5044 (1995), 2.5148 (Jan.-Nov. 1996)

b: Calculated using exact figures for volume and value from source data rather than those rounded to nearest tonne and 1,000 US$

Sources: Malaysia. External Trade Statistics; International Financial Statistics, IMF

7.6.4 The European Union

As noted earlier, Eurostat trade statistics for European Union member states do not separate benzoin from other natural gums and resins. However, inspection of the import statistics for *natural gums, resins, gum-resins and oleoresins other than lac and gum arabic* enables one to deduce possible levels of imports of Siam benzoin into Europe.

Table 7.22 shows the volume of imports with this classification into the European Union for the period 1988-95.

Table 7.22 Natural gums and resins[a] - Volume of imports into the European Union[b] from Lao PDR, Thailand and Viet Nam, 1988-1995 (tonnes)

	1988	1989	1990	1991	1992	1993	1994	1995
From: Lao PDR	5	15	27	7	21	19	29	14
Of which to:								
France	5	15	27	7	19	19	29	14
Germany	-	-	-	-	2	-	-	-
From: Viet Nam	12	5	5	1	2	3	11	-
Of which to:								
France	9	5	5	-	-	-	-	-
Germany	3	-	-	1	1	1	2	-
UK	-	-	-	-	1	2	9	-
From: Thailand	14	20	123	18	3	1	39	23
Of which to:								
France	8	6	46	4	2	-	2	6
Germany	5	14	68	14	1	-	1	2
UK	1	-	9	-	-	1	21	15
Italy	-	-	-	-	-	-	15	-

Notes: *a*: Classified as *Natural gums, resins, gum-resins and oleoresins other than lac and gum arabic*
b: Only data for the 12 member states of the former European Community are analyzed, i.e. the UK, France, Germany, Belgium, Luxembourg, Netherlands, Italy, Ireland, Denmark, Portugal, Spain and Greece
Source: Eurostat

In view of the large amount of data available from the statistics, most of which does not relate to benzoin, only Lao PDR, Thailand and Viet Nam – as potential sources of Siam benzoin – have been selected for inclusion in Table 7.22. Imports from Indonesia and Singapore have been excluded because large quantities of other gums and resins would be included in the figures. Totals are not shown - again, because they have no relevance to benzoin - but they usually amount to around 20,000 tonnes annually.

Imports into the EU from Lao PDR are all well within the levels of recorded Lao exports of benzoin (Table 7.2) and it is a reasonable assumption that most, if not all, of the totals for Lao PDR given in Table 7-22 comprise benzoin. France is the sole recipient in all years except 1992, when 2 tonnes of the 21 tonnes were imported into Germany; this is in accord with the fact that France is known to be the most important market for Lao benzoin.

Imports from Viet Nam are recorded for all years except 1995 and the three importing countries are all ones which NAFORIMEX stated that they exported benzoin to. Again, therefore, it is reasonable to suppose that the data for Viet Nam refer to benzoin. Table 7.22 shows that France was the main destination during 1988-1990 but imported nothing thereafter, the recipients, instead, being Germany and the UK.

It is more difficult to judge to what extent the imports from Thailand include benzoin. France and Germany are the main importers (and both countries are given as destinations in the Thai export statistics for benzoin – Table 7.10) but the high figures for 1990 make it likely that other gums or resins are included. Thailand exports large amounts of damar and although most goes to India it is possible that some is also shipped to Europe.

The difficulty of reconciling trade statistics with the opinions of people in the trade is illustrated by the view given by a large German importer of gums and resins, including benzoin. The company estimates German imports of Siam benzoin to be 10-15 tonnes per year, considerably more than the data in Table 7.22 indicate. The company states that they purchase benzoin mainly from Lao PDR and Viet Nam, with a little from Thailand.

Value/unit value data for EU imports of natural gums and resins from Lao PDR and Viet Nam for the period 1988-95 are given in Table 7.23. Unit values were calculated for imports from Thailand and they showed a wide range, supporting the contention that the data include gums other than benzoin; they have therefore not been included in Table 7.23.

The high unit values for French and German imports from Lao PDR support the view that the imports are likely to represent benzoin. On the whole, the same is true for imports from Viet Nam, although unit values for the UK and some of the German imports are lower than those for the French imports and may indicate the presence of gums or resins other than benzoin. The unit values of French imports from Viet Nam are higher than those from Lao PDR and suggest that Vietnamese imports contain a higher proportion of the premium grades of benzoin.

Table 7.23 Natural gums and resins[a] - Value and unit value of imports into the European Union from Lao PDR and Viet Nam, 1988-1995 (1,000 US$; US$/kg)

	1988	1989	1990	1991	1992	1993	1994	1995
From: Lao PDR								
Value[b]	76	199	265	88	227	179	308	154
(Unit value)	(15.15)	(13.30)	(9.81)	(12.58)	(10.81)	(9.44)	(10.62)	(11.03)
Of which to:								
France	76	199	265	88	201	179	308	154
	(15.15)	(13.30)	(9.81)	(12.58)	(10.58)	(9.44)	(10.62)	(11.03)
Germany	-	-	-	-	26	-	-	-
	-	-	-	-	(12.97)	-	-	-
From: Viet Nam								
Value[b]	174	75	71	7	18	18	80	-
(Unit value)	(14.50)	(14.99)	(14.26)	(7.44)	(9.08)	(5.86)	(7.24)	-
Of which to:								
France	154	75	71	-	-	-	-	-
	(17.10)	(14.99)	(14.26)	-	-	-	-	-
Germany	20	-	-	7	13	Na	na	-
	(6.71)	-	-	(7.44)	(12.97)	(na)	(na)	-
UK	-	-	-	-	5	Na	na	-
	-	-	-	-	(5.19)	(na)	(na)	-

Notes: *a*: See note *a*, Table 7.22
b: CIF value in ECU converted to US$ using following average exchange rates (US$ per ECU): 1.1839 (1988), 1.1024 (1989), 1.2730 (1990), 1.2405 (1991), 1.2968 (1992), 1.1723 (1993), 1.1886 (1994), 1.3081 (1995)

Sources: Eurostat; International Financial Statistics, IMF

Photo 7.1 Siam benzoin (Lao PDR) Scale: 1 cm divisions
Top (L→R) Grade A, B and C
Bottom (L→R) Grade D and fresh mixed

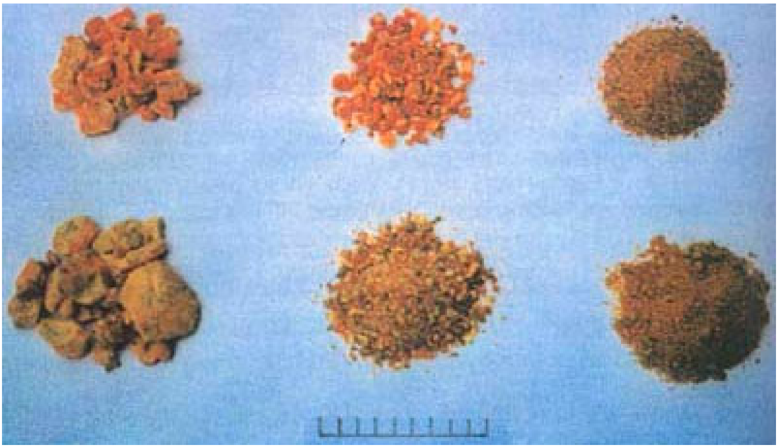


Photo 7.2 Sumatra benzoin (ex Singapore) Scale: 1 cm divisions
Top (L→R) Grade 1, 2 and 3 (dust) [company A]
Bottom (L→R) Almonds, siftings and almonds dust [company B]

Chapter 8. Marketing

8.1 Products

8.1.1 Grades

The sorting and grading of Siam benzoin according to size in Lao PDR was described earlier in Chapter 5, section 5.3.5. The grading criteria used in Viet Nam for Siam benzoin and in Indonesia for Sumatra benzoin almonds are similar. In Lao PDR the grades are given a simple letter or number designation, e.g. A-D or 1-4. The friable nature of the benzoin, particularly after it has been freshly harvested, means that it has a tendency to break into smaller pieces through physical attrition during its transport from the village to Vientiane and the repeated handling that it receives. The proportion of the smaller grades therefore increases at each stage of its handling and eventually accounts for the larger part of the year's crop. After cleaning and grading at the exporter's warehouse, there is typically around 10% of each of the two higher grades (A & B) and 35-40% of each of the lower grades (C & D). The large price differential between the top and bottom grades means that the process of physical attrition leads to an overall devaluation of the product.

8.1.2 Quality

Quality is clearly a key factor in determining the price which the exporter is able to get for benzoin. In order to see if there might be ways in which the quality of Lao benzoin can be improved it is necessary first to understand the factors which influence quality.

If the same grades of Siam and Sumatra benzoin (comparable size, colour and purity) are compared, the former commands a much higher price than the latter. There are therefore two aspects to quality: 1) intrinsic quality, which is a reflection of the chemistry of benzoin; 2) the quality which is determined by its extraction and the treatment and handling of it subsequent to exudation from the tree. Since Siam benzoin from Lao PDR (at least, that intended for export) does not have the wide variation in types that the Sumatran has, the discussion here is focused mainly on benzoin almonds, which both Indonesia and Lao PDR produce.

8.1.2.1 Intrinsic quality

The intrinsic quality is genetically determined at the species, provenance and individual tree level. Thus, benzoin from *Styrax tonkinensis* (Siam benzoin) is different to that from *S. benzoin* (Sumatra benzoin). Within a species, however, it is possible for resin from different natural populations, as well as individual trees within the population, to have different chemical (and therefore different sensory) characteristics.

Benzoin collected from different areas is said to have different properties. Benzoin from Luang Prabang province, Lao PDR, is claimed to have a stronger odour than that from other areas. When the FAO project trees are old enough, resin samples should be collected for analysis from individual trees from the provenance trials. If significant differences exist, then it may be possible to take advantage of these differences and select superior germplasm for planting. An Indonesian extractor of benzoin stated that odour strength varies between different parts of Sumatra, although in this case it is possible that the benzoin comes from different species. Jafarsidik (1986) states that benzoin from *S. parallelonurum* grown in Dolok Sanggul is a better quality than that from *S. benzoin* grown in Pangaribuan, Pahae and Sidilalang.

Even the same tree can yield resin of different qualities. Sometimes this is simply because the larger pieces of resin are picked off the tree first and the smaller, dirtier pieces are collected on a second visit to the tree. But in Sumatra, as noted in Chapter 6, section 6.5.1.4, white and coloured forms of benzoin are apparently exuded from the same tree, although it is not clear under what conditions they are produced.

8.1.2.2 Methodological influences on quality

The manner in which the tree is wounded can also affect the quality of resin obtained by tapping, either as a result of the particular system of tapping which is used or as a result of different standards of workmanship with which it is applied. If sufficient care is not taken when making the cuts in the tree, then it may not be easy to remove the hardened benzoin subsequently without also removing pieces of bark to which it is attached. In Indonesia, more resin seems to be allowed to run down the tree – rather than being trapped between the cut bark and the stem – than in Lao PDR, and is subsequently scraped off the tree, rather than picked; this results in a poor quality benzoin.

The length of time that the resin remains on the tree before it is collected, and the climatic conditions which prevail during this time, affect the quality of the benzoin. Although the resin has to be left on the tree a sufficient time to dry and harden, the longer it is left, the longer it is open to the degradation by sun and rain.

Once it has been collected, the major sources of quality deterioration of benzoin almonds are the repeated handling which the benzoin receives in going from the collector to the exporter, and the conditions in which it is stored, both at intermediate points in the delivery chain and at the exporter's warehouse prior to shipment. Breakdown of the large pieces to smaller ones, and sticking and compacting of pieces of benzoin or dust and siftings caused by high temperatures, are the main consequences.

Finally, if sufficient care is not taken during storage of the consignment at the exit and entry ports and during shipment to its destination overseas there may be some deterioration in quality. Undue exposure of the container to the sun or a source of heat such as a ship's boiler should be avoided. These are precautions which the exporter and importer, with the cooperation of the shipping agent and ship's owner, should attend to.

8.1.2.3 Quality criteria

Size is the principal criterion for grading of benzoin of the almonds type in the producer countries but the question now considered is how the end-user perceives quality, how this relates to size, and what other parameters are used to measure quality.

1) **Size and odour properties:** The most important properties of benzoin, and the reason it is used by the flavour and fragrance industries, are its sensory or oganoleptic characteristics. These characteristics are not easy to measure in the laboratory since the presence of only trace amounts of some chemicals can drastically affect the odour of a substance. The perfumer's nose is still the best means of assessing odour quality. However, the superior properties of Siam benzoin over Sumatra benzoin are well-recognized and account for the higher price of the former. Siam benzoin has a rounder, more vanilla-like odour than Sumatra benzoin, which is harsher to the nose.

   Given the great price differential between the top and bottom grades of both Siam and Sumatra types of benzoin, it is difficult to escape the conclusion that there *are* genuine differences in odour properties between them, and that the premium paid for larger sized pieces is not due to their size *per se*. If the smaller pieces and the dust had intrinsically the same purity and sensory characteristics as the large pieces, then end-users would not be prepared to pay a higher price for the latter. It is reasonable to suppose that the finely divided state of the benzoin dust and siftings promotes oxidation and loss of important volatile constituents, to the detriment of the odour properties.

2) **Foreign matter:** The presence of foreign matter will clearly also affect quality and smaller pieces of benzoin almonds are likely to have a greater proportion of bark (which has escaped the cleaning process) mixed in with them. Benzoin dust derived from almonds may also have finer extraneous material present (sand, dirt, tiny pieces of

bark) and this is a genuine reason for the buyer being unwilling to pay top prices for it. Even if it can be demonstrated that the dust is as pure as the larger pieces of benzoin, there is a natural reluctance on the part of any buyer to purchase material that can not be seen by the naked eye to be clean and free from adulteration. Low grade Sumatra benzoin is dark and dirty, with foreign matter present which is not easily removed from the benzoin itself.

3) **Yield:** For extractors of benzoin, the extractive yield is important in addition to the odour of the extract. However, the yield is, on the whole, determined by the factors just discussed. Siam benzoin gives higher yields than Sumatra benzoin; clean benzoin gives higher yields than material which contains foreign matter; and benzoin dust gives lower yields than larger pieces.

4) **Age and colour:** The question of age and colour appears to be clear-cut: the fresher and paler the benzoin is, the better. In Lao PDR buyers are unwilling to pay the same price for benzoin that is a year old that they would for material from the present year's crop. In the course of storage, there is an inevitable darkening of colour, from the very pale, uncharacteristic colour when the benzoin is freshly harvested, to one which is a tan, sandy colour. Efforts are therefore made to clear stocks of benzoin quickly and to prevent the colour darkening.

   However, a leading producer of benzoin extract stated that fresh benzoin has a poor aroma and that if fresh material (Siam or Sumatra benzoin) is purchased it must be set aside to age for 2-3 years. This seemed to be true for a sample of freshly-collected benzoin in Lao PDR; it did not have the characteristic vanilla-like odour of older samples. Once again, therefore, good aroma is seen to be all-important in quality terms. The ideal situation would be to have the pale colour of fresh benzoin combined with the superior odour properties of the aged material.

Although the need to age the benzoin appears to contradict the evidence from the lower prices offered for older stock in Lao PDR, it does, nevertheless, appear to offer a way out for exporters who wish to find a market for such stock.

8.1.3 Analysis and analytical parameters

Because benzoin's end-uses depend mainly on its sensory characteristics and these are not easily quantified, exporters rarely lay down specifications for the raw material. Neither is it expected of them by the importer. The extractor or end-user does usually carry out some analyses to check the quality of a consignment and will take action if it is not what it should be. A detailed examination of the various analyses possible is beyond the scope of this discussion, but results of thin layer chromatography (TLC) analysis carried out on some of the samples of benzoin collected in the field is given below, together with some indication of the other parameters which can be measured.

8.1.3.1 TLC analysis of benzoin samples collected

Thin layer chromatography (TLC) is a means of separating mixtures of compounds into their component parts. It presents a simple visual *fingerprint* of the sample being analyzed and can be used to check the purity of a substance or its identity with another one. An explanation of the method and the results which were obtained by analyzing 15 samples of benzoin collected are given in **Appendix 2**. Included were six samples of Siam benzoin of different grades (five from Lao PDR), six of Sumatra benzoin and three of benzoin block The main findings were as follows:

1) The samples of Sumatra benzoin were immediately distinguishable from the Siam samples. The top running spot in the Sumatra samples is assumed to be due to one or more of the cinnamates, which are not present in Siam benzoin. The top running spot in the Siam samples

may be due to benzoates, which are also present in Sumatra benzoin but in smaller amounts.

2) Qualitatively, the different grades within each of the two types are the same, but quantitatively there appear to be some small differences. In particular, the freshly collected sample of Siam benzoin has a larger top running spot than the four standard grades, and the bottom grade (grade D, dust) has the weakest, suggesting that there are indeed genuine differences between the grades. It should be noted that vanillin, which is an important aroma constituent of benzoin, was not available to include in the analysis.

3) The sample of Siam benzoin obtained in Bangkok (glassy in appearance) was much poorer quality than the Lao ones (a very weak top spot and more polar material near the origin). Similarly, the sample of Sumatra mixed (low) quality was confirmed as being very poor compared with the standard grades.

4) The presence of damar in the two samples of low quality block benzoin was readily detected. The sample of good quality block benzoin (stated by the company to contain benzoin almonds rather than damar) was confirmed as having no damar present. The benzoin was the Sumatra type.

TLC is thus a simple, rapid method of analysis that can provide useful information when comparing different types of benzoin. It gives an indication of purity and can detect some forms of adulteration.

8.1.3.2 Analytical parameters

Pharmaceutical use of benzoin generally requires compliance with national pharmacopoeia specifications. Examples of eight different specifications are given in **Appendix 3**. They are listed because they serve to illustrate the differences in quality between Siam and Sumatra benzoin (in terms of acceptable foreign matter or alcohol solubility, for example). Moreover, although designed for a pharmaceutical end-use, some of the test methods may be appropriate in any quality control or certification scheme which might be introduced in Lao PDR.

The parameters most commonly measured, and the limits given in the pharmacopoeias, are summarized in Table 8.1.

Alcohol solubility is important since this gives an indication of foreign matter present (and any alcohol-insoluble organic matter) and a measure of extractive yield. Acid value, ester value and total balsamic acids content can be determined using standard titrimetric methods and are often used by end-users as a means of quality control. For Siam benzoin, balsamic acids are calculated as benzoic acid, while for Sumatra benzoin they are calculated as cinnamic acid. Spectrophotometric measurements of a prepared resinoid are also used by some companies to assess the suitability of the benzoin for their purposes.

Table 8.1 Pharmacopoeia specifications for benzoin[a]

	Benzoin type	Loss on drying	Alcohol-insoluble matter	Total ash	Acid-insoluble ash	Balsamic acids[b]
British (1980)	Siam	Max 10.0%	Max 5%	max 2.0%	-	min 25%
	Sumatra	Max 10.0%	Max 20.0%	max 2.0%	-	min 25%
British (1993)	Sumatra	Max 10.0%	Max 20.0%	max 2.0%	-	min 25%
Chinese	Siam	Max 2.0%	Max 2.0%	max 0.5%	-	min 30%
French	Siam	Max 10.0%	Max 5%	max 2.0%	-	min 25.0%
Japanese	Sumatra[c]	-	Max 30%	max 2.0%	max 1.0%	-
Swiss	Siam	Max 10.0%	Max 5%	max 2.0%	-	min 20%
Thai	Siam	Max 10.0%	Max 5.0%	-	max 0.5%	min 25%
	Sumatra	Max 10.0%	Max 20.0%	-	max 1.0%	min 25%
US	Siam	-	Max 10.0%	-	max 0.5%	min 12.0%
	Sumatra	-	Max 25.0%	-	max 1.0%	min 6.0%

Notes: *a*: For references see **Appendix 3**.
b: Calculated as benzoic acid for Siam benzoin and cinnamic acid for Sumatra benzoin (but see details of Thai and US specifications).
c: Specification refers to benzoin from *Styrax benzoin* (i.e. Sumatra type) *or other species of the same genus* (i.e. could include Siam benzoin).

8.1.4 Brand names

The quality of block benzoin is determined not only by the qualities of the damar and benzoin used in its preparation but by the proportions in which they are mixed. The almost limitless number of permutations of benzoin quality, damar quality and ratios of the two in the mixture gives rise to a large number of different types of block benzoin, all with different qualities. Defining their quality would be no simple task and manufacturers in Singapore do not attempt to do so. Different producers have different *recipes*, which are proprietary information, and it is therefore impossible (and for the companies themselves, undesirable) to have a meaningful system of grading which relies solely on letters or numbers. Instead, there has evolved a large number of brand names that are registered by the producer but may be assigned for exclusive use by a trader. There are no specifications for the brands, but both importer and end-user know from experience which one suits their own requirements, presumably taking advice in the first instance from the producer or exporter.

The following list illustrates some of the brand names used in Singapore for block benzoin of commerce: *A1*; *AAA*; *Aeroplane*; *Arrow*; *Baby*; *Bee*; *Bridge*; *Butterfly*; *Camel*; *Cannon*; *Crocodile*; *Crown A1*; *Deer*; *Double key*; *Dragon fly*; *Eagle globe*; *Eye*; *Flower*; *Flying bomb*; *Flying eagle*; *Globe*; *Hand*; *Jade seal*; *Leopard*; *Oak tree*; *Palm*; *Pigeon*; *Pistol*; *Pomegranate*; *Rake*; *Shark*; *Shuttlecock*; *Spear*; *Squirrel*; *Stork*; *Tank*; *Tiger*; *Tower*; and *Turkey.*

8.1.5 Adulteration

The deliberate inclusion of damar in block Sumatra benzoin is practised in Indonesia. Damar is considerably cheaper than benzoin and readily available within the country. It may serve a functional purpose by acting as a binder to enable the block to be made, and the block itself is a convenient form in which to transport and handle the benzoin.

In India, samples of benzoin from the local market have been found to be adulterated with pine rosin but this is almost certainly a problem peculiar to India.

Lao exporters have not reported any complaints from customers regarding perceived adulteration, nor have they complained about receiving adulterated benzoin themselves from traders and agents within Lao PDR. Sumatra benzoin is sometimes adulterated with vanilla to pass it off as Siam (using relatively cheap synthetic vanillin rather than natural vanilla extract).

8.2 Channels of distribution

The benzoin industry is one in which the product must pass through many hands in going from collector to exporter. Although the road infrastructure in Lao PDR is improving, the difficult nature of the terrain and the distance of many villages from roads or navigable rivers, still makes the task of transporting fragile goods like benzoin slow and arduous. Even if the village is near a road, the villagers may not have the means of transporting the benzoin other than on foot, and this may entail a day's travel. A *second best* to motor transport may be a bicycle. Out of necessity, the job is taken on by people with greater resources at each stage to see that the goods reach their final destination, the exporter. Occasionally, the exporter resorts to air freight to transfer benzoin quickly from a regional center such as Luang Prabang to Vientiane in order to meet an export order.

At the beginning of the chain there are a large number of people involved in benzoin collection. These collectors sell their production to a smaller number of village traders who, in turn, sell it to a still smaller group of other, larger traders who act as agents for the exporters. The situation is illustrated schematically in Figure 8.1.

The exporter's agent is not tied exclusively to the exporter, and he may choose to sell his purchases through other channels. This can include making cross-border sales to the People's Republic of China or Viet Nam. The advantage of this to the agent is that he does not pay tax on the sale and, in the case of China, he can take the opportunity if he wishes to buy cheap, Chinese-made goods and transport them back to Lao PDR for subsequent resale.

In practice there may be more or fewer stages in the chain than is indicated in Figure 8.1. At the village level, individual families who have chosen to collect benzoin may sell their production to a village middleman or they may sell it directly to the exporter's agent. In exceptional circumstances it is even possible for the exporter to buy directly from the village. The choice is often determined by the personalities of the various market participants and the outcome of previous years' transactions.

8.3 Prices

8.3.1 Producer prices

The price of benzoin is critical to collector, trader and end-user alike. If the price paid to the collector is not attractive enough then he may prefer to undertake more profitable activities. The trader (whether a middleman or an exporter) tries to maximize his returns by buying at as low a price as possible and selling at the best price he can get. The importer or end-user likewise wishes to purchase benzoin at a favorable price.

The price at the point of export is clearly influenced by the number of middlemen in the chain between the collector and the exporter, as well as the exporter's own costs. Each member of the chain will introduce a mark-up on the buying price, reflecting the costs incurred and the profit margin. These costs include a number of things in addition to the purchase price, their magnitude (and relevance) reflecting the trader's position in the chain: transport; marketing; storage; insurance; cleaning and sorting; bank (or other lending institution) interest charges; packaging; and overheads.

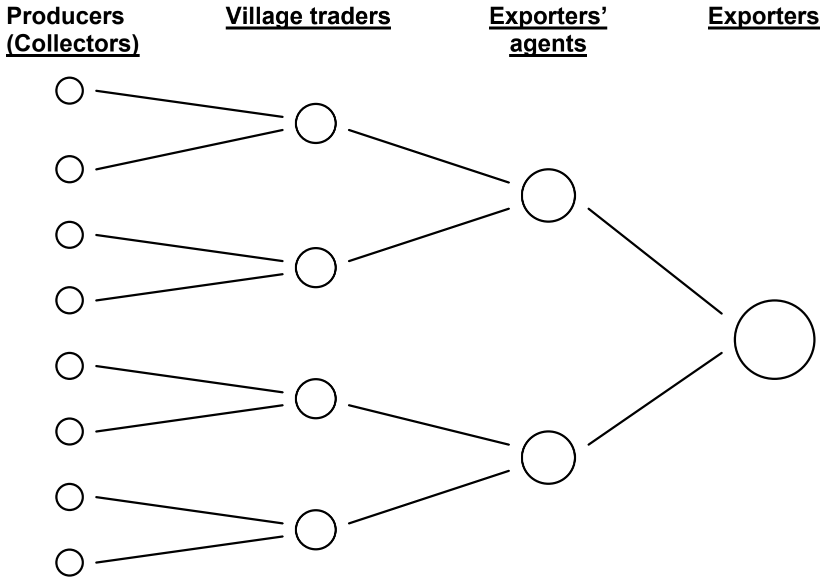


Figure 8.1. Schematic representation of marketing channels

To a greater or lesser degree the costs are made up of different components: labour, materials, financial services, rent, warehouse and office overheads, depreciation, etc. A detailed analysis of these aspects and quantification of marketing margins at each stage of the chain is outside the scope of this discussion, but it would merit attention in any further study.

Knowledge of the price that can be expected for potential cash crops is a major factor in determining which one(s) the villager chooses to produce. In the case of benzoin, however, the decision is not an easy one to make. There is no single, fixed price and no mechanism for announcing prices in advance. Indeed, the agent is usually unable to give advance notice of prices because he only buys from villagers when he himself receives an order from the exporter or another trader, and this is often very close to the start of the collecting season.

Different villages or individuals adopt different strategies for arriving at their decision. In large part, the price obtained by an individual or someone else in the village the previous year will influence the decision. If no one in the village tapped trees the year before, then they may have to rely on information from neighbouring villages, or the farmer may decide, in any case, to tap the trees as an insurance. Once tapped, the farmer then has to make the decision as to whether to harvest the benzoin about 5 months later. He may decide to pick only the larger pieces from the best-yielding trees first and see what price he is offered, or he may wait to see what other villagers are paid before committing himself. If he is unhappy with the price he may hold on to the benzoin to see if a better offer is made or he may store it for sale at a later date.

Recent past experience is not encouraging for the benzoin collector. Prices (per kg) paid to the village trader for mixed benzoin by one middleman have fallen over the last 4 years:

1994	2,800 kip
1995	2,200 kip
1996	1,800 kip
1997	1,800 kip (price at start of harvesting season)

The price to the collector may be as low as 1,200 kip per kg. For an average harvest of 10 kg per family (a figure typical in Ban Kachet, Luang Prabang Province), this means 12, 000 kip in cash income.

The above prices are only indicative. Undersupply encourages an increase in price in an effort to persuade those who have stocks of benzoin to release them. There is evidence that this occurred in mid-1997.

8.3.2 Export prices

Apart from sensory and other functional considerations, the relative prices of Siam and Sumatra benzoin determine to a large degree the particular end-use to which each is put, e.g. the dose levels which are employed, the extent of blending of the two types, the use of cheaper alternatives, etc. Export prices for the different types and grades of benzoin are detailed in this section. Reliable time series for prices are not available, making it difficult to judge trends. In a few cases, prices quoted by one source have been significantly different from those quoted by another one for comparable grades. Such differences are not easily explained. The prices given below are the most reliable but should be regarded as indicative only.

In the case of Lao exports, only a few tonnes of benzoin are shipped at a time. Sharing a container with other goods, the ocean freight cost is relatively small and FOB approximates to C & F. A Singaporean exporter quoted about US$ 65 per tonne for shipment to Europe. One Lao exporter quoted around US$ 200 per tonne for transport Vientiane-Bangkok and US$ 300 per tonne for Bangkok-Marseilles, which seems rather high.

8.3.2.1 Siam benzoin

Lao PDR: Typical recent export prices to Europe are as follows:

(price per kg, C & F Marseilles, 1996)

Grade A: US$ 16
Grade B: US$ 13-14
Grade C: US$ 10-12
Grade D: US$ 8-9

Using these figures and the proportions of each grade indicated in section 8.1.1, the average export price of benzoin is approximately US$ 10 per kg.

Viet Nam: Prior to 1990, when NAFORIMEX had a monopoly on sales, the average FOB price for the different grades was US$ 7-8 per kg. The range of current prices is stated as:

Grade 1: US$ 14-15
Grade 7: US$ 2.50-3.00

8.3.2.2 Sumatra benzoin almonds

Two Singapore sources quoted US$ 8-9 and US$ 7-12 per kg for benzoin bought from importers in Singapore. A third Singapore source pays S$10 per kg (*ca* US$ 7.40) for *average* grade almonds.

Prices for specified grades imported into Singapore (price per kg, FOB Medan, 1997) are:

Grade 1:	US$ 8
Grade 2:	US$ 6
Grade 3:	US$ 4
Grade 4:	US$ 2

One Indonesian exporter claims to buy mixed benzoin for Rp 24,000 per kg (*ca* US$ 10) and after cleaning and sorting to sell three grades of almonds for US$ 10-15 per kg FOB Belawan. This seems very high compared with prices for Siam benzoin.

8.3.2.3 Block benzoin

Prices vary according to quality/brand. Typical ranges quoted by two sources for export prices from Singapore for block benzoin are shown below (manufactured in Singapore but bought and exported by other traders), price per kg, FOB Singapore, 1997:

Various brands: 1) US$ 0.80-4.00; and
2) US$ 1.20-4.20

8.3.2.4 Benzoin extract

Prices per kg for hard extract (FOB Belawan, 1997):

Siam:	US$ 20-25
Sumatra:	< US$ 20

With regard to these prices, one source stated that Siam benzoin extract is 30-40% higher in price than Sumatra extract. Another source (a flavour and fragrance manufacturer) stated that they buy hard Sumatran extract for US$ 5-8 per kg.

8.3.2.5 Damar

The availability of low-cost damar in substantial quantities from Indonesia is a compelling reason for using it as a *filler* in the production of block benzoin. The low prices of all grades of damar compared to those of benzoin are illustrated below (price per kg, FOB Belawan, 1997):

Mata kuching	US$ 0.90-1.00
Lopaz	US$ 0.80
Hitam/tanduk	US$ 0.40
Batu	US$ 0.30-0.40

8.4 Promotion

The problem of Lao exporters wanting to increase their sales but having little or no access to market intelligence in order to try to do so is discussed in Chapter 9, section 9.7, since the problem is not restricted to exporters of benzoin. Attempts by benzoin exporters to negotiate long-term contracts with their established customers have been unsuccessful in the past. Importers prefer to retain a free negotiating position and not be tied to a contract price. Some exporters have tried notifying their customers of the stock position with respect to the different grades, with an indication of price and the enclosure of samples, to encourage orders. However, this does not always elicit a response. In general, and with a limited customer base, the exporters are obliged simply to wait for orders, with no certainty as to if and when they will be received.

8.4.1 Market prejudices

Importers of Siam benzoin in Singapore and Indonesia who do not buy directly from Lao PDR are sceptical that Lao exporters can supply benzoin of the required quality; they are also believed to be a business risk. This prejudice against primary producers is not uncommon. Importers often prefer to deal with middlemen in Singapore, Hong Kong or some other intermediate destination, who they feel are more attuned to modern business practices and are less of a risk. If there is a dispute over a shipment the importer feels it is likely to be settled more quickly through a middleman than having to deal with a supplier at origin. Singaporean traders stated that buyers of Sumatra benzoin likewise preferred to deal with them rather than Indonesian exporters.

In seeking increased sales Lao exporters will have to overcome both the hesitance of existing customers to change existing practices, and the reluctance of potential new customers to do business directly with Lao PDR. In the latter case, the reluctance can only be overcome by a gradual process of confidence-building measures designed to first attract, and then retain, new customers.

8.4.2 Quality certification

Certification, although concerned with quality assurance, is relevant here because an important reason for its introduction would be to try and overcome the prejudices referred to above.

As an expression of the seriousness and good intentions of the Lao exporters, and as a demonstration to potential new customers of the ability to produce benzoin of acceptable quality, the concept of certification has some merit. In essence, each consignment of benzoin to be exported would be tested and given a certificate as evidence that it was of the quality stated. Such a scheme, if mandatory for all exports of benzoin, would have the added advantage of enabling the exports to be recorded for statistical purposes.

Before initiating such a procedure it would be necessary to decide which parameter(s) should be selected for testing, and to analyze a sufficient number of representative samples of the different grades to know the range of results expected for good quality benzoin. A reasonable limit could then be set for each grade that would enable all such similar samples to be accepted, while excluding unacceptable samples outside the limit.

A parameter important to an extractor of benzoin is alcohol solubility, which is one of the specifications in many pharmacopoeas. A limit in these terms can be expressed as a minimum percentage alcohol solubility (e.g. 95%) or a maximum percentage alcohol-insoluble matter (e.g. 5%). It would therefore be of practical value to the extractor or end-user, as well as being an indicator of purity. It is also a parameter which can easily be measured without the need for expensive equipment. Visual inspection to ensure that the sample conformed with the stated grade (size) would be necessary in addition to measurement of alcohol solubility.

An institution capable of undertaking certification is the Food & Drug Quality Control Center in Vientiane. The laboratories are clean, spacious and well-equipped, and the Center undoubtedly has the facilities and competence to do the work. It also confirmed that its role as a government laboratory could include that of certification.

Some of the other points to be considered before deciding whether to adopt certification are discussed in Chapter 10, section 10.4.7.

Chapter 9. The future: assessment of the problems and prospects for improved benzoin production and marketing in Lao PDR

9.1 Supply

If benzoin production in Lao PDR is to prosper the supply of benzoin must be assured. If present levels of sales are to be maintained the supply must be maintained. If demand is judged to be buoyant or increasing, and efforts are made to increase sales, the supply must be able to keep pace with it. The supply of benzoin is dependent on two factors: the availability of suitable trees to tap (and their productivity) and the willingness of people to tap them.

Unlike some other natural gums or resins which are collected from mature, wild trees, and whose supply is therefore at risk from tree loss through logging, removal for fuelwood, etc, the availability of *Styrax tonkinensis* is dependent on the agricultural practices of the hill farmers. Not just in terms of the total number of trees potentially available for tapping, but on whether they will reach an age at which they *can* be tapped. The decreasing length of the shifting cultivation cycle means that there may be fewer trees being tapped now than in the past and that those which *are* being tapped are yielding less.

Adding to this concern over the supply base is the attitude of the people to tapping the trees. Each family sets priorities for their activities on the land according to their subsistence needs and their desire for cash income. If there are more profitable or less demanding activities than tapping styrax trees, then those alternatives may be undertaken. Even in a largely agrarian society standards of living are improving and social attitudes are changing slowly. The task of tapping is arduous work and keeping livestock or tending alternative crops which give quicker returns becomes increasingly attractive as the economic returns of benzoin are perceived to be marginal. Village surveys have documented the lack of interest in collecting benzoin in some villages (e.g. Soydara *et al*., 1997) and the Oudomxai area seems to have been particularly hard hit by disaffected farmers.

Improvements to the road infrastructure mean that perishable goods can reach potential markets more quickly. Non-traditional employment and cash-earning opportunities are also beginning to appear. Increasing liberalization of the economy is attracting foreign investment and leading to the development of manufacturing and service industries such as tourism, and this encourages some drift of population away from the rural areas towards urban centers. All of these factors add to the danger of a decline in production and shortage of benzoin if steps are not taken to address the problem.

9.2 Price and the collector

The difficulties for the collector in knowing whether it is going to be profitable for him to tap and collect benzoin, and the uncertainty this creates in the supply base, have been discussed in Chapter 8, section 8.3.1. It is difficult to know how to resolve the problem. The exporter is unable to secure long-term orders from his customers and can give no orders to his agents until he receives them himself. The time he receives these is close to the harvesting season and the agent is therefore unable to know in advance how much benzoin he needs to buy from the village traders or collectors and what he is able to offer them as a fair price in order to secure the required amounts. In a free market system, if the agent's first offer to the village trader or collector is not considered adequate, then the latter will withhold the benzoin that he has until a better price is agreed. The collector's success in obtaining a better price depends on the pressure on the agent to secure supplies. Government intervention in the form of setting a fixed minimum price is not a sensible option.

9.3 Quality aspects

The problems caused by repeated handling of the benzoin in going from collector to exporter and the other factors which influence quality have already been discussed. These problems, and those of discoloration and the *compacting* of small pieces of benzoin or dust into lumps, are no worse than the same problems experienced by exporters of comparable grades of Sumatra benzoin in Indonesia and Singapore.

Leaving aside the question of raising quality by using improved tapping methods and/or superior planting stock, the following aspects need to be considered as more immediate options for achieving improvements:

1) Can means be found to minimize the size degradation which occurs so that a greater proportion of the benzoin collected is retained in its original form? If this can be done, then more value will accrue to the exporter and, if some of this added value is passed on, to the collector also. This assumes that importers and extractors would be willing to purchase a greater proportion of their requirements as the higher-priced top grades.
2) Is a more effective method of cleaning possible which would give a purer product?
3) Are changes possible in the conditions under which benzoin is stored which would reduce discoloration and *compacting*?
4) Are alternative forms of packaging possible which would preserve quality either during storage or during shipment on export?

9.3.1 Minimization of size degradation

A reduction in the number of middlemen in the marketing chain might have some beneficial effect in terms of a reduction of handling which the benzoin receives, but the distances involved in its transportation, and the terrain over which it has to be carried, would remain essentially the same. Some means of packing and protecting the benzoin during its transportation seems, therefore, to be the main solution to the problem of attrition. However, it is not easy to identify suitable materials – or a design – which would achieve this. Whatever was chosen would need to be lightweight so as not to add to the burden of carrying the benzoin on foot and, for the same reasons, it should not be bulky. The materials would almost certainly need to be natural ones, rather than manufactured, and available locally. Alternate layers of dried grass and benzoin might be one possibility, but this would cause problems in assessing the weight of the benzoin for payment purposes and it might prove difficult to separate the two at the cleaning and sorting stage.

9.3.2 Improved cleaning

Except for some of the large volume gums which have centralized cleaning operations, and where very large throughputs are being handled, cleaning and sorting of other types of natural gums and resins in preparation for export is invariably done by hand, in much the same way as for benzoin. Mechanical means would not be appropriate for benzoin, because it is too fragile. Apart from the obvious advice to minimize repetitive handling during cleaning, there are no changes which can be advocated to improve the present methods of cleaning.

9.3.3 Improved storage and packaging

Four factors typically contribute to the deterioration of natural products in storage: light, heat, air and moisture. The presence of light and air can cause oxidation or other chemical changes, and if this occurs, the process is accelerated by elevated temperatures. No information is available in the literature to know whether such changes occur with benzoin but there is a fair probability that they do. If this were the case, then the greater surface area offered by the dust and siftings would make this grade the most vulnerable to degradation.

Storage in the dark is the simplest action which can be taken to minimize benzoin deterioration, and this is largely achieved in some storage facilities in Vientiane. Storage in air-tight plastic bins with lids, rather than bamboo baskets with open tops, might be advantageous but this would need to be the subject of monitoring tests before recommending it.

Action has already been taken by some exporters to reduce temperatures during storage by the use of air conditioning and this appears to have had the desired effect of reducing *compacting.* Further reductions in temperature might be possible by increased air conditioning but may not be cost-effective. Storage below ground (i.e. in a cellar) is another possibility but it is not possible to predict the benefits in terms of a reduction in temperature or, more importantly, the benefits in terms of improved benzoin quality and price.

Exclusion of air needs a more technological solution. Air-sensitive materials can either be stored under an inert gas such as nitrogen or stored under vacuum. The latter would be the cheapest option and an investigation of the effectiveness of vacuum packing in raising benzoin quality is to be carried out. Whether vacuum packing could easily be done on bulk material in storage is open to question. Its use in packing benzoin for shipment overseas is equally untested and would represent a radical departure from normal practice. The practicalities of its use and the benefits to be gained, if any, need to be properly assessed before making any decision on its adoption.

9.4 Substitutes

Most natural flavours and fragrances can be imitated to a greater or lesser degree by synthetics. In some cases, where the characteristic flavour or fragrance is due to the presence of one specific chemical, then the synthetic *nature-identical* chemical may successfully compete with the natural material. The driving force for wanting to use the synthetic compound is the greater security of supply which it offers, the more consistent quality and the cheaper price. Synthetic vanillin is an example of a *nature-identical* chemical which is used to some extent to imitate natural vanilla. The use of *vanilla* to pass Sumatra benzoin off as Siam benzoin has already been referred to.

In most cases, however, a fragrance is a complex mixture of compounds which is difficult to imitate perfectly. A synthetic *base* mixture can usually be made and if the end-use does not require a perfect match with the natural then this may be a suitable substitute. A benzoin *base* containing vanillin, cinnamaldehyde and other constituents approaches the odour of natural benzoin but does not have its completeness. Offering a cheaper alternative to natural benzoin is not the only reason for a flavour or fragrance compounder to consider synthetic substitutes. The conditions in which the flavour or fragrance material is used in the end-product may demand something which the natural material cannot offer e.g. stability in acid or alkaline media, or some degree of water solubility.

For a particular end-use, the ultimate selection criterion for the flavour or fragrance compounder is the budget set by the customer/end-user. The compounder will use natural benzoin or a substitute, or a mixture of the two, according to which one best meets the needs of the customer in terms of organoleptic and functional requirements, and cost. The same criteria determine whether Siam benzoin or Sumatra benzoin is used for a particular application.

Siam benzoin will therefore continue to be used in those products where its relatively high cost can be borne and it meets the other criteria. The threat from substitutes is not believed to be any greater now or in the foreseeable future than it has been for some time. A decision to switch to a new formulation (e.g. from a natural ingredient to a substitute) is not taken lightly by a manufacturer. It entails much cost and, in the case of benzoin, there would only be a switch to greater use of substitutes if there were to be an unacceptable increase in the price of Siam benzoin or a shortness in its supply. Equally, however, if such a switch were made, then a return to the previous levels of consumption of natural benzoin if circumstances improved is not something which could be taken for granted. The shortages of gum arabic following the severe Sahelian droughts of 1973/74 resulted in major reformulation by end-users who switched to alternatives, and these market losses were not fully recovered afterwards.

9.4.1 Benzoin

Benzoin (2-Hydroxy-2-phenylacetophenone, also called 2-hydroxy-1, 2-diphenylethanone) is a specific, synthetic chemical bearing the same name as the natural product. The name for the synthetic product is italicized here to distinguish if from the natural product. Synthetic *benzoin* is described as a yellowish-white, crystalline solid with a "vanilla, medicinal taste" or with a "very faint, sweet, nondescript odour". It is used as an intermediate in chemical synthesis but is also reported to be used as a food additive. Use levels are given below (Burdock, 1995):

Baked goods	14.50 ppm
Frozen dairy	2.97 ppm
Soft candy	5.99 ppm
Gelatin, pudding	5.82 ppm
Non-alcoholic beverages	5.82 ppm
Alcoholic beverages	5.67 ppm
Chewing gum	9.60 ppm

The above use levels are around 10-20 times lower than those cited earlier for benzoin resin.

However, there is obvious confusion in the literature on this compound. All sources agree on its chemical name, molecular formula, and physical and chemical properties, but one source (Radian Corp., 1991) mistakenly refers to it as a balsamic resin from *Styrax* species (i.e. confuses it with genuine benzoin resin), while another (Arctander, 1962) explicitly states that its confusion with natural benzoin, once made, tends to be repeated over many decades. It is therefore not at all clear whether the reputed uses of *benzoin* (2-hydroxy-2-phenylacetophenone) are genuine or should be attributed, instead, to natural benzoin.

The general view in the flavour and fragrance industry is that 2-hydroxy-2-phenylacetophenone has no relevance to gum benzoin and poses no threat as a substitute to the use of Siam benzoin.

9.4.2 Oliffac® products

International Flavors and Fragrances (IFF), the largest manufacturer of flavours and fragrances in the world, produces two benzoin substitutes: Benzoin Oliffac 63® and Benzoin Oliffac 999®.

Benzoin Oliffac 63 is described as "a cost-effective substitute for the sweet, vanilla, resinous, benzoin complex so valuable for many fragrance types". Its use level in products is stated to be up to 5%. Benzoin Oliffac 999 is described as an "excellent economical substitute for benzoin resinoid products to which it is similar in odour performance"; it is a "characteristic balsamic, vanilla, resinous complex". Its use level is also put at up to 5%. It is not known what the consumption, or trend in consumption, of these two products is.

9.5. Demand

9.5.1 Competition with other producers

Lao PDR is in something of a unique position in that it is virtually the only producer of Siam benzoin. Viet Nam may produce small amounts but most of what appears in international trade is likely to be of Lao origin. The same is true for exports of benzoin from Bangkok. Lao PDR is therefore not competing with other producing countries for a greater share of the Siam benzoin market.

If Siam and Sumatra benzoins satisfied completely separate markets then there would be no competition between these two either. This is not entirely the case, and there is some overlap between the two, although Siam benzoin is used primarily in perfumery and fine fragrance applications, rather than the large volume flavour and fragrance markets. The flavour market in particular is price-driven and uses the cheaper Sumatra benzoin in preference to Siam benzoin. Beyond this it is not possible to quantify the breakdown of Siam benzoin's end-uses any more precisely. Siam benzoin also finds some pharmaceutical use but, again, the available data do not enable this to be quantified.

Blends are sometimes used and substitutes are also available as cheaper options for the end-user who wants a benzoin-like aroma.

9.5.2 Demand and demand trends

Much is known qualitatively and quantitatively about the geographical destinations of benzoin in international trade, but the vast majority of this is Sumatra benzoin. Siam benzoin is not separated in the trade statistics from Sumatra benzoin and this has meant that its inclusion in some of the data has had to be deduced indirectly by calculation of unit values.

Europe, and France in particular, is known from Lao exporters to be the most important market for Lao benzoin, but, again, the supporting evidence from trade statistics has had to rely on assumptions about the likely identity of imported natural gums and resins from Lao PDR and Viet Nam. Germany appears to be the second most important destination in Europe but there is some disagreement between published import statistics and the estimate by at least one German importer of benzoin on the magnitude of this trade. If all of the European imports from Lao PDR under the *natural gums and resins* classification are taken as being benzoin, then they still represent an under-recording of actual imports if the Lao export statistics are correct. Since 1991 (to 1995), Lao exports of benzoin have averaged 41 tonnes per year, while recorded imports into the EU from Lao PDR (of what is presumed to be benzoin) averaged only 18 tonnes per year for the same period. Inclusion of Viet Nam in the calculation only raises this figure to 21 tonnes.

An alternative explanation is that there are significant markets for Lao benzoin outside Europe (such as China) or significant quantities are entering Europe from other intermediate destinations. Trade with China is known to occur but is impossible to quantify, and it is not known how much of it is captured in the Lao export statistics. Exporters in Vientiane do not appear to be directly involved in such trade themselves.

All these difficulties make it equally problematic to identify the underlying origins of any trends which are indicated by the data and knowing, in any case, whether the trends are genuine. The Lao export data show a general upward trend from 1988 to 1995 while European imports are very erratic.

9.5.3 Quality and demand

The suggestion that raising quality would automatically generate increased sales of benzoin is not supported by evidence that this would be the case. Indeed, there is no evidence that Lao benzoin is perceived to have a quality problem by European importers. Lao exporters assert that their customers were generally quite happy with their supplies apart from the occasional instance of *compacted* benzoin. Claims of dirty or adulterated shipments have never been made and there has been no indication that orders have been lost because of inferior quality or that orders would have been gained by improvements in quality. In terms of colour and cleanliness, Siam benzoin is no different in appearance to Sumatra almonds.

While the importance of quality should not be diminished, therefore, its improvement is not in itself the simple solution to increased sales of benzoin.

9.5.4 The search for new markets

Supply and demand of Siam benzoin appear to be broadly in balance. Unsold stocks of the lower grades from one year's harvest are usually sold the next year and there is no steady accumulation of stockpiles which become ever greater year by year. That is not to say that efforts should not be made to reduce them because they represent a loss in value and cash flow – and also mean that the exporter incurs added storage costs. There is some cause for optimism that extractors in Singapore and Indonesia who have not previously purchased benzoin directly from Lao PDR are prepared to do so and that these purchases could include the lower grades.

Unless new end-use applications for benzoin are opened up as a food additive by the submission of toxicological data formally confirming its safety in foods – an unlikely scenario in the case of Siam benzoin – the best means of developing new markets would appear to lie in targeting fragrance industries in countries other than France, the traditional destination for Lao benzoin. To avoid simply gaining new geographical markets at the expense of some of the French market, these new ones should, ideally, be those which are largely insulated from the French fragrance industry. However, this is not easy to do. The clearest business trend in recent years, in whatever industry one likes to think of, has been that of mergers and acquisitions, and there has been a shrinkage in the number of separate companies involved in a particular sector. This is true in the fragrance industry and means that there are far fewer companies to whom one might turn to as independent users of a raw material than in the past. It means, too, that fragrance compounders in Southeast Asia, India, South America and elsewhere are more likely to be subsidiaries of multinational companies who import their requirements from regional headquarters. India has an indigenous fragrance industry and might have been considered a prime target for Lao exporters. However, the market is not as sophisticated as the European market and low-cost raw materials are used wherever possible. In other instances, Indian subsidiaries of the large, multinational fragrance companies probably draw on supplies from outside India but within the business group.

China is a potentially huge market, although not likely to be as lucrative as other Western markets. China's large and growing fragrance industry could well be targeted as a market for Lao benzoin, and the possibilities of long-term contracts explored.

9.6 Value-added processing

One option for strengthening the industry in Lao PDR and gaining increased value is that of undertaking some form of processing within the country. There are two possibilities: production of benzoin extract and block benzoin. In neither case, however, are there grounds for believing that this would be a sensible option to take.

In the case of benzoin extract, there are at least three reasons for not recommending it. First, and most important, the extractors in Indonesia and Singapore have an established, world-wide customer base which it would be extremely difficult to break into, particularly by a producer with no previous experience and *track record* of this type of operation. There must be compelling reasons for customers to switch from a tried and trusted supplier to a new one: most importantly, a significantly cheaper price, or a better or more consistent quality (combined with reliability of supply). It is unlikely that either of these could be attained.

Second, without importing Sumatra benzoin to use as a raw material, only Siam benzoin extract could be produced. Potential customers who use both types would therefore still have to purchase Sumatra extract from their existing supplier and this would make it illogical to switch to a new one for supplies of Siam extract.

Third, the small scale on which extraction would necessarily be carried out would mean that the unit cost of production (requiring imported equipment and materials, such as steel vessels, a filter press, evaporator and alcohol) would be high, and the equipment would lay idle for most of the year.

Production of block benzoin is not recommended either. If Siam benzoin were to be used in its manufacture, it would be a novel departure, since block benzoin conventionally contains Sumatra benzoin. Mixing intrinsically high quality Siam benzoin with lower quality materials would represent a devaluation of it. In any case, low quality benzoin of the type used as the supporting matrix in the manufacture of block benzoin is not available in Lao PDR as it is in Indonesia or Singapore. Indigenous sources of damar are available in Lao PDR but this does not sway the argument in favor of producing block benzoin.

9.7 Institutional weaknesses in Lao PDR

9.7.1 Statistics

Although benzoin has a relatively small monetary value compared to some other Lao exports, it does offer a source of income to one of the poorest and most disadvantaged groups in the country. It therefore has a socioeconomic value which extends beyond its dollar value. Benzoin production undoubtedly has the potential to contribute more to the resolution of the shifting cultivation problem but analysis and assessment of the industry aimed at improving it are hampered by the lack of reliable statistical information:

1) How much benzoin is produced and where (at the provincial and district levels)? – from which one could identify more accurately and easily the centers of production.

2) What has been the trend in production year-by-year (nationally and at the provincial and district levels)? – knowledge of this would enable village surveys to be better targeted at places which show a pronounced upward or downward trend to discover the reasons.

3) What is the FOB value of exports of benzoin from Lao PDR and what are their destinations? – past and existing geographical markets can then be precisely identified, as well as possible targets for more active marketing.

The acquisition of *production* data for benzoin is already taking place in some instances, but at best only at the provincial level. It is unclear where the responsibility for acquiring production data lies – with the Department of Agriculture & Forestry or the Department of Trade. There is no centralization and checking of the data in Vientiane. Customs data also remain largely inaccessible. The limited resources available to address these problems in terms of skilled manpower, computer hardware, etc., are recognized but the rewards in addressing it will be high, and not restricted to benzoin.

9.7.2 Market information

Market information is the lifeblood of exporters and traders. It is essential to know the end-uses of benzoin; the countries which have such end-use industries but which are not yet exporting targets; which other companies in those countries import benzoin, in addition to those already being traded with; and how those companies can be contacted. Without such information, an exporter's chances of expanding its customer base and increasing sales are severely limited. Some of the benzoin exporters in Vientiane have a very limited knowledge base. They have their established importers in France but they are hindered in their efforts to seek new customers elsewhere by the lack of reference information or a national institution which they can turn to for advice.

Information specifically on benzoin is not easy to come by, but simple resources such as foreign trade and telephone *Yellow Pages* directories are valuable sources of company information and can be consulted under headings such as Gums, Resins, Fragrance manufacturers, etc. Such sources proved to be useful in identifying benzoin importers in Singapore. In some cases, local telephone *Yellow Pages* are more useful than attempting to gain nationwide coverage – Hamburg in Germany is an important European destination for many commodities and several leading gums and resins importers are located there. Other European countries besides France and Germany could be targeted, as well as Japan and the United States, if information on potential customers were available.

The Department of Export Promotion (DEP) in Vientiane has responsibility for promoting Lao exports and should be the institution which exporters can turn to for information and advice. The DEP has sent representatives to several international trade fairs in the region but these have concerned such things as handicrafts, textiles and furniture. Benzoin has never been included in any promotion. The DEP should adopt a higher profile, making itself better known to exporters in terms of the services it can provide and become more proactive.

The need for market information is also relevant to the producer (collector), although in this case, it is mainly price information that is wanted. One means of communicating such information to a wide audience is radio, specifically through Lao National Radio. In mid 1997, the Radio II schedules included a daily half-hour programme for farmers and a weekly half-hour programme devoted to agriculture and forestry. Lao National Radio was interested in making benzoin the subject of one of the weekly programmes. Such a programme could include interviews with different *players* in the business such as collectors and exporters. It would be an opportunity to *popularize* benzoin and to inform those people already engaged in or interested in its collection, of the efforts being made to promote it and find ways of improving economic returns to all parties.

9.7.3 Human resource development

If measures are taken to strengthen the aspects of the industry highlighted above, they will only be effective if the individuals involved are equipped with the necessary knowledge, expertise and understanding to be able to assess and appreciate the problems, see ways of addressing them, and take action to resolve them.

The burden of responsibility to maximize the human-resource potential does not rest solely with government institutions. The exporters themselves have an important role to play and if they are to take advantage of improved facilities and better accessibility to trade and market information then they, too, will need to be equipped to do so. This will obviously include relatively simple measures such as instruction in how to use such facilities but may extend to developing business skills or improving standards of English, which will be essential if new, international markets are to be explored. Human resource development along these lines can yield benefits not just for benzoin, but in other areas through the wider business community.

Chapter 10. Strategies for benzoin development and recommendations

10.1 Workshop and recommendations

A National Workshop was held in Luang Prabang, Lao PDR, in May 1998 that focused on improving benzoin production within the country. Presentations were made which covered the general status of benzoin production; socio-economic conditions at villages; styrax tree improvement and silviculture; tapping and processing; and marketing.

After the workshop presentations, the participants identified three major topics for group discussion. Three working groups were then formed to address the topics of: 1) silviculture and benzoin processing; 2) land use policy; and 3) marketing system. The working group discussions and recommendations are presented below. In some instances, the recommendations made by FAO consultants and officers who were involved in the benzoin project (not necessarily presented at the workshop) are incorporated into the relevant sections and identified as to its source.

10.2 Silviculture and benzoin processing

10.2.1 Genetic improvement

The potential variation in growth and resin yield and the opportunity for selection and improvement of *Styrax tonkinensis* were recognized. The provenance trials established by the FAO Benzoin project are the first step towards determining the genetic variation within the species. However, these trials are still young and need several more years before reliable conclusions can be drawn.

The working group felt that **until reliable results from the project provenance trials become available there is no need to undertake additional research on tree improvement in the immediate future.**

10.2.2 Maintenance of field trials

The project has initiated two provenance trials and one agroforestry trial. All were established in 1997. For the provenance trials it is necessary to maintain them until they are suitable for resin tapping and the best provenances in terms of resin production and growth are identified. For this reason the trials need to be maintained for at least an additional five years up to 2003. The agroforestry trial was re-established with the first rice and mung bean crops sown in April/May 1998. At least two seasons of crop cultivation are needed in order to examine changes in soil properties. A third crop planting should be considered if it is practicable.

Although funding from FAO carried through only until June 1998, further support has already been secured from an EU Micro Projects Luang Prabang Phase II in Luang Prabang until 2002. The funds are sufficient to maintain and measure the above trials. Nevertheless, the working group **recommended that technical inputs from specialists be sought to assist the Luang Prabang Forestry Section in: 1) conducting resin tapping experiments; and 2) data analysis and interpretation of results of agroforestry and provenance trials.**

10.2.3 Silvicultural treatments for better stand management

There have been no systematic silvicultural treatments in the benzoin cultivation areas. Some silvicultural treatments that may help improve benzoin production are:

1) thinning young styrax plants after rice harvest to reduce competition among them and lead to more uniform growth of the styrax trees; and
2) promoting a large crown canopy by undertaking pruning or pollarding. It is expected that this silvicultural treatment will lead to an increase in stem diameter. It will also increase the overall transpiration rate which should stimulate sap flow and subsequent formation of resin.

Thinning appears to be relatively simple to carry out in young styrax stands when the optimal stocking density is known. The timing and intensity of pruning or pollarding however need to be determined. The working group **recommended that pruning and pollarding treatments be studied in the follow-up work programme funded by the EU.**

10.2.4 Future approach of the agroforestry trial

The agroforestry trial employed an alley cropping system where rice and mung bean were planted between rows of styrax trees. This experiment aimed to determine: 1) the suitable spacing of styrax trees that will permit inter-cropping for as long as possible; 2) the efficiency of mung bean in restoring soil fertility to maintain, if not improve, rice yields; and 3) the opportunity for inter-planting other income-generating trees and crops.

The working group **recognized that alley cropping systems were not always feasible for villagers. General inter-cropping where suitable numbers of naturally regenerated styrax trees occur may have the greatest potential.** Information obtained from the alley cropping experiment and from other sources such as the IUCN Sustainable Utilization of Non-Timber Forest Products in Lao PDR can be modified for general application in the future.

10.2.5 Tapping techniques

There were clear differences among eight tapping methods in terms of resin yield and size of resin drops. The Malaysian methods proved to be least effective while the Standardized Traditional Lao Method A (Type 5), the Standardized Indonesian Method (Type 7) and the V-shaped Method (Type 8) gave satisfactory results (see Chapter 5, section 5.3). The tapping trials, however, have yet to define the best method and its practicality.

The working group **recommended that the effectiveness of the three best tapping methods (Types 5, 7 and 8) be examined further, and**

that the methods be tested at another site. It was also recommended that the timing of tapping be investigated.

10.2.6 Processing and product development

The benzoin exported from Lao PDR is in the form in which it is collected from styrax trees. The price of the raw benzoin paid to the collectors fluctuates considerably; in recent years it has been relatively low. At the beginning of the 1998 season the collectors obtained 2,500-3,000 kip per kg. The price is dependent, in part, on the levels of supply, i.e. the productivity of a particular season.

Development of finished products using benzoin as a raw material might be one way of trying to help expand markets and so increase demand and hence price to the collector. It may be more appropriate at this stage to consider cottage industry products aimed at the domestic market. Incense sticks and traditional medicines are already being produced in China. In Viet Nam, toothpicks are made from the wood of *S. tonkinensis.*

The working group **recommended that a feasibility study be conducted to explore the possibility of developing local industries for finished products using benzoin as well as the wood of *S. tonkinensis*.**

10.3 Land use policy

10.3.1 Benzoin production and land use

The working group acknowledged the importance of sources of cash income such as benzoin for the rural people living in the uplands of northern Lao PDR. Therefore, the production of benzoin should be continuously promoted, as well as the research on improving its production and developing its use. Both possibilities to produce benzoin, extraction from natural stands and production from cultivated stands (plantations), should be included in the future research agenda. Special consideration should be given to keep the production of benzoin on a farm-based level, so that the people who traditionally produce benzoin can also derive greater benefit from it in the future.

The working group agreed that the focus on one particular non-wood forest product such as benzoin does not sufficiently reflect the socio-economic and production conditions in which the farmers live. **It was recommended that other NWFPs be included in an adapted and broader future working focus on benzoin.**

10.3.2 Land allocation

For the production of benzoin, a minimum fallow/production period of 7-8 years is required. Present land allocation schemes do not appear to take this fact sufficiently into consideration. On the currently allocated plots the fallow period is too short for benzoin production.

Based on the experiences of projects working with land use planning and land allocation, the working group **recommended that future activities to promote benzoin production take into consideration the entire production system**.

10.3.3 Village development plans and surveys

Land allocation could be made a part of village development plans which are supported by the local governments. This could include activities in the fields of: 1) agroforestry; 2) permanent crop cultivation (including NWFPs); and 3) creation of non-agricultural jobs.

The future stability of the supply of benzoin rests with the villagers. In the shorter term, a more attractive price to the farmer is the clearest way of ensuring that benzoin continues to be collected. Not enough is known about the opinions of the farmers themselves and what they see as being necessary to improve the situation. Is price the most important aspect of the decision-making process when farmers are deciding whether or not to tap/collect benzoin? What would be necessary to induce those who choose not to tap to change their mind? Is tapping being increasingly left to the older members of the village? What is the attitude of the young in the villages to benzoin collection? How do the economic returns from livestock and other cash crops compare to those from benzoin, now and in the foreseeable future? To provide answers to these questions, it was **recommended that village surveys be undertaken in as many districts as possible in the benzoin-producing provinces. The surveys should assess the attitudes of shifting cultivators to benzoin production and identify the factors which are most important in determining whether or not they participate in it.**

10.3.4 Forest classification

The forest classification system presently used in Lao PDR does not deal with the use of NWFPs**.** The working group **recommended that the potential of the forest classification types for incorporating NWFPs be investigated further**. There may be a need for further refining the forest classification system.

10.3.5 Guidelines for the use of NWFPs

The Government of Lao PDR already recognizes the importance of NWFPs for rural development. The working group **recommended that a more detailed version of the present guidelines on the use and promotion of NWFPs be formulated.** This should also give higher priority to NWFP cultivation in agroforestry management systems, which would be of benefit to benzoin production.

10.4 Marketing system

10.4.1 Quota system and government regulations

The Ministry of Agriculture and Forestry controls all agricultural and forestry products, including non-wood forest products (NWFPs).

Businessmen and private companies have to register their names and provide proof of funds in banks and evidence of storage facilities. Each June, the applicant must submit an annual buying plan for each commodity they deal in that province. Based on this request, final approval and permission is issued by the Provincial Agriculture and Forestry Office (PAFO) as a quota for the year, because PAFO is responsible for the exploitation of forest products. At that time, the applicant must pay a 3% natural resource tax.

The working group **recommended that the government should review its policy on the current quota system and regulations concerned.**

10.4.2 Access to the villages

Some benzoin traders prefer to have free access to benzoin-producing villages. However, in order to maintain a stable benzoin market at the village level, the government guidelines only allow the benzoin traders who have registered with PAFO to deal directly with villagers collecting benzoin. These traders cannot buy benzoin more than the quota being approved by PAFO. The working group **recommended that this issue be reviewed for any better alternatives.**

10.4.3 Buying policy and pricing system

The traders seem to have final and decisive power to determine the price of the product. In general, there is no difference in price according to quality when benzoin is purchased from farmers. Traders or middlemen undertake grading based on the size of benzoin pieces, together with cleaning (removing sand, dust, etc.). Prices are largely controlled by the export prices of the year and tend to fluctuate.

In the last few years, benzoin prices have remained at a low level. This discouraged farmers from tapping benzoin and led to a shortage in benzoin supply during 1996-97. A sharp increase in prices in 1997 followed. The devaluation of the kip against the US dollar after July 1997 also contributed to this trend. Traders and middlemen have started to pay much higher prices to the producers.

The working group **recognized a need for PAFO to monitor such a changing trend.**

10.4.4 Export and other taxes and its procedures

Businessmen or private companies are required to pay a 10% export tax to the government. In addition, they are assessed for other taxes, such as a business tax, income tax, and profit tax. The working group noted that the current export tax system might function as a disincentive. The FAO consultants and officers **recommended that the export tax be removed in order to encourage NWFP exports.**

Some working group members stated that there are many constraints in the government trade and export procedures, which cause considerable delays in the export of benzoin. Noting that such constraints have resulted in missing business opportunities, the working group **recommended that the government simplify procedures involved in exporting benzoin.**

10.4.5 Marketing routes through Thailand

The working group noted that although Thailand officially prohibits imports of agricultural products from Lao PRD, which includes NWFPs such as benzoin, in reality imports of such commodities do take place. This situation has unnecessarily made the export of Lao agricultural products and NWFPs to Thailand illegal. **It was recommended that the issue of trade in agricultural products and NWFPs between Lao PDR and Thailand be discussed and resolved in a forum of the Association of Southeast Asian Nations (ASEAN) or the ASEAN Free Trade Area (AFTA).**

10.4.6 Examination of benzoin quality and grading system

The working group noted that the current grading system is insufficient in terms of quality control. As mentioned in section 10.4.3 above, grading is practised by middlemen or traders and is done by size alone. Although this meets the current market requirements as far as it goes, there was a consensus within the working group of the need to improve the system to make it more attractive to buyers and fairer to the producers. **It was recommended that the grading system be reviewed to determine how to establish better quality standards and improve the payment to producers on the basis of quality scales in size, colour and purity.**

The question of how to preserve the quality of benzoin after harvesting and during the post-harvesting period was discussed. The change of colour from white to light brown and brown suggests that oxidation takes place on the surface, while the interior of the benzoin pieces remains white. Under the current system, this is not a quality issue of concern to traders. Traders are concerned with adulteration and the quantity of dust in the benzoin. It may be necessary to await results of the chemical analysis on samples to understand the degradation process and what measures could be recommended to improve the handling and storage. One storage option to be investigated is vacuum packing. The FAO consultant **recommended that despite reservations about the practicalities and benefits of vacuum packing, tests of its use with benzoin be undertaken.**

10.4.7 Benzoin quality certification

If quality certification of benzoin were to be adopted in Lao PDR, careful consideration must be given to the conditions under which it might operate. The issues are varied and complex and include:

1) Should certification be compulsory or voluntary?

2) Who would bear the cost of certification?
3) How and where should the consignments be sampled and analyzed, and by whom?
4) If certification were to become compulsory, what measures would need to be taken to ensure that benzoin exported from points other than Vientiane was included?
5) Who would be the arbiter in the event of dispute between buyer and seller over a certified consignment?

In view of the fundamental change to business practices that the introduction of quality certification would represent, The FAO marketing consultant **recommended that the views of all parties concerned – producers, exporters, government departments – be first sought through a round-table meeting.** The meeting could be organized and chaired by a representative of the Food & Drug Quality Control Centre.

10.4.8 Benzoin statistics

The problems of the poor recording of benzoin statistics at both the national and provincial levels urgently need to be addressed. The FAO marketing consultant **recommended that representatives of the Department of Agriculture, the Department of Forestry, the Department of Trade, and the Ministry of Commerce (Statistics Division) meet to discuss and formulate procedures for collecting and collating production and domestic trade data annually. In collaboration with Lao Customs, steps should also be taken to see that records are kept of benzoin exports by volume and value, with countries of destination, and that these records are made easily accessible.**

10.4.9 Information system for villagers, exporters and middlemen

The working group acknowledged that France has historically monopolized the Lao benzoin trade although accurate trade statistics quantifying this are not available. The benzoin trade information in the country appears to be in the hands of the traders. Government offices, such as PAFO, should regularly investigate the production levels of benzoin in villages but the effort remains incomplete because of difficulties in allocating staff and funds to permit visiting remote villages. FAO officers and consultants **recommended that staff and budget of PAFO be increased to conduct this regular survey in collaboration with the District Agriculture and Forestry Offices (DAFO).**

Villagers have no idea about prices and demand levels of the current year unless they are informed by middlemen. This is a source of frustration among villagers because they cannot decide production levels in advance of tapping operations for the season.

FAO officers **recommended that PAFO and DAFO should establish the information collection and dissemination services to villagers based on the benzoin prices of the year predicted by traders and quota permissions issued in June.**

10.4.10 Developing new markets

The best chances of success in developing new export markets lie with extractors and other traders in Singapore and Indonesia. Many of the companies already extract Siam benzoin and there is potential for increased utilization if it becomes available. Several advantages would result from this marketing approach. First, the companies already have a broad network of customers and contacts and know where the opportunities are for increased sales. Second, the Singaporean and Indonesian extractors have stated that if the lower grades of Lao benzoin were clean they would be interested in purchasing them.

The Southeast Asian and Indian fragrance industries are also worth targeting as potential new markets. The FAO marketing consultant

recommended that market research be conducted to investigate potential new markets for Lao benzoin.

In seeking out new markets good presentation is a key part of promotion but it must be done honestly. If samples are sent for evaluation they must be fully representative of any shipment which may follow. Trial shipments at a discounted price may be necessary to persuade the importer of the reliability of the Lao exporter. In pursuing potentially large new markets it is important not to generate a demand which outstrips the supply.

In furtherance of expanding exports into new markets, the FAO marketing consultant **recommended that the Department of Export Promotion become a broader-based, more publicly accessible provider of services to exporters.**

10.4.11 Review of government policy on benzoin

The working group expressed strong concern about the present government land use and allocation policy, which intends to stop shifting cultivation and to introduce more intensive land use with a shorter rotation cropping system. As far as the traditional benzoin production system is concerned, this policy could inevitably lead to a serious reduction in benzoin production. **It was recommended that a policy review be conducted to find an alternative solution that would preserve traditional benzoin production.**

10.5 Overall recommendations

The following general workshop recommendations were made without specific working group attribution:

- There is a need to have a forum within the government system to facilitate coordination and problem solving with respect to functions of NWFP production, trade and marketing.

- The current over-dependence on a limited number of overseas markets has many negative impacts on the benzoin producers and traders. It is necessary to make efforts to expand the international market and to develop the domestic market for benzoin.
- To achieve the foregoing objective, joint efforts between the government and private sectors should be encouraged, through the forum suggested above. If necessary, the government should seek technical advice from UN agencies such as FAO. A strategic planning approach to the marketing of benzoin and other NWFPs is strongly recommended.
- The government should review the current lengthy export procedures and streamline them. This will help promote activities in the private sector and benefit NWFP producers.
- After the completion of this FAO TCP project, an EU project will fund the fieldwork of silvicultural and tapping trials. However, there is no clear follow-up plan for the improvement of benzoin trade and marketing. It is, therefore, **strongly recommended that the government take the initiative to develop a concrete follow-up programme on benzoin trade and marketing.**

Appendices

Appendix 1. List of key organizations, traders, companies and experts on benzoin

A. Government organizations and officials:

Country	Name	Organization / Position	Mailing Address	Tel, Fax & E-mails
Australia	Mr. Khongsak Pinyopusarerk	Forest Research Officer, CSIRO Forestry & Forest Products (Team Leader, FAO Benzoin Project, 1996-98)	P.O. Box E4008 Kingston ACT 2604, Canberra	Tel.: 61-2-6281 8247 Fax: 61-2-6281 8266 khongsak@ffp.csiro.au
Indonesia	Ir Pipin H. Pandjaitan	Head, Dinas Kehutanan Propinsi Sumatera Utara [North Sumatra Forestry Service] (Information source of Sumatra benzoin)	Jl Sisingamangaraja, 14, km 5.5 Medan	Tel: 62-61-762065
Lao PDR	Mr. Sianouvong Savathvong	Chief, Forestry Section, Provincial Agriculture and Forestry (PAFO), (Province Coordinator, FAO Benzoin Project, 1996-98)	Luang Prabang Forestry Section, P.O. Box 530 Luang Prabang	Tel.: 856-71-212 016 Fax: 856-71- 212 915
Lao PDR	Mr. Sommay Souligna	Forestry Section, Provincial Agriculture and Forestry (PAFO), (Field Manager, FAO Benzoin Project, 1996-98)	Luang Prabang Forestry Section, P.O. Box 530 Luang Prabang	Tel.: 856-71-212 016 Fax: 856-71-212 915
Lao PDR	Mr. Kong Keo Silisack	District Agriculture and Forestry Office (DAFO), (Staff, FAO Benzoin Project, 1996-98)	Nam Bak town, Nam Bak district, Luang Prabang province	Not available
Lao PDR	Mr. Kamphai Manivong	Director, Forestry Research Centre, National Agriculture and Forestry Research Institute (NAFRI)	P.O. Box 7174 Vientiane	Tel./fax: (856-21) 732298 Mobile: (856-20) 513138 frcfiss@laotel.com

Country	Name	Organization / Position	Mailing Address	Tel, Fax & E-mails
Lao PDR	Mr. Kamphone Mounlamai	Forestry Research Centre, NAFRI (National Project Coordinator, FAO Benzoin Project, 1996-98)	Ministry of Agriculture and Forestry (MAF), (He is now studying at AIT, Bangkok.)	st017009@ait.ac.th
Lao PDR	Mr. Bandith Ramangkoun	Director, Non-Timber Forest Products Information Centre (NIC), NAFRI	Ministry of Agriculture and Forestry (MAF), Vientiane	Tel/Fax: 856-21-415 774
Lao PDR	Mr. Sounthone Ketphanh	National Project Coordinator, NTFP Project, NAFRI	P.O. Box 4340 Vientiane	Tel./fax: 856-21-732 298 Mobile: 856-20- 511 653 frclao@laotel.com
Lao PDR	Mr. Chanpheng Bounnaphol	Acting President, Lao National Chamber of Commerce and Industry	Phonsay Road, P.O. Box 4596 Vientiane	Tel.: 856-21-412 392 Fax: 856-21-414 383
Lao PDR	Mr. Diederik Koning	Co-Director, EC Micro Projects II (1998-2002), (Follow-up work of FAO Benzoin Project up to 2002)	P.O. Box 535 Luang Prabang	Tel.: 856-71-212 890 Fax: 856-71-212 776
Lao PDR	Mr. Chan Pheng Vilay	Coordinator for forestry activities, EC Micro Projects II	Luang Prabang Forestry Section, P.O. Box 530 Luang Prabang	Tel.: 856-71-212 016 Fax: 856-71-212 915
Thailand	Mr. Prachoen Sroithongkham	Forestry Officer, Royal Forest Department (RFD) (Tapping consultant, FAO Benzoin Project, 1997-98)	NWFP Research Station, Kladong, Pak Chong, Nakorn Ratchasima 30320	Tel: 66-44-361 128

B. Benzoin tappers, traders and companies:

Country	Name	Organization / Position	Mailing Address	Tel, Fax & E-mails
Indonesia	Mr. Ali Johnsen	Vice President, CV Aroma & Co., (major extractor of benzoin)	113-115 Jl Timor Medan 20231	Tel. 62-61-530188 Fax 62-61-527338
Lao PDR	Mr. Sichanh	Benzoin tapper, Headman of Ban Kachet village	Ban Kachet, Nam Bak district, Luang Prabang province	Not available
Lao PDR	Mr. Gong	Benzoin tapper, Ban Kachet village	Ban Kachet, Nam Bak district, Luang Prabang province	Not available
Lao PDR	Mr. Tavanh	Benzoin tapper Ban Kachet village	Ban Kachet, Nam Bak district, Luang Prabang province	Not available
Lao PDR	Mr. Francis Chagnaud	Benzoin trader, Export Forestry Products Company	23-45 Pierre Morin Road, P.O. Box 6622 Vientiane	Tel.: 856-21-216 276 Fax: 856-21-216 261 France: Tel: 331-42760658 Fax: 331-42786926
Lao PDR	Mr. Kampheng Vongkanty	Benzoin trader, Export Forestry Products Company	23-45 Pierre Morin Road, P.O. Box 6622, Vientiane	Tel.: 856-21-216 276 Fax: 856-21-216 261
Lao PDR	Mr. Somsack Chantaphone	Benzoin Trader, Society Development of Forest Export	P.O. Box 3859 House 073/1, Nokeo Khoummane Road, Vientiane	Tel.: 856-21-215 812 Mobile: 020-511 289

Country	Name	Organization / Position	Mailing Address	Tel, Fax & E-mails
Lao PDR	Mr. Bounpheng Chantaphone	Benzoin trader, Society Development of Forest Export	Nokeo Khoummane Road, 073/1 P.O. Box 3859 Luang Prabang	(Through Mr. Somsack)
Singapore	Mr. Quah Eng Hwee	Managing Director, New Nanyang Benzoin Factory Private Ltd. (major Sumatra benzoin trader and producer of block benzoin)	61 Defu Lane 12, Defu Industrial Park, Singapore 539147	Tel: 65-283 5709 Fax 65-280 0263
Singapore	Mr. Lee Cheng Suan	Manager; Tjiat Seng & Co Pte Ltd. (major Sumatra benzoin trader and producer of block benzoin)	P.O. Box 1893, Singapore 913899	Tel: 65-289 5022 Fax: 65-234 0691

C. Individual experts who are familiar with benzoin:

Country	Name	Organization / Position	Mailing Address	Tel, Fax & E-mails
France	Mr. Renaud Costaz	Marketing consultant	88 bd Lepic 73100, Aix Les Bains	Tel: 33-04-7961-0869 Fax: 33-04-7934-1472 RenaudC73@aol.com
Indonesia	Ms. Esther Katz	Researcher (benzoin), Centre for International Forestry Research (CIFOR) (Note: She left CIFOR for France.)	P.O. Box 6596 JKPWB Jakarta 10065	Tel: 62-251-622622 Fax: 62-251-622100

Country	Name	Organization / Position	Mailing Address	Tel, Fax & E-mails
Lao PDR	Mr. Manfred Fischer	Programme Adviser, DANIDA Natural Resources and Environment Programme, Dept. of International Cooperation (DIC) (Associate Professional Officer, FAO Benzoin Project, 1997-98)	DANIDA P.O. Box 9990 Vientiane	Tel: 856-21-223 687 Fax: 856-21-223 688 silkfish@laonet.net Germany: silkfish@gmx.net (will leave for Germany in March 2002.)
Thailand	Mr. Masakazu Kashio	Forest Resources Officer, FAO Regional Office for Asia and Pacific	Maliwan Mansion, Phra Atit Road, Bangkok 10200	Tel.: 66-2-697 4141 Fax: 66-2-697 4445 Masakazu.Kashio@fao.org
United Kingdom	Mr. John J. W. Coppen	Non-Timber Forest Products Specialist (Marketing and processing consultant, FAO Benzoin Project)	12 Devon Close, Rainham, Kent ME8 7LG	Fax: 44-1634-379231 john.coppen@virgin.net

Appendix 2. Results of TLC analysis of 15 samples of benzoin[*1]

Thin layer chromatography (TLC) is a means of separating mixtures of compounds into their component parts. A small amount of a solution of the mixture - in this case that of a benzoin sample - is spotted near the bottom of a glass plate coated with a thin layer of silica gel. When immersed in a shallow depth of solvent, the solvent is absorbed and travels up the plate, dragging each of the constituents of the mixture with it. Different constituents travel at different rates and the end-result is that when the solvent reaches the top of the plate they are spread in a line from bottom to top. By using a suitable detection system, the constituents are visibly revealed as spots on the plate. If more than one sample is analyzed on the same plate, spots which travel the same distance represent the same (or a similar) compound. TLC can therefore be used qualitatively to identify the same compounds in different samples. If standards are available then it may be possible to identify the compounds themselves. Some spots fluoresce under ultra-violet light. If a chemical spray reagent is used to detect the spots, different colors may be produced by different compounds, and this, too, assists identification.

The intensity (size) of the spot is proportional to the concentration of the compound in the mixture and so quantitative analysis is also possible under carefully controlled conditions.

15 samples of benzoin collected during the regional fieldwork were analyzed at the Royal Forest Department[*2] and the results are shown below (over). Some of the conclusions to be drawn are discussed in the main body of the report but the characteristic patterns of spots (and their colours) can be seen to distinguish the Siam from the Sumatra types

[*1] This is derived from the report *Gum Benzoin: Its Markets and Marketing and the Opportunities and Constraints to Their Improvement in Lao PDR*. July 1997, by J.J.W. Coppen.

[*2] The analyses were carried out by Ms. Pannee Denrungruang.

(although some spots are common to both types). The forms of block benzoin which contain damar are also clearly seen.[*3]

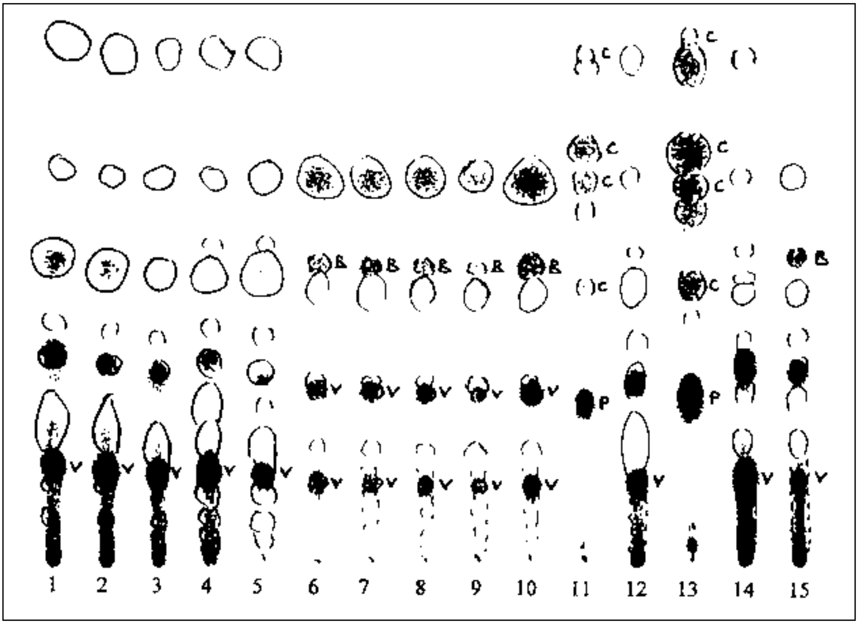
Experimental conditions were as follows:[*4]

Samples:	100 mg dissolved in 2 ml ethyl acetate; 2µl spotted
Plates:	Silica gel GF_{254}
Solvent system:	Benzene/methanol (95:5)
Detection:	Fluorescence at 254 nm; anisaldehyde spray reagent

[*3] Subsequent TLC in the UK of a sample of damar and of block benzoin confirmed that the crimson spots in samples 11 and 13 were due to the presence of damar.

[*4] Subsequent work at the Food & Drug Quality Control Centre, Vientiane, showed that silica gel 60 F254 HPTLC (high performance TLC) plates give an improved separation of spots compared to the TLC plates used here (*Sample Collection and Training of Staff at Food & Drug Quality Control Centre, Vientiane, in Benzoin Analysis*, April 1998, J.J.W. Coppen). Furthermore, use of a methanolic dip solution containing the anisaldehyde detection reagent (into which the HPTLC plate is dipped for a few seconds) was found to give much better results than applying the reagent as a spray: a more uniform application of the reagent to the plate was achieved, resulting in more sharply defined spots. It is preferable, also, to substitute dichloromethane for benzene in the solvent system.

B = blue, V = violet, P = pink, C = crimson



Sample identification:

1 Sumatra, grade 1, ex Singapore [company A]
2 Sumatra, grade 2, ex Singapore [company A]
3 Sumatra, grade 3 (dust), ex Singapore [company A]
4 Sumatra, grade 1, ex Singapore [company B]
5 Sumatra, grade B, ex Indonesia [company C]
6 Siam, grade A, ex Lao PDR [company D]
7 Siam, grade B, ex Lao PDR [company D]
8 Siam, grade C, ex Lao PDR [company D]
9 Siam, grade D (dust), ex Lao PDR [company D]
10 Siam, mixed grade, freshly collected, ex Lao PDR
11 Sumatra block (low quality), ex Kuala Lumpur
12 Sumatra block (good quality brand), ex Singapore [company A]
13 Sumatra block (low quality brand), ex Singapore [company A]
14 Sumatra, mixed (low quality) ex Singapore [company B]
15 Siam, ex Bangkok

Appendix 3. Pharmacopoeia monographs on benzoin[*5]

Pharmacopoeia monographs on benzoin are listed below. They were the latest available at the time of the fieldwork for the FAO project (1997) and give descriptions and definitions of benzoin (either Siam or Sumatra types or both), identification tests, specifications and assay methods.

In addition to the British Pharmacopoeia (1993), which only describes Sumatra benzoin, an earlier one (1980) is also listed since this includes Siam benzoin and describes a method for thin layer chromatographic (TLC) analysis of benzoin.

1. British Pharmacopoeia (1980, Siam benzoin)

   British Pharmacopoeia (1980) Siam Benzoin; Sumatra Benzoin. Vol. 1, pp. 51-53.

2. British Pharmacopoeia (1993)

   British Pharmacopoeia (1993) Sumatra Benzoin. Vol. 1, p. 75. [Benzoin Inhalation and Compound Benzoin Tincture are described in Vol. 2, p. 791]

3. French Pharmacopoeia

   Pharmacopée Française, 10th edition (1996) Benjoin du Laos. 3 pp.

4. Swiss Pharmacopoeia

   Pharmacopoea Helvetica, 7th edition (1995) Benzoe Tonkinensis = Benjoin du Laos. 2 pp.

5. US Pharmacopoeia

   The United States Pharmacopeia, 23rd edition (1994) Benzoin. pp. 177-178.

[*5] This is derived from the report *Gum Benzoin: Its Markets and Marketing and the Opportunities and Constraints to Their Improvement in Lao PDR*. July 1997, by J.J.W. Coppen.

6. Thai Pharmacopoeia

   Thai Pharmacopoeia (1987) Benzoin. Vol. 1, Part 1, pp. 47-49.

7. Japanese Pharmacopoeia

   The Japanese Pharmacopoeia, 13th edition, English version (1996) Benzoin. p. 741.

8. Chinese Pharmacopoeia

   Pharmacopoeia of the People's Republic of China, English edition (1992) Benzoin. pp. 5-6.

Appendix 4.[*6] Examples of traditional Thai/Chinese medicines containing benzoin[a]

Medicine A (taken internally twice a day for digestive disorders)

1. *Myristica fragrans* Houtt.
2. *?*
3. *Mansonia gagei* Drumm.
4. *Tarenna hoaensis*
5. *Dracaena lonriri*
6. *?*
7. *?*
8. *Alyxia nitens* Kerr.
9. *Cinnamomum loureirii* Nees.
10. *Cinnamomum* sp.
11. *Cinnamomum* sp.
12. *Kaempfera roscoeana* Wall.
13. *Vetiveria zizanoides* Stapf.
14. *?*
15. *Mimusops elengi* L.
16. *Mesua ferrea* L.
17. *Mammea siamensis* Kosterm.
18. *Nelumbo rucifera* Gaertn.
19. *Jasminum sambac* Ait.
20. *Jasminum* sp.
21. *Michelia champaca* L.
22. *Cananga odorata* Hokker F.et Thoms.
23. *Pogostemon cablin* (Blanco) Benth.
24. *?*
25. *Pandanus amaryllifolius* Roxb.
26. *?*
27. *Picrorrhiza kurroa* Benth.
28. *Artemisia vulgaris* L.
29. *Angelica sylvestris* L.
30. *Saussurea lappa* Clark
31. *Conioselinum univitatum* Turczaninow
32. *Levisticum officinale* Koch.
33. *Atractyodes lyrata* Sieb. et Zucc.
34. *Citrus hystrix* DC.
35. *Mansonia gagei* Drummond
36. **Benzoin** (*Styrax benzoin*)
37. *?*
38. *Pogostemon cablin* (Blanco) Benth.
39. *Nyctanthes arbor-tristis* L.

[*6] This is derived from the report *Gum Benzoin: Its Markets and Marketing and the Opportunities and Constraints to Their Improvement in Lao PDR*. July 1997, by J.J.W. Coppen.

Medicine B (taken internally for heart problems)

1. *Conioselinum univitatum* Turczaninow
2. *Levisticum officinale* Koch.
3. *Angelica sylvestris* L.
4. *Atractyodes lyrata* Sieb. et Zucc.
5. *Artemisia vulgaris* L.
6. *Jasminum* sp.
7. *Mimusops elengi* L.
8. *Mammea siamensis* Kosterm.
9. *Nelumbo rucifera* Gaertn.
10. *Mesua ferrea* L.
11. *Aquilaria agallocha* Roxb.
12. *Cinnamomum bejolghola* (Hom.) Swect.
13. *Glycyrrhiza uralensis* Fisch.
14. *Glycyrrhiza glabra* L.
15. *Albizia myriophylla* Benth.
16. *Diopyros* sp.
17. *Amomum krervanh* Pierre
18. *Syzygium aromaticum* (L.) Merr. & Perry
19. **Benzoin** (*Styrax* sp.)

Note: *a* - Botanical names were identified from the Thai words;
? - Indicates species name not known

Appendix 5. Results of the follow-up studies in 1999 and 2000[*7]

The FAO project "Improved Benzoin Production" initiated activities which needed further attention after the project was completed. The results of the study on tapping techniques and other field experiments such as provenance and agroforestry trials were still inconclusive.

In 1999, the EU Micro Project Luang Prabang (Phase II) took over the funding for a follow-up programme. Project implementation stayed with the Luang Prabang Forestry Section.

The follow-up programme covered mainly maintenance of the field trials as well as data collection and analysis. In 1999 and 2000 a former staff of the "Improved Benzoin Production" project was fielded for two short-term missions. The objectives of these missions were:

1. To supervise harvesting of benzoin resin in the experimental plots;
2. To analyse the collected data concerning quantity and quality of the benzoin harvest and evaluate the tapping techniques; and
3. To evaluate the activities carried out in the other project field trials.

The main findings and results from the two missions are briefly described as follows:

A. Benzoin Tapping Trials

1. Trial to identify the best tapping method

- In the 1999 tapping season, the traditional Lao and the V-shape method produced the highest benzoin yield. The traditional Lao method produced also the best quality.

[*7] This is derived from the two reports: 1) *Benzoin Production Consultancy: Mission Report, April 1999;* and 2) *Benzoin Production Consultancy: Second Mission Report, April 2000,* by M. Fischer.

- The above results were confirmed in the 2000 tapping season. It was concluded that the most suitable tapping method was the traditional Lao method.
- Since the most suitable method was identified, the objective of this research plot was achieved. It was therefore recommended to close this trial.

2. Trial on the relationship between tree size and resin production

- In 1999, there seemed to be a positive correlation between bark thickness and benzoin production. The results of the year 2000 trial were not as clear and pronounced as in the previous year. Nevertheless, it could be concluded that bigger stem diameters (to a limited extent) and bark thickness (to a higher extent) are indicators for higher benzoin production.
- The analysis of the 1999 trial data seemed to confirm the hypothesis that benzoin yield increases with the height of the tapping notches on the tree. This hypothesis could not be confirmed in 2000. A final conclusion was not made. However, it seems that the tapping height does not significantly influence the yield per tapping notch.

3. Trial on the effects of undergrowth on the benzoin yield

- The trial data of both years (1999 and 2000) did not support the assumption that undergrowth has a significant influence on the capacity of trees to exude benzoin. The differences between individual trees might be more important.

4. Trial to test the effect of beating the bark in order to stimulate resin flow

- The preliminary conclusion from the 1999 study (beating stimulates the resin flow) could not be verified after the analysis of the trial data in 2000. In 2000, the data basis for this experiment was considerably broader than in the previous year. It was therefore concluded that bark beating has no significant influence on the benzoin production.

5. Comments and recommendations concerning the tapping trials

- The benzoin harvest in the year 2000 was considerably lower than in the previous year, most likely due to different weather conditions.
- For some aspects (relationship between tree size and resin production) a longer observation period (2-3 years) is necessary in order to come up with scientifically proven results.

B. Provenance Trials

- The survival rate in the Ban Thali plot was too low to assure a reliable date basis for future experiments. It was recommended to discontinue this research plot but to collect growth data (DBH and height) beforehand.
- The survival rate in the Ban Kachet trial was satisfactory. It was recommended to continue according to the proposed work plan.

C. Agroforestry Trial

- The results of the year 2000 experiment showed no considerable improvements compared to 1999 and the previous years. It was therefore proposed to discontinue the agroforestry experiment.

Appendix 6. Bibliography

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Appendix 7. Examples of products using Siam benzoin

From left to right: alcoholic perfumes (*Egoïsre* from Chanel and *Shalimar* from Guerlain); cleansing cream; toilet soap; and toothpaste.

Incenses

From left to right: ice creams; caramel; vanilla flavours; cookies; and yogurts

Cigarettes

Benzoin ..... Better life for the children living in shifting cultivation communities in Lao PDR