

Forest Products, Livelihoods and Conservation

Case Studies of Non-Timber Forest Product Systems

VOLUME 1 - ASIA

Editors

Koen Kusters and Brian Belcher



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Contents

Contributors	vi
Acknowledgements	x
Foreword	xi
Chapter 1 Non-timber forest product commercialisation: development and conservation lessons <i>Brian Belcher and Koen Kusters</i>	1
FOOD, FEED AND MEDICINE	
Chapter 2 The socio-economic and ecological impact of <i>Garcinia gummi-gutta</i> fruit harvest in the Western Ghats, India <i>Nitin D. Rai</i>	23
Chapter 3 Cardamom (<i>Amomum</i> spp.) in Lao PDR: the hazardous future of an agroforest system product <i>Catherine Aubertin</i>	43
Chapter 4 Harvesting and commercialisation of <i>kroto</i> (<i>Oecophylla smaragdina</i>) in the Malingping area, West Java, Indonesia <i>Nicolas Césard</i>	61
Chapter 5 <i>Song rong</i> (<i>Tricholoma matsutake</i>), a valuable forest mushroom from China: consumption, development and sustainability <i>Ying Long Chen</i>	79
Chapter 6 The production of oak mushrooms (<i>Lentinula edodes</i>) as a source of farmers' income in the Republic of Korea: the case of Cheongyang-Gun <i>Yeo-Chang Youn</i>	95

Chapter 7

- Extraction and trade of Cardamom (*Amomum villosum*)
from Ba Be National Park, Vietnam 107
Dinh Van Tu

Chapter 8

- Lapsi (*Choerospondias axillaris*) emerging as a commercial
non-timber forest product in the hills of Nepal 117
Krishna H. Gautam

Chapter 9

- Cardamom (*Elettaria cardamomum*) in Kerala, India 133
T.K. Raghavan Nair and M. Govindan Kutty

RESINS, SCENTS AND ESSENTIAL OILS**Chapter 10**

- Benzoin*, a resin produced by *Styrax* trees
in North Sumatra Province, Indonesia 151
Carmen García Fernández

Chapter 11

- The marketing of *tout tiang*, a climber belonging
to the Urticaceae family, in Lao PDR 169
*Joost Foppes, Vannalack Sengsavanh, Michael Victor,
Viloune Soybara and Sounthone Ketphanh*

Chapter 12

- Case study of the production-to-consumption system of sandalwood
(*Santalum album*) in South Central Timor, Indonesia 187
Dede Rohadi, Retno Maryani, Made Widiana and Irdez Azhar

Chapter 13

- Damar agroforests in Sumatra, Indonesia: domestication of a forest
ecosystem through domestication of dipterocarps for resin production 207
*Hubert de Foresta, Geneviève Michon, Ahmad Kusworo
and Patrice Levang*

WOOD AND FIBRES**Chapter 14**

- Paper mulberry (*Broussonetia Papyrifera*) in Lao PDR:
a successful example of forest product domestication 227
Catherine Aubertin

Chapter 15

- Moso bamboo (*Phyllostachys heterocycla* var. *pubescens*)
production and marketing in Anji County, China 247
Fu Maoyi and Yang Xiaosheng

Chapter 16

The development of the woodcarving industry and the cultivation of *Paraserianthes falcataria* in Bali, Indonesia
Dede Rohadi, Pipin Permadi and Syarif Hidayat 265

Chapter 17

Domestication of rattan (*Calamus tetradactylus*) in the buffer zone of Ke Go Natural Reserve Area, Cam Xuyen district, Vietnam
Vu Dinh Quang 283

Chapter 18

Case study of *tendu* leaves (*Diospyros melanoxylon*) in Harda District, Madhya Pradesh, India
Arvind A. Boaz 295

Chapter 19

Rattan (*Calamus* spp.) extraction in the Philippines: the case of Manggapin and Kalakwasan watersheds, Palawan
Honorato G. Palis 313

Chapter 20

The kitchen utensils home industry in Sukaraja subdistrict, Java, Indonesia: wood (*Agathis boornensis*) from a state owned plantation used by local enterprises
Pipin Permadi, Syarif Hidayat and Dede Rohadi 325

Chapter 21

Bamboo (*Neohouzeaua dullooa*) production and trade in Cho Don, Vietnam: NTFP extraction from allocated forest lands
An Van Bay 335

Chapter 22

Rattan (*calamus* spp.) gardens of Kalimantan: resilience and evolution in a managed non-timber forest product system
Fadjar Pambudhi, Brian Belcher, Patrice Levang and Sonya Dewi 347

Sources used for illustrations

365

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Foreword

J.E. Michael Arnold

Products other than timber and other industrial roundwood have always constituted a large part of the forest economy in developing countries. Individual products provide inputs and income directly to huge numbers of rural and urban households. In many countries the aggregate of non-timber forest products (NTFPs) contributes as much, if not more, to national product as industrial roundwood. However, their designation as ‘minor’ forest products reflects their relative neglect until quite recently. Produced and consumed largely outside the monetary economy, they attracted only limited attention and even less in the way of measurement and research.

The recent increase in interest in NTFPs has been a consequence of a number of shifts in developmental focus. With the evolution in thinking about the importance of rural development and poverty alleviation has come growing interest in how forests and forest products contribute to households’ food and livelihood security. Within this framework forest product activities have begun to attract particular attention as being often one of the larger income-generating components of the non-farm part of the rural economy. In recent years this interest has been reinforced by shifts in development policy and strategy towards more market driven activity within this part of the economy.

At the same time, concerns that development activities be consistent with environmental integrity, and not prejudice the future potential of forest and land resources, have highlighted arguments that managing them for NTFPs might be less environmentally damaging than alternative uses of forests. In addition, the policy shifts that encourage devolution of control and management away from central governments to local institutions have drawn more attention to NTFPs as a potentially important incentive to local forest management.

However, the state of knowledge about these aspects of NTFP activities has not kept pace with this emerging and evolving perception of their increased importance. Though quite a lot is known about the characteristics of many individual products, much less is known about their commercial performance and developmental linkages. Consequently, we are still at a quite early stage in the process of establishing general patterns of NTFP activity that could help us

understand the factors that determine the circumstances in which they are or are not likely to be commercially successful and appropriate.

This knowledge is so rudimentary not only because of the low priority attached to NTFPs in the past, but also because of the complexities of researching and understanding such a highly diverse group of products, produced in such a wide range of different ecological and socioeconomic situations. Some are generated within predominantly subsistence livelihood systems, in order to generate the limited amounts of cash income needed to fill seasonal gaps or tide households over hard times. Others form part of livelihoods that are integrated into the market economy, and can form important and growing sources of household income and improvement. Many NTFPs are goods that fall out of use as incomes rise, or that can no longer compete when more efficiently produced alternatives become available in their markets. Others, in contrast, face expanding markets and generate attractive returns. Consequently greater exposure to market forces may disrupt or even overwhelm some NTFP trades, while offering new or expanded opportunities for others. It is therefore important to understand more precisely the factors that shape such possibilities and threats, in order to be able to identify what types of intervention might encourage the one, or help avert or alleviate the other.

There are also different scenarios to be considered on the supply side. Some NTFPs are extracted from existing 'wild' resources, others are produced from forest resources under some form of management, while still others are outputs of cultivated tree resources within a predominantly agricultural environment. Issues that we may need to know more about include how different forms of management relate to the different roles particular NTFPs play in the associated livelihood and socioeconomic system; the extent to which different NTFP production systems conform to conservation objectives and concerns; and the capacity of existing governance mechanisms to effect desired outcomes.

These three volumes represent one output from a substantial pioneering exercise designed to help fill some of these gaps in our present knowledge base. The study set out to determine what patterns of interaction between factors such as those mentioned above can be discerned from existing information, based on comparative analysis across a substantial number of different products in different situations in Africa, Asia and Latin America. This is not a random, or necessarily representative, sample of case studies. Their choice reflects the availability of the needed information, but the selection covers a wide range of product, circumstance and situation.

The analysis of information provided by this body of work has shown that important patterns can be identified. These are summarised in the introduction chapter of Volume 1. Each volume complements this comparative analysis by providing a descriptive account of each case study that was contributed from a particular geographical region, prepared by the researchers involved. Together they provide a wealth of information about individual NTFPs and the situations in which they are being produced and traded, and indicate the extent of the research base drawn upon in the course of this important exercise. It is to be hoped that it will provide a starting point for further research and analysis to continue the process of improving understanding of the potentials for NTFP activities to contribute successfully to livelihood enhancement and sustainable forest use.

Chapter 1

Non-timber forest product commercialisation: development and conservation lessons

Brian Belcher and Koen Kusters

INTRODUCTION

Non-timber forest products (NTFPs) feature prominently in discussions of rural development and forest conservation. Poor rural people depend on a wide variety of plants, animals and fungi for their own direct use and for sale. Some of these products have important commercial markets and generate substantial revenues. In the search for ways to promote development while at the same time protecting the environment, the idea that forests can produce a flow of valuable products without being subject to the destructive harvesting often associated with industrial forestry has proven attractive to environmental non-governmental organisations, donors and development agencies.

Influential studies, such as the one by Peters *et al.* (1989) suggesting that harvesting NTFPs in tropical forests could generate higher revenues than logging, created a flurry of excitement. Many studies have since been done to document and analyse all aspects of NTFP use and management and projects have been launched to improve NTFP management and to help create and capture more value from NTFP production, processing and trade (see reviews such as Townson 1994; Ruiz-Pérez and Arnold 1997; Neumann and Hirsch 2000). The underlying assumption of many of these activities, implicitly or explicitly, was that NTFPs could be used to improve people's welfare in an environmentally friendly way. More ambitiously, some proposed that by making standing forests more valuable, NTFP commercialisation would create incentives for conserving forests.

Further research and practical experience tempered the early high expectations. Some commentators criticised the economics of the Peters *et al.* (1989) study (e.g., Sheil and Wunder 2002). Other studies found that NTFP values were much more modest (e.g., Godoy *et al.* 2000). Even so, enthusiasm for the approach has continued to grow without a commensurate increase in understanding of the role and potential of NTFPs to contribute to livelihood

and conservation objectives. This inconsistency reflects two interrelated problems. First, the concept of 'NTFP' remains ambiguous. There is no generally agreed upon definition and different groups use the term in different ways to suit their purpose (Belcher 2003). Secondly, research and development approaches have differed greatly in focus, scale, approach and methodology (Arnold and Ruiz-Pérez 1996; Belcher and Ruiz-Pérez 2001; Belcher *et al.* 2003; Marshall *et al.* 2003). Anthropologists, biologists and economists have all taken an interest in NTFPs, but have asked different questions, used widely different methods to answer those questions and, collectively, failed to provide a systematic understanding of the relation between NTFP commercialisation, poverty reduction and forest conservation.

The authors of this book, and the companion volumes from Africa and Latin America, have tried to fill this gap by comparing and contrasting a large number of NTFP case studies. The researchers, each equipped with a detailed understanding of one or more cases, documented 61 cases using a standardised set of variables. Each researcher has written a narrative description of the case to provide the contextual information necessary to understand the quantitative and qualitative data. Collectively these reports provide a rare and valuable resource—a set of NTFP case studies presented in a consistent and comparable manner. This volume presents the narrative reports of the Asian cases. The location of each case study is shown in Figure 1 and some of the more important characteristics of each case are presented in Table 1.

In this introductory chapter we analyse the patterns and key issues derived from the case studies in two ways. First we consider the general patterns that emerged from the analysis of the overall global set of cases. Then we look at the key elements of NTFP production-to-consumption systems that influence the role these systems play in development and conservation, with examples from the Asian cases. We conclude with a summary of the main lessons learned about how to use and support these kinds of systems.

GENERAL PATTERNS IN A GLOBAL ANALYSIS

The study approach

The comparative analysis included 21 cases from Asia, 17 from Africa and 23 from Latin America. They were selected to meet two key criteria: (1) the product has a demonstrated commercial value and (2) the production-to-consumption system (PCS) has been researched and documented, with data available for a large proportion of the variables. The cases were documented using 114 nominal, ordinal, interval and ratio variables organised in categories describing various aspects of the PCS including:

- geographic setting
- biological and physical characteristics of the product
- characteristics of the raw material production system
- ecological implications of production
- socio-economic characteristics of the raw material production system
- institutional characteristics of raw material producers

- policies affecting raw material production
- characteristics of the processing industry
- characteristics of the trade and marketing system
- outside interventions

The rich data set was then explored for relationships among different groups of cases and variables. Exploratory statistical techniques were used to find patterns, identify key context variables, and create a typology of cases. A detailed description of the methodology and variables can be found in Belcher and Ruiz-Pérez (2001).

NTFPs in household strategies

The relationship between the degree to which an NTFP contributes to household economy (measured as a percentage of total cash and in-kind income) and the degree to which households are integrated into the cash economy (measured as the percentage of total household income earned in cash) is very informative. Three main groups of cases can be identified (see Belcher *et al.* 2003 and Ruiz-Pérez *et al.* forthcoming):

1. Low contribution of the product to household economy in the context of low integration into the cash economy ('Coping Strategy');
2. Low contribution of the product in the context of high integration into the cash economy ('Diversified Strategy'); and
3. High contribution of the product with high integration into the cash economy ('Specialized Strategy').

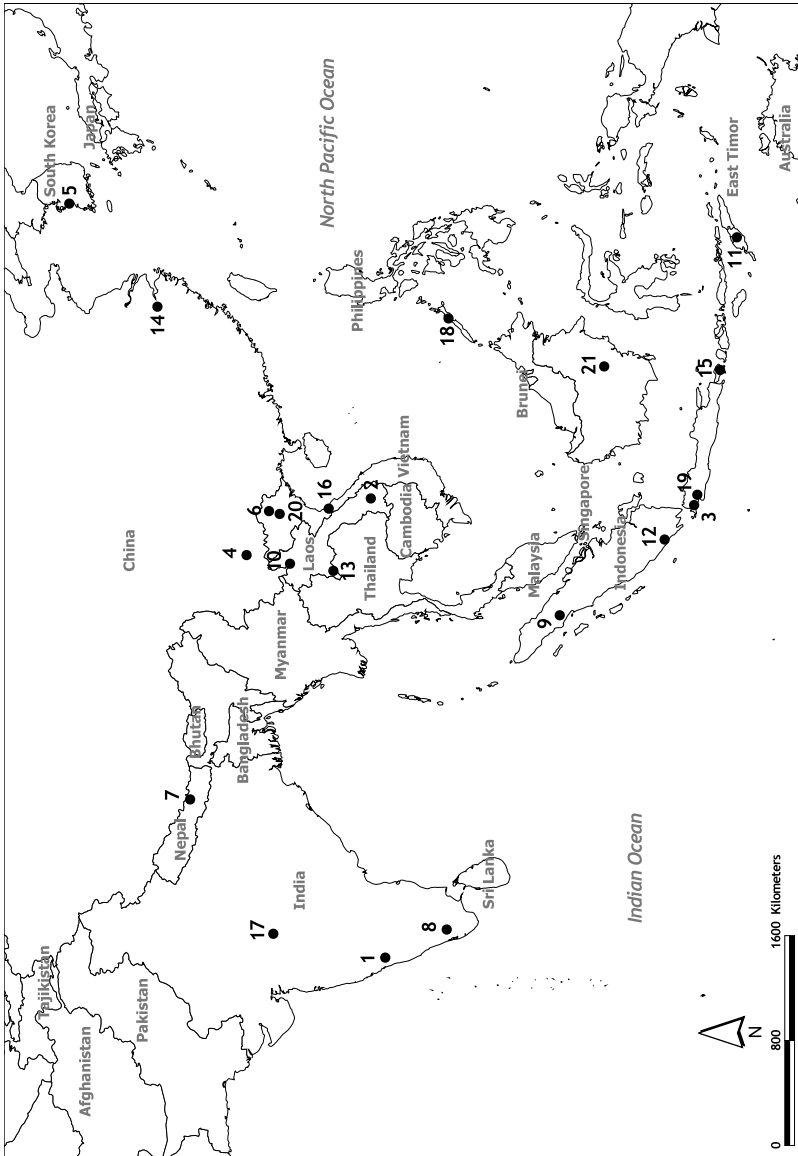
Each of these groups of cases is associated with a number of other characteristics that help describe and explain their socioeconomic and ecological performance.

Coping Strategy

In the first group the NTFP provide less than half of the total household income in subsistence-oriented households. Nevertheless, the NTFP is often the main or even the only source of cash income. Household incomes are low and NTFP producers have incomes that are lower than the local average. These NTFP producers also use a larger number of other forest products, either for their own consumption or (less often) for trade. These cases tend to be located in relatively remote areas, with abundant forests and limited transportation infrastructure. The land from which NTFPs are extracted is often owned by the state. In some cases traditional rules govern access, but in many examples access to the resource is open.

People in this group have limited opportunities for employment. They work as subsistence farmers and supplement their incomes with hunting and gathering. This kind of situation is described in the nonfarm rural economy literature (Lanjouw and Feder 2001), from which we borrowed the term 'coping strategy'. Off-farm activities, such as NTFP harvesting and sales, help make ends meet and provide important sources of cash, but often prove

Figure 1. Location of the case study areas



Source: ESRI Data and Maps 2002.

Table 1. Important characteristics of the cases

no.	country	species	common names	part of the resource used	dominant form of management	transformation*	scale of trade	national trade and export**	geogr. range***	author
1.	India	<i>Garcinia gummi-gutta</i>	Garcinia, Upagge	fruit	wild	high	international	high	small	Rai, N.D.
2.	Lao PDR	<i>Amomum</i> spp.	Cardamom, Makneng	fruit	managed/ cultivated	high	international	medium	large	Aubertin, C.
3.	Indonesia	<i>Ocophylla smaragdina</i>	Sennut rangrang, Weaver ant, Sirerangge	larvae	wild	low	national	low	medium	Césard, N.
4.	China	<i>Tricholoma matsutake</i>	Matsutake, Pine mushroom, Song rong	mushroom	wild	low	international	high	small	Ying Long Chen
5.	Korea Republic	<i>Lentinula edodes</i>	Shitake, Oak mushroom, Pyo-go	mushroom	cultivated	low	international	high	large	Yeo-Chang Youn
6.	Vietnam	<i>Amomum villosum</i>	Cardamom, Sa nhan	fruit	wild	medium	international	low	large	Dinh Van Tu
7.	Nepal	<i>Choerospondias axillaris</i>	Lapsi	fruit	managed/ cultivated	medium	national	low	medium	Gautam, K.H.
8.	India	<i>Elettaria cardamomum</i>	Cardamom, Elam	fruit	cultivated	low	international	high	small	Nair, T.K.R. and Kuty, M.G.
9.	Indonesia	<i>Styrax paralleloneurum</i>	Kemenyan, Benzoin, Hamjion toba	resin	cultivated	high	international	medium	medium	García Fernández, C.
10.	Lao PDR	<i>Boehmeria malabarica</i> or <i>Debregeesia longifolia</i>	Shui-mao-pi, Tout tiang	bark	wild	medium	international	low	medium	Foppes, J. et al.
11.	Indonesia	<i>Santalum album</i>	Cendana, Sandalwood, Hau meni	resin and wood	wild	high	international	medium	medium	Rohadi, D. et al.
12.	Indonesia	<i>Shorea javanica</i>	Damar kaca, White meranti	resin	cultivated	high	international	medium	medium	de Foresta, H. et al.
13.	Lao PDR	<i>Broussonetia papyrifera</i>	Paper mulberry, Posa	bark	wild/cultivated	medium	international	medium	large	Aubertin, C.
14.	China	<i>Phyllotachys heterocycia</i> var. <i>pubescens</i>	Moso, Bamboo, Mao zhu	stem and shoot	cultivated	medium	international	high	large	Fu Maoyi and Yang Xiaosheng
15.	Indonesia	<i>Paraserianthes falcataria</i>	Sengon, Albizia, Belalu	wood	cultivated	medium	international	high	large	Rohadi, D. et al.
16.	Vietnam	<i>Calamus terredactylus</i>	May nep, Rattan	stem	wild/cultivated	medium	international	high	small	Yu Dnh Quang
17.	India	<i>Diospyros melanoxylon</i>	Tendu	leaves	wild/managed	medium	international	high	large	Boaz, A.A.
18.	Philippines	<i>Calamus</i> spp.	Yantok, Rattan	stem	wild	medium	international	high	medium	Palis, H.G.
19.	Indonesia	<i>Agathis borneensis</i>	Damar, Agathis, Damar pilau	wood	cultivated	medium	national	low	medium	Permadi, P. et al.
20.	Vietnam	<i>Neohouzeaua dulooa</i>	Nua, Bamboo	stem and shoot	wild	medium	international	high	large	An Van Bay
21.	Indonesia	<i>Calamus</i> spp.	Rotan, Rattan	stem	cultivated	medium	international	high	large	Pambudi, F. et al.

* Degree of transformation (degree of processing that is required): low (e.g. fruit, bush meat or other products that can be used directly by the consumer); medium (e.g. fibre from grass used for weaving or handicrafts; wood for carvings); or high (e.g. essential oil extracted from plant and used in incense or as a chemical component in medicine).
 ** Value of national trade and export in 1998: low (< 1,000,000 US\$/year); medium (1,000,000 - 10,000,000 US\$/year); high (10,000,000 US\$/year).
 *** Geographic range: total area (global) over which the target species lives: large (>1,000,000 km²); medium (<1,000,000-75,000 km²); small (<75,000 km²).

insufficient to lift people out of poverty. These households tend to invest very little effort in NTFP management. The products are harvested from natural forest or fallow fields in extensive systems. In almost all cases in this group the target NTFP resource was declining as a result of overexploitation, loss of habitat and insufficient or ineffective management.

Diversified Strategy

In the second group, the target NTFP provides supplementary income for households that earn the bulk of their income from agriculture or from off-farm labour or trading. It proved useful to subdivide this group into those cases in which the target NTFP is cultivated, and those in which the target NTFP is harvested from the wild (Belcher *et al.* 2003). In the first subgroup, NTFP production is often integrated with other agricultural production on lands over which the farmer has some control. The NTFPs are cultivated and managed on bunds and in hedgerows, integrated with other commodities in fields or combined with tree species in agroforests. In the second subgroup, NTFP producers tend to harvest the product from wild resources with little or no management.

NTFP production is generally important for diversifying sources of income, thereby helping to spread risk. Forest products can be especially important in times of the year in which income from other sources is low. NTFP production rarely competes with other agricultural activities because forest products are usually collected when labour requirements for agriculture are low.

Specialized Strategy

In the third group the target forest product contributes 50% or more to the total household income in the context of high integration into the cash economy. Generally (but with some exceptions) these producers have the highest incomes of the three groups, and also tend to have higher incomes than the local average in the case study area.

Products in this group tend to have the highest value per weight. They include a number of special foods—mushrooms, Brazil nuts, fruits—and medicinal products, and many of these products are traded internationally. These products are managed relatively intensively. Some are cultivated, but the majority are managed in naturally regenerated systems. Owing to the high management input combined with the high product value, these resources tend to have the highest value of forest-product production per hectare. And because it is an economically attractive activity, there are many local producers, resulting in a relatively large total trade in the study area. Overall, the characteristics of the specialized group of cases portray a situation of relative stability and mature markets, offering good incomes for producer households.

Economic geography

Our case groupings, and the related literature, show the importance of the local context in determining how people use forest and other resources. Some of the key variables identified in this study are property rights, size and accessibility of markets and the availability of alternatives, that is, the 'opportunity costs' of labour and land in the area. Transportation infrastructure and the availability of electricity, fuel and communication facilities also determine whether it is possible to produce, process and trade NTFPs. Soil quality, relief, climate and the land-tenure regime determine what other activities, competitive or complementary, are possible. In poor remote areas with open access to resources there is a tendency for overexploitation of marketable NTFPs and dissipation of rents. This trend is exacerbated where more households become involved in harvesting and trade in response to new opportunity (e.g., new market, increasing price) or need (e.g., contracting economies, drought or other factors limiting alternatives). In these situations, forestry (including NTFP harvesting) is often the default option and there are few alternatives for employment and income earning.

In areas that are less remote and have more agricultural development, typically with a high proportion of land under private ownership, NTFP production fits in with other land uses by making productive use of land that is marginal for agriculture (e.g., steep slopes, fence rows, water courses) and by using labour readily available at low periods in the agricultural cycle. In areas where the market is sufficiently attractive, the product is sufficiently valuable and tenure is secure, people invest in managing NTFP. Management options range from the very basic—weeding around desired plants—to intensive management of domesticated plants or animals. In the global analysis, households cultivating NTFPs tended to have higher incomes than the local average and higher returns per unit of land than noncultivators.

Regional patterns

The cases were grouped by region to look for patterns of association with other characteristics (Ruiz-Pérez *et al.* forthcoming). This yielded significant differences between the three regions. African cases tended to have lower household incomes and smaller volumes of trade in the forest product than the other two regions. Human populations are growing in the African case study areas (sometimes with reverse migration from economically faltering urban areas) and there is an increasing market demand for the NTFPs. This situation translates into increasing pressures on the resource base, but most production still comes from wild sources and cultivation efforts are relatively sparse.

The Asian cases reflect higher and more stable economic conditions and slower population growth in case study areas (urban migration absorbs large numbers), resulting in stable NTFP markets and more stable resource bases. In most cases this stability is achieved through intensified management (the Asian group has the highest representation of intensified management and cultivation). Government intervention tends to be more frequent and the percentage of cases with private investment is higher, reflecting the products' commercial

value. These findings are consistent with expectations, given that many NTFPs have been traded nationally and internationally for long periods (centuries in some cases).

Latin American cases have economic conditions and population trends that fall between the other two regions and exhibit more variability. There is a higher frequency of unstable markets ('boom and bust' situations) than in the other regions. Products are produced from a diversity of sources and there is no apparent tendency in terms of pressure on the resource base. There is some government and non-governmental organisation support but little private sector investment. Trade in many of the products has developed only recently. New products are coming to market every year, and many of the Latin American cases in our set have been the focus of recent market development activities.

PRODUCTION-TO-CONSUMPTION SYSTEMS: EXAMPLES FROM ASIA

The analysis based on household livelihood strategies shows that opportunities for NTFP-based activities, and the competitiveness of those activities, depend on the local biophysical, social and economic conditions, on the demand for the NTFP and on the functioning of the market. The regional analysis indicates a larger generalized pattern. Such general typologies and patterns help to understand and structure the great diversity of NTFP production systems, but subsume and mask many interesting and informative details. Therefore we now consider some of the more specific issues using the PCS framework, illustrated with examples from individual Asian cases. We refer to individual chapters with numbers in superscript.

Raw material production

There is a continuum of options available for the production of any biological resource, ranging from pure 'extraction', where naturally occurring resources are harvested without any management, all the way to intensified management in plantations or greenhouses. The Asian cases include examples at several points along this continuum.

Gathering from the wild

The gathering of forest products from the wild is associated with the coping group. These cases are characterised by subsistence-oriented livelihood strategies, remote settings and products that are mostly gathered from *de facto* open-access resources. Gathering from the wild does not necessarily mean gathering from an undisturbed natural forest. Many valuable products grow well in secondary forests. For example, some bamboo and cardamom species and the *tendu* tree prefer the more open environment of disturbed forests^{7,9,18,21}. In some cases valuable products are harvested from fallow agricultural fields^{3,11}.

Managing wild resources

NTFP producers may manage naturally regenerating resources in order to improve productivity or quality. An example of such an approach in the Asian set of cases is that of *tendu* leaves in Harda district, India¹⁸. The trees are kept close to the ground by pruning, and their roots are deliberately damaged to stimulate more vigorous growth. Thus the managed areas are gradually transformed into quasi-plantations dominated by *tendu* shrubs. These practices increase both the quantity and quality of leaves. But only a small percentage of the resource is managed in this way. Because the *tendu* grows on state-owned lands, harvesters have no individual control over the resource and may well be unable to reap the benefits of their management investments. Indeed, the management efforts in the district are initiated by a state-owned co-operative federation that pays groups of people to prune the *tendu* trees on public lands.

Cultivation

In about half of the cases presented in this volume the target species is harvested predominantly from planted populations. In all of these instances cultivation has been encouraged by strong demand—a good market exists and reasonable returns can be expected on investments in cultivating and managing. Confidence in the market is important as cultivation requires a reasonable period of investment. The average time to maturity for the planted species in the Asian set of cases is about eight years.

But cultivation needs more than market demand. It needs tenure security so that investments in planting and managing long-lived species can be recouped. Interestingly, there is a two-way relationship between NTFP cultivation and tenure in several of our cases in that NTFP cultivation is sometimes used to mark ownership and establish tenure. In Lao People's Democratic Republic (PDR), for example, the cultivation of NTFPs is used to redefine forestlands and fallows into 'gardens' to prevent government officials from redistributing these lands under the new land policy^{3,11,14}. Cultivation also has other social and economic functions, such as risk spreading, income diversification and labour maximisation. And often cultivation is done in combination with other production activities.

Management of cultivated NTFPs ranges from intensive management in single-species plantations to extensive management where the NTFP is integrated into a diverse system of several economically valuable products. Using hired labourers, large landowners in the Western Ghats of India cultivate cardamom in intensively managed plantations under planted shade trees. The high yielding varieties they use need more fertiliser and irrigation and give significantly higher production and profits per hectare⁹. This level of management is, however, not accessible to the small and poorer landowners (let alone the landless) who lack the necessary financial resources or credit. These cardamom producers manage less intensive systems in agroforestry gardens that retain some of the original secondary forest vegetation.

Several of the Asian cases integrate NTFP production into fallow forests in a shifting cultivation cycle. Valuable products such as cardamom, paper mulberry

and rattan are planted with field crops or after their harvest and mature within the secondary forest when the field is left fallow^{3,14,22}. Perennial species, which germinate easily and require little management, are particularly suitable for such extensive cultivation systems. Domestication in fallow systems may even result in permanent agroforests. Both the *damar* gardens in southern Sumatra¹³, which now provide more than 80% of the total resin production in Indonesia, and the rattan gardens in East Kalimantan²² emerged out of shifting cultivation systems. The results are complex agroforestry gardens that feature a mix of planted and self-established plants with high biodiversity and processes comparable to natural forests that produce and reproduce without much human input.

Dynamics

Regional developments quickly change the opportunities available to local people. New roads have enormous impacts (e.g., Chomitz and Gray 1996; Kaimowitz and Angelsen 1998). The loss of forest resources and/or the introduction of alternative sources of income, such as wage labour for mining or plantation companies, can quickly make NTFP growing or harvesting less attractive. Throughout the world, many people are shifting from the natural-resource-based activities of farming and forestry to wage-paying employment in the secondary and tertiary sectors. Perceptions of a modern lifestyle make such possibilities highly attractive, especially for younger generations²². *Benzoin* producers used to enjoy high status in northern Sumatra, for example, but with the introduction of more profitable cash crops and the decreasing market value of *benzoin* resin since the late 1960s, younger generations have come to consider its production as backwards¹⁰. In other places, young people tend to migrate to urban areas, looking for new ways to make a living. Youn describes how this trend has led to an ageing labour force in rural areas in western South Korea⁶.

Trade chains

As with production systems, the organisation of NTFP trade reflects the prevailing social, geographic and economic conditions. In remote areas with poor transport and communications facilities the costs of transporting goods to the market are high. In some cases, producers themselves act as traders on an opportunistic basis^{7,17}. In many instances, though, producers rely on middlemen to transport and market their produce. And it is still common in the NTFP literature to see middlemen accused of exploiting producers and taking excessive profits. Typically, such analyses compare the final market price of a product with the price at which it was bought from the raw material producers and conclude that the large gap must contain an unfair profit for the trader (and the typical recommendation is to try to bypass the middleman, or to 'shorten the trade chain'). In practice, NTFP traders don't seem to be a particularly wealthy group. Césard, for example, describes

how profits for traders who buy from raw material producers remain low because of the high cost of transporting small amounts of the product to market by public transport⁴.

Moreover, in many cases, especially in the less developed and more remote systems, traders play a critically important role. Most obviously, they provide or arrange for transport to get the product to market. In some villages in Kalimantan, farmers cannot sell their rattan unless a trader comes to the village. But traders also provide market connections and market information, grading and sorting, credit (often in the form of advance payments on future harvests) and the valuable service of collecting the small quantities of product from numerous individual producers to aggregate marketable quantities. Indeed, in some cases, quantities of product are so small and markets so insecure that traders must deal in several products. Aubertin argues that the trade in paper mulberry is feasible only because it is part of a panel of traded products¹⁴. Traders deal with bureaucratic requirements, including official permits and (more frequently) unofficial payments (bribes), which are so often required to transport NTFPs to market. They also absorb the considerable risk of shipments being lost, confiscated, or perishing en route and of falling prices in unpredictable markets. As Garcia Fernández writes, 'Moving up the trade chain, profits increase, but so do the risks'¹⁰.

This is not to argue that NTFP traders are a bunch of altruists. They have market advantages and they certainly use those advantages where they can. By offering advance payments and longer-term loans, traders secure the loyalty of producers and lower buying prices⁸. Traders have knowledge of the market, market connections and the capital needed to organise the collection and transport, storage, grading and semiprocessing that allows them to get the best prices when they sell. Producers, on the other hand, often have disadvantages that translate into weak bargaining power: open access resources, remote locations, small product lots, uneven quality and timing, poor knowledge of prices and quality requirements and poor storage facilities. Bargaining power of producers is higher in the more developed systems, where markets are more stable, better organised and larger.

Post-harvest processing and manufacturing

Post-harvest storage and processing can extend the economic life of the harvest, give producers more bargaining power (reducing urgency for selling, allowing collection of larger volumes), and reduce transportation costs by concentrating the valuable component (Belcher and Schreckenberg 2003). Several cases in this volume show the importance of post-harvest treatment. Some perishable products are dried immediately after harvesting, using either sunlight or firewood. When the product is not consumed fresh, drying may add value to it. In Ba Be, Vietnam, sun-drying cardamom doubles its value. In other cases the product is dried because it is the only option for marketing. Drying then prevents deterioration but the value of the dried product is lower than that of the fresh product.

Other forms of processing can also add value and profitability, though for small-scale producers to take advantage the technology must be affordable (Clay 1992; Arnold *et al.* 1994). Making bamboo chips, for example, requires only cutting and splitting of bamboo culms, but the price per kilogram of chips is up to three times higher than the price per kilogram of culms²¹. Yet, even when the technology does not require any investment, processing is not necessarily a good option for small-scale raw material producers, because it may have high opportunity costs. Processing of *lapsi* fruits into candy does not require investments, is simple and brings high returns, but subsistence farmers may not have enough time to take advantage⁸. Raw material producers often do not know what qualities the market wants. Paper mulberry bark processors in Lao PDR ask different prices for different qualities of raw material, but the farmers, unaware of the required qualities and associated differences in prices, sell the bark to traders without grading it, and thus miss the opportunity to increase their profit¹⁴. Misguided efforts at semiprocessing can actually reduce the value of a product. This happened in a village in Kalimantan, where people decided to semi-process (split) rattan themselves, only to discover that their main buyer could not use the quality they were able to produce.

Markets and demand

Market size and nature are critical determinants in how a particular product will be managed. Economists distinguish between goods and services that are consumed primarily within the producing region and those that have important markets outside the producing region, labelled 'non-tradables' and 'tradables', respectively (Haggblade *et al.* 2002). Tradables tend to have significantly larger markets. Assuming producers of tradables have access to the market, their most important challenge is to increase quality and quantity of production at competitive prices. The production of tradables can act as a powerful engine for economic growth as in the cases of bamboo production and processing in Anji county, China¹⁵, and woodcarving in Bali, Indonesia¹⁶. But for other NTFPs the market is restricted to the local area. The small-scale kitchen utensil industry described by Permadi *et al.* falls into this category²⁰. The main market for wooden kitchen utensils is formed by local department stores and due to decreasing demand during the economic crisis in Indonesia in the late 1990s more than half of the small-scale enterprises from the research area were forced to close.

Changes in demand, whether up or down, are driven by a wide range of factors. Changes in accessibility and transportation possibilities have huge impacts on forest product markets^{5,16,21,22}. Technological innovations can replace natural products or, conversely, create new uses for natural products^{10,13,15,21}. Also, consumers' preferences change over time. With the modernization of Indonesian society, for example, the demand for *benzoin* has decreased as rituals that use *benzoin* incense have become less common. And younger generations of Indonesians prefer modern cigarettes to the traditional cigarettes

that use *benzoin*¹⁰. A similar phenomenon is observed in India, where traditional cigarettes made from leaves of the *tendu* tree face increasing competition from modern paper-wrapped cigarettes. At the same time, the export volume of traditional Indian cigarettes is increasing, however, as Western markets grow for products with a 'natural' image¹⁸. The expanding domestic demand for oak mushrooms in South Korea is related to the same trend, with demand for oak mushrooms driven by a popular perception that they are a 'natural' food free of chemicals⁶. Future demand for many forest products may depend on such niche markets. But markets can be fickle, especially in the pharmaceutical and cosmetic industries. Trade in the rind of *Garcinia* fruit, for example, boomed when it started being used in weight loss pills in the United States, but decreased dramatically when scientific tests showed that the drug did not have the desired effect².

Gender roles in the PCS

Many NTFP production-to-consumption systems involve women, sometimes in a leading role (Hecht *et al.* 1988; Falconer 1990; Terry and Cunningham 1993). Most of the examples in this volume show a clear division of tasks by gender within systems, but there is no clear pattern among different cases. For example, women collect cardamom from the forest in Vietnam's Ba Be district⁷, while the cardamom harvest in the Lao case is typically a male activity³. In Cho Don district, Vietnam, men collect bamboo culms while women collect the bamboo shoots and do the primary processing (splitting culms and boiling, drying and packing the shoots)²¹. In Madhya Pradesh, India, women collect *tendu* leaves, and men process them¹⁸. In Sukabumi, Indonesia, men carve wooden kitchen utensils, and women polish and pack²⁰.

The Asian cases reconfirm that many NTFP systems are of particular importance to women. NTFP trade creates opportunities for women at all stages of the PCS; their involvement ranges from hired labourers for harvesting⁹ to independent traders⁷. From the literature we know that commercialisation sometimes leads to men taking over business from women (Tewari and Campbell 1996). The cardamom case in Vietnam shows how the trade of small quantities is dominated by women, but further up the trade chain, where quantities—and profits—are larger, men are in charge⁷.

Policy and regulation

The policy environment affects opportunities and choices. Governments can influence the opportunities and profitability of forest product harvesting through regulations, and the way these regulations are enforced (the payment of bribes to officials is common, especially where NTFPs are extracted from state lands). Research and extension, taxation and land tenure all affect land use options. So do export regulations. In Vietnam and Lao PDR economic liberalisation has created new export markets resulting in increased exports of forest products^{3,14,11,17,7}. Aubertin describes how in Lao PDR the export of bark from the paper mulberry

tree to Thailand increased when the Lao government started promoting a market economy in 1989¹⁴. And the boom in the bamboo sector in Anji county resulted directly from policy changes. Government regulations can also aim to restrict markets. Governments of raw material producer countries, for example, may restrict the export of raw materials in order to stimulate domestic processing activities, with possible negative consequences for raw material producers when the foreign market falls away^{17,22}. Heavy taxation in importing countries of imported processed materials, with virtually no taxes on raw materials, also distorts markets¹¹.

NTFPs have been largely overlooked by governments. Considered ‘minor forest products’, they are ignored or subjected to rules designed for timber, with high fees and inappropriate restrictions. In many cases it is unclear how regulations apply to NTFPs. The Indonesian Ministry of Forestry, for example, classifies the *benzoin* resin from cultivated trees as a ‘forest product’, while local regulations define it as a ‘garden product’ falling under jurisdiction of the Ministry of Agriculture¹⁰. In most countries a tax is levied on the trade of forest products to compensate for forest damage, but legislators seldom recognise the distinction between cultivated and noncultivated forest products^{3,10,14}. Likewise, there is the problem of distinguishing between products harvested from public and private lands⁷.

Tenure security

Tenure continues to be one of the most important points on the conservation and development agenda (Lynch and Talbott 1995; Peluso 1996; Colfer and Byron 2001; Pandit and Thapa 2003; Ribot and Peluso 2003). Experience presented in this volume underlines this importance. Colonial regimes in South and Southeast Asia established state control over forestlands and this arrangement was taken over by the national governments after independence. As a consequence, many forest-dependent people never received formal rights to own or use forest resources. Most NTFP management systems on state lands are vulnerable; conflicts arise when government-sanctioned land uses (e.g., forest concessions or plantations) compete with traditional uses. Over the last few decades tenure became not only a justice issue, with people claiming the rights to the lands they use, but also a key element in the concept of sustainable development. Effective management of a resource requires secure property or user rights to ensure that managers capture the benefits of management and to protect the resources from overexploitation.

Tenure has emerged as an important issue in most countries and governments have increasingly been formulating policies to formalise people’s access to land and forest resources. In China’s Anji county, the government granted long-term use contracts for bamboo stands to individual farmers, including provisions that guarantee inheritance of the contract and permit subletting¹⁵. In Lao PDR and Vietnam state lands have been allocated to individual farmers as part of land allocation programmes^{3,11,14}. Collective user rights are also on the agenda. In India various regulations differing from state to state were

instituted to grant rights to tribal communities¹⁸. According to a ministerial decree in Indonesia, communities can gain rights to manage forest areas based on customary law¹⁰. Tribal communities in the Philippines have been awarded user rights to their 'ancestral domain'¹⁹. And farmers living in and near Zixi National Park in China have been granted the collective right to harvest mushrooms⁵. Such regulations may look better on paper than they do in practice. Often, regulations are designed on the basis of unrealistic assumptions, lack proper implementation and procedures are onerous^{2,3,9,10,11,14,15,17,18,19,21}. In the Philippines, for example, the forest for which the Batak tribe has a land use certificate is also leased out to a private rattan concessionaire. Palis describes how this results in overexploitation of the rattan resources in the area¹⁹.

In Zixi National Park in China, despite the collective user right, organisation amongst collectors is weak. Competition between individual harvesters leads to the harvesting of immature mushrooms and a significant reduction in individual and collective earnings⁵. Such practices are associated particularly with the lack of clear tenure. Other examples are the harvest of immature *tendu* leaves¹⁸, cardamom^{3,7} and *Garcinia* fruits², and rattan canes¹⁹. The reasoning is rational from an individual harvester's point of view: 'If I don't take it, someone else will.'

Tenure status also influences investment behaviour, as people are willing to invest more when they know they can reap the benefits themselves. Efforts to reform land ownership and use rights for local people are promising, yet far from perfect, as described above. Furthermore, the highest quality forests usually remain in the hands of governments or large-scale enterprises (Scherr *et al.* 2003).

DEVELOPMENT AND CONSERVATION LESSONS

Commercialisation as a strategy for poverty alleviation?

There is a strong link between poverty and dependence on NTFPs, and forest products generally are more important to low-income than to high-income people (Jodha 1986; Hecht *et al.* 1988; Falconer 1992; Cavendish 1997; Pimentel *et al.* 1997; Neumann and Hirsch 2000; Angelsen and Wunder 2003). But, to what extent can NTFPs play a role in raising people's incomes?

The case comparison indicates that intensified NTFP management is associated with higher profits. But intensification is not always a good option for the poor. NTFPs are often elements in diversified portfolios and part of people's risk spreading strategies. Focusing on one product increases vulnerability to production failure or a fluctuating market. Moreover, poor producers may not have the labour or land available for intensification. For example, farmers in the primarily subsistence-oriented economy in Huaphan, Lao PDR, are uninterested in domesticating cardamom as it would require additional labour and thus compete with subsistence agriculture. Instead they prefer to harvest from the wild in periods of labour surplus³. Likewise, devoting

land to the cultivation of *lapsi* trees limits the land availability for subsistence purposes, so small landowners in Nepal cultivate this tree mainly on bunds and watercourses⁸. Intensification of NTFP production can even undermine the incomes of the poorest, because increased supply from those who can afford the required investment leads to reduced prices for wild gathered products, affecting those who still depend on the wild resource for additional income.

Sunderlin *et al.* (2003) distinguish between two types of poverty alleviation: (1) poverty avoidance, i.e., preventing people from falling deeper into poverty; and (2) poverty elimination, i.e., lifting people out of poverty for good. There is little doubt that NTFPs are of crucial importance in poverty avoidance, filling gaps during periods of low income, spreading risk, and functioning as ‘safety nets’. But NTFP-based poverty elimination would require that increased trade results in a permanent increase in income and welfare. As discussed, the possibilities to do this are determined by the availability of a market, physical access, availability of skills and information, availability of labour and security of tenure. In the specialized group of cases, most of these conditions are in place, and producers have been successful in intensifying management and improving cash income from NTFP trade. But the conditions typically faced by the poor—on the community as well as the regional and global levels—limit the possibilities to increase trade or to benefit from increased trade.

Commercialisation and conservation of the target species

Increased commercial value of non-cultivated forest products can lead to resource depletion^{11,12,19}. The biology of the resource, and in particular the abundance and regeneration capacity of the targeted part of the resource (e.g., fruit of the *lapsi* tree, leaves of the *tendu* tree, bark of the *tout tiang* climber), determine the vulnerability to over-harvesting. Some species regenerate slowly after harvest^{12,16,17,19,20,22}, while others respond with more vigorous growth^{3,18}. Pressure on the target population can also be indirect. The harvest of fruits, for example, may affect the reproduction of the tree^{2,8}. The pruning of *tendu* prevents the trees from maturing and thus decreases propagation through seeds, which is important in terms of genetic diversity¹⁸. Cultivated NTFPs are usually not associated with threats to the target resource, but Aubertin points to the ‘genetic’ threat related to the replacement of local varieties with ‘improved’ high yielding varieties³.

Sometimes non-cultivated forest products are harvested in a way that compromises future availability. Examples of such deleterious harvesting practices are the removal of the topsoil layer when looking for mushrooms, which destroys the mushroom’s habitat; the cutting of mature trees for their fruits, as has been reported in India with *Garcinia*; and the digging up of roots of the sandalwood tree and the *tout tiang* climber (for oil content and bark, respectively), which limits regeneration possibilities^{2,5,11,12}. Long-term impacts of harvesting practices are not always taken into consideration. Poor people may make decisions aimed at meeting immediate needs—a characteristic of

coping strategies—making future availability less of a priority. Such harvesting practices can also be related to a lack of knowledge concerning the regeneration properties and conditions of the target species, as is the case with the harvest of the *song rong* mushroom in China⁵.

The *tout tiang* case¹¹ shows that establishing user rights and devolution of responsibility and decision-making power does not automatically lead to sustainable harvest of the target species. Foppes *et al.* describe how, despite extraction rights and community-defined rules regarding quantity and quality of harvest, high demand still results in rapid depletion of the resource. As discussed above, people do not necessarily prioritise long-term availability of a resource and do not always have the knowledge required to change practices in a way that sustains the resource. Moreover, people may be unable to prevent extraction by outsiders. Rai, however, describes how informal arrangements allocating a piece of forest to individual households (using natural boundaries such as ridgelines) have positively changed behaviour for harvesting *Garcinia* fruit in some areas in the Western Ghats in India².

Conservation of the forest ecosystem

The notion that increased value of NTFPs can encourage environmentally sound forest management is based on questionable assumptions. First, it assumes that local people have control over local forests and that they are (potentially) responsible for deforestation. In practice the main agents of deforestation in Asia are large-scale logging and plantation development, outside the control of local communities (Scherr *et al.* 2003). Second, it assumes that extractive NTFP production is more valuable in the long term than the harvest of timber. Third, it assumes that NTFP production is 'environmentally sound'. Intensification of NTFP production (and related activities such as the gathering of firewood for drying NTFPs) may, however, have negative impacts on the forest environment. Thus, increased NTFP demand and higher prices may actually trigger a shift from diverse production systems toward intensively managed systems with lower diversity. Some bamboo plantations in China, for example, are managed as monoculture plantations with high inputs of labour and fertilisers. Compared with the natural forest they imply a drastic decrease of environmental quality. Fu, however, argues that such plantations contribute positively to the local environment when they are established on degraded lands by providing some essential forest services, such as soil and water conservation, and reducing people's dependence on the natural forest¹⁵.

This brings us to the important issue of benchmark: What point of reference do we use when assessing the conservation value of a system? Most NTFP production systems will have lower species diversity and other forest functions than the natural forest they replace, but they may be significantly better than the most likely land use alternative. Many of these systems provide ecological services that are similar to the natural forest. Sometimes the NTFP system is the only forested environment in an area, and so provides a refuge

for natural flora and fauna that would otherwise disappear. The *damar* gardens in Sumatra described by De Foresta *et al.* even have a global significance for biodiversity, since they are home to endangered species such as the Sumatran rhino and the Sumatran tiger¹³. Gautam describes how commercialisation of the *lapsi* fruit has stimulated farmers to grow these trees on agricultural lands, resulting in increased tree cover on private lands, contributing to soil and water conservation in the hills and reducing the pressure on natural forest, since branches of the planted trees are used for firewood⁸. Kutty and Nair stress the importance of the cardamom production system in providing forest functions⁹. They also argue that cardamom producers have a vested interest in preserving forest functions in nearby protection forest and they report that farmers work directly with the forestry department to help prevent poaching and encroachment. Youn argues that the increasing value of oak trees for use in mushroom production has stimulated a shift from planting conifers to growing native hardwood species, with government support for stand improvement of natural forests with native species⁶.

Supporting NTFP systems

In all of the cases we looked at, NTFPs provide valuable income sources, sometimes with substantial employment opportunities. Individual case studies and overall comparative analysis point to ways and means to help support NTFP systems to benefit local people and to encourage ecologically sound practices. When looking for ways to increase the benefits of NTFP trade for the forest-dependent poor, it is important to consider whole systems and all the actors involved to identify the most important bottlenecks and opportunities. To help development and conservation agencies and governments to formulate more appropriate interventions we identify general lessons at each stage of the PCS:

- Raw material production. If there is a strong market for an NTFP, producers can take advantage by improving the quality and quantity of their produce through improved management and/or expanded production area. But efforts to promote increased production have to beware that the required inputs do not compromise the producer's flexibility. Particularly in the coping and diversified cases, people tend to rely on many (forest) products as part of their risk spreading strategies. For them, too much emphasis on a single product is risky, and more so in an uncertain market. Furthermore, such projects should pay extra attention to groups that lack the assets required for intensification (land and labour), because they may be negatively affected by competition from the expanded production. For wild harvested species, basic ecological knowledge is needed, along with appropriate monitoring techniques to measure the impact of extraction, to facilitate management. Intervening institutions will also have to understand that it is not always possible to fully reconcile development and conservation goals; there are tradeoffs. Sometimes intensified management makes a system less environmentally benign and choices may need to be made.

- Post-harvest processing and manufacturing. Such activities are often attractive to producers only if they are cheap, simple and impose no risk. Drying and grading are good examples of post-harvest treatment with potential to increase benefits for producers. Providing information about market requirements, grading schemes and prices can help producers, and research to develop effective low-cost technologies may offer new opportunities. It is common in the literature to find recommendations to encourage raw material producers to take on more semiprocessing and processing activities to add and capture more value. In fact, this can be effective only where producers truly have a competitive advantage to do so. Such advantage may exist in the form of better access to raw materials, lower opportunity costs of labour or even a 'fair trade' market premium. But most activities beyond rudimentary processing also require access to electricity, good transport facilities (including port facilities for export products) and, very importantly, the knowledge, contacts and skills to manage the business.
- Markets and demand. Market size and structure are key factors determining what type of intervention is appropriate. Small local and regional markets can easily be saturated. In such cases, increased production of raw material can lead to reduced prices, while efforts to access new markets can create new opportunities. Larger markets present opportunities for producers to increase their market share by producing more and/or better quality product, and through better marketing. This often requires specialized skills that can be provided through training or dedicated support services. To improve bargaining power NTFP producers need access to information about pricing structures, availability of substitutes, quality requirements and consumer preferences. Small-scale producers may also gain strength through collective action. Co-operatives or other organisations that allow producers to pool resources (for storage, post-harvest processing or transportation, for example), share information and pool small lots of product for the purpose of grading and collective bargaining can be effective. Certification has become a hot topic for timber and also increasingly for non-timber forest products. There may be opportunities for NTFP producers to benefit from emerging markets for 'green' and 'fair' trade, but recent studies, such as by Shanley *et al.* (2002), have pointed out important limitations, including high costs, high level of organisation and information required and limited demand for certified products in many markets.

The comparative analysis showed the utility of classifying NTFPs according to their role in household economic strategies. Different roles imply different potential and indicate the need for different kinds of interventions. In specialized cases, NTFP production, processing and marketing is well developed and investment at an appropriate point in the production-to-consumption chain can stimulate further development. In many of the coping and diversified cases, NTFPs are important as supplementary sources of income,

but do not offer great potential for expansion due to larger, systemic constraints. Still, project- and policy-interventions can be aimed to take advantage of existing opportunities and to overcome some of the key constraints (as discussed above), but care is needed to avoid creating conditions that will actually disadvantage producers.

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Chapter 2

The socio-economic and ecological impact of *Garcinia gummi-gutta* fruit harvest in the Western Ghats, India

*Nitin D. Rai*¹

Common names	Part of the resource used	Management	Degree of transformation	Scale of trade	Geographic range
Garcinia, Upagge	Fruit	Wild	High	International	Small

OVERVIEW

The fruit of *Garcinia gummi-gutta* is a valuable product obtained from the rainforests of the Western Ghats of southern India. The dried rind has long been used in the kitchen as a souring agent, and that market continues to exist. Since more recently the rind is also used for the extraction of hydroxy citric acid (HCA), an active ingredient in human weight loss formulations. The sudden appreciation in value of the dried rind because of the newly discovered export markets has greatly enhanced the income of harvesters. The species is dioecious, and pollination is by weevils. The fruit is an important resource for primates, civets, and squirrels. The seeds are dispersed by primates and civets. The structure of harvested populations suggests that fruit collection has little impact on recruitment. However, intense fruit harvest is recent, and if current trends continue, the species and the forest ecosystem might experience grave impacts. The harvest of unripe fruit might affect frugivores dependent on the fruit, and subsequently the dispersal of seeds. The collection of large amounts of firewood from the forest, required to dry the fruit rind, might also have an ecosystem level effect. The open access nature of forests is a hindrance to the regulation of harvest and the implementation of sustainable practices. Changes in the current forest access laws, such as greater tenurial security for local communities, could reconcile the two, often conflicting outcomes—sustainability of ecological processes and the generation of economic benefits.

INTRODUCTION

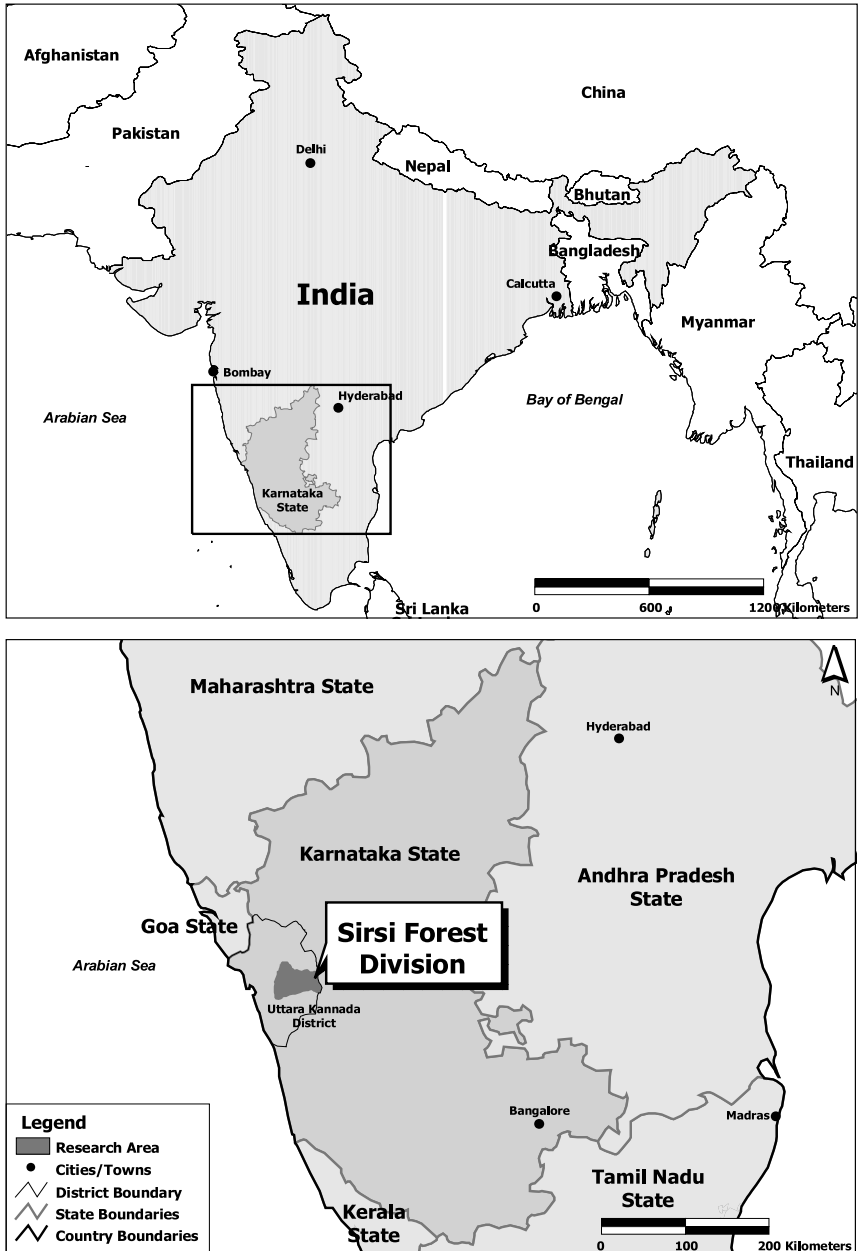
The fruit of the under-story rainforest tree, *Garcinia gummi-gutta* (L.) Robson (Family Guttiferae, *Uppage* in Kannada) has, over the last decade, assumed a major role in the economic landscape of villages in Uttara Kannada district in the Western Ghats of India. The rind of the fruit, traditionally used as a souring agent in food, is currently used for the extraction of a secondary compound that has been found to be effective in human weight loss programmes. The precipitous increase in demand for *G. gummi-gutta* fruits and the open access nature of forest, has however, resulted in destructive harvesting practices. Since *G. gummi-gutta* extraction has a recent history, there is great scope for the formulation and implementation of a sustainable harvesting strategy. In the face of forest degradation by external commercial forces, this economically valuable species could provide the right balance between conservation and resource extraction and give local communities a reason to conserve forests. I explored extraction behaviour and institutional structures that affect the trade and ecology of *G. gummi-gutta*. My results suggest that non-timber forest products (NTFP) policies of the state need to be revised if species like *G. gummi-gutta* are to be harvested in a sustainable manner.

G. gummi-gutta is endemic to the Western Ghats and Sri Lanka (Ramesh and Pascal 1997). It is common in evergreen and lower *shola* forests up to a height of 2000 m (Tissot *et al.* 1994). The species occurs only in forests on humid slopes and the crest-line and has, therefore, a restricted distribution. The species is androdioecious, with male flowers on one plant and hermaphrodite flowers on the other. The flowering season is from February to April, while the fruits ripen in June and are available until August. The fist-sized fruit weighs about 75 g and is a deep yellow when ripe. The fruit is an important resource for frugivores such as *Presbytis entellus* (common langur), *Macaca radiata* (bonnet macaque), and *Paradoxorus hermaphroditus* (palm civet). Frugivores are highly dependent on this resource, as few other tree species fruit at the same time. *Ratufa indica* (giant squirrel) is a seed predator, and local hunters claim that *R. indica* are unusually fat after the rains, having fed on the oil rich seeds of *G. gummi-gutta*. Small rodents are also dependent on this seasonal resource.

The geographic setting

The Western Ghats of South India are a 1,600 km long north-south oriented hill range that traverses the states of Maharashtra, Karnataka, Tamil Nadu, and Kerala. Uttara Kannada, where this study was conducted, is in northern Karnataka (Figure 1). The district of Uttara Kannada was chosen because a large proportion, 79%, of it is under forest. The area under forest is remarkably high for any district in India. The average annual precipitation of 3,500 mm in the production area is largely restricted to the monsoon months of June to October. The average altitude is 620 m. The tropical wet forests along the crest-line and the western slopes, in which *G. gummi-gutta* occurs, have high levels of endemism: 12% for birds and 60% for amphibians (Daniels 1991, 1996).

Figure 1. Map of India and Uttara Kannada district showing Sirsi forest division



Source: ESRI Data and Maps 2002.

Myers (1990) identified the Western Ghats as one of 18 hotspots of global biological diversity. More recently, Myers *et al.* (2000) considered the Western Ghats as one of eight global 'hottest' hotspots.

The vegetation that clothes the hills of the Western Ghats in southern India is a result of long use and habitation by humans, both subsistence use by local communities and intense exploitation by colonial and commercial forces. What remains is a mosaic of landscape elements arrayed in various combinations depending on the predominant land use and geographic location. In the district of Uttara Kannada the forest and cultivation mosaics are finely integrated, and the ensuing matrix provides a prime area for studies of human use of forest resources.

The area selected for the study (henceforth, the production area) is the tropical wet forest in which *G. gummi-gutta* trees occur within the Sirsi forest division. The production area measures 869 km² and falls in five forest ranges within the division. A forest range, with an area of about 250 km², is the basic administration unit of the Forest Department. The current human population size in the production area is 48,418 in 127 villages, with an average household size of 5.4 individuals. Although *G. gummi-gutta* is collected from other forest regions of the Western Ghats, the wet forests of Uttara Kannada account for a large portion of the rind production because of the high density of *G. gummi-gutta* trees there.

Photo 1. Collector carrying a bag of *G. gummi-gutta* fruits (Photo by Nitin D. Rai)



The main agricultural crop in the area is a palm, *Areca catechu*, the nut of which has a long tradition of use in India. The palms are grown in the well-watered and sheltered valleys of the wet coastal and hill tracts. A little over 100 years ago, the then British administration leased out to *Areca* orchard owners 9 ha of surrounding forest for every 1 ha of orchard owned. This allowed farmers to harvest leaf biomass, which was used as mulch for areca trees. These forest patches, which form about 20 percent of the forest area in the district, are referred to as *soppinabetta*, which roughly translates as 'leaf providing forest'. Rice cultivation is the other major land use. However, with the recent increase in the price of the areca nut there has been a trend towards conversion of paddy land to other uses, predominantly the plantation of *Acacia auriculiformis*, a fast growing exotic tree used as fuel and pulpwood.



(*Garcinia gummi-gutta*)

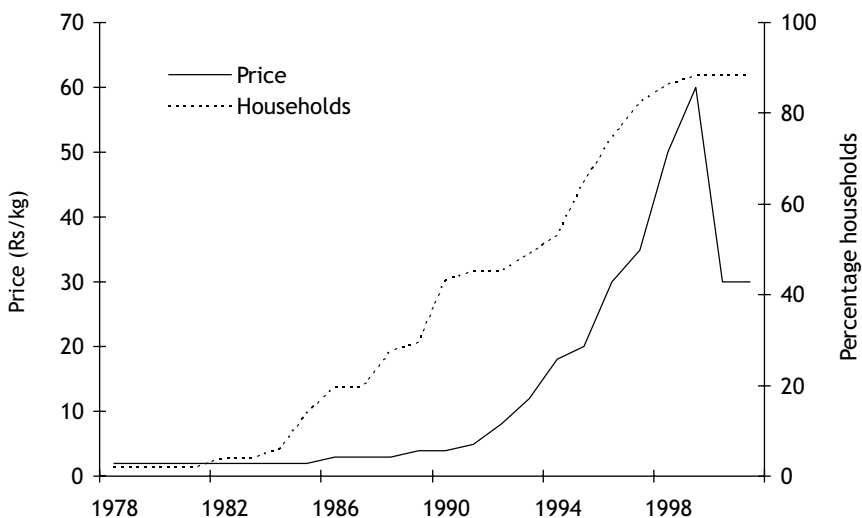
THE PRODUCTION-TO-CONSUMPTION SYSTEM

The Product

The fruit of *G. gummi-gutta* (*uppage*) has a variety of uses in different parts of its range. In Uttara Kannada district, oil extracted from seeds is used in the making of sweets. The process is labour intensive and practised by only a few communities, hence on a small scale. In the state of Kerala, which is south of the production area, the use of *G. gummi-gutta* is more intensive.

The dried rind is used as a souring agent in food. Several households in Kerala therefore grow *G. gummi-gutta* trees in their gardens. The collection of rind in Uttara Kannada commenced in the late 1980s with the realisation that a market for the rind existed in Kerala. However, the price of US\$0.24 per kilogram (US\$1 = Rs42) was not attractive enough to warrant much attention and labour. In the late 1980s, some studies showed that Hydroxy citric acid (HCA), a secondary compound present in the rind of *uppage* fruit, might be effective in weight loss (Sergio 1988). This finding interested drug manufacturers in the United States of America, who touted the drug as a natural solution to obesity (Majeed *et al.* 1994). Drugs such as *Citrin* and *Citrimax* were widely sold over the counter. These nutraceuticals, as drugs derived from natural products have come to be called, were aggressively advertised despite a lack of rigorous studies on their efficacy. As a result of the increased demand for these products in Western markets, the price of *uppage* rind increased rapidly in India. The aggressive advertising campaign did not go undetected by regulatory authorities. The U.S. Food and Drug Administration fined Home Television Network for making unsubstantiated claims regarding the product. A team of researchers from the Roosevelt Obesity Center, New York, however, delivered the biggest blow. The results of the institute's randomised clinical trial showed that the control group, which was given a placebo, lost more weight than the treatment group that was given HCA (Heymsfield *et al.* 1998). As the results of this study were disseminated widely, primarily on the Internet, demand for the product declined. The effect on the price of rind in India was dramatic (Figure 2).

Figure 2. The trend in price paid to *G. gummi-gutta* collectors and in household participation in *G. gummi-gutta* trade (n=51) from 1978 to 2002



The price fell from an average of US\$1.43/kg (Rs60/kg) in 1999 to US\$0.66/kg (Rs28/kg) in 2000, and the price of HCA exported to the US fell from US\$30/kg in 1999 to US\$8.50/kg in 2000. Subsequent warnings by various other agencies regarding the continued usage of the drug have further debilitated demand.

Species ecology

G. gummi-gutta is restricted to the narrow strip of rainforest that occurs on the crest line and western slopes of the Western Ghats (Pascal 1988). In the high canopy forests that occur on deep soils, *G. gummi-gutta* is an understorey tree and occurs at low densities. In stunted forests, which are more prevalent in Uttara Kannada district, the species occurs in the canopy and is more abundant. The density of individuals with diameter at breast height greater than 10 cm varies from 5 trees per hectare in diverse high-canopy forest to 123 trees per hectare in stunted forest. In the southern part of the state, the relative density of *G. gummi-gutta* (the proportion of individuals of a species to the total number of stems in the sample) has been reported to be 0.25% for a wet forest plot in southern Karnataka (Claire Elouard, personal communication) compared to the relative density of 7.2% in Uttara Kannada (N. Rai, unpublished data). This suggests that the density of *G. gummi-gutta* is highly variable along its range.

Male *G. gummi-gutta* trees flower earlier and more profusely than female trees and continue to flower late into the season. Flowers open just before dusk. Male flowers open a little before female flowers. Pollination occurs at dusk and is by weevils. Although female flowers offer no rewards to pollinators, the strong aroma attracts weevils of the genus *Deleromus* to female and male flowers. The earlier anthesis of male flowers ensures that a certain proportion of weevils visit male flowers first and subsequent 'mistake' visits to female flowers ensures the deposition of pollen on the stigmatic surface of female flowers. The small size, smooth surface, and sphericity of the pollen suggests that wind pollination might also occur, but experiments have been unable to confirm this. Many *Garcinia* sp. in South-East Asia are known to be parthenogenic, but pollen exclusion experiments have shown that *G. gummi-gutta* is an outcrosser.

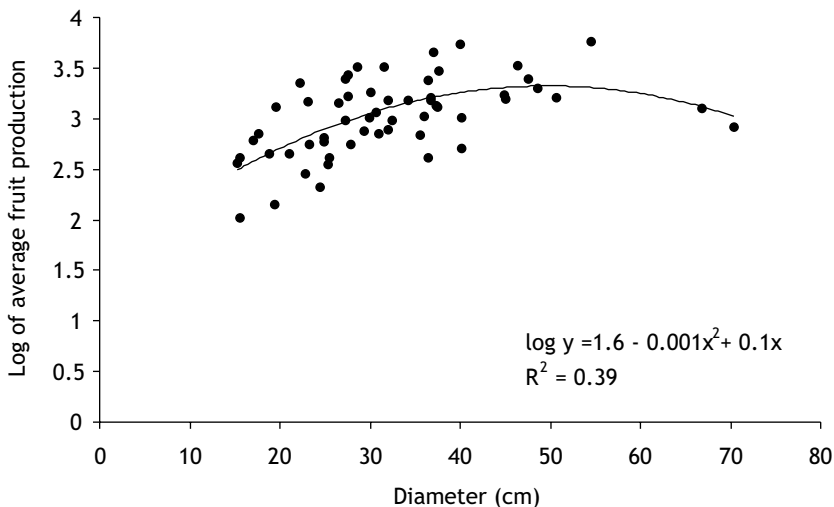
Fruits on a *G. gummi-gutta* tree do not ripen synchronously, with the result that when a few fruits are ripe and ready for harvest, the majority of the fruits is still unripe. This strategy ensures effective fruit dispersal by frugivores. By offering dispersers only a few fruits at a time the tree ensures that all fruits are consumed and few fall to the ground unconsumed—and thus undispersed. After consuming the pulp of ripe fruits, bonnet macaques, palm civets, and common langurs disperse the seeds. While langurs eat the pulp and disperse seeds close to the parent tree, macaques transport seeds farther by carrying them in their cheek pouches. Palm civets ingest the pulp and seeds and egest the seeds whole and undamaged. There may be other dispersers such as bats and the lion tailed macaque, a major frugivore in other parts of the range of *G. gummi-gutta*. Experiments show that seeds dispersed far from the parent

tree have a greater chance of surviving to germination (Rai 2003). Thus seed dispersal is an important mechanism in maintaining the population. The dispersed seed germinates after an eight-month dormancy period. The germination coincides with the advent of the monsoon rains.

The seeds are nutrient rich and weigh approximately 1.14 g with seed coat and 0.54 g without. The seeds are therefore an attractive food resource for insects and rodents. In an experimental study to estimate the amount of seed predation by insects and animals I found that 93% of the 950 seeds provisioned in the forest were eaten. The large seed, however, enables *G. gummi-gutta* to compete with smaller seeded species, as a larger seed provisions the emerging seedling with resources until the seedlings are large enough to tap into soil nutrients.

During dispersal, primates eat only the pulp and discard the rind to the forest floor. The rind is therefore undamaged by frugivores. If the fruit is allowed to ripen on the tree, primates can access the fruit, disperse seeds, and discard the rind for humans to collect later. Thus the rind can be collected with little effect on the ecology of the species. There is a curvilinear relationship between tree size and fruit production (Figure 3). Fruit production increases with tree size up to a diameter of about 60 cm. Trees greater than 60 cm in diameter produce fewer fruits than smaller trees, probably due to senescence.

Figure 3. The relationship between *G. gummi-gutta* fruit yield and tree diameter

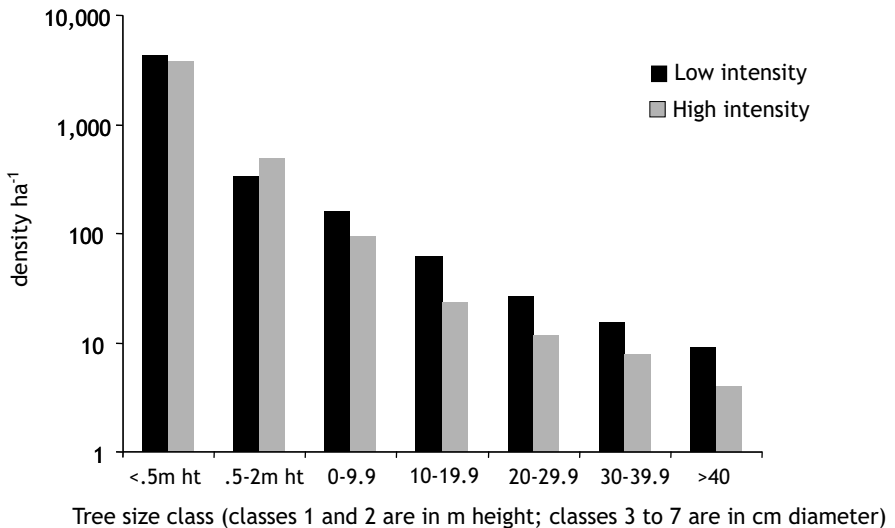


Impact of fruit harvest on species ecology

The hypothesised effect of fruit harvest is a reduction in seedling regeneration. The mediation of such a process could be failure to establish in dense, mixed species stands, aggravated by reduced seed input. Further, damage done to trees during harvest might result in reduced yield and increased tree mortality.

I established several plots in the study area to determine the population structure and seedling abundance. The size class distribution of individuals showed the ‘reverse J’ pattern typical of stable plant populations (Figure 4). The seedling density was high at all sites, and even sites that experienced high harvest intensity showed high seedling numbers. This implies that harvest does not have a large impact on recruitment.

Figure 4. Population structure of *G. gummi-gutta* in low intensity and high intensity harvest sites



I found that seeds that fall under adult trees have a higher mortality rate than dispersed seeds. Seeds falling under the parent tree may be more prone to predation while seeds falling far away may escape predation due to their being in low densities. As a consequence of density dependent mortality of seeds and seedlings, established saplings tend to occur far from adult females. The finding that seeds dispersed far from parents have a higher chance of survival has important implications for management of *G. gummi-gutta*. By manually broadcasting seeds far from parent trees and into low-density stands of *G. gummi-gutta*, the density of *G. gummi-gutta* in a forest could be increased.

The lack of tenurial security and the high price of the rind have resulted in the harvest of unripe and small sized fruits. The apprehension that other collectors might harvest fruits first encourages early harvest. This harvest practice truncates the seed dispersal scenario, with serious ramifications for future recruitment. In areas where harvesters have access security over trees, fruits are harvested after they ripen, a practice that ensures availability of seeds for future propagation and better quality rind. Moreover, rind obtained from ripe fruit attracts a higher price than rind from unripe fruit.

There is also an ecosystem-level effect of the harvest of *G. gummi-gutta* fruit. Once harvested, *G. gummi-gutta* fruits have to be preserved, as they are susceptible to decay. This is accomplished by drying the rind in rudimentary wood fired ovens. Fuel-wood for the ovens is obtained from the surrounding forests. The open ovens are inefficient and this inflates the amount of fuel wood required. I estimated the amount of wood required to dry rind at 10.5 kg of wood per 1 kg of dried rind produced, an estimate that was corroborated by collectors during interviews. Official estimates, however, place it at 25 kg of wood to obtain 1 kg of dried rind (Saibaba *et al.* 1996). The larger question of ecosystem degradation can be addressed by investigating whether this wood extraction is sustainable. The total wood above ground biomass production in the production area has been estimated at 1,100 to 3,100 kg/ha/year (Lele 1993). The amount of dried rind produced per hectare of forest in the production area is 34.5 kg. Using this estimate we get a fuel wood consumption of 362.3 kg/ha/year, well below the wood production from these forests. It is, however, important to note that the spatial distributions of wood collection and fruit harvest are not coincidental: while wood is removed from near habitation, fruits are obtained from farther afield.

Raw material producers and socio-economic context

Human habitation in the Western Ghats can be traced back to the Mesolithic Age, about 5,000 years ago. The land came to be settled between 1000 B.C. and 300 B.C., and the agroforestry practices of today probably commenced about 1,500 years ago (Chandran 1997). Areca (*Areca catechu*), black pepper (*Piper nigrum*), betel leaf (*Piper betle*), cardamom (*Elettaria cardamom*), and banana (*Musa sapientum*) were grown in multicrop orchards. Spices from these plantations have been traded with Arabia and Southeast Asia since the ninth century, and with Europe since the sixteenth (Achaya 1998). Pepper, destined for markets in Europe, came from the orchards and the surrounding forests, where vines were trained on trees.

The population density of Uttara Kannada district is among the lowest in the country. The density in the production area is 54 people per square kilometre. The region saw a drastic decrease in population in the early part of the twentieth century as a result of malaria epidemics. After India's independence from the British in 1947, the region saw a spurt in population growth. Largely because of the high value of the areca nut, the average annual cash income in Uttara Kannada is 1.2 times the national average suggesting that it is not an economically backward area.

The richest and most politically influential section of the village community is the Havyak Brahmin, who introduced the cultivation of the areca palm to the study area about 400 years ago. Other communities, which comprise the economically lower strata of society, are the Kare-Vokkaligas, Goudas, Acharis, Naiks, Siddis, and Kumri-Marathis. These communities are mostly paddy cultivators and farm labourers. Kumri-Marathis were involved in shifting cultivation until a century ago, when the British government stopped the practice. Areca gardens require labour throughout the year, which is provided

by people who migrated from the coast and plains. Over the past few decades, many non-Brahmin communities have established their own areca orchards by converting paddy or forested valleys. Havyak Brahmins have continued to increase their areca holdings by encroaching into adjacent forest and valleys (Nadkarni *et al.* 1989).

The most resource intensive and economically profitable land use of the area is the areca orchard. Ownership of these orchards is largely restricted to Havyak Brahmins. The other communities, mostly tribal, form the labour force for these areca orchards. Access to forests is inequitable. For instance, only the traditional areca growers have access to *soppinabetta*, while the landless and recently established farmers are dependent on the open access forests for all their needs.

In the mid 1980s the price of areca nuts increased appreciably, because of increased domestic demand. This put the rich areca farmers in an even stronger economic position. The effects on the social structure and the agricultural and forested landscape were great. Income disparities between low-income paddy cultivators and high-income areca plantation owners became even more marked. Brahmins, in the role of the clergy, have for centuries laid siege on the affairs of the village, effectively stifling participation of other communities in social discourse. With the increase in earnings from areca, this social hegemony has been augmented with economic clout. Areca growers converted their paddy land to areca gardens in well-watered sites, and to *Acacia auriculiformis* plantations where water availability was low. Adjoining forestland was encroached upon and the process continues to date. As nutrients for areca gardens are derived from the forest, the expansion of areca plantations has put pressure on the remaining forests.

The high value and availability of *G. gummi-gutta* in open access forests and *soppinabetta* has resulted in the participation of all sections of the community in the harvest. However, the relative contribution of *G. gummi-gutta* to the income of individual harvester households varies widely. Areca growers harvest fruit from trees that grow in their *soppinabetta*. The assured access to these trees means that they can follow harvest practices that are ecologically benign and economically beneficial, such as the late harvest of ripe fruit. The fruits in the Reserve forest are available to all sections of the village community who then compete with each other. The income thus generated is variable depending on one's success with harvesting fruit before others. Moreover, the processing of unripe fruits requires more labour and time, and attracts a lower price. Thus *soppinabetta* owners benefit disproportionately from *G. gummi-gutta* fruit harvest and are better positioned, by virtue of their ability to hire labour, to harvest fruits from the reserve forest.

Processing industry

Fruits are either collected from the ground under the canopy of the trees or harvested by climbing them, and are then taken to the homes of the collectors where they are deseeded and the rind is smoke-dried in a wood-fired oven.

The contractor buys rind from the village agent for eventual sale to processing firms. The firms are capital-intensive industrial units with the necessary technology and expertise to extract HCA from the rind for subsequent export. Most of these firms are multiple product units that extract active ingredients from a variety of plant products, and hence are able to survive fluctuations in market and demand of any single product. As the market is recent, processing firms have not yet organised themselves. Processing and export firms are almost always integrated with the result that the trade chain at this end is short and profits high. Firms involved in the extraction of HCA have had previous experience with plant product extraction and export, and hence have been able to transition to HCA extraction with ease. Access to global markets, experience, and existing capital and infrastructure defines who can play a role in the processing and export of HCA.

About 35 processing firms are involved in the extraction of HCA. Sami Chemicals, situated in Bangalore, a subsidiary of Sabinsa Corporation, USA, was the first processor and continues to be the largest. Citing an international drop in demand, Sami did not buy any rind in 2000, with the result that prices fell to the pre-export level of US\$0.59 (Rs25). The price of HCA in the international market was US\$30 to US\$35 in 1994, while in 2000 it dropped to between US\$9 and US\$11. The drop in demand was largely due to findings that HCA was not as efficient in reducing human body weight as previously claimed (Heymsfield *et al.* 1998). Exporters also attributed the drop in prices to a steep increase in the number of processors, the low quality rind due to the harvest of unripe fruit, and the import of fruit from Sri Lanka at cheaper rates.

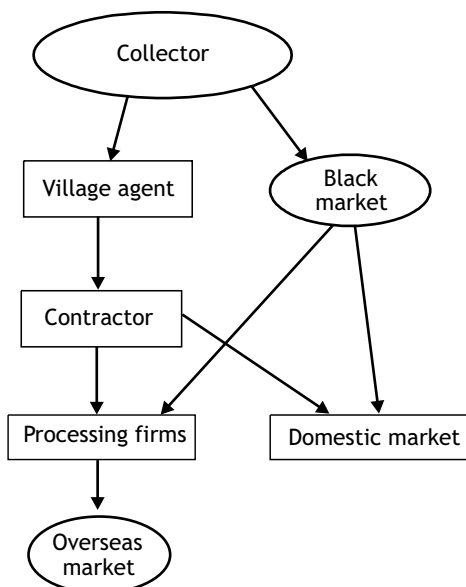
Photo 2. Drying the rind of *G. gummi-gutta* fruit (Photo by Nitin D. Rai)



Trade and marketing

The Forest Department auctions the rights to the harvest and trade of *G. gummi-gutta* biannually. Auctioning of the rights to NTFP trade has been a practice for several decades. Rights are auctioned for each forest range. These range-wise contracts, usually won by affluent business people from outside the area, give individuals, henceforth called contractors, marketing rights to all extracted fruit (Figure 5). Contract regulations require contractors to harvest fruits themselves, effectively marginalizing the local community. The task of collecting *uppage* fruit from vast areas of forest is impossible, even if the contractor employs people for that purpose. The harvesting of the fruit is therefore done by local people. Contractors announce that they will issue passes to local people and suggest a date for the commencement of harvest. Seldom, however, is a pass issued or a date announced.

Figure 5. The *G. gummi-gutta* trade network from harvester to overseas market



The fruit, after drying, is sold to the contractors, who find markets for the rind in larger cities such as Bangalore. The price paid to collectors is determined by the contractor. Great effort is made to ensure that the produce is not purloined to a neighbouring range, the domain of another contractor, where prices may be higher, even if marginally. Tensions therefore run high in the harvest season. This monopolistic marketing regime has spawned a black market in the rind that keeps prices buoyant. The short lease period of two years gives contractors little incentive to ensure that NTFP harvest is conducted with minimum impact to the resource base.

Official estimates of total rind production are not accurate, as contractors rarely disclose exact amounts. Deflating the actual value of the product enables contractors to keep bid rates down at auctions. Table 1 gives the official estimates for the past decade. The two-year periods reflect the duration of contracts. In 1995-97 the Forest Department earned US\$147,900 through its NTFP auctions, 57% of it from *G. gummi-gutta* alone. This illustrates the importance of *G. gummi-gutta* trade in the production area.

Table 1. Quantity collected from Sirsi division over two-year contract periods and harvest value

Period	1989-91	1991-93	1993-95	1995-97	1997-99
Rind (kg)	6,144	6,905	9,929	26,542	77,690
Auction amount (Rs)	9,245	9,155	21,450	84,419	41,667

Source: Gaonkar *et al.* 1998 for 1989-95 data; forest office records for 1995-99 data. My ecological and survey data suggest that actual amounts may be 1.5 times greater than Forest department figures.

The discovery of the weight reduction property of HCA and of overseas markets in 1993 had a dramatic impact on the price and harvest intensity. Under the present harvest regime there is little scope for regulating extraction. An alternate system of NTFP collection and marketing needs to be evolved wherein local people are given more tenurial security over forest land that would ensure their long term interest in the ecological viability of the species and landscape. The current monopolist contractual system and lack of tenurial security encourages rampant harvesting and price schedules not commensurate with actual market demand.

The collectors sell the dried rind to agents operating in the village, who in turn sell it on to the contractor. These agents are actually appointed by the contractor. The agent gets a commission on the basis of weight collected. Apart from the contractor appointed agent, there are other buyers who acquire small quantities of rind in a bid to make some fast money. These traders sell to either the legal contractor or to other traders who operate on the black market. Though contractors make great efforts to curtail this illegal trade there is little support either from villagers, who stand to benefit by selling at higher prices to the black marketers, or from the Forest Department which, having auctioned off the contract, does not interest itself in the actual harvest and trade. The rind is then sold to HCA processing firms, which are mostly situated in far off cities. About 10% of the rind, especially the illegally obtained rind, is sold to traders in the Kerala food market. The processing firms buy after inspecting the quality of the rind. After extraction the HCA is exported directly to overseas customers.

Forest access

In 1878, the British government set up Reserved and Protected forests to assume control over the forests and all resources therein. This arrangement

meant the demise of local control and free access to resources. The Forest Act of 1927 further intensified state control of forests. This act has continued to hold sway over all subsequent forest policies, even those framed after independence in 1947. The Wild Life (Protection) Act of 1972 provided protection for various species and also set the stage for the creation of protected areas such as sanctuaries and national parks. The establishment of protected areas for wildlife conservation is based on the assumption that human habitation is inimical to wildlife, and hence local people are viewed as hurdles to conservation and are seldom involved in conservation planning or implementation. This basic premise has ruled over most forest policies framed in the country.

It is beneficial to understand the forest access regime in place in the production area. The history of access rights in the district is unique. During the last century the then British government passed a series of land laws that continue to affect, to this day, forest access by local communities. The three tenurial regimes that exist in the forests are 'reserve' forest, 'minor' forest, and *soppinabetta*. Though all forest is owned by the state the different classifications come under different use regimes. Reserved forests are the largest of the three categories and the state has the greatest control over these lands. While local populations are allowed to harvest fuel wood, graze cattle and harvest NTFP, these privileges could be withdrawn at any time. Minor forests comprise forest that was awarded to villages in the early 1900s in the ratio of approximately 2 acres of land for every head of cattle. These lands are used for the extraction of fuel wood, fodder, leaf manure and NTFP. After decades of intense use, the condition of these forests is very poor.

The third tenurial regime, *soppinabetta*, is more exclusive. This status was awarded to areca orchards at a ratio of 9 ha of forest for 1 ha of areca. The collection of fuel wood, fodder and NTFP, lopping of trees, and some timber for personal use is allowed. The farmer maintains control over use and management of these forests. Thus farmers have control over all *G. gummi-gutta* trees and the harvest on their *soppinabettas*. The forest policies of the last century continue to dictate the resource access regime of today, and this has a bearing on the extraction of *G. gummi-gutta* fruits. Reserve and minor forests face the greatest pressures, while *soppinabetta* is not affected by the intense harvest. However, the condition of *soppinabetta* forests, whose main role is to provide leaf litter, is far from what can be considered a functional forest.

In what has been touted as a major breakthrough for local governance, the Extension to Scheduled Areas Act was enacted in 1997. It confers rights of collection of NTFP to tribal *panchayats* (village governments). However, it is valid only in designated tribal areas, even though a large number of tribal people live outside the scheduled areas. A committee set up by the Ministry of Environment and Forests in 1998 suggested that only usufructuary rights be extended to all *panchayats*, tribal and nontribal, excluding those in protected areas. This is a climb down from what was proposed for the tribal areas, a slightly positive move for nontribal areas, and a real setback for inhabitants of protected areas.

NTFP trade policy

The Karnataka State Forest Policy document (Karnataka Forest Department 1999) outlined the following policy objectives for NTFP use and management in natural forests: a) ensure the sustainable use of forest resources; b) give local collectors first rights on forest produce and manage the resource through local bodies (such as NTFP societies); c) in tribal areas, trade NTFP through tribal co-operatives; and d) motivate and train forest dependent communities in the protection, improvement, harvesting and disposal of NTFP, including nondestructive collection, processing and marketing of value added products.

The government NTFP policy states that the state will explore the possibility of providing seed money or funding to establish societies. In a report prepared for the state forest department, Gaonkar *et al.* (1998) suggest that the current contractual system be replaced by a NTFP society that undertakes the trading of the product directly, thus eschewing the contractor and earning higher rewards for collectors' efforts. This, they propose, should be combined with key policy changes such as a reduction in sales tax, forest development tax and income tax, and the payment of a small royalty to the Forest Department. The current equitable sharing of profits between Village Forest Councils and the Forest Department is a disincentive to collectors. The report states that revenue lost to the Forest Department as a result of these changes will not impact its functioning since revenue from NTFP in the production area accounts for less than 1% of total revenue.

No clear NTFP policy exists at the national level. The National Forest Policy 1988 was aimed at 'conserving the natural heritage of the country by preserving the remaining natural forests with the variety of flora and fauna, which represent the remarkable biological diversity and genetic resources of the country'. The policy, however, says little about the people who live in and around protected areas. The establishment of a protected area is a great hindrance to resource use by local communities.

TRENDS AND ISSUES—DEVELOPMENT AND CONSERVATION LESSONS

The economics of unsustainable practices

Several observers (Saibaba *et al.* 1996; Gaonkar *et al.* 1998) have noted that trees are being extensively damaged during collection and even hacked down to facilitate collection. I observed the cutting of lateral limbs of *uppage* trees during harvest in heavily used areas. Out of the six sites I sampled, I observed tree damage at two sites. Of the 187 trees observed at these two sites, some branches were cut on 57% of trees, all branches on 8%, and 11 trees (6%) were cut at the trunk at a height of 1 m with the bole of the tree lying near the stump. Because of the short history of fruit harvest such extreme impacts are currently confined to the forest patches close to high-density villages below the Western Ghats from where migrant harvesters originate. An increase in the price of *uppage* could result in these impacts rapidly spreading to larger areas, if local villagers are not given more control and access rights to *uppage* trees.

In the absence of local control over harvesting, *G. gummi-gutta* might go the way of species such as nutmeg (*Myristica malabaricum*), which was overharvested to the point where the government banned the harvest of fruits (Saxena *et al.* 1997).

In a report prepared by the Forest Department, Saibaba *et al.* (1996) suggested that the firewood used for the drying of *G. gummi-gutta* rind was a huge loss to the Forest Department. They estimated the loss in revenue at US\$22,023, or three times the revenue earned from the sale of contracts for *G. gummi-gutta* trade. They concluded that the sale of *uppage* fruits by tender sales should be banned in order to conserve the limited stocks available and to prevent further damage to the forest. That a mere loss of revenue, and a hypothesised reduction in resource base due to overharvesting, can be cited as reason enough for the cessation of all harvest is evocative of the disregard shown by the government for local use of the forest and the hegemonic control the state has over the forest and all resources therein.

The harvest of unripe fruits is a threat to sustainable harvest, and if markets refused to accept unripe rind then the harvest might become more sustainable. This change might force communities to evolve modes of resource partitioning. In some areas with low population density, households have informally partitioned the forest based on such natural boundaries as ridgelines, and harvest fruit from within their respective patches. These informal arrangements greatly change harvest behaviour. Long after collectors in other areas have exhausted their resources, having prematurely harvested all fruit, households with informal partitioning arrangements continue to harvest ripe fruit.

Recent trends suggest that the *G. gummi-gutta* case might be waning in importance. Even when prices declined precipitously in 2000, the harvest of unripe fruit continued despite warnings that this would affect the quality of the product, and both collectors and contractors continued to deal in unripe fruit. The rind that reached processors had lower proportions of HCA than economically viable, with the result that when the option of getting rind from other sources was available, processors availed themselves of it (Suresh Kumar, Sami Chemicals, Bangalore personal communication). Rind was then imported from Sri Lanka with governmental approval. In addition, there was a drop in demand for HCA because of the collapse of the export market. However, the domestic market in Kerala state, although not as lucrative as the export market, has been steadier. The ecological fallout of this changing scenario is positive, since competition for resources may be lower and thus harvesting may become more benign. During interviews, several harvesters spoke about their hope that prices would decrease resulting in a reduction in competition and resource abuse.

Are harvesting practices detrimental to the long-term survival of *G. gummi-gutta*?

Data on regeneration and population structure show that harvested populations are not experiencing depletion in numbers that threaten the population. I used a stage structured matrix model to determine the population growth

rate of a harvested *G. gummi-gutta* population and found that the population was not declining (Rai 2003). Ratsirarson *et al.* (1996) used stage structured demographic models to predict sustainable yields for the palm *Neodypsis decaryi* in Madagascar and estimated that 95% of the seeds could be harvested without any impact on population growth rates. During *G. gummi-gutta* fruit harvest a portion of the fruit is left behind because of difficulty in accessing remote branches, and my estimates show that about 5% to 10% of the fruits remain on the tree. Collectors, mostly women, scour the forest floor long after fruits are harvested from trees to collect rind from the fruits that were left on the trees. One collector claimed he made twice the daily labour rate per day by collecting fallen rind late in the season. If fruits are left on the tree to ripen and the rind that falls is then gathered from the base of trees, all rind can be picked with virtually no effect on the ecology of the species or dependent frugivores. However, there is no information on the role of the rind in the forest ecosystem, and what effect large scale removal of rind might have on the forest.

Drying the rind

One major concern is the process employed to dry rind. Fuel wood is obtained from the vicinity of the household or village, areas that are already impacted by biomass removal. Wood extraction at the scale seen in the production area may be sustainable since that harvest is less than the estimated annual wood biomass increment. The area from which wood is extracted is small, however, and thus local effects may be high. One solution may be to install more efficient dryers that use a fraction of the wood used now. Since such dryers may well be too expensive for a small harvester, villages could install one or two dryers in convenient locations, but ground realities may discourage people from using communal dryers. The rind takes anywhere from 5 to 7 hours to dry. The logistics of waiting by the dryer as the rind dries, the partitioning of space and time, and the distance to dryers may discourage their continued use. Another solution might be the establishment of a village co-operative, where profits are distributed based on the amount of rind collected by each harvester. The quantity of fresh fruit obtained by each harvester could be recorded, and the drying carried out collectively by members of the co-operative. The profits from the sale of the dried rind could then be proportionally disbursed based on the quantities collected.

Conclusion

G. gummi-gutta has played a major, although short-lived, role in the economic landscape of the production area. Low-income farmers have benefited from the sale of the product. The skewed distribution of resources within the village, whereby richer farmers access a larger portion of the rewards from *G. gummi-gutta* harvest, can only be addressed through the establishment of local, democratic institutions. The continued trade in *G. gummi-gutta* will benefit the community as a whole, but to ensure ecological sustainability and

equitable resource distribution, measures such as resource monitoring and changes in the trade system have to be made. If the current harvest and trade regime were to continue, the resource and the forest may be adversely affected. Assistance from the state with storing, transporting, and marketing the product is needed. Recent government policy suggests that the state is interested in establishing and sustaining community forest initiatives and co-operatives. This will go a long way in helping the ecological and economic welfare of the community.

If extracted in a sustainable manner, NTFPs can be economically beneficial to local communities and aid in the maintenance of biotic integrity of forests (Peters *et al.* 1989; Peters 1994). *G. gummi-gutta* is a good example of such an NTFP. If rights of harvest and trade are given to local communities, there is hope that institutional structures may evolve to manage the resource. The nature of the resource is such that by merely following a regime of delayed harvest, both economic and ecological outcomes can be simultaneously improved, as both the seed dispersal scenario and markets prefer ripe fruit. The beneficiaries of trade in *G. gummi-gutta* rind are numerous. Most deserving are the harvesters, especially the landless and small rice farmers, for whom the additional income is crucial. The decrease in the price of the product adversely affected this community of harvesters, who are dependent on the resource. A change is therefore required in the access and trade regime to one where control over the resource is local and a larger portion of profits from the sale of the resource is distributed amongst the harvesters rather than amongst a handful of traders in the cities. Control over resources will mean unprecedented empowerment of forest users and the opportunity for ecological monitoring and management by the local community.

ENDNOTES

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Chapter 3

Cardamom (*Amomum* spp.) in Lao PDR: the hazardous future of an agroforest system product

*Catherine Aubertin*¹

Common names	Part of the resource used	Management	Degree of transformation	Scale of trade	Geographic range
Cardamom, Makneng	Fruit	Managed/ Cultivated	High	International	Large

OVERVIEW

Medicinal cardamom spontaneously sprouts anywhere in Lao People's Democratic Republic (PDR) under the cover of the forest canopy, at elevations upwards of 700 m. Wild cardamom gathering and domesticated cardamom planting take place in traditional agroforestry systems based on shifting agriculture. Cardamom is a non-timber forest product for which the harvesting process tends not only to maintain, but even to augment, yields without any damage to the local natural environment. Cardamom is exported to China and Thailand, where demand is high as it has been for more than a millennium. Curiously, cardamom is not used in the developed herbal medicine of Lao PDR. Cardamom offers the main cash revenue for upland farmers and is second to coffee in value as an agricultural export product. In the government's struggle to reduce or eradicate the practice of slash-and-burn with land allocation policies, traditional cardamom production is now threatened. Furthermore, the land allocation policies result in declining rice yields, thus increasing cash needs of farmers and stimulating both the harvest of wild cardamom from natural forests and intensified production of standardised varieties of cardamom in monocultures. The preference for imported standardised varieties in development projects seems to be leading to imported standardised cultivars being generally favoured over local varieties.

INTRODUCTION

Cardamom, of which there are several species in the genus *Amomum*, is an herbaceous, perennial plant within the family Zingiberaceae (the ginger). It attains a height of one to two meters and is commonly found in humid forest environments in certain parts of Southeast Asia. The seeds of medicinal cardamom (*Amomum* spp.) are highly sought after in Lao People's Democratic Republic (PDR) for traditional Chinese medicine, whereas edible cardamom (*Elettaria cardamomum*), which is valued world-wide as a cooking spice, particularly from the Middle East to India, is not found or known in Lao PDR. Medicinal cardamom is one of those rare forest products of Lao PDR that are produced in sufficient tonnage to easily enter export markets. All production is exported—indeed, there is no domestic consumption—primarily to Thailand and China. The export of Lao medicinal cardamom to China dates back perhaps a millennium. Even though official statistics probably reflect only one quarter to one half of the actual export volume of medicinal cardamom, it is still second to coffee in value as an agricultural export product.

Completely wild cardamom is still found in secondary forests in Lao PDR, but for the last 50 years, certainly, it has been domesticated (i.e., intentionally planted and cultivated), both in the forest and in newly established *ray*² (swidden). More recently cardamom has also been cultivated in village plantations, exclusively using cultivars imported from China. In 1997, it was estimated that no more than one third of cardamom production originated from plantations, the remainder being harvested from wild, naturally occurring forest populations. As rural development plantings are becoming productive, it is likely that in 2002 two thirds of the harvest came from plantations.

As a premier, export-oriented non-timber forest product (NTFP) Lao cardamom faces no marketing problems. Light in weight, greedy neither for labour nor for input (investment and chemicals) and environmentally friendly in its exploitation, cardamom has recently been touted as a 'miracle species' across a host of rural development projects. Nevertheless cardamom development in Lao PDR seems to be threatened by land use and tenure policies.

Medicinal cardamom allows us to study the relationship between agroforestry activities and the necessities of forest conservation, as well as the process of domesticating formerly wild-gathered NTFPs. In Lao PDR, such a study allows us to broach the crucial questions of land allocation and land use policies including forest regulatory zoning. Add the 'struggle' against the continued practice of slash-and-burn, and we can examine the aggregate impact of all these factors on the traditional way of life of upland populations.

Research area

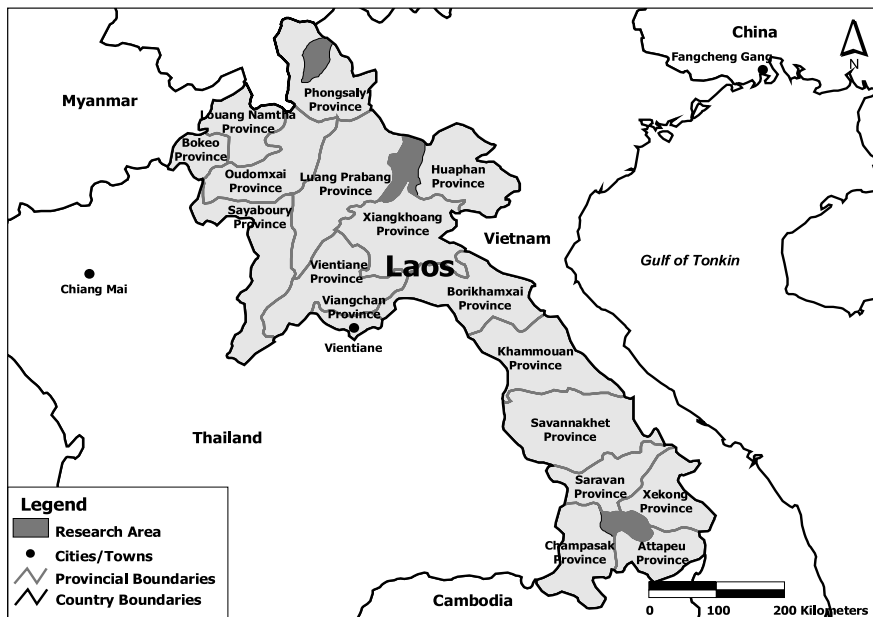
Fieldwork on the production of cardamom was undertaken at three sites (Figure 1):

- in the north-east in the *tasseng* (an old, smaller administrative area) of Muang Peu, Viengthong district of Huaphan province, a gathering-only site in a remote mountain area on the Vietnamese border, where the

main ethnic groups—the Tai dai, Tai deng, Khamou and Hmong—practice shifting agriculture and where the population density is less than 3 people per km²;

- in the far north in Phongsaly district, Phongsaly province, a mountainous area close to the Chinese border where gathering sites—and more recently plantations of imported cultivars—have to compete with shifting agriculture and opium eradication projects and where the population density is about 15 people per km²; and
- in the south on the Bolovens Plateau in Champassak province, a dynamic and central coffee production area integrated into the international market and the site of long-time domestication of cardamom, where the main ethnic group is the Lao Loum and the population density is about 50 people per km², high for Lao PDR.

Figure 1. Map of the study site



Source: ESRI Data and Maps 2002.

THE PRODUCTION-TO-CONSUMPTION SYSTEM

Cardamom

Cardamom can be found throughout Lao PDR at elevations upwards of 700 m. It sprouts spontaneously under cover of the forest canopy. The botanical literature contains only superficial studies on wild cardamom. In the field, the basic distinction is made between green cardamom, *Amomum ovoidum*,

which has an ovoid seed capsule and small spines or thorns, and cardamom proper, which is less widely distributed and smaller and has a round, slightly wrinkled capsule containing red seeds. There also exists a 'black cardamom' in the northern region of Phongsaly, and in the south of the country another species occurs, *Amomum kravanh*, which is common in Cambodia.



(*Amomum villosum*)

Cultivated cardamom, with red fruits borne in a smaller capsule, has been encountered for the past 40 years on the Bolovens Plateau (Photo 1). It is closer to the so-called 'Chinese cardamom' (*Amomum villosum* var. *xanthoides*), a cultivar recently imported for rural development projects from the Xishangbanna Botanical Garden in southern China, about 60 km from the Lao border. The fruit may vary a lot from village to village, however, and identification remains difficult (Table 1).

All species of cardamom are happiest in secondary forests, near watercourses, at altitudes between 700 m and 1400 m. Cardamom demands consistent rainfall of about 100 days of precipitation annually and a highly humid environment. Notwithstanding the full sunlight in new *ray* fields, as on the Bolovens Plateau, cardamom prefers shady sites. The ideal temperature for cardamom is around 19°C to 22°C, and the plant does not tolerate temperatures below 12°C. The best soils for cardamom are those rich in organic material with a pH of between 5 and 7, fairly acidic to neutral (Zhou Shouqing 1993; Xishangbanna Tropical Botanical Garden 1999).

Photo 1. Cardamom on Bolovens plateau (Photo by J. Pollini)**Table 1.** Cardamom in two villages on the Bolovens Plateau

Conditions	Ban Houaychiate, Pakxong	Ban Kouangsi, Bachieng
Altitude	1,000 m	350 m
Relative humidity	80-90%	60-70%
Mean temperature	27 °C	25 °C
Average rainfall	3,000-4,000 mm/year	2,000-3,000 mm/year
Size and appearance of cardamom fruit	Big, elongated, hairy, thick-skinned	Small, round, short hairs, thin-skinned
Dry weight of one <i>touque</i> * of fruits	1.0-1.2 kg	1.5 kg
Quantity of capsules per <i>touque</i>	visibly more	visibly fewer

*One *touque* is equal to about 20 litres.

Source: Aubertin 1998.

The mature plant attains a height of 1.5 m to 2 m, with a foliage breadth of about 1 m. Its elongated, pointed leaves range in length from 15 cm to 40 cm and have a width of about 3 cm. The coveted seeds are about 3 mm in diameter, enclosed in an egg-shaped capsule about 2 cm in diameter. These are borne on stolons several centimetres below the soil surface. The roots are relatively shallow and rarely extend below a depth of 10 cm. Stoloniferous propagation occurs naturally. Certain insects are recognised as pollinators of cardamom species including *Apiscerana indica*, *A. dorsati* and *Nomia strigate*. The plant flowers from April to June.

One hectare of wild cardamom can yield about 50 kg of whole (i.e., in capsules) dried fruits. This is of course an extrapolation since under natural conditions there could never be a full hectare of forest entirely occupied by wild cardamom. A single plant yields approximately 50 capsules, amounting to about 10 g to 50 g per year. Under plantation conditions, the yield may attain 200 kg/ha/year, and Chinese farmers have obtained yields as high as 750 kg/ha/year. The feasibility of new cardamom cultivation projects is ordinarily predicated on the basis of expected yields around 100 kg/ha/year.

Cultivated cardamom plants produce their first fruits in their third year, and annually thereafter. The yield generally increases until somewhere between the 8th and 10th years, when normally a figure of 100 kg/ha/year is achieved, and then begins to diminish. It has ordinarily been the practice of cardamom cultivators to uproot or destroy plants upon reaching their 15th year and to replant the site with new cultivars, not necessarily including cardamom. This practice follows the traditional rhythm of long-fallow slash-and-burn. On the Bolovens Plateau within secondary forests, however, it is common to see cardamom plants that were planted as long as 40 years ago, but which are still yielding in the order of 20 kg/ha/year.

Gathering

Cardamom is harvested at the end of the rainy season, during the break just prior to the rice harvest (a period of labour availability), if weeding of cleared lands is finished. The entire village may participate in the harvest, which is done at the family level; for example, some 70% of the families in Muang Peu and some 30% of the families in Phongsaly are involved in picking capsules. In Lao PDR cardamom gathering is primarily the work of males, and in Muang Peu about 60% of the harvesters were men or boys. There are no special rites or ceremonies associated with the cardamom harvest.

In the less populated regions cardamom gathering takes place over two to four days per year. According to the time available to each individual and to the likelihood of encountering the best plants, villagers devote between half an hour and eight hours per day to seed-gathering. An individual harvester may amass, on average, between 2 kg and 3 kg per day, for a seasonal total of between 5 kg and 20 kg (Schlemmer 1999).

Often it is the village chief who signals that the time for harvesting cardamom has arrived and who organises the harvesting groups, but sometimes villagers also gather cardamom in a more dispersed manner because 'there isn't enough cardamom for everybody'. In another village, however, this same rationale may be given for a more collective mode of cardamom gathering.

Recently we observed at our three field sites a tendency towards premature harvesting of cardamom to avoid the possibility of neighbouring villages helping themselves first, although prematurely harvested fruits are smaller and of lower quality. Normally, villagers have customary harvesting rights within the village forest, but a new system of forest classification nominally prohibits harvesting within conservation zones, which are no longer under anyone's accountability or responsibility.

If the cardamom harvest is done carefully by using a knife to detach mature fruits, leaving in place undeveloped fruits and refrain from uprooting the plant, it remains uninjured and its capacity to produce new shoots is actually promoted. Harvesting and some rough weeding around each plant are the only conservation measures ordinarily taken. Thus cardamom is one of those rare species of NTFPs for which the harvesting process tends not only to maintain, but to augment the yield. Cardamom is also considered to be an excellent cover crop in terms of soil erosion protection and for its ability to choke out undesirable plant growth.

Culture

Cardamom culture requires neither particular onerous input nor much labour. The land simply needs to be prepared and then weeded from time to time. When the cardamom culture is established within *ray*, i.e., at the same time as the land is prepared for upland rice and various other vegetables on a parcel of land that has been slashed and burned, it is difficult to distinguish the specific labour requirements of cardamom. Studies show a 30 man-days/ha/year requirement for an average yield of around 30 kg/ha/year on the Bolovens Plateau. For cardamom under monoculture plantations, as promoted in development projects, approximately 100 man-days/ha/year are required (Table 2).

Table 2. Labour requirements for a cardamom plantation project in Phongsaly

	Man-days/ha/year
Planting seedlings	10
Weeding	60
Harvesting	30
Drying (with dryer)	1
Total	101

Source: Pelliard and Ducourtieux 2000.

For the cardamom projects in Phongsaly (i.e., in cardamom plantations established from the Chinese varieties) the Xishangbanna Botanical Garden in Yunnan supplied the initial cultivars, but thereafter the plantations used new shoots for extending the project. The Chinese varieties are considered less tolerant of full sun than the varieties planted on the Bolovens plateau. The plantation density norm is one plant per square meter, i.e., about 10,000 plants per hectare.

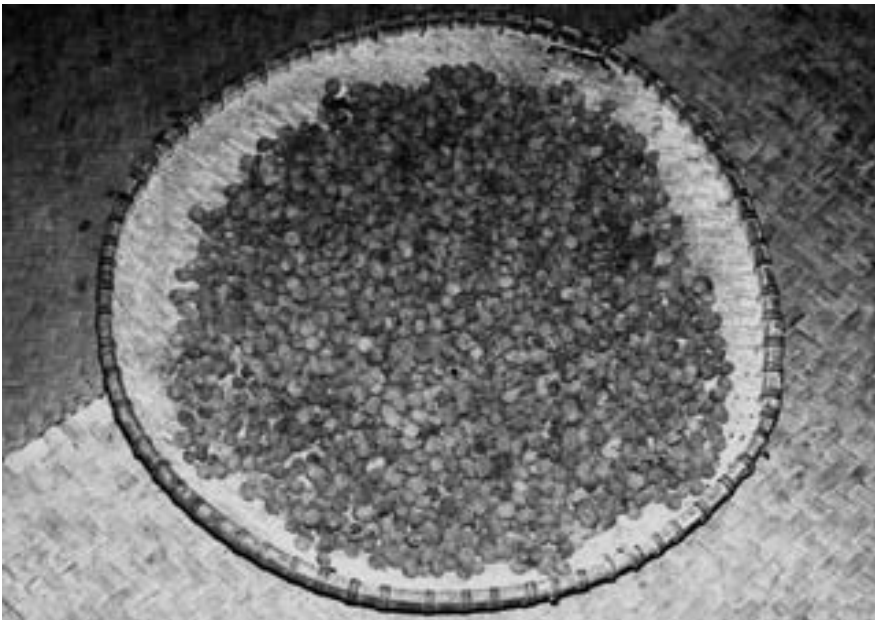
Propagation is either by cuttings or by planting seeds. For cuttings, a shoot about 20 cm in length, including the root, is prepared. Cuttings are planted in 1.5 m x 1.5 m spacing, but if the farmer grows rice on the *ray*, the spacing will be as wide as 4 m x 4 m. For seeds, a good quality cluster rich in mature fruits is chosen. The farmer removes the seed covers and lets the seeds dry for two to three days, then with one dry hand squeezes the fruit in

order to separate it from the seeds. The seed is planted in a plot previously prepared and sheltered from the sun. It is imperative to establish the nursery within the week following the harvest or successful germination is diminished. In fact the germination success rate declines with each additional day until it fails completely about a month after the seed has been gathered. If shoots are planted, fruits can be harvested after only three years compared to five years required for plants established from seed.

Processing

Gathering cardamom is undertaken from August to September, at the end of the rainy season but before harvesting the paddy. This arrangement allows for the adequate drying of seed capsules that is necessary for their preservation. Drying occurs in the village on the ground or on a tarpaulin in the sun, or the product is smoked on a metal sheet or on a bamboo platform. It takes 15 days of sun-drying to achieve satisfactory dryness. As drying is done during the rainy season, peasants consider it generally preferable to smoke the product. It still requires five to seven days for smoke-drying 50 kg of seed capsules. The ratio of fresh weight to dry weight is about 5:1; thus 5 kg of harvested capsules will yield 1 kg of dry capsules (Photo 2).

Photo 2. Dry red cardamom capsules (Photo by J. Pollini)



Every family that participates in the harvest will undertake their own drying. Apart from drying and bagging—and exceptionally the removal of the outer capsules—there is no local processing within Lao PDR. The manufacture of cardamom essential oil is done entirely in the importing countries.

Marketing

Producers market cardamom primarily in the form of dried capsules, although Korea buys a small quantity of decorticated cardamom seeds. Marketing follows immediately after the cardamom harvest during the two-month period at the close of the rainy season, which represents both a break in labour demand and a time at which producers are most vulnerable economically while cardamom capsules are most abundant. There exists little real possibility of storage to hedge against short-term price declines as the supply peaks (Saint-Pierre 1998). We did not observe any apparent difference in market price in relation to product quality.

The buying price for whole dried capsules varies between US\$1³ per kilogram around Huaphan in the north (far from communications and transport routes) to about US\$3 per kilogram for cultivated cardamom originating in less remote regions, as offered by middlemen who come directly to the villages. There are many such middlemen and competition between them tends to keep prices steady. In general, it is the village women who negotiate cardamom sales. The middlemen sell to wholesalers, on whom they are dependent. Wholesalers sort the cardamom fruits, dry them for another two or three days and rebag them into 60 kg sacks. The export price hovers around US\$5 per kilogram. On the Bolovens Plateau, the marketing chain for cardamom is essentially identical with that for coffee. The Chinese market has a high demand for cardamom and absorbs more than 1,500 tonnes annually from Lao PDR as well as another 1,000 tonnes produced domestically.

The system of quotas and trade licenses is difficult to understand, as regulations are applied most opaquely and in a highly diverse manner from province to province, and even district to district. It appears that the administration gives preferential licenses to buyers who provide certain financial incentives. As are all forest products, cardamom is nominally subject to a special excise tax of 3% for exported 'forest resources', even if the cardamom originates from plantations. Monopoly rights for marketing, and sometimes even producing, cardamom are handed out by the Lao provincial administration.

For upland families, the collection of cardamom is one of the many contributions to the ensemble of products exploited from slash-and-burn sites and secondary forests. The logic of its harvesting is contingent upon the valuation of labour. Trade does not so much depend on the availability of cardamom, but rather on the labour required for harvesting it. In forested areas the peasant economy is essentially a subsistence economy. The sale of cardamom and buffaloes is often the only actual source of cash. Such remuneration is hardly negligible, amounting to between US\$3 and US\$20, or 10% to 40% of total annual household cash income. While the harvesting of cardamom is done by a group, the resulting profit is generally paid to an individual.

Nevertheless, that income may sometimes be turned over, in whole or in part, to the village. In the region around Viengthong revenue flow from forest products often comprises the sole source of income for the village treasury.

Under plantation conditions, based upon an estimated land parcel size of 0.1 hectare per family leading to an annual production of about 10 kg of fruits, our study indicates a typical income of about US\$50 per year. Nevertheless, the quantities of land and labour allocated to cardamom culture are subordinate, in the Bolovens, to those devoted to coffee and rice, and in Phongsaly, subordinate also to opium growing.

Usages and exportation

In its processed state as an essential oil cardamom serves numerous purposes in traditional Chinese herbal medicine. Alone or with other ingredients it is regarded as a curative for stomach pains and digestive disorders. While we sometimes find such medicines imported from China in the form of vials or gelatine pills of cardamom oil in Lao markets, for the most part the cultivators and gatherers of raw cardamom have little knowledge of what eventually becomes of their unprocessed product. Interestingly, cardamom does not figure in the highly developed herbal medicine of Lao PDR.

Lao cardamom production is exported in its entirety to China and Thailand primarily, but also to Vietnam, Myanmar and Korea. Export statistics are unreliable, however, to a fantastic degree. It appears that the authorities at the national level have no interest in establishing a credible database on cardamom exports, though provincial authorities gather a lot of information. Accordingly, while the countrywide exports of cardamom probably come close to 2,000 tonnes annually, the official customs records indicate a total of no more than 500 tonnes. The statistics from the Vientiane Chamber of Commerce presented in Table 3 may allow us to grasp a trend.

Table 3. Cardamom exports, 1995-1998

Year	1995	1996	1997	1998
Quantity (kg)	140,142	171,453	571,433	424,347
Value (US\$)	630,639	829,611	3,333,359	2,376,343
Price per kg (US\$)	4.50	4.84	5.83	5.60

Source: Adapted from Foppes and Ketphanh 1998.

TRENDS AND ISSUES—DEVELOPMENT AND CONSERVATION LESSONS

Cardamom is a plant associated with the traditional practice of slash-and-burn and its corollary, long-rotation fallow. It is characteristic of the plant community of secondary forests in Lao PDR. Cardamom gathering, no less than its culture, poses issues directly related to tenure and land use in the contexts of land

allocation and the definition of forest zoning, as are presently underway in Lao PDR. The study of cardamom production presents questions regarding the ownership both of the plants themselves and of the land on which they grow; and moreover, questions regarding agricultural and environmental policies that bear directly on upland populations.

Cardamom: a plant threatened by land use and tenure policies

The government's land use and land tenure policies, presented to the donor community as a token of its commitment both to environmental protection and to the emergence of private property, have amounted to a death sentence for a widely practised traditional agroforestry system. Land tenure formalisation individualises usufruct over fixed and definitive land parcels, thereby putting an end to the traditional upland villages and a flexible collective land management system.

The recent governmental strategy for the agricultural sector shows a clear distinction between 'modernising lowlands' and 'backward uplands', leaving the former freely subject to market forces but declaring the latter as duly within the scope of public intervention (MAF 1999). Within that scheme cardamom hardly plays any role at all. The agroforestry system practised by Lao upland farmers is ignored and its key element of slash-and-burn unreservedly condemned in order to meet the twofold objective of modern agriculture (i.e., irrigated rice fields) on the plains and preservation of forests in the mountainous region by supposedly protecting it from 'ethnic minorities'. Any economic development model so requiring sedentary and 'industrialised' agriculture is clearly maladapted to most upland ecosystems (Aubertin 2001). These interventions are actualised by a system of forest zoning, by the creation of National Biodiversity Conservation Areas (NBCA), by favouring private ownership, by prohibiting the practice of slash-and-burn and by the displacement of populations—i.e., ethnic minority highlanders—downslope towards the plains (Goudineau 1997). Such solutions seem to effectively put into question the very survival of these peoples.

Accordingly, 20 NBCA now cover more than 30,000 km² of Lao PDR, amounting to some 12.4% of its land surface. In the Viengthong district, two thirds of the land area is classified under some category of forest reserve. Nation-wide, under present forestry law, 8 million ha of land is classified as either Conservation Forest or Protection Forest. Thus, over 70% of the forested areas of Lao PDR are ascribed today under one or another categories of protected forest.

Otherwise, the process of land allocation goes on. It consists of distributing three land parcels per family for rain-fed or dry rice. With the former rotation calendar spanning 15 years, a farmer would typically have lands in every stage of regeneration, from new *ray* to well-forested and ready for initiating the next slash-and-burn cycle. With the present 'three parcels per family' rule, but without technical improvements in rice culture, we see both a decrease in soil fertility and an increase in the labour required for weeding (Jouve 1999). This new system is incompatible with the lifecycle of certain key NTFPs such

as cardamom and *benzoins*, which would spontaneously sprout on fallow fields and be productive from the 4th through 15th year following the rice harvest.

The system of forest zoning and the establishment of reserved and conservation forests and NBCA has not yet been translated into rights permitting upland communities both to exploit and to defend their protected zones; nor do the regulations recognise the previously practised agroforestry activities (Koning 2000). Peasants no longer have the right to collect NTFPs in protected forests. Numerous witnesses have attested that certain lands long since characterised by agroforestry practices have not figured at all in the new land allocation process. In this way, the cardamom-bearing forests themselves are now classified as conservation zones and thenceforth put off-limits to cardamom gathering. Even certain projects aimed at cultivating cardamom in older degraded forests have not moved forward after colliding with the prohibition of slash-and-burn necessary to open the clearings required for establishing young cardamom plants. This situation has engendered numerous conflicts between the government's new land laws and traditional land allocation and tenure rights. According to the latter the land belongs to the first person who clears it, idle pasturage and free gathering of NTFPs are authorised within forest clearings after the rice harvest and access to the village forest is reserved only for the inhabitants of that village.

A slash-and-burn species integrated into agroforestry systems

In Lao PDR the harvesting of NTFPs is inseparable from the traditional lifestyle of upland populations. In such villages more than half of the cash income comes from the sale of forest products, and the greater part of the animal protein supply is obtained from fishing and trapping or shooting small wildlife (Aubertin 1998; Foppes and Ketphanh 1998). The climatic and topographic conditions disfavour perennial agriculture. About 20% of the total land area of Lao PDR is comprised of plains, primarily the lowlands of the Mekong Valley, while the rest of its territory is 'mountainous', with slopes exceeding 12% and still largely forested. The population, about 80% rural, still lives for the most part on a subsistence economy.

The low human population density, about 20 inhabitants per km², allows for swidden-grown upland rice as the primary cereal crop, which, contrary to the dogma of the Lao authorities, by no means can be dismissed as archaic and predatory. In such an environment, resorting to slash-and-burn is a good choice. Given the limitations on land tenure and ownership and the difficulties in mobilising capital and labour, the production of dry upland rice is an adequate strategy for achieving both security and a good return on labour input. Indeed, swidden can be the most appropriate response to a milieu unable to support more intensive agriculture and needs to be considered on its own terms as an agroforestry system.

The ecology and economy of cardamom cannot be separated from the peasant agroforestry systems and the environment that these agricultural practices engender. The gathering of cardamom has been thoroughly integrated into the cycle of upland rice production. It is a swidden plant,

which is harvested as it matures during the emergence of secondary forest on fallow upland rice fields. The collection of 'wild' cardamom is done at the end of the rainy season on older fallow sites, as the final weeding of the swidden field is completed just before the rice harvest. The labour force's free time is allocated to cardamom gathering at exactly the period during which there otherwise is a critical gap in the availability of food and money with which to buy it. Cultivated cardamom, when planted at the same time as upland rice, can produce satisfactory yields for some 15 years during the long fallow period required to restore soil fertility.

Relations with the cultivation of opium and coffee

At all three studied field sites we observed that the investigation of cardamom production provides a key to understanding the entire productive system of upland farmers. In Phongsaly we noted an almost perfect concurrence between the culture of cardamom and the culture of opium. The added value of opium can reach US\$1,200 per hectare per year. Pressed by American donors, however, the Lao government aims to eradicate opium. The cultivation of cardamom, which may contribute up to US\$500 per hectare per year, appears as a possible alternative crop, and in any case it is a good indicator of the success, locally, of the antidrug struggle.

On the Bolovens Plateau, the same remarks are true in relation to coffee production. There we find cardamom plantations on soils disavouring successful economic yields of coffee. The principal exporters of Bolovens coffee are also the buyers of cardamom, and they finance—on credit extended from coffee production—the 'cardamom projects' campaign. Cardamom thus benefits the same commercialisation networks as coffee does. Yet seeing how the price of coffee has recently crashed, following the glut of production, we can expect a land conversion in favour of cardamom.

Increasing commercialisation as a result of land policies

Despite the unfavourable factors described above there is a growth in the commercialisation of NTFPs owing in part to improved data management, the opening of penetrating roadways and the liberalisation of enterprise. We can analyse this phenomenon first as a response to new pressures on land use and land ownership. Three larger categories of such reactions have been noted:

First, because of the reduction in land area devoted to rice and the lower yield that followed the ensuing reduction of fertility, pressures have been growing on forest resources. Because less rice is being produced under the changed situation of limited land access and disabled long-fallow refertilisation, it has become necessary to buy rice in the market, which requires cash. We noted that overexploitation of resources arises out of competition amongst gatherers of certain forest products in regions where access rights are especially ill defined (e.g., wild cardamom in Phongsaly and Huaphan). As mentioned above, in order to counter the harvesting of cardamom by people from other villages, there has been a tendency to collect immature seed capsules.

A second response has been to play with the status of land. Gardens (*swan*, in Lao) and rice fields (*na*) have not been included in the lands subject to redistribution. They remain the property of their occupants and, unlike newly distributed land parcels, may be resold. When so called ‘cultivated’ or ‘maintained in good condition’ NTFPs are converted, legally if not horticulturally, into garden plants, their cultivation becomes a strategy to head off the consequences of land use and land tenure reform. Thus it is up to village chiefs and the proponents of NTFP projects to play the ‘garden definitions game’ with the officials in charge of land allocations. The cultivation of cardamom on slash-and-burn areas or within unburnt forests, thereby redefined as ‘gardens’, escapes the condemnation weighing on *ray* and cultivation within protected forests. Where such manoeuvres are successfully passed off, these gardens will be fine-and-well privatised. Thus they are not included in the lands being distributed and indeed added to the three land parcels allocated to each family.

Finally—once the land allocation process is executed—the domestication of NTFPs answers likewise to the need for perennial crops suitable for rice substitution. In development projects one is always looking for imported varieties to put into cultivation as new sources of revenue more apt to respond to the requirements of the market, rather than trying to domesticate or adapt indigenous biotypes. On such an occasion the method of appropriating outputs also changes: if we often observe the collective harvest and collective distribution of revenues from certain NTFPs ‘belonging to the village’, we have also seen the privatisation of both the revenues and the plants themselves, once they have become cultivated. Medicinal cardamom is thus in the process of becoming an agricultural commodity like any other, which simply needs a little more forest cover.

Closing arguments: a plant for sustainable development?

For the profitable exploitation of naturally occurring medicinal cardamom the forest cover needs to be maintained. Beyond that cardamom requires little additional care and local farmers even regard cardamom as weed tolerant. As we have seen, cardamom is one of those rare NTFPs for which harvesting and exploitation actually tend to favour its growth and development. The cardamom resource remains barely threatened so long as the forest itself is not destroyed. In the case of cultivated cardamom the situation is slightly different: here, it is necessary to prepare the land surface and to keep up a minimum of weeding. This would indicate sensitivity to competition from other species, all the more so when cultivation has been stoloniferous, where the young cardamom may easily be overwhelmed. In any case, cardamom is considered as benefitting subsequent cultivation of the site. It enables the quick preparation of the soil for planting while also choking out invasive weeds. Within a conceptual framework of sustainable development such ecological factors can easily be combined with the basic economic concerns of the highlanders to present medicinal cardamom as an ideal species. Nevertheless, as we will see, it’s not so simple.

Issues regarding domestication

The transformation from wild plant to domesticated cultivar has practically never been observed within a gathering-dominant context, as in the case of Huaphan. The households we interviewed never expressed interest in domesticating cardamom. They well know that, because of land tenure policies, they would have to dedicate scarce land to cardamom. They would have to provide labour at fixed times and grow more dependent upon the cardamom buyers' requirements. Why would they renounce the income derived from wild cardamom during a period of local labour surplus? Indeed, the families given most to cardamom gathering are either the poorest ones—those already making their living from NTFPs because they have no alternative—or the better-off families that have land available to plant cardamom or enough labourers to gather wild cardamom from the forest.

Neither can domestication of cardamom be observed in the context of plantation cardamom projects. As project team leaders are looking for secure outlets they prefer buying seedlings produced at the Xishangbanna Botanical Garden. With these standardised seedlings they get concomitant guarantees that they will be able to sell their production to Chinese merchants. This choice leads to the replacement of local varieties of cardamom with standardised cultivars and so threatens the local varieties' very existence.

Measures to promote cardamom development

The measures to promote cardamom development are well identified. It is of utmost importance to assure tenure and usufruct rights for communities in order to prevent premature picking and squabbling between neighbouring villages. Small size and poor quality characterises cardamom fruits that are collected too early, and a differential pricing system, which duly rewards the better quality producers, appears absolutely indispensable. Because price negotiations are made individually, cardamom sellers associations could be mobilised in order to obtain quality-keyed prices. Finally better, more energy efficient technologies for drying harvested fruits and allowing at least some stockpiling to avoid production gluts, thus strengthening the producers' position in negotiations, could be introduced at a relatively modest price. Solar drying kilns are already being tested in Luang Namtha.

Government policies help or hinder?

The existing legislation is inadequate and vague on key issues like the right of access to the land, the nominal state monopoly over cardamom, the mechanism and application of production quotas and the unfavourable taxation system (Enfield *et al.* 1998). But above all, the Lao government's agricultural and economic policies seem to go contrary to the development of mountainous regions. How, then, with the government's condemnation of agroforestry systems can the objective of poverty reduction and forest protection be reached by establishing cardamom? How can upland communities organise

themselves towards exploiting and commercialising NTFPs without recognition of their rights and a guarantee over their tenure and usufruct?

The systems that we have been discussing here cannot be inscribed under 'natural evolution' where humans patiently improve the state of their resources and their milieu. These spring instead from ruptures caused by altering the legal status of the land, the resources, and the actors themselves. In every case the market has not been the sole determinant. We can interpret the systems undergoing mutation in response to external threats bearing essentially upon secure land tenure and ownership, and on the rights of upland populations more generally. These systems are sharply different in their social and historical determinants. The evolution towards intensification is due to a break up in the production systems. The latter comes from the restrictions on access to the land and from the condemnation of traditional practices, especially shifting cultivation. It is essential to note that such a rupture, paradoxically, is the result of governmental policies put forward in the name of the environment! These policies, implemented by a government that sets agriculture apart from forestry and ignores agroforestry systems, have the opposite effect of intensifying, on the one hand, the harvest of wild plants, while on the other hand, moving towards the cultivation of standardised varieties.

We must stress that it is impossible for us to put forward comparative advantages in terms of specificity of Lao cardamom to account for its development. If there are any comparative advantages, they would lie in the opportunity costs of land and labour compared to those in neighbouring countries. The cardamom boom in Lao PDR is rooted both in market expansion and the scarcity of land for cardamom production in Yunnan, China. As a result of the homogenisation of tastes and the process of globalisation, Lao medicinal cardamom is becoming a commodity like any other, seldom sought for its specific genetic or ecological characteristics. As it discloses the problems with land tenure, and with the rights of upland populations, our study of cardamom prove to be eminently political. The central issues remain, actually, the modes and norms of social regulations and national integration of forest dwellers as well as the control of natural resources, the ecological management of the landscape and the creation of wealth.

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ENDNOTES

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2. *Ray* is an area where the forest has been cut and burnt for temporary cultivation of rice and other crops. It is the cornerstone of shifting cultivation, a form of agriculture in which soil fertility is maintained by rotating fields rather than crops. New plots are usually cleared by slash-and-burn and cropped until soil exhaustion. The land is then left to regenerate naturally while cultivation is conducted elsewhere.

3. Exchange rate July 2000: US\$1 = 7500 kips.

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Chapter 4

Harvesting and commercialisation of *kroto* (*Oecophylla smaragdina*) in the Malingping area, West Java, Indonesia

Nicolas Césard¹

Common names	Part of the resource used	Management	Degree of transformation	Scale of trade	Geographic range
Semut rangrang, Weaver ant, Sireum sirarangge	Larvae	Wild	Low	National	Medium

OVERVIEW

The Asian weaver ant (*Oecophylla smaragdina*) larvae and pupae are collected in the wild from trees and commercialised as songbird food and fishing bait in Java, Indonesia. The produce called *kroto* brings substantial income to numerous rural households throughout the year. The resource's durability is until now ensured by the species' distribution (various ecosystems and polycalic structure of nests), the constraints for collection (inaccessibility of small nests and ants' aggressive behaviour) and the limited number of collectors. However, constraints related to storage and transportation of the resource, retailer's margins and a policy on animal trade (i.e., birds) are limiting the benefits of commercialisation for collectors.

INTRODUCTION

Kroto is the Javanese name given to a mixture of Asian weaver ant (*Oecophylla smaragdina*) larvae and pupae, which is sold in animal markets and small shops as food for songbirds or fishing bait. By extension, the term *kroto* also refers to a range of dried preparations made of small quantities of ants, chicken eggs and honey used as birdfeed. Ant larvae and pupae are not always included in this mixture, which is sold in the markets. Indeed processing companies keep the well-known name of the resource for commercial reasons.

Studies on insects as forest products are limited, but insects and their by-products are popular forest resources in Southeast Asia. Most of these insect products are eaten, some are commercialised (De Beer and McDermott 1996), but few are traditionally managed (De Jong 2001). Honey (*Apis* spp. mainly) is collected mostly from the wild and sold in marketplaces, as are beeswax, pollen and venom (Chuntanaparb *et al.* 1985; Giesen 1987; Marsh and Gait 1988). The resinous secretion of several species of tiny louse (*Laccifer lacca*) is a source of lac with a wide variety of uses (Gupta and Guleria 1980).

This study focuses on the Malingping area of Banten Province, one of the main *kroto* production areas, as well as locations where the resource is commercialised, such as Jakarta and to a lesser extent, Bogor. Asian weaver ants can be found almost anywhere in Indonesia. Thus, many poor people in rural parts of the country harvest *kroto* in order to earn extra money or as a regular source of income. Collection is locally based and is an organised activity led by a collector/trader or by small groups of individuals. But *kroto* production is not confined to organised groups: numerous collectors, songbird owners and amateur fishermen prefer to collect the fresh larvae rather than buy it.

Context and uses

Kroto is an animal product well known all over Java and on other Indonesian islands. Although the name is familiar in other parts of the archipelago, local communities have used ant larvae as bird food for a long time but not called it *kroto*. In Java especially, the resource is strongly related to the population's enthusiasm for captive songbirds such as *murai* (varieties of blackbirds and thrushes), *kutilang* (*Pycnonotus aurigaster*) and *perkutut* (*merbock* or zebra dove, *Geopelia striata striata*). The call of each of these birds is distinct, with its own melody, structure, pitch, base and treble. Songbirds have been a part of the Javanese way of life for a long time and have provided their owners with a symbol of their social status.

According to bird lovers, most songbirds can be fed *kroto* with the exception of granivorous birds. People buy the old *kroto* (*kroto tua*), i.e., two- or three-day old larvae, regarded as the lowest quality *kroto* (*kroto kasar*), for feeding chickens since it is believed to accelerate both feather growth and flesh production. Lacking freshness, this *kroto* is also called *kroto busuk* (rotten *kroto*) by songbird owners, as well as *kroto hitam* (black *kroto*) for its poor quality.

A diet of ant larvae is known to provide vitamins, proteins and other mysterious, but essential nutrients, which are believed to improve a bird's performance. Songbird owners nourish their most beautiful and skillful birds with ant larvae in order to prepare them for singing contests, but also for the sole satisfaction of listening to the warbling of their favorite birds at home. Some bird owners occasionally collect the larvae, but most buy the resource from their local shopkeeper or pet shop.

Freshwater anglers also use the fresh *kroto* as bait. In some locations, depending on the fishing season, the ant larvae are used fresh in a home-made mixture of chicken eggs, honey, maize and beans. Most of the *kroto* sales in Bogor are for this purpose.

Box 1. Weaver ants as food and medicine

In Thailand and the Philippines, the larvae and pupae of Asian weaver ants are commonly eaten. The taste has been described as creamy. The adults are also eaten; their taste has been described as lemony or creamy and sour. In Malingping, another species of small ant is eaten. *Oecophylla smaragdina* is used as medicine in India. In the Bastiar region (Chhattisgarh), the adult ants are directly used in the treatment of rheumatism, as oil to cure stomach infections and as an aphrodisiac (Oudhia 1998).

Two other uses have been reported in Malingping and in Pelabuhanratu. The excrement of weaver ants is harvested to make a multipurpose varnish (in addition to turpentine), locally used to protect wooden furniture. In Malingping, a few shops (*toko besi*) sell from time to time a home-made varnish made of dry adult ants, called *malam serim*, in small packages for US\$0.05² per package.

Collection sites

In West Java and Banten Province, the larvae of weaver ants are collected from locations such as Cianjur, Purwakarta, Banjar, Cirebon, Indramayu and Lebak. The collecting grounds in the Malingping area are Cihara, Cimadur, Cisiuh, Bayah, Cibaliung, Muara Binuangeun, Bagendur and even the Ujung Kulon National Park area (Figure 1). The *kroto* production area studied is located in the subdistrict of Malingping (Lebak District) in Banten Province. The Malingping subdistrict measures 166.76 km² and includes coastal areas, extensive agricultural lands (mostly rice fields) and, in addition to Ujung Kulon National Park, secondary and divided forests.

Most collectors have a good knowledge of the different production areas, which is especially important for frequent harvesting. They make the decision about their next harvest based on the season, abundance of the resource, accessibility of the area, climate and length of time since last harvest. If an area is harvested only during a certain time of the year, regular collectors may know more than 15 places in that area from which to harvest, but every year they try new places or, sometimes, they just go further in their explorations in the same areas.

PRODUCTION-TO-CONSUMPTION SYSTEM**Distribution and species habitat**

The *kroto* sold in West Java comes from various ecosystems: from coastal areas and gardens to secondary forests and agroforests. Larvae at different stages of development as well as pupae (*telur semut*; 'ant eggs' being the direct

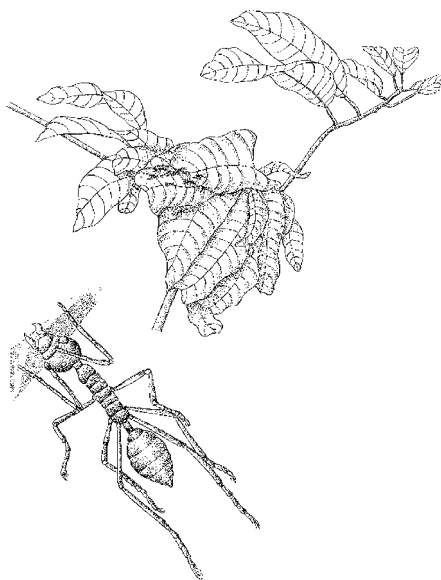
Figure 1. Collection sites around Malingping



Source: ESRI Data and Maps 2002.



translation) are taken from the high nests of weaver ants (Hingston 1923). The distribution of the most common species, *Oecophylla smaragdina* (Fabricius) (Hymenoptera: Formicidae) is wide, throughout the Indonesian archipelago. The Asian species is known as *semut rangrang* in Indonesian, while in the central and western part of Java it is known as *sireum sirarange* (in the Sundanese language).



(*Oecophylla smaragdina*)

Box 2. Other ant species consumed as *kroto*

Informants reported two other species besides the Asian weaver ant that are occasionally consumed as *kroto*. Their larvae are difficult to find and harvest, however, and therefore seldom collected. Those species are humpback ants (*semut bongkok*), which live in bamboo culms and crevices of dead trees, and ground ants (*semut telas*), which live in soft soil layers. Most of these ants' larvae are not sold, but used by individual collectors to feed their birds; this product should be distinguished from the traded *kroto*.

The distribution of the most common species, *Oecophylla smaragdina*, ranges from India to Australia and extends to most of the rainforests in Asia (Wheeler 1922; Hölldobler 1983). This weaver ant is well known as an unusually aggressive predator, as well as for the construction of complex arboreal nests (or calies). The ant colony may occupy various nests in a single tree (polycalic

structure) or even occupy several trees. Way (1954) mentions having observed a colony that had 151 nests spread over 12 trees.

The queen is located in one nest and her eggs and larvae are distributed to other nests. The ants feed on nearly all insects that attack the host tree, mainly Dipteran, Coleopteran and Hymenopteran (Dejean 1991). Weaver ant nests are among the most complex of social insect nests. *Oecophylla* species use the extremely well developed silk glands of their larvae for connecting living leaves to form their nests. Workers carrying larvae between their mandibles pull leaf edges and weave them together with the silk the larvae produce when pressured lightly. Gradually more and more leaves are connected to the nest.

Weaver ants have delimited territories with a mosaic distribution (Majer 1972; Leston 1973) in a wide range of habitats, both natural as well as plantation areas, and are the dominant species in their habitat. They occupy a great variety of trees from large bananas to small *petai* (*Parkia speciosa*). Collectors harvest the *kroto* in fruiting trees, such as *jengkol* (*Archidendron pauciflorum*, syn. *Pithecellobium jiringa*), jackfruit (*Artocarpus* spp.), mango (including *Mangifera indica*), *duku* (*Lansium domesticum*), *rambutan* (*Nephelium* spp.), *jambu air* (*Syzygium aqueum*) and other trees such as rubber (*Hevea brasiliensis*), teak (*Tectona grandis*), *buni* (*Antidesma bunius*), *kedondong* (*Spondias* spp.) or cacao (*Theobroma cacao*). According to collectors, some of the best places for harvesting *kroto* are in coconut and oil palm plantations (see Way and Khoo 1991; Way and Bolton 1997), in which the *kroto* is described as abundant and of good quality.

Harvesting

The ants are active during the day, their activity peaking about noon. The best time for collection is during early morning, from six to ten o'clock, and then in the afternoon from two to five o'clock if the morning harvest was insufficient. During the wet season, the best time to harvest is between two rainfalls, allowing the sun time to dry the nests.

In Malingping, as in other locations, collectors go together to the field since travelling together is often easier. The harvesting site is chosen the day before or on the morning of departure. Once they arrive at the collection site, they split into groups of two to three and may divide again at another point, since collectors often look individually for trees with nests, but will try to stay within earshot of fellow collectors. A collector who finds an ant nest will search the host tree and its vicinity for further nests.

Some of the study area consists of former agricultural lands on rolling hills, some of which are fallow lands covered in a mixture of large herbaceous vegetation, dotted with a variety of trees and bushes. This open, seemingly discarded landscape abounds in *kroto* host trees. The openness of the area makes collection much easier than in the woods. (Perhaps this is the reason why weaver ants are more likely to be found in agroforestry systems, orchards and sometimes gardens in the vicinity of houses.) Although an abundant harvest is possible from plantations and untapped forest areas, even if the host trees

are rather scattered, collectors are a bit reluctant to harvest *kroto* in areas that are less familiar to them. The parts of primary forests not dedicated to cultivation are located on hillsides (often difficult to access) and in a protected area (where collectors are not allowed to gather forest resources, although, discreetly, they do enter). Thus, the harvest in unknown areas is expected to be exhausting and less bountiful. Another criterion apparently decisive to collectors is the remoteness of forested areas from the village. The difficulty of access even by road leads to high transportation costs and lost time.

Kroto harvesting is marked by two climatic seasons, which partly intersect the biological cycle of the ants: the dry season with final-stage larvae and the wet season, when the pupae of the future queens, males and worker larvae are smaller. During the dry season the resource is less abundant and consequently more difficult to find, according to collectors, and the *kroto* consists of big larvae, pupae and sexual forms (future queens and males) that collectors call ‘capsule’ (*kapsul* in Indonesian) for their similarity to capsules used to hold medicines. Big larvae are considered as of poor quality since they are too big for use as birdfeed, and the dry season is known as low quality season for that reason. *Kroto* harvested at that time of year is also described as black (*hitam*), because the pupae are almost adults, and moist (*basah*), because of the weight of the mixture.

Songbird owners prefer the ‘rice’ type of *kroto*, which is the most valuable and marketable product of its kind. Rice *kroto*, or *kering* (dry) because of its appearance, is made up of small larvae and pupae that are common during the rainy season. Paradoxically, *kroto* harvesting decreases during this season, as collectors are busy with other subsistence or economic activities. The peak season for harvesting *kroto* is in the transition period between two monsoons (the *pancaroba* season), in particular during parts of July and August.

For the harvesting of *kroto* collectors require stamina, patience and a lot of dexterity. The collector bursts the nest and then shakes it with the tip of his 5 m or longer bamboo stick, to which a conical paddy bag is attached. Most of the larvae, as well as many ants, fall into the bag. The collector repeats the procedure multiple times until almost all the biggest nests of a tree are collected. Some collectors will add an extension of 2 m or 3 m (added to the 5 m bamboo stick) to get to the top of the tallest trees. Nevertheless, the highest nests often remain out of reach and are sometimes hidden by the vegetation. The collector will memorise the location of a bountiful tree for a future trip, waiting a couple of weeks for the ants to move to more accessible nests or to build new nests.

The harvest often turns into a painful ordeal for collectors. During the harvesting many larvae and ants fall from the nest to the ground. Trying to defend their nests and save their larvae, the thousands of aggressive ants bite anything under the tree, the collector included, making the harvest a dangerous operation. After the collector’s departure, the ants climb back up the host tree with the remaining larvae and pupae to rebuild the ripped open nests or to start new ones.

Up to 60% of the harvested produce may be lost before arriving at the trader’s house. About 40% of the *kroto* of harvested nests is lost at the site

Photo 1. *Kroto* is collected with a long bamboo stick to reach the nest in the trees (Photo by N. Césard)



and during the rest of the day while the collector is working other sites. Adult ants, larvae and various organic fragments fall from the bag during the harvest and during the trip from the one site to another. The insects in particular will continue to escape from the bag during the trip, leaving behind most of their larvae. At the end of the day the collector will remove another 20% of the initial weight in the form of debris. After having quickly removed the undesirable debris, collectors transfer the contents of their bags to a container or appropriate box, eventually cleaning the bag of the last ants using a synthetic feather duster (*kemoceng*). Twigs and small leaves, but also dead insects or their remains, are graded and separated from the larvae.

Many fruit tree owners welcome collection in their orchards and plantations³ as they see weaver ants as a nuisance, especially during fruit harvesting, which can become a painful operation. Collectors and fruit tree owners are unaware of the positive role these ants play in the eradication of insect defoliators (caterpillars, larvae and adult coleoptera) and Heteroptera (Majer 1972; Leston 1973; Room 1975; Dejean 1991).

Raw material producers and socio-economic context

In Indonesia, numerous rural families earn part of their living from the collection and commercialisation of *kroto*. Most collection takes place by individual, self-employed collectors who sell directly to merchants, bird owners or fishermen. Small producers sometimes also play the role of middlemen, buying *kroto* from other collectors, and selling it on to other middlemen or merchants.

Box 3. The use of weaver ants in agriculture

In other parts of their range *Oecophylla* have frequently been used as a natural control agent in the prevention of insect pests for many tropical crops: cashew (Peng *et al.* 1995), citrus (Way 1954, Huang and Yang 1987), mango (Way 1954), coconut (Vanderplank 1960; Way and Khoo 1992), cocoa (Room 1975) and coffee (Leela 1961). In the Mekong Delta in Vietnam, citrus farmers also appreciate the benefits of ant husbandry in terms of the improvement of fruit quality—a direct response to the fertilising properties of the excretions deposited by weaver ants patrolling the fruit (Stapley 1980). In Sri Lanka, however, the weaver ants' utilisation as a biological control agent has been given up because of their aggressive behaviour during the coffee harvest (Leela 1961).

Kroto is harvested and sold throughout the year, although there are periods of the year during which the harvest is more productive and of better quality than others. Some collectors harvest only the larvae from December to May, when the quality of larvae ranges from fair to good. Others will collect the larvae from August to October. Farmers in Malingping usually collect *kroto* between the two rice harvests (each rice-harvesting season lasts for two to three months). Several collectors harvest the larvae daily all year round and have no other source of revenue. Others harvest *kroto* maybe two or three days a week and engage in other activities the rest of the week.

Nowadays in Malingping only eight collectors are involved full-time, six days per week throughout the year. The collection takes place outside Malingping subdistrict in places such as Karang Taraje (Bayah subdistrict) and villages near Ujung Kulon (Labuhan). Collectors sell their production to a local trader, who has been in business for 15 years. They leave their harvest at the trader's house at the end of each day. During the month of Ramadan, collectors limit their harvesting to only a few hours a day.

Over the last few years production has been low compared with 8 or 10 years ago. Formerly, there were more than 15 collectors from Malingping and surrounding villages who harvested the nests every day. The trader used to hire several collectors. Relatives, neighbours, and friends were also welcome, on the single condition that they sold their collection to the trader. At that time, a group of collectors could harvest 30 kg to 50 kg in one day, an average of 2 kg to 5 kg per collector.

Today, harvesters still collect the *kroto* in the same way, choosing large nests made of fresh leaves and avoiding old nests known to be poor in larvae. One of these fresh nests can contain 1 oz. to 2 oz. (28 g to 56 g) of *kroto*. A collector may harvest from 6 to 10 trees per hectare. During the rainy season (the high season) collectors are able to collect up to 2 kg per person (an average of 1.5 kg per day) and the price may be US\$1.2 per kg depending on demand. It often gets harder for collectors at the end of the high season,

when the *kroto* is a bit moist and less plentiful, but on the other hand the price is better and can reach on average US\$1.4 per kg.

The collection of *kroto* offers not only additional but also substantial income to numerous families. Generally speaking, farming is the main activity in Malingping. Collectors and their families use the money they earn from *kroto* for daily subsistence, not luxuries. They buy meat, fish, rice and sometimes clothes for everyone in the family. Among those higher up in the trading chain, however, there are cases where the income is used to acquire luxury goods, such as one of the main traders who bought a television set a few years ago after saving for a long time. He is the one who organises the market chain to Jakarta, and therefore earns more than the collectors.

During the months of July and August collectors obtain higher income from *kroto* and might save the money for harder times. Additional money is especially welcome during the month of Ramadan (fasting month) in order to buy food and presents for relatives at *Idul Fitri* (end of Ramadan). Exhausted by the fasting, collectors' harvesting activities are considerably reduced during Ramadan.

There is the belief that *kroto* is *haram* (unclean, almost immoral, according to Muslim law), even if it is not consumed directly by humans. Therefore, many people think that the money earned from selling *kroto* is also *haram*. A collector told the author there was no benefit from *kroto* in terms of prosperity as long as collectors considered the resource immoral. For many people, collectors or not, the money from the sale of *kroto* is deemed dirty money that must be quickly spent and not saved. In view of this, it is relevant to ask why people would still harvest *kroto*. The answer is simple. The product is regarded as a chance to earn cash, and according to a collector, poor households will always try to make a living from a free resource.

Trade and Marketing

In Malingping, *kroto* is widely used for fishing bait, but demand for this purpose is modest—about 5 kg per day. The main outlet for *kroto* in West Java is the capital Jakarta where up to 100 kg of *kroto* are sold every day for both birdfeed and fish bait⁴.

At the trader's house, after cleaning the larvae and separating out the last debris, collectors pack the *kroto* in a *beseke*, a 1 kg box made from raw bamboo collected in the surrounding area. The trader usually buys the boxes from other families for a few cents. The trader, or occasionally a friend or relative, takes the boxes to Jakarta every day. Sometimes a trader may wait another day to gather more *kroto* from his collectors, but he will go or send it as soon as he can. Freshness assures the quality of the produce and thus appears to be commercialisation's main restriction. Indeed once collected, *kroto* can be kept fresh for only two days, but according to a trader, a freezer may help to maintain the resource longer before transportation.

During the wet season, larvae are very small and the risk of losing the resource during transportation to Jakarta increases as they deteriorate rapidly. Heat and storage change the colour of larvae to pale yellow; because

Photo 2. A *besek* of ant larvae equals 1 kg of ‘wet’ quality *kroto* (Photo by N. Césard)



of the quick deterioration of *kroto* it is again subjected to grading in Jakarta. More than 10% of the produce may have to be thrown out. From experience collectors know that weaver ants produce fewer larvae during the hottest months of the year, but that the nests contain the biggest larvae (sexed larvae). This *kroto* can be kept longer than the *kroto* composed of smaller larvae.

In Pasar Pramuka, Jakarta's main animal market, there is a rule among merchants that during the low season (the season of bad quality *kroto*), the price should be fixed. However, conflicts may arise among middlemen who sell *kroto* to merchants. Indeed, there is competition among middlemen as to who gets better sources (fresh *kroto*) first. Some middlemen are willing to pay collectors more for fresh, good quality larvae. A few individual collectors and some traders enforce their bargaining position by following the classic supply and demand system: they know that a good quality resource is difficult to find and try to increase the margin. Nevertheless, the maximum price set for the low season rarely exceeds US\$1.4 per kg at the collector level.

In Malingping one middleman has been in business for more than 15 years and is still co-ordinating the harvesting and packaging of fresh *kroto* from Malingping to Jakarta. His production now goes to the Pramuka market whereas it used to be sold in Bogor. The middleman sells the *kroto* at US\$1.6 to US\$1.7 per kilogram to two merchants in the Pramuka market, one of whom is an old acquaintance. Depending on the season, quality of the produce and amount of supply in the market, the merchant sells the *kroto* at US\$0.3 to US\$0.6 per ounce. This means there are regular variations for 1 kg ranging from US\$3.5 to US\$5, which is two to three times as much as the buying

price. According to its aspect and composition, two categories of *kroto* are distinguished in the market by various descriptions: *kroto basah* (wet) differs from *kroto kacang* (literally meaning ‘peanut’ in Indonesian, i.e., dry) and *kroto kasar* (inferior quality) from *kroto halus* (superior quality). Middlemen pay between US\$5 and US\$7.5 for transportation to Jakarta per trip, thus profits appear low.

There are three main markets where *kroto* is sold in Jakarta—Pasar Pramuka, Barito and Jatinegara—and many small shops and stalls all over the city sell small quantities. Those retailers buy the resource from individual collectors who deliver directly to their shops or they buy *kroto* from bigger shops or at bus stations in the early morning for resale. Bus stations are attractive places for local men who specialise in various produce (*kroto* included) because of their central locations and good connections to different production areas. Middlemen in Kampung Rambutan Terminal (South Jakarta) buy *kroto* from collectors not only from Malingping but also from other areas in West Java, especially Banten and Lampung provinces in south Sumatra. It also serves as a place for distribution to bird shops in Jakarta, and even to surrounding cities, such as Bogor, Bekasi, and Tangerang (see Figure 2).

Figure 2. Main trading flows of *kroto* in West Java



Merchants have tried to find more reliable sources in South Sukabumi, Cianjur, and Lampung in order to meet demand. This year especially, collectors from Malingping were competing with collectors from Lampung. The province

of Lampung has a few competitive production areas and has an effective transportation system to the capital. Collectors harvest the ant larvae during the day, then their trader leaves for Jakarta in the evening, travelling all night by boat and bus (seven to eight hours altogether) to meet merchants the next day at the market.

Processing the resource

Fresh *kroto* from harvest to the produce being sold in the marketplace requires little to no processing—only cleaning and grading are necessary—but the raw material can also be processed to obtain dried *kroto*, a less perishable produce. Prepared at home, dried *kroto* does not require sophisticated processing by the collectors' families: the larvae are boiled for one hour and dried for two or three days. Five kilogram of fresh *kroto* make 1 kg of the dried variety (20% of the original weight). It is a *kroto* that contains many adult ants and can be kept for at least six months. The price for dried *kroto* is usually half that of the fresh variety.

A few sources report that some small companies have commercialised a mix of dry larvae and ants, chicken eggs, maize, honey and beans as songbird food. This product is often labelled as *kroto* even though it contains only a small quantity of ants. The processing and packaging of this product may need more investment in time and capital. The product is sold in national animal markets and may be exported. No gatherers in Malingping seem to be selling the product for this purpose. According to birdfeed sellers, some of the *kroto* used is produced in the Sukabumi area, south-east of the capital.

Policy environment

Collecting *kroto* is a solitary job, even if collectors go to the forest in groups of two to four people. If they find the same resources in the same areas, conflicts are unlikely to occur, as there is a sort of customary law which states that whoever finds the resource first has all rights to it. This is open access tenure where no land title deed is required. *Kroto* is considered public property that can be collected wherever it is found: even in another collector's garden. However, in the early 1990s, the demand for *kroto* was diminished by a policy that limited the trade in songbirds. There is little government interest in the conditions of *kroto* production. In fact, local officials ignore the whole process.

TRENDS AND ISSUES—DEVELOPMENT AND CONSERVATION LESSONS

Trends

There is high demand for *kroto*, in particular for fresh larvae. Good quality *kroto* is quickly sold from street stalls and market shops. For instance, 5 kg of fresh product is sold within a few hours in Bogor every day. Even old larvae are sold in two or three days in Jakarta. The merchants in Pasar Pramuka

often complain of irregularities and delays in traders' deliveries. Consumers, songbird owners and fishermen often have to wait for the produce to arrive. Demand for first-rate *kroto* has increased. Because more people are getting involved in collecting *kroto*, the competition for the resource has increased in the last few years. Collectors are going back to sites where *kroto* is easy to find more frequently than they used to and thus collect from the same host trees more often. They collect all the nests they can find, even the smallest ones. Collection is often still organised as it was before, with small groups of collectors and middlemen, but in addition many individual collectors are now looking for *kroto* on their own. They know where to look for nests and then sell directly to retailers, who are often willing to pay more for fresh *kroto*. People collecting *kroto* seem to be less regular in their activities than before, seeking other opportunities first, and spend only a few days per week or month harvesting *kroto*.

Ecological implications

Under normal conditions, weaving ants have a quick population recovery. Regeneration takes between 17 and 24 days (Paimin and Paimin 2001). According to collectors, it takes five days before new nests appear and around 20 days for the ants to produce new larvae. It underlines the collectors' knowledge of the resource: they know that rotations in space and time allow the ants to build new nests with larvae. Nowadays, both old and new collectors less often respect the necessary harvesting rotations, thus harvesting becomes destructive and the resource is becoming scarce in several exploited areas.

When discussing resource regeneration, it should be taken into account that one colony can extend to several trees and that the queen's nest is often unreachable. We assume that if not all larvae are harvested, this will allow the resource to partially regenerate (under specific and nondestructive harvesting conditions of the nests). The medium sized nests of queen ants are located near the tree canopy, being indeed the most inaccessible of nests. The queens apparently stay in one nest from which eggs are distributed to the other nests in the colony. Each tree contains many nests, but only one nest contains queens. There are commonly multiple queens in mature colonies (Peng *et al.* 1998).

Weaver ants prefer fruit trees, and therefore so do *kroto* collectors. The tree owners are only too happy to let the collectors remove the nests from their trees, as discussed earlier. The impact of harvesting nests on tree growth and fruit production in the region may well be worth evaluating.

The importance of *kroto* in livelihoods

Income gained from *kroto* does help collectors, but it hardly brings major economic changes to their lives. Households spend the money earned to cover basic needs. Small amounts of money may be saved so as to start other economic activities or to buy useful equipment or accessories to help the production (i.e., a refrigerator or motorcycle). Transportation from the

production area to the market places proves to be an important limitation. Collectors or traders have to sell the product to shops that are located in large cities far from the production areas. They use public transport, which implies they have to wait for long periods of time and change vehicles several times. This is especially difficult with the fresh larvae: profits are dependent on the rapidity with which collectors can deliver the resource to the sellers. The alternative to fresh *kroto* is dried *kroto*. However, the production of dried *kroto* means more pressure on the resource, since it requires larger quantities of both ants and larvae, and results in a poor quality end product.

As with many other non-timber forest products, *kroto* collectors cannot take advantage of an increase in demand (Dove 1993). Merchants establish the product's price and appear to be the main beneficiaries of the commercialisation of *kroto*. Most middlemen are in the same situation as the collectors (Padoch 1992). Both collectors and middlemen could have more power over selling prices, since the resource is becoming scarce, but they do not negotiate with merchants to increase their profit margin. We may see this attitude as a lack of consensus between collectors and middlemen, and between middlemen and merchants, to the detriment of both collectors and middlemen. Many collectors never meet merchants and ignore the extent to which *kroto* is in demand.

In terms of livelihoods, harvesting *kroto* does not present an alternative to agriculture conversion or logging. For most collectors, harvesting *kroto* complements other economic activities, principally agriculture. Moreover, the agricultural extension does not seem to prejudice the colonisation of weaver ants so long as trees are left to host the nests. One may consider the resource and its collection as adapted to a very modified natural landscape, which is prevailing in Java, and in that sense, one may think of *kroto* as a forest resource as much as a post-forest resource.

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ENDNOTES

1. Institut de Recherche pour le Développement (IRD), Wisma Anugraha, Jalan Taman 32 B, Jakarta 12730, Indonesia. E-mail: ncesard@wanadoo.fr

2. Exchange rate (September 2001): US\$1 = Rp10,000.

3. In the 1970s, an informant reported that before insecticides were widely used in orchards and plantations to eradicate weaver ants and other small fruits predators, local villagers used buffalo bones to kill ants. A bone would be hung on a tree branch, where the targeted ants were swarming.

Once gathered, bone and ants were set on fire in order to kill all the ants. This procedure was repeated for three days in a row.

4. According to some bait merchants the trend is changing. Fish caught with *kroto* have bruises in their mouths as *kroto* contains a heating agent, and merchants think about changing to another animal bait if demand for *kroto* decreases.

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Chapter 5

Song rong (*Tricholoma matsutake*), a valuable forest mushroom from China: consumption, development and sustainability

Ying Long Chen¹

Common names	Part of the resource used	Management	Degree of transformation	Scale of trade	Geographic range
Matsutake, Pine mushroom, Song rong	Mushroom	Wild	Low	International	Small

OVERVIEW

Growing only in parts of East Asia, *song rong* [*Tricholoma matsutake* (Ito et Imai) Singer] is the most important edible fungus in the region, with farm gate prices of up to US\$370 per kilogram. This chapter is based on a case study of *song rong* in the Zixi mountain area of Yunnan province, China. More than half the farmers in the research area are involved annually in the harvest of *song rong*, which contributes, on average, 62% to their annual cash income. The bulk of the harvested mushrooms reach the most important consumer market, Japan, within two days; the mushrooms are most valuable when fresh. The increasing Japanese demand for fresh *song rong* (a result of declining *song rong* yields in Japan) and the increasing price have resulted in rampant harvesting. An important side effect of the harvest is that the ecological conditions for this fungus are negatively affected. Moreover, because of intense competition between collectors, harvesters also collect young buttons, which fetch much lower prices than mature buttons. The decline of *song rong* has become a serious problem that needs to be addressed.

INTRODUCTION

China has had a long tradition of mushroom consumption, especially in rural communities. It is approximately 2,000 years since the function and usage of wild edible mushrooms as a food and medicine for humans was first recorded.

Today a wide variety of edible mushrooms, including a number of symbiotic forest fungi (wild mushrooms) with edible fruiting bodies, are consumed in large quantities around the world, especially in East Asia and Continental Europe. The worldwide consumption of mushrooms was over 4,273,000 tonnes in 1991, including 200,000 tonnes of edible mycorrhizal fungi (Chang 1993; Hall *et al.* 1994). Trade in forest mushrooms has recently expanded into a multimillion-dollar industry. The world market value of these mushrooms has been estimated at somewhere between US\$3 billion and US\$6 billion (Huang 1993; Hall *et al.* 1994; Chen 2002a).

Nearly 900 fungal species have been documented as valuable edible mushrooms, of which 352 species (belonging to 60 genera) are ectomycorrhizal fungi (Huang 1993; Gong *et al.* 1997; Chen 2000; Mao 2000). The most valuable mushroom in China, in fresh weight price paid to harvesters, is *song rong* [*Tricholoma matsutake* (Ito et Imai) Singer, i.e. Matsutake], which is available in relatively large amounts only in south-west and north-east China². The natural production of *song rong* has dramatically declined in the past 60 years in Japan and other production sites in China, and consequently the price has increased. For this case study we chose the Zixi mountain area (25°09'N and 101°21'E) of Yunnan province in south-west China (Figure 1), a production site where the harvest and sale of *song rong* brings significant economic gain to rural communities in the region.

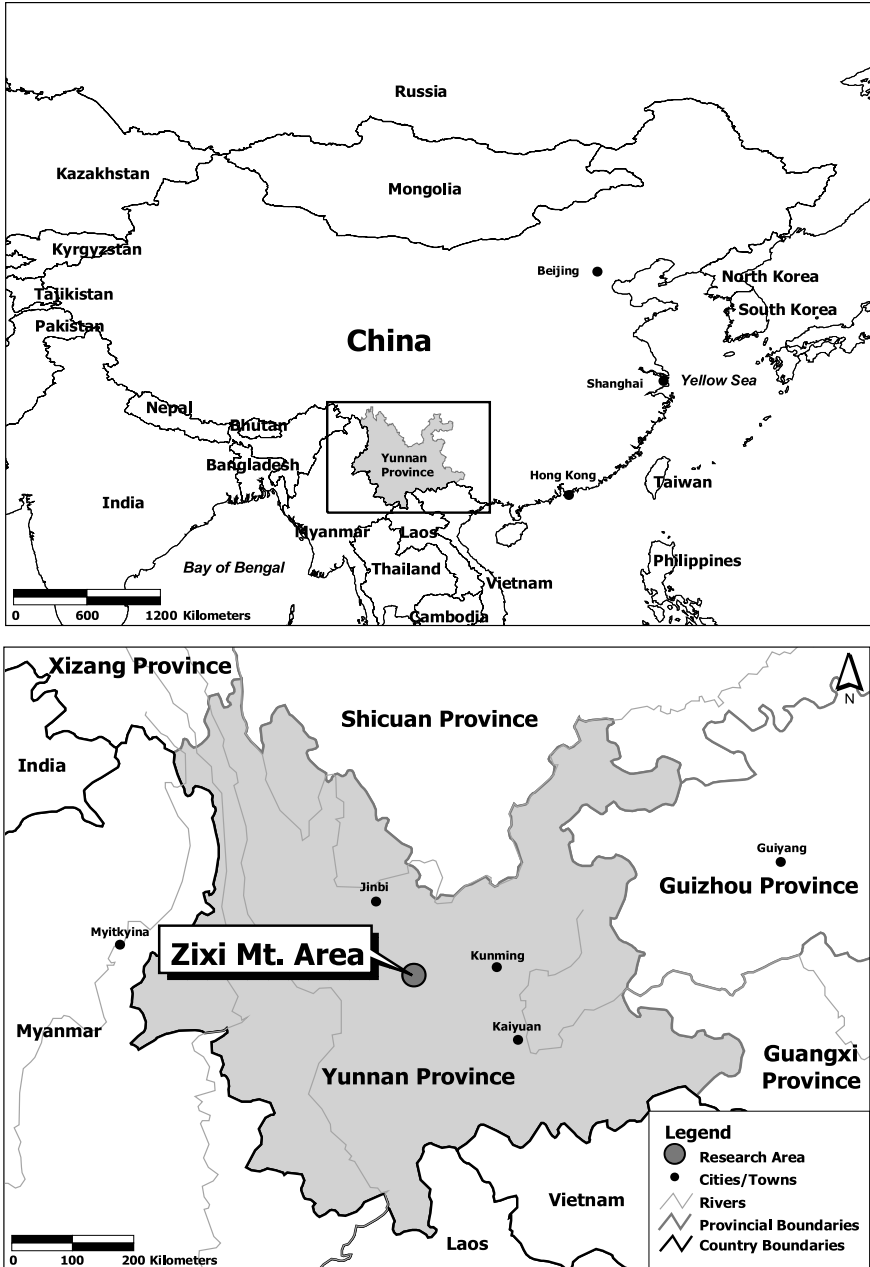
The study site is situated about 20 km south-west of Lu Cheng, the capital city of Chuxiong Prefecture. It consists of Zixi Forest Park and four villages around the mountain. In 1998, there were 1,633 households with a total population of 6,793, of which 32% belonged to minority groups, mainly Yi and Hui people. This area has a subtropical, monsoon climate with elements of temperate and tropical climate. There are distinct rainy and dry seasons and the annual precipitation is about 909 mm, over 90% of which falls between May and October. The mean temperature is 8.3°C in January (winter) and 20.9°C in July. These climatic characteristics are suitable for the growth of wild mushrooms.

The spatial extent of the *song rong* raw material production area is 11,360 ha (113.6 km²), which is the sum of the collection area, Zixi mountain (1,712 ha), and the adjacent villages (9,644 ha). The raw material production area includes 664.5 ha of agricultural lands and 9,107.1 ha of forest; 77.9% of the total land area (8,844.5 ha) is well covered by forests, mainly conifers. The state owns 95% (1,627.2 ha) of the Zixi mountain area, which covers the conservation area. A community legally occupies the remaining 5% (85.6 ha).

Song rong in the Zixi mountain area

Until about 50 years ago Zixi mountain was covered in luxuriant natural forests consisting mainly of conifers, but in the 1950s most of the forest was destroyed by human activities. In 1958, for instance, trees were cut down to provide charcoal for the iron and steel industry. This was followed by another local initiative to develop yam. The establishment of the Zixi Mountain Forest Farm in 1962 brought hope to the forests. Forest farms, like the Zixi Mountain Forest Farm, were mostly state-run at that time and engaged in the establishment of

Figure 1. Location of the study area



Source: ESRI Data and Maps 2002.

plantations and the restoration of forests. Both government and local farmers became aware of the importance of forest preservation, and many steps have since been taken to develop forests. Now, as a result of the establishment of the forest farm, Zixi mountain is again covered in green trees, almost all secondary coniferous forests. There are approximately 389 ha of secondary *Pinus armandii* forest in the reserve park.

The specific highland climate of the Zixi mountain area, located on the Yun-Gui plateau, is ideal for the growth of edible fungi. Furthermore, the mixed conifer and hardwood forests support a large number of edible fungi, most of which are symbiotic and capable of forming mycorrhizal associations with host plants. The predominant tree species are *Pinus yunnanensis* Franch, *P. armandii* Franch., *Quercus* spp., and *Castanopsis* spp., but other trees of the genera *Fagus* and *Alnus* intermingle with Pinaceae and Fagaceae. These mixed forests have a moderate number of shrubs in their understorey including *rhododendron* species, but lack herbs.

The mean elevation of the Zixi mountain area is about 2,200 m, the highest elevation being 2,502 m a.s.l. The organic litter layer is usually thick, up to 6 cm in the coniferous forests. *Song rong* (*Tricholoma matsutake*) fruits abundantly under coniferous trees, especially at elevations from 1,800 m to 2,300 m. The dense layer of litter protects buttons of *song rong* from predation by birds and animals.

The collection season of *song rong*, an autumn delicacy, begins in the middle of June and extends over four months to late October. Though *song rong* produces harvestable fruiting bodies throughout this period, the most effective harvesting months are July and August because of climatic limitations,

Photo 1. *Song rong* (Photo by Ying Long Chen)



such as rain, in the other months. Other edible fungi, such as cep (*Boletus edulis* Bull. Fr.), *B. speciosus* Frost, yellow morel [*Morchella esculenta* (L.) Pers.], ganbajun (*Thelethora ganbajun* Zang), chanterelle (*Cantharellus cibarius* Fr.), termite mushroom [*Termitomyces albuminosus* (Berk.) Heim] and cow spunk [*Suillus bovinus* (L.:Fr.) Kun.], also occur commonly in the forests in this area and are sometimes collected for international or domestic consumption. Most of these fungi are mycorrhizal mushrooms, which mainly grow in pine stands or mixed forests.

THE PRODUCTION-TO-CONSUMPTION SYSTEM

Resource Base

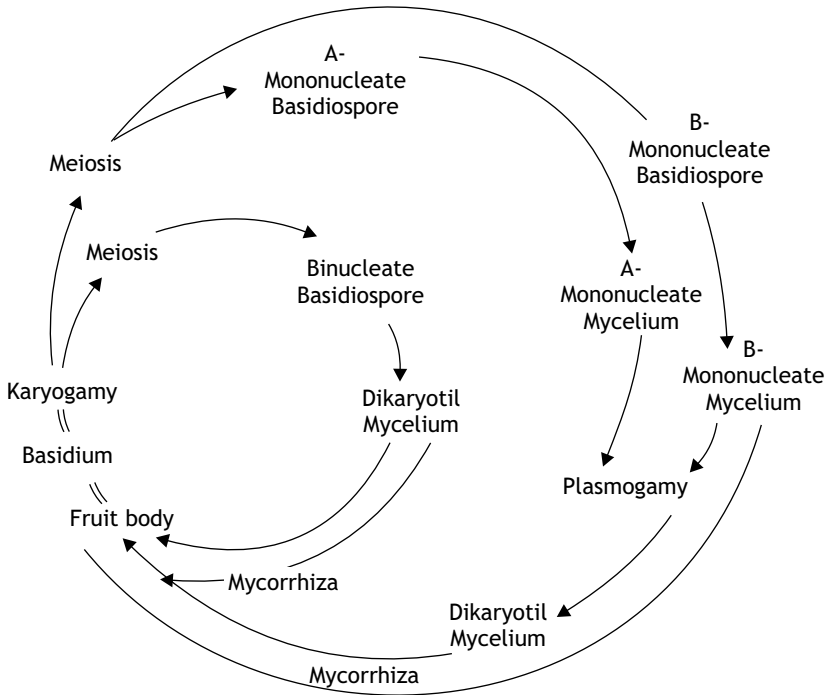
Song rong is the local name and trade name of *Tricholoma matsutake* in China (Photo 1). The word 'matsutake' is a Japanese collective name for a group of similar mushrooms growing in coniferous forests (*matsu* = pine, *take* = mushroom) with fruiting bodies closely resembling *Tricholoma* spp. Though the name *matsutake* has been extended to a number of other species of genus *Tricholoma*, especially the American *matsutake* [*T. magnivelare* (Peck) Redhead, i.e., white *matsutake*] and foolish pine mushroom (*T. bakamatsutake* Hongo), it actually refers to Japanese *matsutake*, i.e., *song rong* (*T. matsutake*), which grows naturally in East Asia.

The first description of *song rong* in China was printed in 1094 in a book on Chinese herbal medicines compiled by Tang Shenwei, a scholar in the Song Dynasty. The Japanese later adopted the Chinese character for *song rong* but use a different pronunciation.

As mentioned above, *song rong* is principally an Asian species, which grows widely in red pine (*Pinus densiflora* Sieb. et Zucc.) forests throughout Japan, South Korea, North Korea, north-east and south-west China and Primorsk Kray, Russia. With the dramatic decline in *song rong* production in Japan, Yunnan province has become a major *song rong* producer and exporter in Asia.

Song rong develops fruiting bodies and forms mycorrhizal associations with the roots of *Pinus densiflora* Sieb. et Zucc., but it also has symbiotic relationships with various other species such as *P. thunbergii* Parl, *P. pumila* Regel, *Tsuga sieboldii* Carr, *T. diversifolia* Mast, *Picea glehnii* (Fr. Schm) Mast in Japan; *Pinus karaiensis* Sieb. et Zucc. on the Korean Peninsula; *Abies mariesii* Mast in Sakhalin; and *Pinus yunnanensis* Franch, *Pinus tainanensis* Hay, *Pinus massoniana* Lamb. and *Pinus armandii* Franch in China (Tominaga 1978; Zhao 1986; Zang 1990; Lake and Read 1997). The mechanism of *song rong*'s symbiotic behaviour is still unclear, but studies prove that the establishment of mycorrhizal associations between *song rong* mycelium and the fine roots of trees is essential for the development of fruiting bodies. The mycorrhizal stage is a distinct characteristic of the life history of *song rong*, in which *song rong* obtains photocarbon from plant roots through inner hyphae and, in return, transfers mineral nutrients from soils to plants. Figure 2 shows the life history of *song rong*.

Figure 2. The life history of *song rong*



Implications of harvesting

There is great pressure on *song rong* because of overharvesting. Local farmers mostly collect *song rong* using a curved blade on a short stick (Photo 2). They walk around in the forests, every now and then removing the litter layer to seek *song rong* mushrooms. The practice of removing the litter from the forest floor while searching is detrimental to the mushrooms. The *song rong* mushrooms require good leaf litter in which to grow and reproduce (Hosford *et al.* 1997). The harvesting practices also have a negative affect on the development of *shiro* (the fruiting place with hyphae mats in the litter, amongst tree or plant roots). So this practice does not only negatively change the microhabitat on which the fungus depends but also damages the propagating hyphae in the litter. Moreover, in the intense competition between collectors, harvesters collect almost all *song rong* buttons, even the very young, out of fear that the next collector will harvest them. The value of immature *song rong* buttons on a weight basis is as much as one tenth less than that of first-rate mushrooms, though still at least five times the price of fresh vegetables in the local market.

Photo 2. Collectors usually use a sharp iron tool to remove the litter to reveal *song rong* mushrooms (Photo by Ying Long Chen)



The use of *song rong*

Song rong has been used and revered by the Japanese for over a millennium and both the Japanese and the Chinese consider it an autumn delicacy. It also symbolises fertility and by extension represents good fortune and happiness in the culture of local communities in both Japan and China. In China, the Naxi minority in Lijiang, Yunnan, traditionally eat *song rong* at wedding feasts. In Japan, it has been considered a royal tribute since ancient times and is used in diplomatic transactions.

The sporocarp of *song rong* has great nourishing value as a food. Its fruiting bodies are an abundant source of nutrients, especially amino acids, when compared to other popular edible fungi. *Song rong* is well known for its delicious taste and smell. The special flavour results from specific amino acids such as tricholoma acid, L-matsutake-ol, iso-matsutake-ol, ethyl-amylketone and methyl-cinnamate acid, which make the food palatable and tasty. There are diverse methods of cooking *song rong* depending on the cultural background. In Japan, for example, the mushrooms often are cooked with rice (or rice with mixed vegetables and meat) or stewed with fish, vegetables, sauce and vinegar, to which they impart a strong aroma and characteristic rich taste. In Yunnan, *song rong* is often served as soup or combined with green vegetables. In addition to its culinary attributes, studies have also demonstrated its medicinal properties (Huang 1993).

Prices of *song rong* compared with other mushrooms

The most expensive edible fungi are European truffles, especially the Périgord black truffle (*Tuber melanosporum* Vitt.) and Italian white truffle (*T. magnatum*

Pico), which are only available in western European markets (Hall *et al.* 1994; Chevalier and Frochot 2000; Chen and Gong 2000). *Song rong* is a comparable edible fungus in Asia and is the best-selling mushroom in the region. The farm-gate price of *song rong* can be as high as US\$370³ per kilogram fresh weight at the start or end of the season. The price of *song rong* is much higher than that of any other mushroom in Asian markets. For example, it costs at least 10 times as much as ceps (*Boletus edulis*) in Yunnan province, even in the peak harvesting season. A value comparison between *song rong* and other high priced edible fungi is provided in Tables 1 and 2, reflecting markets at the domestic and worldwide level, respectively (Hall *et al.* 1994).

Table 1. Average value of various forest mushrooms in three major mushroom markets in Yunnan province, late July to mid August 1999

Scientific name	Common name	Baoshan (west)	Chuxiong (centre)	Kunming (east)
<i>Tricholoma matsutake</i>	Song rong, matsutake	36.6-61.0	61.0-67.1	79.3
<i>Thelephora ganbajun</i>	Ganbajun	6.1	4.9-11.0	15.9
<i>Termitomyces arbutinosus</i>	Termite mushroom	2.2	2.1-2.4	1.7-4.3
<i>Boletus edulis</i>	King bolete or cep	2.2-3.7	2.6	3.0
<i>Boletus speciosus</i>	Fen jianshou	1.0	—	2.7
<i>Boletus aereus</i>	Black cep	0.7	2.4	2.0
<i>Russula xanihopilinus</i>		1.1	1.1	1.0
<i>Russula virencens</i>	Virescent russula	1.0	1.0	1.5

Note: All prices in US\$ per kilogram fresh weight. All of these mushrooms are mycorrhizal except *Termitomyces*, which is associated with termite nests.

Socio-economic context

The Zixi mountain area consists of Zixi Forest Park and four villages (Zijin, Yunqing, Lengshui and Muzhang) around the mountain. In 1998, the average household size was 4.16 people. Previously, there were seven families living on the mountain, but they were displaced by the park. The value of land is relatively low in this poor area. The price is about US\$100 per ha per year if rented. The transportation infrastructure is poor in part because of the difficulty of negotiating the mountainous terrain.

The local economy in the study area is dominated by agriculture, including low productive forestry, and living conditions are poor. The average annual household income (subsistence + barter + cash) in the research area was US\$714.3 in 1998. In the same year 62% (6,793 people) of the people in the research area were involved in the commercial extraction of mushrooms, and the average total annual income of these producer households was US\$917.6. Producers of *song rong* products have high status in the local community. For an average producer household, US\$571.4 came from mushroom production and US\$107.1 from other agricultural activities including tobacco and poultry. Most farmers are unwilling to work outside of their

Table 2. Some high priced edible mycorrhizal mushrooms on the world markets

Scientific name	Common names	Markets	Prices (US\$/kg)
<i>Tricholoma matsutake</i> (Ito et Imai) Singer	Matsutake (Japan); Song rong (China); Song koumo (China)	Japan	110-1,100 (wholesale, domestic produce) 114.4 (wholesale, from China) 103.4 (wholesale, from South Korea)
<i>Tuber melanosporum</i> Vitt.	Perigord black truffle; Truffe du Perigord (France); Tartufo nero pregiato (Italy); Schwarze Truffel (Germany); Hei kuaijun (China)	Worldwide	797.5 (wholesale, London) 4,950 (retail, London) 165-660 (picker, France) 1,650 (canned; retail, Auckland) 1,320 - 2750 (bottled; retail, London) 770 (canned; wholesale, Cahors)
<i>Tuber magnatum</i> Pico	Italian white truffle; Truffe d'Alba; Tartufo bianco pregiato; Bai kuaijun (China)	Worldwide	1,567.5 (bottled; retail, London) 1,210 (wholesale, Bologna)
<i>Boletus edulis</i> Bull. Ex Fr.	Cep, penny bun; Porcino; Steinpilz; Meiwei niugan (China)	Europe, North America	66 (retail, Hamburg) 16.5 (retail, Bologna) 93.5 (dried: retail, Zurich)
<i>Cantharellus cibarius</i> Fr.	Chanterella; Jiyoujun (China); Girolle; Gallinaccio; Pfifferlinge	Europe, North America	16.5 (retail, Hanover)

Note: Priced at fresh weight unless stated otherwise.

Source: Hall *et al.* 1994.

village, perhaps because of their isolation from the outside world and local traditions. The local labour rate ranges from US\$1.8 to US\$3.6 per day.

Song rong production is the most essential activity for cash income for local families. There is a general increase in the trend of household involvement in production, processing and marketing of the product. A few other non-timber forest products, including some other forest mushrooms, pine nuts and medicinal herbs, are also collected in the study area. Household income from the collection of forest products has increased over the past 10 years.

Processing industry

The degree of transformation of *song rong* from raw material to finished product is relatively low. Harvested *song rong* sporocarps are sold to first order buyers fresh after grading by the harvester, who distinguishes several qualities based on size, maturity etc. The first order trader sells the fresh mushrooms to the upper level buyers from the local town. Apart from fresh mushrooms, a small proportion of *song rong* is dried, salted or canned. There is one factory in China that produces *song rong* wine and another that produces *song rong* cookies, but both have low outputs. (The processing of *song rong* into wine and cookies is not included in this report as these side products are still at an early stage of the industry when compared to the trade in fresh mushrooms.)

Trade and marketing

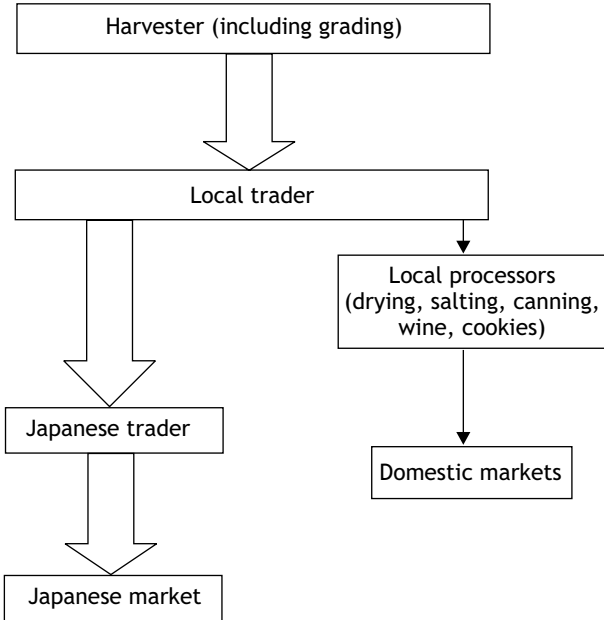
The *song rong* market in Zixi came into existence in the late 1980s. In the 1970s, north-east China produced and exported *song rong* to Japan. When the production from north-east China decreased dramatically (as did the production in Japan), Japanese entrepreneurs opened a business in Kunming after having been told that south-west China also had *song rong*. The late start of the *song rong* trade in this area can be attributed to poor information and transportation connections between the remote production area and the outside world. Before the export to Japan started, the mushroom was used for local consumption only. At first there was only a simple buying station temporarily established on the side of the road during harvesting season. With the awareness of the value and increasingly high price of *song rong* and other mushrooms (mainly *Boletus* and *Termitermices*), the market expanded and became well known to local collectors and farmers.

During the study years (the harvesting seasons of 1997, 1998 and 1999), the number of traders in the production-to-consumption system varied between 15 and 40 first order traders, between 5 and 10 second order traders, and between 2 and 5 third order traders. However, sometimes it was difficult to distinguish a trader's real position in the trading order as some collectors have a number of choices as to whom they sell their product to. Normally collectors sell their produce to two to four buyers. Some middle buyers are from local towns and collaborate with upper order buyers in the area or in Kunming.

Under normal storage conditions *song rong* stays fresh for two days without any treatment, six months when canned and 12 months as a dried, vacuum packed product. Some important attributes such as flavour, taste and colour are lost in storage, which in turn may mean a 50% drop in value.

The markets in the study area are located in the fast-food restaurant areas and shops in the Zixi Forest Park, where several food and mushroom products are sold. The middle buyers buy *song rong* from these local markets and transport the mushrooms to Kunming immediately, where the mushrooms are sold to Japanese businesses or their agents. The product then is flown to Japan. Fresh mushrooms may be served at a table in a Japanese restaurant on the same day or just a few days after they were harvested. In Figure 3 a trade diagram is presented; only about 5 percent of the *song rong* production is processed in China while the remaining 95% is traded fresh to the Japanese market.

Figure 3. Trade diagram



As *song rong* is almost always traded fresh, the shape of the fruiting bodies is considered the most vital factor controlling market price. Grade 1 buttons (above 20 cm long) are sold at US\$250 to US\$370 per kilogram, whereas the lowest quality buttons may fetch only US\$6 or less per kilogram despite there being no great loss in taste. The average farm gate price is about US\$54 to US\$75 per kilogram for *song rong* originating from Zixi mountain.

As a forest product, *song rong* brings great economic benefits to the local communities in Yunnan province. According to the Yunnan Department for Foreign Trade, from June to August 1997 about 350 tonnes of fresh *song rong*

were exported from Yunnan province to Japan. From this figure the annual income from *song rong* in Yunnan is estimated at US\$4 million, which would be 48.8% of the national *song rong* income. It clearly has become an important source of income for the relatively undeveloped province.

Policy environment

To date there is no specific law or regulation on harvesting, processing and dealing in *song rong* in China. But some policies, including national laws, regional regulations and industry product standards, may influence the *song rong* sector indirectly. *Song rong* is a forest resource, according to the Forestry Law of the People's Republic of China (PRC) released in 1984 by the National People's Representative Congress. Other national laws, including the Wildlife Protection Law, the Law on Water and Soil Conservation, and the Environmental Conservation Law of PRC, underscore the importance of natural resources and the necessity for their conservation and protection. The latter also decrees that environmental protection be taken into consideration as fundamental during economic development and resource utilisation. The Land Management Law of 1999 describes the property rights of landowners. In the case of Zixi mountain area the legal rights of producers to harvest the product for commercial purposes have improved in the past decade. *Song rong* collectors have no legal rights to change the land use to another production system, but they do have recognised legal rights to harvest the product from open forestland for trade. There is no entry fee into the reserve for the local people like there is for tourists. Anyone who has the relevant skills may harvest *song rong* from the reserve, while no one seems committed to maintaining the resource in a sustainable way.

Producers in the community are generally aware of their legal rights to harvest the product for commercial purposes and over the last 10 years there has been no official claim by producers to increase land or resource rights. Some legal aspects of *song rong* production and trade are still unclear, however, especially for local residents. For instance, who is responsible for the sustainability of both forest and mushrooms? And: does the resource belong to the state, forest owners, leaseholders, or the public? Local producers have requested special regulations to restrict the entry of 'illegal' harvesters (harvesters from other villages, though not officially illegal, are considered 'illegal' by the local people of the Zixi mountain area), but such regulations would be difficult to enforce.

The government's revenue policy is not intended to influence the production of *song rong*, but local authorities collect a tax of 8.8% of the total product value from the middle buyers. This tax rate is similar to that of agricultural products in the PRC. The tax regulation has no clear effect on the production of the mushrooms.

Both the national and local governments in charge of forestry management recognise the importance of production and sustainable development of *song rong* in the area. The Chinese Forestry Administration funded a five-year research project to verify ecological impacts on the

growth of *song rong*, to seek potential solutions to production problems and to improve production. The Association of Science and Technology of Chuxiong Yi Autonomy Prefecture also (initially) supported a local forestry research institute to study this species in the region. The local forestry department and private companies, dealing with agricultural products, provide local farmers and buyers with some advice. There also is an organisation working with collectors and buyers that provides local buyers with general information on the price of each product. Only a small number of producers participates in the organisation, however.

TRENDS AND ISSUES—DEVELOPMENT AND CONSERVATION LESSONS

Dynamic changes in time

The yield of *song rong* is declining because of overharvesting in the case study area. In the past decade, production has decreased at an estimated rate of 5% per year, especially in the first half of the 1990s. This trend is true for the rest of the country and other East Asian countries as well. Hosford *et al.* (1997) and Wang *et al.* (1997) reported that the yield of *song rong* in Japan, which had been 6,500 tonnes in 1950, had declined to less than 200 tonnes in the late 1990s. The decrease was caused by two factors. First, the ecological changes wrought by a fast moving parasite, the pine nematode (*Bursaphelenchus lignicolus*), which attacks the roots of pine trees, consequently killing the whole tree, have been devastating. Second, certain forest practices such as increased firewood harvesting and the cutting of living trees further diminished the pine population. To compensate for the local decline Japan started importing *song rong* in the 1970s from China and Korea, and also imported white *matsutake* from North America (Zhao 1986; Hosford *et al.* 1997; Redhead 1997).

Destructive harvesting techniques

Current practices for *song rong* collection have greatly affected the growth of the fungus. *Song rong* is being collected in the button stage and the duff and near-surface root horizons are removed, exposing the bare soil to rain-wash. This is a consequence of harvesting for short-term gain. Unfettered access encourages collectors to harvest sporocarps early because of competition between collectors. A survey of fresh products at the buying station (market) in Zixi Forest Park showed that only 50% of harvested *song rong* sporocarps were grade 1 to grade 3, while about 35% were young buttons sold as out-of-grade product with a low market value. Also, site disturbance resulting from the gathering of mushrooms is leading to increased soil erosion here as elsewhere in Yunnan. Researchers and local forest managers are urgently appealing to the legislature and forest administration to establish trade and harvesting regulations for *song rong*. In addition to the lack of appropriate regulations, collectors generally lack basic knowledge of the biology of *song rong*. It is important to educate local collectors to enhance their understanding of the fungus and the impacts of harvesting in order to prevent the harvesting

of immature buttons and to improve the techniques for harvesting to prevent the occurrence of soil erosion. It is necessary to educate local collectors to enhance their understanding of the life history of fungi and appropriate harvesting techniques so that production sites and development areas will be consciously protected during collection.

Access rights

How access to the resource is balanced between competing interests often determines the long-term sustainability of the harvest. The tenure regime for collection and trade of *song rong* and other forest mushrooms is still not clear as they are regarded as common property. Therefore there is a need to clarify the ownership of this property, according to the current laws and regulations, lest no one will invest while everyone harvests. At the same time, specific regulations to guide access control during the fruiting season need to be legislated to promote sustainable harvesting.

Further research

During the study period there have been some efforts to improve the production and conservation of *song rong*, including the transplant of pine seedlings colonised by *song rong* hyphae in selected forest areas. This is just a beginning, however, and further research is absolutely necessary. Some issues to be covered by further research include: (1) the biology and ecology of *song rong*, and in particular the multiple values of *song rong* as a non-timber forest product that, apart from its attribute as a food, also has a function in the cycling of carbon, water and nutrients; (2) the ecological and socio-economic effects of harvesting and intensive fungi farming; and (3) feasibility of intensively managed plantations for the cultivation of *song rong* by transplanting mycorrhizal seedlings in the forests. The progress in developing intensively managed plantations so far is unsatisfactory with this specific mycorrhizal fungus (Tominaga 1978; Ogawa and Ito 1989; Zang 1990; Chen 2002b). Knowledge of European truffles (*Tuber melanosporum*, *T. uncinatum*, *T. magnatum*, *T. brumale* etc.), which can be harvested in plantations after transplanting inoculated plants (as is being done in France, Italy, USA, New Zealand and Australia), would also be useful for other forest fungi (Hall *et al.* 1994; Dell *et al.* 1999; Chevalier and Frochot 2000; Chen 2002c).

ENDNOTES

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2. These mushrooms are also reported in several other provinces in China, but there the availability of the mushrooms is too low for commercialisation.

3. Exchange rate (1998): US\$1 = Yuan 8.2.

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