

Forest products, livelihoods and conservation

Case Studies of Non-timber Forest Product Systems

VOLUME 3 - LATIN AMERICA

Editors

Miguel N. Alexiades and Patricia Shanley



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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

Forest Products, Livelihoods and Conservation: Case Studies of Non-Timber Forest Product Systems

Miguel N. Alexiades¹ and Patricia Shanley²

INTRODUCTION

One of the most intriguing and challenging aspects of non-timber forest products (NTFPs) is their complexity and multidimensionality. Forest products are not only natural resources used to meet subsistence needs, or mere economic resources traded among different kinds of social actors. Forest resources are also embedded in the political, institutional, and cultural life of people involved in their collection and consumption. The multidimensionality of NTFPs is evident in the myriad of processes, actors, and factors that shape their management, processing, and commercialisation. The diversified subsistence strategies of producers and the constantly changing interactions among local producers, processors, traders, markets, and forests—all dynamic entities—means that forest products have distinct, often long and complex, historical trajectories.

In recent years, this historical trajectory has been marked by a renewed interest in NTFPs as tools to promote socially equitable and environmentally sustainable economic development (Nepstad and Schwartzman 1992; Plotkin and Famolare 1992; Clement *et al.* 1999; Viera 2002). This interest is evident not only in the rapidly growing volume of literature, but in the number of government and private interventions directed at this sector, particularly in tropical forests (Ruiz-Pérez and Arnold 1996; Neumann and Hirsch 2000). As Belcher and Ruiz-Pérez (2001:3) note, however:

Much of this investment is based on the premise that improving prices for producers, adding value locally through increasing post-harvest processing and improving local organizations, can lead to long-term economic and political gains for these groups. Some also argue that these kinds of interventions can lead to forest conservation. And yet, understanding of the true role and potential of forest product development to contribute to human development or conservation,

based as it is on untested theory and scattered and inconsistent case-based research, remains limited.

The Center for International Forestry Research (CIFOR) “Assessment of the potential for non-timber forest products based development” initiative is an attempt to address this problem and to improve our understanding of NTFP systems through a comparative and formal analysis of a wide range of cases of forest product development.³ A standardised set of descriptors has been developed to capture the key ecological, technological, social, economic, and institutional aspects of forest production, processing, and trade.

The goal of the case comparison is to

- create typologies or groups of similar cases;
- identify conditions associated with particular kinds of development and conservation outcomes; and
- develop and test hypotheses about forest product development.

Collaborators from 47 institutions in 27 countries in Africa, Asia, and Latin America were identified and recruited, contributing over 60 cases. The criteria for selecting cases included:

1. The forest product has significant demonstrated commercial or trade value; that is, the product is traded in the cash economy.
2. The production, processing, and marketing system has been researched and documented with data available on approximately 70% of the variables.
3. An individual or team of experts is available and willing to collect additional data to complete the case documentation and to participate in the comparative analysis.
4. A suitable range of cases is represented in the study.

Representativeness of cases

The lack of basic information regarding NTFPs is clearly a limiting factor when attempting to compile site-specific case studies, particularly given the need to include detailed economic and social information on the different stakeholders along the trade chain. A dearth of even basic ecological and biological information on key forest resources is endemic in the American tropics (Peters 1994), and it is particularly acute for some of the more vulnerable forest species, for example, the rarer, long-lived, and slow-growing large trees with low rates of regeneration, such as *Endopleura uchi* Cuatrec (chapter 11). Even some highly utilised and ecologically and economically important species, such as Brazil nut (*Bertholletia excelsa* H.B.K., chapter 5) and chicle (*Manilkara zapota* (L.) van Royen), are poorly understood in terms of their natural history or ecology (Ortiz 2002). In other cases, such as asaí (*Euterpe precatoria* Mart., chapter 6), ecological data do exist with regards to such important variables as recruitment and growth, but these vary among research sites and according to the methods employed.

The unequal distribution of scientific knowledge among different taxa, types of forest products, production systems, countries, and regions

helps explain some of the biases in the case studies selected. The fact that ecological data are more easily gathered in the case of short-lived species and that more economic data are available in the case of widely commercialised forest products, for example, often contributes to a research bias against slow growing species (Cunningham 2000) or against those with limited market value. Thus, of the 22 plant case studies included in this volume, 19 correspond to fast-growing species with a short reproductive life span, mostly herbs, shrubs, and palms, which in turn are generally more easily brought into cultivation. Indeed, cultivation involves the main form of production for seven of the cases presented in this volume, and it is recognised as a highly viable option in another eight cases.

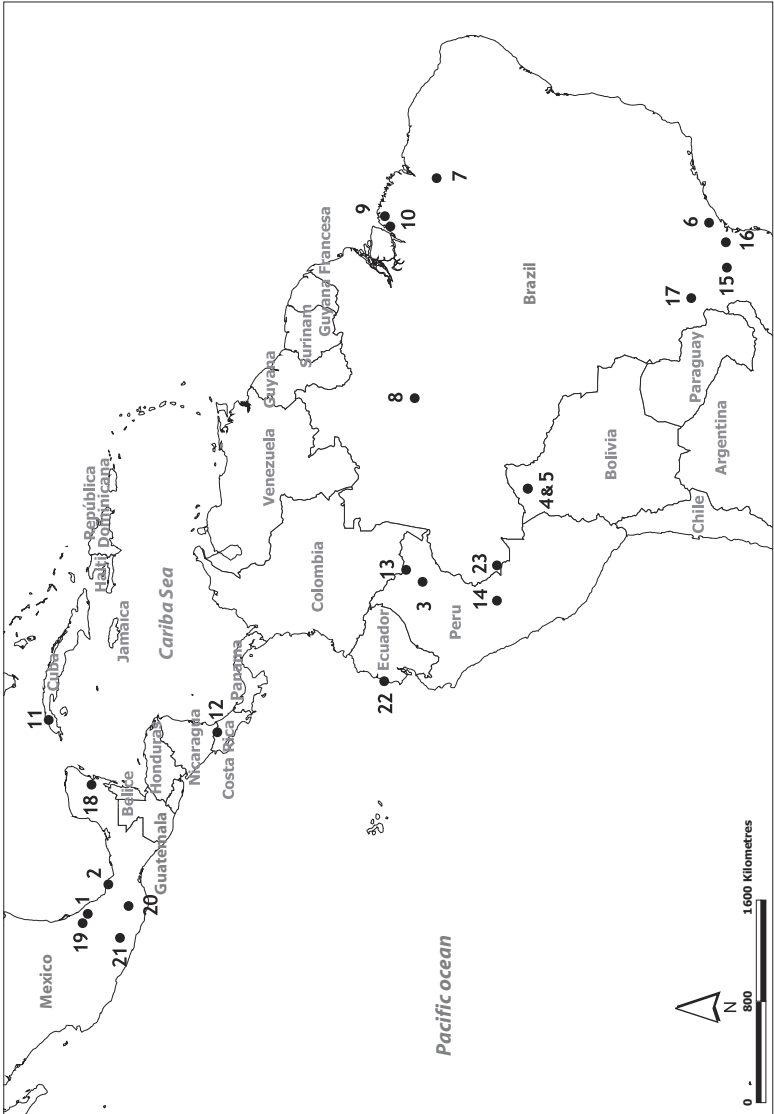
Geographical bias is also evident in the selection of cases presented, with one third of the sample originating from Brazil and one quarter from Mexico. This distribution, in part, reflects a long history and interest in ethnobotanical research as well as active training in universities and botanical gardens in these two countries. In spite of these biases, however, the 23 cases presented include a wide diversity of products, management practices, and trade regimes, thereby reflecting the multidimensionality that characterises forest products in Latin America.

NON-TIMBER FOREST PRODUCTS OVER TIME: DYNAMISM, HISTORY, AND CHANGE

The multidimensionality of NTFPs has a clear temporal dimension, which often translates as a long and complex series of historical trajectories. Aubertin's (1996) observation that the history of the lowland American tropics is inextricably linked to the history of use and exploitation of NTFPs provides an interesting perspective by which to examine this aspect of the multidimensionality of forest products. The long history of commercial forest product extraction in Latin America can conveniently be divided into five more or less distinct eras or phases: pre-Hispanic or pre-Columbian, colonial, industrial, modern, and postmodern.

Pre-Hispanic phase. Pre-Columbian networks of trade and exchange linking different regions in the Americas—notably the coastal plains, the Andes, the Amazon and Orinocco basins, as well as meso and north America—were sustained largely through the flow of commodities such as metal tools, salt, and such animal and plant products as *Spondylus* shells, feathers, pets, medicinal plants, and resins such as copal (Renard-Casevitz *et al.* 1988; Currie 1995; Shatto 1998; Purata *et al.* chapter 21; Hersch *et al.* chapter 22). In contrast to other parts of the world, notably south-east Asia and parts of Africa, where trade routes and commodity flows have been maintained for several thousand years, many of the American regional trade networks were severely weakened or destroyed following European conquest and the concomitant depopulation and the re-organisation of indigenous social and political institutions. Similarly, while some of the plants included in this volume, notably *Pimenta dioica* (L.) Merrill, *Pouteria sapota* (Jacquin) H.E. Moore & Stearn, *Carludovica palmata* R&P, and *Sabal yapa* Wright ex Becc. (chapters 2, 3, 19, 23), have retained a relatively salient position in

Figure 1. Location of study cases



Source: ESRI Data and Maps 2002.

Table 1. Important characteristics of study cases

no.	country	species	Common names	part of the resource used	Dominant form of management	transformation*	scale of trade	geogr. range**	Regional status***	author
1	Mexico	<i>Pimenta dioica</i>	Pimienta gorda, Allspice	fruit	managed	medium	international	high	increasing	Martínez, M.A. <i>et al.</i>
2	Mexico	<i>Pouteria sapota</i>	Maney, Zapote maney	fruit	wild	low	national	high	increasing	Nava-Cruz, Y. and Ricker, M.
3	Peru	<i>Tayassu tajacu</i> ; <i>Tayassu pecari</i>	Pecari, Sajino and Huangana	meat	wild	low	national	high	decreasing	Cornejo A., C.
4	Bolivia	<i>Bertholletia excelsa</i>	Castaña, Almendra, Nuez del Brazil, Brazil nut	seeds	wild	low-medium	international	high	stable	Stoian, D.
5	Bolivia	<i>Euterpe precatoria</i>	Asai, Palmito, Palm heart	palm heart	wild	medium	international	high	decreasing	Stoian, D.
6	Brazil	<i>Euterpe edulis</i>	Palmitero, Palmito, Palm heart	palm heart	wild	medium	national	medium	decreasing	Fantini, A.C. <i>et al.</i>
7	Brazil	<i>Orbignya phalerata</i>	Babacu	fruit	wild/managed	high	national	high	decreasing	Pinheiro, C.U.B.
8	Brazil	<i>Bactris gasipaes</i>	Pupunha, Pejibaye, Peach palm	fruit	cultivated	low	national	high	stable	Clement, C.R. and Van Leeuwen, J.
9	Brazil	<i>Platonia insignis</i>	Bacuri	fruit	managed	low	national	high	decreasing	Medina, G. and Ferreira, S.
10	Brazil	<i>Endopleura uchi</i>	Uxi	fruit	wild/ managed	low	national	high	decreasing	Shanley, P. and Gaia, G.
11	Cubal	<i>Pinus caribaea</i>	Pino macho	exudate	managed/cultivated	high	international	low	stable	Betancourt F., Y. <i>et al.</i>
12	Costa Rica	<i>Psychotria ipecacuanha</i>	Raicilla, Ipecacuana, Ipecac	root	cultivated	medium	international	high	stable	Ocampo S., R.A.
13	Peru	<i>Myrciaria dubia</i>	Camu-camu	fruit	wild	medium	international	medium	decreasing	Pinedo P., M. and de Jong, W.
14	Peru	<i>Uncaria tomentosa</i> ; <i>Uncaria guianensis</i>	Uña de gato, Cat's claw	bark	wild	high	international	high	decreasing	Navarte A., W. y de Jong, W.
15	Brazil	<i>Baccharis trimera</i>	Carqueja	stem and leaves	managed	medium	national	high	stable	Steenbock, W.
16	Brazil	<i>Maytenus ilicifolia</i>	Espinheira-santa	leaves	wild	medium	national and international	medium	stable	Scheffer, M.A.
17	Brazil	<i>Pfaffia glomerata</i>	Batata-do-mato, Fáfia, Brazilian ginseng	root	wild	medium	international	low	decreasing	Corréa, C.J. and Lin Chan Ming
18	Mexico	<i>Sabal yapa</i>	Xa'an, Guano	leaves	wild	low	national	medium	stable	Caballero, J. <i>et al.</i>
19	Mexico	<i>Trema micrantha</i>	Jonote	bark	managed	medium	international	high	stable	López, C.
20	Mexico	<i>Bursera glabrifolia</i>	Copal, Copatillo	wood	wild	medium	international	medium	decreasing	Purata, S.E. <i>et al.</i>
21	Mexico	<i>Bursera alioexylon</i>	Xochicopal, Copalcojtlí, Linaloe	wood	wild	medium	international	medium	decreasing	Hersch M., P. <i>et al.</i>
22	Ecuador	<i>Carludovica palmata</i>	Paja toquilla, Sombrero de Panamá, Panama hat	leaves	wild/managed	medium	international	high	stable	Alarcón G., R. y Burbano, M.F.
23	Brazil	<i>Hevea brasiliensis</i>	Seringueira, Seringa	exudate	wild	medium	international	high	stable	Pantoja, M.C.

* 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).

** 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).

*** Status of the population in Latin America.

the resource management profiles of forest dwellers since pre-Columbian times, others, such as *Bactris gasipaes* Kunth (chapter 9), never regained their former importance.

Colonial phase. The period between the sixteenth and nineteenth century involved a series of intense and profoundly important exchanges of plants between continents (Hobhouse 1985). Neotropical crops such as chocolate (*Theobroma cacao* L.), potato (*Solanum tuberosum* L.), manioc (*Manihot esculenta* Crantz), and maize (*Zea mays* L.) became important food crops in other parts of the world, while cultigens like bananas, coffee, and sugarcane were incorporated into Latin American colonial agriculture. A number of neotropical forest products, notably vanilla (*Vanilla planifolia* Andr.), sarsaparilla (*Smilax* spp.), copaiba (*Copaifera reticulata* Ducke), quinine (*Cinchona officinalis* L.), ipecac (*Psychotria ipecacuanha* (Brotero) Stokes, see chapter 13), and copal (*Bursera aloexylon* (Schiede) Engl., chapter 22), became important commodities in the rapidly growing global economy and were subject to the boom and bust cycles that have characterised the history of commercial forest product extraction in Latin America (Bunker 1985; Homma 1992).

Industrial phase. The synergistic conflation of numerous factors in the late nineteenth century led to an explosion in demand for forest products from the tropics. Technological innovations, including mechanisation, allowed entrepreneurs to transform natural products into new kinds of commodities at an unprecedented scale. This ability, combined with rapid urbanisation and the revolution in transportation (notably the steam engine and the locomotive) and communication (notably the telegraph), led to a veritable explosion in the number and size of global commodity chains, many of which involved tropical forest products. The classic example is rubber (*Hevea brasiliensis* Müll. Arg., chapter 24): it was only after Goodyear discovered the process of vulcanisation in the nineteenth century that this forest product, transported from remote areas to industrial centres by steamboats and railways, could be used to produce new commodities, such as tyres. Similar extractivist booms were taking place throughout the world in response to the same interaction between economic forces and technology (e.g., Warn 2000).

The industrial revolution in northern Europe and subsequently in the United States created a huge demand for natural resources, a demand that in Latin America translated into a series of economic booms linked to the extraction of mineral and biological resources including tin, copper, bird guano, and forest products such as rubber, chicle (*M. zapota*), vegetable ivory (*Phyttelephas macrocarpa* R&P), barbasco (*Lonchocarpus nicou* (Aubl.) DC.), ipecac (*P. ipecacuanha*, chapter 13), linaloe (*B. aloexylon*, chapter 22), and Panama hat, *C. palmata* (chapter 23). While some of these forest products—ipecac and linaloe are examples—have been exported since colonial times, others, like rubber, entered the global market for the first time during this period. As a result of these extractivist booms, an enormous amount of wealth was generated: rubber, for example, was the third most important export from Brazil from 1887 to 1917 (Padoch and de Jong 1990). A large part of the enormous wealth generated by the extractive economy during this period was captured by an elite whose ties with the industrial powers,

and notably the United Kingdom, contributed to the formation, consolidation, and expansion of modern Latin American nation states and the independence from imperial—and unindustrialised—Spain and Portugal (Skidmore and Smith 2001).

Modern phase. By the middle of the twentieth century, the same process of technological innovation that had helped create forest product commodity chains in the nineteenth century generated their demise. Advances in post-World War II inorganic, and especially petroleum-based, chemistry led to the replacement of forest products such as gums, resins, fibres, and medicines by cheaper synthetic alternatives. Whereas 20% of all buttons produced in the United States during the 1920s were made of vegetable ivory (*P. macrocarpa*) harvested in Ecuador, by the 1960s plastics had replaced vegetable ivory almost completely (Acosta Solís 1944, cited in Barfod *et al.* 1990:293). Similar declines followed for barbasco, replaced by DDT, chicle, replaced by synthetic chewing gum, as well as malva (*Urena lobata* L.), Panama hat (chapter 23), and natural rubber (chapter 24).⁴

Postmodern phase. The contemporary stage of global capitalism has unleashed new social and economic forces, which in turn have revitalised some old commodity chains while creating new ones. On the one hand, the expansion of the global economy, the communications revolution, and the widespread suspension of state subsidies during the late twentieth century have exposed Latin American products to intense competition from other regions. Alarcón and Burbano (chapter 23), for example, note how the cheapest Panama hats cannot compete with synthetic or with natural fibre hats from Asia. Likewise, the remains of the rubber extraction industry in Brasil and Bolivia⁵ collapsed following the neoliberal reforms imposed by the International Monetary Fund in the 1980s, which entailed the suspension of government tariffs and subsidies designed to protect the national rubber industry.

The vegetable ivory industry, on the other hand, which had almost disappeared by the 1970s, began to thrive again in the 1990s, with exports to Japan, Germany, and Italy (Barfod *et al.* 1990). The vegetable leather and, to a lesser extent, Panama hat cases described in this volume are other examples of industrial commodity chains that experienced modern decline and postmodern revitalisation. The expansion of the service economy, and tourism in particular, the growth of niche markets, and a postmodern fascination with the local and the indigenous, have all opened new spaces for commercialisation of forest products in Latin America, particularly for crafts (for example, alebrijes, papel amate, Panama hats, and vegetable leather), specialty foods (Brazil nuts, zapote mamay), nutritional supplements (vitamin C from camu-camu, and medicinal plants carqueja, espinheira-santa, and cat's claw). Many of the cases in this volume highlight the way in which forest products, once associated with the rural underclass and with recent urban migrants, have in the past decades become part of the urban 'chic'. The process of coating cotton or other fibres with *Hevea* latex, originally used by rubber tappers to waterproof their bags and garments, is now used in fashion accessories in Rio de Janeiro, Paris, and London (chapter 24). Likewise, well-made and marketed 'Panama hats' fetch up to US\$1,000 in London,

and painted wood carvings, alebrijes, from villages in Oaxaca, Mexico, are on display in California art galleries. Medicinal plants such as cat's claw (*Uncaria spp.*), sangre de drago (*Croton lechleri* Müll.Arg.), espinheira-santa (*Maytenus ilicifolia* Mart. ex Reiss), and Brazilian ginseng (*Pfaffia glomerata* [Spreng.] Pedersen), once purchased mostly by the lower middle class from street vendors in Peru and Brazil, have been scientifically legitimised and are now consumed by the urban affluent in these countries as well as abroad (Alexiades 2002a, b; Nalvarte and de Jong, chapter 15; Scheffer, chapter 17; Corrêa and Ming, chapter 18), as have *Maytenus ilicifolia* and *Pfaffia glomerata* in southern Brazil. Indeed, 15 of the 23 cases presented in this volume describe forest products that either have entered the world market or whose international commercialisation has been revitalised in the past decade or so.

KEY ISSUES ALONG THE TRADE CHAIN OF FOREST RESOURCES

The 23 cases in this volume provide a detailed and textured composite of NTFP systems in Latin America today. Besides illustrating the multidimensionality and diversity of conditions under which forest products are extracted, processed, and traded, the accounts illustrate a number of recurrent themes and raise some important issues and questions, particularly with regard to the role of such systems in promoting environmental and social well-being.

Ecological issues

Ecological factors shape and are shaped by both supply and demand of the forest product. On the one hand, abundance, and distribution of the resource directly shape supply by determining the amount of raw material that is available. The ecological characteristics of species also either enhance or curtail their ability to survive landscape-level changes and to recover from extraction. Some of the key biological factors that influence vulnerability or resilience include life form, age to reproductive maturity, productivity, density, resprouting potential, and plant part harvested (Peters 1994; Cunningham 2000). The notion that harvesting of fruits and nuts causes less ecological impact than harvesting of tissues such as roots is broadly supported by the eight fruit and nut cases presented. The choice of harvesting technique is, however, equally important, as even fruit harvest can be dramatically unsustainable if it entails felling of the tree, as is the case in the harvesting of *Mauritia flexuosa* L. from parts of Peru (Gentry and Vásquez 1989).

Over half of the case studies report declines in the availability of the forest species, though in most cases this is not a result of direct overexploitation but of habitat degradation and land use change. This circumstance is particularly the case in Brazil, which after the 1960s embarked on an ambitious programme for developing the lowland interior through road building, colonisation, logging, as well cattle ranching and large-scale commercial agriculture (Hecht 1985). Levels of deforestation are particularly high in the more developed south. For example, according to Fantini *et al.* (chapter 7), only 10% of the original forest cover remained as of 1990 in the Mata Atlântica of Brazil. Likewise,

Corrêa and Ming (chapter 18) report that the high rate of urbanisation in the state of Paraná leads authorities to estimate that 70% of the superior plant vegetation in the state is at risk. In Mexico, agricultural expansion of unshaded coffee plantations and cattle ranching threaten to destroy the trees used for bark cloth, while in Costa Rica and Ecuador increasing urbanisation and agricultural expansion have led to erosion of the wild resource base.

Conversely, changes in land use may favour some forest species. In Brazil, for example, the babaçu palm (*Orbygnia phalerata* Mart.) thrives in open pastures and resprouts well after fire. Because of conversion of natural forests to pasture, babaçu now occupies over 18 million hectares in Brazil, over half of these in the state of Maranhão (chapter 8). Allspice (*P. dioica*), mamey (*P. sapota*), and guano (*S. yapa*) in Mexico, ipecac (*P. ipecacuanha*) in Costa Rica, and Panama hat (*C. palmata*) in Ecuador are all managed in response to landscape-level changes, thus guaranteeing supplies in areas of large-scale forest conversion (chapters 2, 3, 19, 13, 23).

In a number of cases, increased demand for a forest product has led to the implementation of management practices that appear to favour sustainability. In areas in close proximity to markets in Pará, Brazil, for example, demand has encouraged farmer-led innovations in the management of the fruit trees *Platonia insignis* Mart. (chapter 10) and *Endopleura uxi* (chapter 11). In most instances, however, increased demand has probably contributed to the abandonment of those collection and management techniques that promoted sustainability. Yet in other cases, such as Bolivian palmito (*E. precatoria*), unsustainable harvesting practices probably have had minor impacts on the ecological viability of the species given that the spike in demand was short-lived (chapter 6).

The impact of harvesting or land use change may compromise the genetic diversity even among cultivated species, mainly by its effect on wild populations. As Scheffer (chapter 17) notes for espinheira-santa (*Maytenus ilicifolia*), species where most genetic variation occurs within populations are particularly vulnerable to genetic erosion. Genetic erosion is also noted as a risk for species such as pupunha (*Bactris gasipaes*), Brazilian ginseng (*Pfaffia glomerata*), carqueja (*Baccharis trimera*), and Costa Rican ipecac (*Psychotria ipecaucuanha*). As a result, several authors underscore the need to implement in-situ conservation measures for these species.

Responses to scarcity

Increased rates of harvesting of wild populations frequently lead to forest product scarcity, particularly for rare, slow-growing species with narrow ecological requirements, such as uxi (*E. uchi*, chapter 11). While abundant fast-growing species with broad ecological requirements and rapid regeneration rates are less vulnerable, they may still be locally depleted beyond their capacity to survive, as is the case with espinheira-santa and fáfia in parts of Paraná, Brazil (chapters 17, 18). A useful approach to understanding conservation outcomes of increasing species trade is to examine harvester responses to resource scarcity or local extinction (Cunningham 2000).

Increasing the harvesting range

Increasing the distance travelled to locate and exploit new populations is a common first response to resource scarcity (Cunningham 2000), and is reported for espinheira-santa, Brazilian ginseng, and copal (chapters 17, 18, 22). In some cases, such as that of *Euterpe edulis* in the Atlantic forests of Brazil, finding new wild populations has been the principal response to resource scarcity for several generations of harvesters, leading to widespread local extinction.

Substitution

Simultaneous or serial substitution of species is one common response to a declining resource base, often at the expense of quality (Cunningham 2000). Scheffer (chapter 17), for example, estimates that over 30% of plants commercialised as espinheira-santa in Brazil are other species than *M. ilicifolia*. Likewise, almost half of the wooden boxes sold as linaloe (*B. aloexylon*) in Olinálá, Mexico, are actually made of pine wood (*Pinus* spp.) (chapter 22). The papel amate case from Mexico is an excellent example of serial substitution: over the past 20 years, several species of *Ficus*—traditionally used to make the bark paper—have been replaced by 16 other species (chapter 20). Whereas in this case the serial substitution of the raw material was undertaken by the same harvesters, there are other instances of substitution where the forest product is extracted from other regions. Wild populations of the palm heart from *E. edulis* in the Brazilian Atlantic forest were so severely decimated between the 1930s and 1960s that much of the palm heart industry moved to the Amazon, exploiting wild stocks of *E. oleracea* and *E. precatória*, even if these are of lower quality.

Substitution with cheaper alternatives, whether synthetic or from different species or regions, has led to the collapse of demand for a number of forest products. The fafia or Brazilian ginseng (*P. glomerata*) case illustrates the other side of the coin: though taxonomically unrelated, this plant is now traded in Japan as a substitute for Asian ginseng, whose wild populations have been severely depleted in many parts of Asia (chapter 18). Another form of substitution involves harvesting the natural resource before the plant has reached its optimal stage of development. Hersch *et al.* (chapter 22) describe an instance of ‘green apple-picking syndrome’ in the state of Guerrero, Mexico, following declining stocks of wild *Bursera*. Harvesters have begun to cut increasingly young trees, which in turn have poor-quality wood. As harvesters become more desperate, they begin to steal wood from private properties, forcing owners to themselves harvest individuals which have not yet reached harvesting age.

Intensification of the production system

Intensification of the production system is another response to forest product scarcity. In the case of Panama hat, cultivation of the species in plantations, or *pajales*, in the nineteenth century continued to provide the raw material after the decline in world demand in the middle of the twentieth century.

Many of the cultivated species, including allspice in Mexico, pine (*Pinus caribea* Morelet) resin in Cuba, and ipecac in Costa Rica, are associated with industrial uses and/or international markets (chapters 2, 12, 13). In recent years, the realised or expected increases in the demand for such plants as camu-camu (*M. dubia*) and cat's claw (*U. guianensis*), have led state agencies and nongovernmental organisations (NGOs) to promote cultivation or intensification of the production system, either in the way of direct intervention, technical assistance, or subsidies (chapters 14, 15).

While the ecological characteristics of some species, notably agrestics and heliophytes such as carqueja (*B. trimera*, chapter 16), make them more likely candidates for cultivation, forest species such as ipecac (*P. ipecacuanha*, chapter 13) have also been cultivated under forest canopy. In those cases where cultivation is encouraged as an alternative to extractivism, it is important to consider, as several authors point out, the implications for harvesters, whose subsistence often depends heavily on harvesting wild forest products and who often lack secure land or resource rights and alternative sources of income. Even in cases where cultivation is technically possible, economically feasible, and socially desirable, its contribution to the conservation of existing forests is not always certain. In any event, the fact that significant amounts of the raw materials harvested in 15 of the 24 case studies continue to be collected from wild populations attests to the ongoing importance of extractivism in the Latin American tropics.

Market issues

The kind and degree of industrial transformation of the forest product and the scale of commercialisation vary considerably according to the species and region. Some, such as palm hearts and Brazil nuts, are well-known and widely commercialised: 1997 exports of these from Bolivia amounted to US\$12 million and US\$32 million, respectively (chapters 5, 6). In contrast to such well-known and well-travelled species, most individual NTFPs generate rather modest annual financial returns. In spite of their small individual turnover, the cumulative value of hundreds of these small-scale forest commodities is considerable, forming the monetary base for millions of harvesters, processors, and traders. And while the size in such trade in forest products might be expected to decline as forest products are replaced by substitutes or brought into cultivation (Homma 1992, 1993), in Latin America this decline has not occurred for a multitude of forest products that are still wild-sourced and which still enjoy strong demand from urban centres. Amazonian cities include large and growing numbers of rural migrants, who in turn generate demand for certain forest products (Browder and Godfrey 1997) and who continuously forge new supply links between the forest and the city. Finally, there are also those forest products whose markets are characterised by a high degree of volatility: palm heart from the Bolivian Amazon, for example, experienced a boom and bust cycle in less than a decade (chapter 6).

Local economies and subsistence

Only a small percentage of all forest products gathered in the tropics have any kind of market, and an even smaller proportion of these are commercialised internationally. Even though some export NTFPs, such as palm heart and Brazil nut, generate substantial national revenues, most individual NTFPs have small, often seasonal, and at times ephemeral, turnovers. Even so, the importance of NTFPs to local incomes may be substantial, particularly in cases where few other income-earning options exist. The timing of the income is sometimes almost as important as the amount: the fruit harvest of uxi, for example, coincides with the start of the academic year, when many parents face an additional, small but nonetheless significant, financial burden (chapter 11). The Quilombo producers in the Vale do Ribeira de Igape, Brazil, can always turn to harvesting palm hearts when needs for cash arise (chapter 6). Likewise, weavers in the Manabí, Ecuador, often keep a stock of Panama hats, using them to generate cash at short notice and in times of need (chapter 23). For the predominantly Nahua harvesters of *Bursera* wood described by Hersch *et al.* (chapter 22), incomes derived from forest products are likewise small but significant, especially given the dearth of economic options available to this disenfranchised group of people living in an economically and ecologically marginal part of Mexico. Finally, the pine resin case described by Betancourt *et al.* (chapter 21) provides yet another example of a forest product serving as a safety net, only this time in the context of international politics and the U.S.-led economic embargo against Cuba.

Forest product commodity chains usually involve a large number of actors, who in turn are often placed in diverse and widely separated geographic, social, and economic spaces. The longer the chain and the higher the degree of processing, the greater is the difference likely to be between those who harvest the resource in the forest and those who produce or commercialise the final product. These differences are often reflected in the price changes along the chain, but sometimes also in the way how profits accrue to different kinds of social actors, sometimes even at the same stage of the chain. For example, Brazil nut harvesters may capture anywhere between 6% and 47% of the export price, depending on the kind of harvester, the commercialisation route utilised, and the time of year (chapter 5). In any event, there is a widespread tendency for actors involved in the later stages of the chain—namely processors and middlemen—to capture more profits than the raw material harvesters. In the case of linaloe, for example, intermediaries sell the raw material to carvers for prices up to 10 times what they pay the harvesters (chapter 22). The *Bursera* wood carvers in the states of Oaxaca and Guerrero, Mexico, are likewise better organised, have better access and links to markets and to social capital than the collectors of wood (chapter 21).

As new markets for existing forest products are developed, new and different actors enter the chain. Espinheira-santa, which until recently was only available locally and in the form of crushed leaves to be consumed as a tea, is now consumed in more cosmopolitan contexts and available in other, more processed forms, including capsules and tinctures (chapter 17).

Expansion of trade chains and increases in the degree of processing are often realised by a small group of actors. In many cases, such as that of cat's claw in Peru, the market for these more highly processed or widely distributed final products is dominated by larger firms, which have the capital and know-how for product development and marketing, and which can provide some quality guarantees. In many instances consumers have to choose between the product sold by large companies, which has a guaranteed quality but is sold at a high price, and the 'clandestine' product, which is cheaper, but often of uncertain quality and frequently adulterated.

International markets and globalisation

Not surprisingly, the biggest revenue earners reported in this volume involve products traded in the international market, including Brazil nuts, palm heart, Panama hats, Mexican alebrijes, and pine resin. International markets for Latin American forest and agricultural commodities have shown a historical disposition towards boom and bust cycles, often at a high social cost (Bunker 1985; Homma 1992, 1993; Stoian 2000). Bolivian rubber tappers, for example, turned to Brazil nuts and palm heart following the suspension of state subsidies on rubber in the 1980s and the consequent collapse of its market value (chapters 5, 6). NTFPs have often substituted for cash crops during market lows. Low coffee prices, for example, mean that coffee farmers in the state of Puebla, Mexico, derive more income from allspice, which grows in association with coffee, than from coffee itself (chapter 2).

Many of the cases illustrate the difficulties faced by NTFP producers in a deregulated world market. The danger of substitution by cheaper imports is particularly noticeable among crafts and forest products used in industry, such as babaçu oil (chapter 9) and pine resin (chapter 12). New heightened forms of competition have a mixed effect on product quality. Whereas López (chapter 20), Hersch *et al.* (chapter 22), and Alarcón and Burbano (chapter 23) lament the loss of quality and concomitant loss of skill, knowledge, and expertise following mass production and substitution with cheaper products, high-quality items are at a premium in some niche markets, though these, as in the case of vegetable leather, often need to be developed from scratch.

Economic globalisation has opened spaces for some Latin American products, in particular those linked to specialised or high-end markets, particularly for crafts and medicinal plants. In some instances, neoliberal policies, in the form of liberalised exports or fiscal incentives, as well as investments by the World Bank and other international organisations, have helped promote the international trade and processing of forest products such as Brazil nuts (chapter 5).

Clearly, exploiting such market opportunities requires a certain level of political and entrepreneurial long-term commitment, as well as a degree of organisation among producers or processors, which, as Pinheiro (chapter 8), Clement and van Leeuwen (chapter 9), Ocampo (chapter 13), and Hersch *et al.* (chapter 22) lament, are frequently absent in Latin America. Capital, information, and innovation are also all necessary in order to identify and respond in time to the rapidly and continuously changing characteristics of

the global marketplace. The experiences related in this volume suggest that interventions in these cases should be directed at creating more favourable institutional and legislative environments, strengthening the technical and organisational abilities of producers, ultimately helping them identify new markets, improve product quality, and increase profits. Problems related to quality consistently re-emerge throughout the volume. Variations in quantity and quality of both the raw material and processed goods is one limiting factor in developing international markets for many forest products. In this sense, many authors concur on the urgent need for incentives to improve quality, not only through quality control and training, but by putting in place a pricing system that adds monetary value to quality.

Another important lesson to draw from the case studies is that international markets are often inherently fragile and short-termed, particularly when linked to luxury goods or fads, which in turn are especially vulnerable to economic recessions and to fickle tastes. Quality once again emerges as an important factor, in terms of both developing and holding on to international markets. Problems of inconsistent or poor quality and of product contamination have, for example, limited the access of Bolivian palm heart to the huge Brazilian market (chapter 6), led to the fall in the international price of Brazil nuts (Newing and Harrop 2000; Stoian, chapter 5), and probably contributed to the sudden fall in international demand for cat's claw (chapter 15).

Socio-political and institutional issues

NTFP production systems form part of a matrix of social, political, and institutional relations—as well as economic and ecological ones. The actions of harvesters, traders, and processors respond not only to changes in the abundance, distribution, and accessibility of the species, but also to power relations and institutional dynamics. In many cases, as Fantini *et al.* (chapter 7), Hersch *et al.* (chapter 22), and others note, the main challenges facing the development of sustainable NTFP production systems are social and political, rather than technical (see also Pierce 2002). The various case studies both highlight and qualify some of the socio-political and institutional aspect of NTFP production-to-consumption systems, particularly in the context of state and nonstate interventions.

Resources and property rights

Immersed in the 'subordinate modernity' (Hersch 2003:33) of contemporary Latin American social and political life, NTFPs continue to form a safety net for peasants and indigenous people, helping them weather the ups and downs of the global market and its agents. Some harvesters, such as those described in the cases of sabal, Panama hat, allspice, and vegetable leather, have formally recognised rights over the resources that form the basis for their subsistence. Others, such as the landless, displaced peasants and migrant labourers that harvest fafia, espinheira-santa, palm hearts and linaloe, work and live under conditions of greater social and legal marginality.

The prediction that producers with clearly defined proprietary rights over their resources are more invested in minimising the destructive effects of harvesting is generally supported by the case studies in this volume. The Mexican woodcarving case in chapter 21 elegantly illustrates this notion, suggesting that most populations of *Bursera* have been depleted by extractors without property rights, whereas one community with well-defined property rights and a good level of organisation has set in place an innovative study of resource availability and implemented a management plan for the species. In other instances, such as that of rubber tappers in extractive reserves described by Pantoja (chapter 24), harvesters are economically disenfranchised, but have clear proprietary rights and stronger social institutions, which in turn have helped them regulate resource extraction. In contrast, however, palm hearts in Bolivia were extracted unsustainably during an economic boom, irrespective of the tenure or property regimes (chapter 6).

Interventions

Despite years of research and extension efforts on the part of scientists, governments, and NGOs, the potential and value of many NTFP production systems remains thwarted: the peach palm, Brazilian palm heart and babaçu cases in this volume are examples. Moreover, while ‘intervention’ is often deemed to contribute to community development, conservation, and economic equity, the cases of bacurí and uxi point out that, in these cases, ‘zero intervention’ has allowed producers to formulate their own effective, locally adapted, ecological and economic production systems.

Government interventions. Many of the authors in this volume reflect on the potential, albeit often unrealised, role of the state in improving social and ecological well-being in the context of NTFP development. Many authors criticise governments for a lack of awareness, interest, and commitment to this sector. In some instances, the greatest—often negative—impact of the state on NTFPs has been indirect, and the consequence of broader interventions, typically through development and colonisation programmes. Tax subsidies in Brazil during the military government of the 1970s, for example, led to large-scale conversion of rubber and Brazil nut-rich forests to pastures, the social and ecological consequences of which in turn led to the formation of a well-organised and subsequently highly influential resistance movement of rubber tappers, whose actions contributed to the formation of large extractive reserves in Acre (Allegratti 1990; Elder 1991).

Direct government subsidies have in the past been directed at some of the major NTFP production systems—notably rubber and Panama hat—but most of these were suspended as part of the structural adjustments promoted by the International Monetary Fund during the 1980s. The ipecac case in Costa Rica (chapter 13) provides an example of the challenges faced by governments trying to implement an effective subsidy programme, which in this case led to widespread corruption and abuse, and to the eventual collapse of the co-operative of producers.

Case studies from Peru, Bolivia, and Brazil report on some of the impacts of the current forestry legislation. Fantini *et al.* and Scheffer (chapters 7, 17)

suggest that many requirements, such as obtaining permits and presenting management plans for the targeted species, penalises small producers, who often work with small profit margins and who cannot afford to shoulder the added financial burden, particularly when complicated technical and bureaucratic steps are involved. Macro-economic government measures have also been damaging to small producers of babaçu, as these have curtailed their access to the natural resource. Most of the Brazilian analyses of government interventions are likewise highly critical of efforts at criminalising the extraction of some NTFPs, even when these are under threat, as this has reportedly favoured corruption, led to a lowering of product quality and price, and contributed to the vicious cycle of ecological degradation and social marginality. Several authors likewise emphasise that many government interventions lack a coherent long-term vision, placing too much emphasis on the regulatory aspect, while providing inadequate incentives and support. Likewise, a number of case studies suggest a need for better integration and coordination among the various agencies and forms of government intervention, especially among research, extension, and enforcement.

Martínez (chapter 2) and Hersch *et al.* (chapter 22) suggest that the failure of government efforts to promote reforestation and promote NTFP production in Mexico is due to technical and logistical factors, as well as a lack of follow-up and long-term commitment, and to the lack of local participation. Despite these shortcomings, there are some success stories. For example, the Mexican government agency Fondo Nacional para el Fomento de las Artesanías has successfully promoted the crafts sector. In parts of Bolivia and Brazil, on the other hand, NTFP harvesters have benefitted from forestry laws that award them proprietary rights over logging companies.

Nongovernment interventions. The economic reforms of the 1980s and 1990s in Latin America had profound social and political ramifications. The dismantling of the welfare state and the contraction of the public sector, coupled with a continent-wide transition towards liberal democracy and political decentralisation, all catalysed the growth and consolidation of civil society in the region (Edelman 2001). On the one hand, the emergence of new social movements related to human rights, social justice, and environmental issues opened up new political and institutional spaces, and these opportunities were effectively utilised by such forest producers as the rubber tappers in Acre. The dramatic growth in the number and influence of NGOs has meant that these institutions have become the principal agents of intervention in many areas, often targeting forest communities and forest products (e.g., Forte 1999). The kinds and contexts of these interventions by NGOs on NTFP production systems varies considerably among cases. In some instances, such as carqueja in Paraná, Brazil (chapter 16), interventions have sought to create an almost entirely new production-to-consumption system: here, a consortium of NGOs has implemented new cultivation and processing techniques, trained processors, established quality controls, developed new products, and identified new markets for this plant. Other interventions, such as the one described for vegetable leather (chapter 24), on the other hand, involve forest products with a long history of use, but which are now being inserted in a new trade chain designed for a completely

new end-product and a different market. Yet another group of interventions, exemplified by the Panama hat case (chapter 23), are directed towards an old and well-established production system and trade chain, often with the goal of revitalising the system or reconfiguring the distribution of profits within the chain. It is quite conceivable that the challenges and outcomes of these interventions vary considerably according to these differences. In any case, the authors of the above-mentioned cases observe that tensions do emerge among NGOs, local organisations, and producers, particularly around issues of representation and control.

Several of the case studies in this volume consider certification as a tool to promote the social equity and environmental sustainability of NTFP production systems. Guidelines for sustainable management have been developed in the cases of Brazil nut, palm heart, and carqueja, both to inform producers and, in some cases, to work towards Forest Stewardship Council certification. As the Brazil nut and palm heart cases suggest (chapters 5, 6), the organic and fair trade certification system may be among the most profitable of the various certification systems. Certification is an accessible and useful option, particularly when there is a market prepared to pay an additional premium and for producers that have substantial financial, administrative, and technical support. In practice, this constraint limits certification to a few production systems—notably crafts, some foods, as well as medicinal and ornamental plants—aimed at supplying an international luxury market. Limited organisational and administration skills coupled with the higher direct and indirect costs generated by certification effectively places certification out of the reach of most NTFP producers. Even so, the process of working towards certification, which includes implementing guidelines for sustainable management and increasing the level of understanding and organisation in relation to markets, has been very useful for many producers (Shanley *et al.* 2002).

CONCLUSIONS

Homma's (1992) influential model of the historical dynamics of forest extraction suggests that commercial extraction of NTFPs in the Amazon follows a cyclic pattern that is characterised by an initial stage of expansion, sometimes followed by a stabilisation phase, but which ultimately gives way to the replacement of extractivism through either product substitution or intensification of the production system, namely cultivation. The main factor leading to the collapse is the interplay of ecological and economic factors: the boom in extractivism creates the ecological demise and a price increase for the forest species, prompting the creation of more easily accessible, and cheaper, alternative production systems. These production systems are typically developed in other regions, leading to the collapse of the boom in the original region. Many of the cases in this volume fit quite well in Homma's model. Wild sourcing of rubber, peach palm, pine, Panama hat, linaloe, allspice, ipecac and, more recently, carqueja has given way to cultivation, often in other parts of the world or in production systems controlled by a different set of actors. In the case of Mexican jonote and palm heart from

Brazil's Atlantic forest, there has been substitution of the species utilised. The babaçu, Brazil nut and the Bolivian palm heart cases likewise fit under Homma's 'stabilisation' phase. In the case of Brazil nut, for example, efforts to cultivate it or to substitute it with other nuts have failed.

On the other hand, however, the social, political, and market conditions of the late twentieth century have led to a resurgence of extractivism for a number of products, which in turn is hard to reconcile with Homma's model. For these cases, one might propose a revised model, which considers the possibility that the expansion-stabilisation-decline cycle occurs repeatedly for the same product. While some of the case studies in this volume, such as cat's claw and Brazilian ginseng, describe plants entering their first phase of expansion, others, such as vegetable leather and to a lesser extent linaloe, are entering a second expansion phase. It is foreseeable, too, that during one of these subsequent expansion phases, some of these plants may enter cultivation.

A historical model for NTFP extraction must also consider the possibility that production systems undergo de-intensification. The research of Caballero *et al.* (chapter 19), for example, shows how the Maya have modified the degree and intensity of management of species such as sabal according to diverse and changing circumstances. A revised Homma model would also consider the option that some forest products undergo intensification within forested and diversified environments, as is the case with zapote mamey, uxi, bacurí, and, possibly in the future, cat's claw and camu-camu.

As a whole, forest products in Latin America are managed, utilised, and commercialised in flexible ways and in highly diversified contexts, as part of subsistence strategies that respond to a biologically diverse and dynamic ecological and economic environment. In this sense, it is important to note that the different forest products illustrated in the following case studies form part of production systems that include multiple species, all of which are simultaneously, dynamically, and strategically managed. Even species such as cat's claw, jonote, or allspice, which show a fairly high degree of economic specialisation, are part of complex multi-use systems. The diversity, flexibility, and complexity of NTFP production systems are one important aspect of their multidimensionality.

It is at times difficult to reconcile the complexity and multidimensionality of forest products and production systems with the reductionism and instrumentalism of many analyses and interventions, particularly given the multiple, and at times contradictory, expectations that have been generated around NTFPs and their potential to generate income, improve social well-being, or contribute to forest conservation. On the other hand, many initiatives have focussed largely on economic aspects of NTFPs, ignoring other basic aspects of the resource and its ecological sustainability, including density and productivity (Peters 1994; Cunningham 2000). Even though large amounts of forest products are traded regionally and internationally, there are often no official statistics and it is difficult to obtain data on the number of actors involved, amounts harvested and exported, and even the currency value of such exports (Campbell and Luckert 2002). Assessing the potential role and value of NTFPs is further complicated by the fact that their value cannot be

measured in merely economic terms; cultural as well as social values are fundamentally important aspects of NTFP use (Posey 1999). Such 'invisible value' is often unaccounted for and therefore ignored by governments, the private sector, and many researchers.

In any case, it is clear that the development of NTFP production systems must consider not only the ecological and technical aspects, but social, institutional, political, and market ones as well. This in turn requires new conceptual and methodological tools, as well as new ways of linking research, external interventions, and endogenous processes and organisations. The following chapters—organised according to product type, such as medicinal plants and spices, crafts, and foods—describe a mosaic of plants, products, realities, processes, actors, and institutions. We hope that the reading will provoke thought, analysis, and discussion, and, above all, a greater appreciation of the complexity of these systems and of the possibilities and challenges that issue from them.

NOTES

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2. Center for International Forestry Research. E-mail P.Shanley@cgiar.org.
3. For detailed accounts of the project's history, premises, and the methodology employed, see Ruiz-Pérez and Byron (1999) and Belcher and Ruiz-Pérez (2001).
4. Pantoja and Saldanha (chapter 19), for example, note that two thirds of the world's production of rubber is synthetic. Even within Brazil, where rubber is indigenous and once was a mainstay of the national economy, 91% the national production is synthetic.
5. Bolivia indirectly benefitted from Brazilian subsidies on wild rubber production until these were terminated in 1986: the Bolivian national rubber industry finally collapsed in 1992 (Stoian 2000).

REFERENCES

- Acosta Solís, M. 1944. La Tagua, corozo o marfil vegetal (*Phytelephas* spp.). *Flora* 4(11-12): 25-58.
- Alexiades, M.N. 2002a. Cat's claw (*U. guianensis* and *U. tomentosa*). In: Shanley, P., Laird, S. and Guillén, A. (eds) Tapping the green market: certification and management of non-timber forest products, 93-101. Earthscan, London.
- Alexiades, M.N. 2002b. Sangre de drago (*Croton lechleri*). In: Shanley, P., Laird, S. and Guillén, A. (eds) Tapping the green market: certification and management of non-timber forest products, 136-155. Earthscan, London.
- Allegretti, M.H. 1990. Extractive reserves: an alternative for reconciling development and environmental conservation in Amazonia. In: Anderson, A. (ed.) Alternatives to deforestation: steps toward sustainable use of the Amazon rain forest, 252-264. Columbia University Press, New York.

- Aubertin, A. 1996. A ocupação da Amazônia: das drogas do sertão à biodiversidade. *In*: Empaire, L. (ed.) A floresta em jogo: o extrativismo na Amazônia central, 23-30. Editorial UNESP, Imprensa Oficial do Estado, Brasília, Brasil.
- Barfod, A., Bergmann, B. and Pedersen, H.B. 1990. The vegetable ivory industry: surviving and doing well in Ecuador. *Economic Botany* 44(3): 293-300.
- Belcher, B. and Ruiz-Perez, M. 2001. An international comparison of forest product development: overview, description and data requirements. Working Paper no. 23. Center for International Forestry Research, Indonesia.
- Browder, J.O. and Godfrey, B.J. 1997. Rainforest cities: urbanization, development and globalization of the Brazilian Amazon. Columbia University Press, New York.
- Bunker, S.G. 1985. Underdeveloping the Amazon: extraction, unequal exchange and the failure of the modern state. University of Chicago Press, Chicago.
- Campbell, B. and Luckert, M. 2002. Uncovering the hidden harvest: valuation methods for woodland and forest resources. People and Plants Conservation Series. Earthscan, London.
- Clement, C.R., Clay, J. and Sampaio, P. 1999. Biodiversidade Amazônica: exemplos e estratégias de utilização. Programa de Desenvolvimento Empresarial e Tecnológico, Manaus.
- Cunningham, A.B. 2000. Applied ethnobotany: people, wild plant use and conservation. Earthscan, London.
- Currie, E. 1995. Prehistory of the southern Manabi coast, Ecuador. *British Archaeological Reports* Number 618, Oxford.
- Edelman, M. 2001. Social movements: changing paradigms and forms of politics. *Annual Review of Anthropology* 30: 285-317.
- Elder, P.A. 1991. Seringueiros e sindicatos: um povo da floresta em busca de liberdade. Master's Thesis, CPDA-UFRRJ, Rio de Janeiro.
- Forte, J. 1999. Emerging local and global discourses on PFNM use and study: a view from Guyana. *In*: Ros-Tonen, M.A.F. (ed.) NTFP research in the TROPENBOS Programme: results and perspectives, 33-42. The Tropenbos Foundation, Wageningen, The Netherlands.
- Gentry, A. and Vásquez, R. 1989. Use and misuse of forest harvested fruits in the Iquitos area. *Conservation Biology* 3(4): 1-11.
- Hecht, S. 1985. Environment, development and politics: capital accumulation and the livestock sector in eastern Amazonia. *World Development* 13(6): 663-684.
- Hersch M., P. 2003. Actores sociales de la flora medicinal en México. *Revista Universidad de México* 629: 30-36.
- Hobhouse, H. 1985. Seeds of change: five plants that transformed mankind. Sidgwick & Jackson, London.
- Homma, A. 1992. The dynamics of extraction in Amazonia: a historical perspective. *In*: Nepstad, D. and Schwartzman, S. (eds.) Non-timber forest products from tropical forests: evaluation of a conservation and

- development strategy, 22-31. *Advances in Economic Botany* 9. New York Botanical Garden, Bronx, New York.
- Homma, A. 1993. Extrativismo vegetal na Amazonia: limites e oportunidades. EMBRAPA, CPATU. Brasília.
- Nepstad, D. and Schwartzman, S. (eds.) 1992. Non-timber forest products from tropical forests: evaluation of a conservation and development strategy. *Advances in Economic Botany* 9. New York Botanical Garden, Bronx, New York.
- Neumann, R. and Hirsch, E. 2000. Commercialization of non-timber forest products: review and analysis of research. Center for International Forestry Research, Bogor, Indonesia.
- Newing, H. and Harrop, S. 2000. European health regulations and Brazil nuts: implications for biodiversity conservation and sustainable rural livelihoods in the Amazon. *Journal of International Wildlife Law and Policy* 3(2): 109-124.
- Ortiz, E. 2002. Brazil nut. *In*: Shanley, P., Pierce, A., Laird, S. and Guillen, A. (eds.) *Tapping the green market: certification and management of non-timber forest products*, 61-74. Earthscan, London.
- Padoch, C. and de Jong, W. 1990. Santa Rosa: the impact of the forest products trade on an Amazonian place and population. *In*: Prance, G.T. and Balick, M.J. (eds.) *New directions in the study of plants and people*. The New York Botanical Garden Press, New York.
- Peters, C.M. 1994. Sustainable harvest of non-timber plant resources in tropical moist forest: an ecological primer. Biodiversity Support Program, Washington, D.C.
- Pierce, A. 2002. Social issues. *In*: Shanley, P., Pierce, A., Laird, S. and Guillen, A. (eds.) *Tapping the green market: certification and management of non-timber forest products*, 283-298. Earthscan, London.
- Plotkin, M. and Famolare, L. 1992. Sustainable harvest and marketing of rain forest products. Island Press, Washington, D.C.
- Posey, D.A. 1999. The cultural and spiritual values of biodiversity. UNEP, Intermediate Technology Publications, London.
- Renard-Casevitz, F.M., Saignes, T. and Taylor, A.C. (1988). *Al este de los Andes: relaciones entre las sociedades Amazónicas y Andinas entre los siglos XV y XVII*, vol. II (Juan Carrera Colin, trans.). Instituto Francés de Estudios Andinos, Quito
- Ruiz-Pérez, M. and Arnold, J.E.M. 1996. Current issues in non-timber forest research. CIFOR/ODA, Bogor, Indonesia.
- Ruiz-Pérez, M. and Byron, N. 1999. A methodology to analyze divergent case studies of non-timber forest products and their development potential. *Forest Science* 45: 1-14..
- Shanley, P., Pierce, A., Laird, S. and Guillen, A. (eds.) 2002. *Tapping the green market: certification and management of non-timber forest products*. Earthscan, London.
- Skidmore, T.E. and Smith, P.H. 2001. *Modern Latin America*. Fifth Edition. Oxford University Press, Oxford.
- Shatto, R. 1998. Maritime trade and seafaring of the Precolumbian Maya. Ph.D. Thesis, Texas A&M University, College Station, Texas.

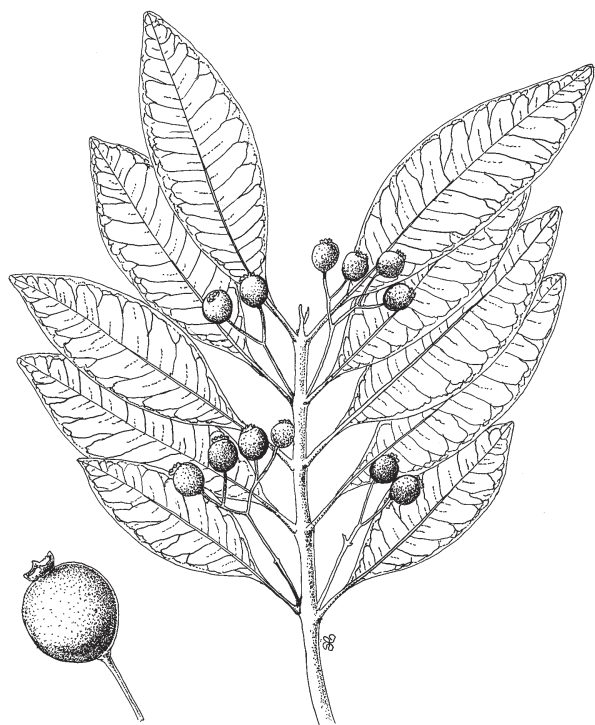
- Stoian, D. 2000. Shifts in forest product extraction: the post-rubber era in the Bolivian Amazon. *International Tree Crops Journal* 10(4): 277-297.
- Warn, F. 2000. *Bitter sea: the real story of Greek sponge diving*. Guardian Angel Press, London.
- Vieira, R.F. (ed.) 2002. *Estratégias para conservação e manejo de recursos genéticos de plantas medicinais e aromáticas: resultados da 1ª Reunião Técnico*. Embrapa Recursos Genéticos e Biotecnologia/Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (IBAMA)/Conselho Nacional do Desenvolvimento Científico e Tecnológico-CNPq, Brasília.

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Chapter 2

Allspice [*Pimenta dioica* (L.) Merrill],
A Non-timber Forest Product of Sierra
Norte de Puebla, Mexico

Miguel Ángel Martínez, Virginia Evangelista, Myrna Mendoza,
Francisco Basurto and Cristina Mapes¹



(*Pimenta dioica*)

Common name	Product part used	Dominant form of management	Degree of transformation	Commercial scale	Geographic distribution
Pepper	Fruit	Managed/ cultivated	Middle	International	Average

ABSTRACT

Allspice, *Pimenta dioica* (L.) Merrill, known in Spanish as *pimienta gorda*, is a 20 m tall tree that is native to the American tropics. It has dietary, medicinal, and industrial uses. A non-timber forest product, it is currently harvested wild from the forests in the Guatemalan Petén region, but in Mexico it is managed within agro-ecosystems. We conducted a case study of allspice producers in a municipality in Puebla, the second most important allspice-producing state in Mexico. In this area, allspice grows in coffee plantations and, to a lesser extent, in maize fields and paddocks. The number of trees in this area has doubled over the last 20 years, responding to growing international demand for this product and to the work of allspice producers' organisations, which collect and export it. Allspice can be managed sustainably and is a resource with great biological, economic, and social potential for the humid tropics in Mexico and the world generally. Our study shows that the production chain in Sierra Norte de Puebla is complex and closely related to that of coffee. Allspice is not industrialised in Mexico, even though 15 allspice producers' organisations operate, collecting and selling the dried fruit internationally. International statistics are confusing as they include the outputs of two unrelated species, pepper (*Piper nigrum* L.) and red pepper (*Capsicum annum* L.). National data show that allspice production has increased in Mexico over the last decade.

INTRODUCTION

Allspice, *Pimenta dioica* (L.) Merrill, belongs to the Myrtaceae family of the order Myrtales. Distributed throughout the humid and dry tropics, this family includes numerous species, many of which are highly important economically, having multiple uses including medicinal, dietary, aromatic, as timber, industrial, and artisanal (Heywood 1978). Myrtaceae species flourish in soils with low contents of magnesium and phosphorus. Hence, regional endemism concentrates mainly in areas where Ultisols and Spodosols, with poor drainage and low nutrient contents, predominate (Ashton 1990).

Despite the taxonomic confusion that exists at the family level (Mori *et al.* 1983), *Pimenta dioica* is a species that is taxonomically well defined (Merrill 1947; Standley 1953; McVaugh 1956; Landrum 1986; Balslev and Renner 1990). Berg in 1854 recognised five varieties—*cumanensis*, *longifolia*, *ovalifolia*, *tenuifolia*, and *tabasco*—whereas Apres in 1907 reduced them to three, not recognising the *cumanensis* and *tabasco* varieties (Fuentes 1985). Neither were the latter varieties recognised by Merrill (1947), and Standley (1953) endorsed only the variety *tabasco*. Chapman in 1985 recognised two varieties for the male and 12 for the female plants (Fuentes 1985).

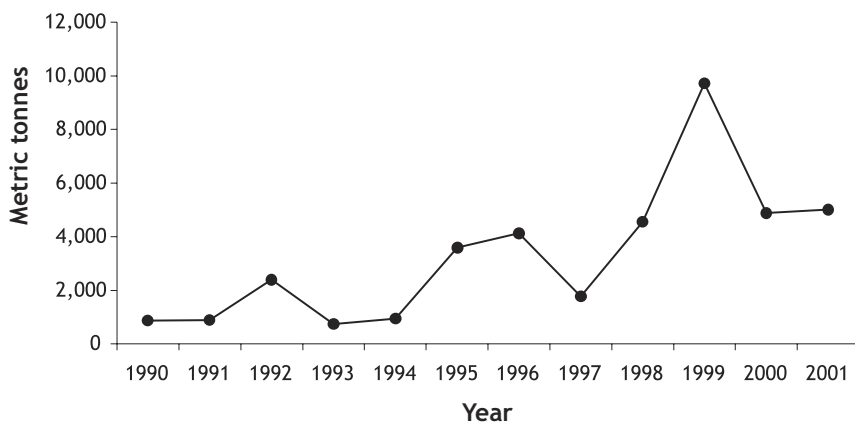
Dried and ground allspice seeds are heavily used as flavouring in Mexican cooking and elsewhere. Mexican traditional medicine treats it as a 'hot' plant, using it to regulate menstruation, alleviate stomach pains, and treat respiratory diseases. It is also regarded as an aphrodisiac, and it is used to treat cultural malaises such as *susto* (anxiety believed to be caused by fright) and *mal aire* (lit. 'bad air', believed to lurk in the respiratory tract) (Macía 1998; field data 2000; Martínez *et al.* 2001). The Renaissance European

Hippocratic and Galenic physicians classified it as having a 'hot nature'. In Mexico its foliage is used as a spice and in Christmas ceremonies. Where they are abundant, male trees are also valued as firewood (Martínez *et al.* 2001).

Internationally, the spice is important in food, pharmaceutical, and cosmetics industries, mostly for preparing perfumes. Its essential oils are used as a dietary additive and antioxidant, facilitating the conservation of meat, even without refrigeration. Seeds contain between 3% and 4.5% of essential oils, together with resins, tannins, sugar, and gums. The essential oils, in their turn, contain eugenol (70%) and small quantities of eugenol-methyl-ether, l-phellandrene, and caryophyllene (Budavari 1989). For the last 10 years, allspice has been gaining ground in Mexico and other countries over other aromatic and medicinal spices. Its use as a food condiment in fast-food preparation and in perfumery is increasing (Fuentes personal communication). Industrial demand for the spice is growing at 4% per year (Ortega 2001).

Allspice is extensively traded internationally. The value of exports in 2000 from the world's two main producers, Mexico and Jamaica, was US\$12.87 million and US\$6.1 million, respectively. Other important producers are Honduras, Guatemala, and Belize. Production in Mexico (Figure 1) increased from 868 tons to 4890 tons between 1990 and 2000, suggesting an attractive future for this spice. Even so, Mexico pays little attention to allspice, as it does to other non-timber forest products (NTFPs) in general. The Mexican government lacks a clear policy for these products. The country's allspice sector is therefore strongly divided, and it receives no technical support for cultivation or marketing.

Figure 1. Allspice production in Mexico



Source: SAGARPA/SIAP 1990-2001.

Historical background

Allspice has been used since pre-Hispanic times (Hernández 1959). The first to report it for its various medicinal uses was Francisco Hernández (1570-1574), who cites it as coming from Copitlán, state of Morelos, and calls it 'tabasco

pepper' or '*xocoxóchitl*' ('acid-flower tree' in the Náhuatl language). Then, in 1671 and 1675, the Italian naturalist Francesco Redi commented on the plant, calling it the '*chiapa*' or '*tabasco* pepper'. Redi considered allspice to be a plant of great economic value and alludes to the works of Nierenberg, Clusius, Ximenez, and Hernández, although, most probably, he did not see these treatises (Langman 1964).

International trade in allspice began in the eighteenth century, mainly through English and Dutch trading companies. The potential of the plant as a crop was identified in Spain by the physiocrats², one of whom was Gómez Ortega, director of the Royal Botanic Garden of Madrid, who wrote a book on the malagueta or tabasco pepper. Reproduced anonymously in 1827, this book also spoke of the industrial importance of allspice as a flavouring and medicine. In the nineteenth century, the first reference to allspice as a cultivated plant in Mexico was made by Herrera (1896), and in the state of Tabasco by the Mexican Agricultural Society (SAM 1897). Herrera observed that allspice would have a great future as a crop for medicine and industry. The states of Chiapas, Tabasco, and Veracruz have been producing allspice since the nineteenth century. In northern Puebla, where our study was conducted, and in Campeche and Oaxaca, cultivation began in the 1970s. Tabasco is the leading allspice-producing region in Mexico.

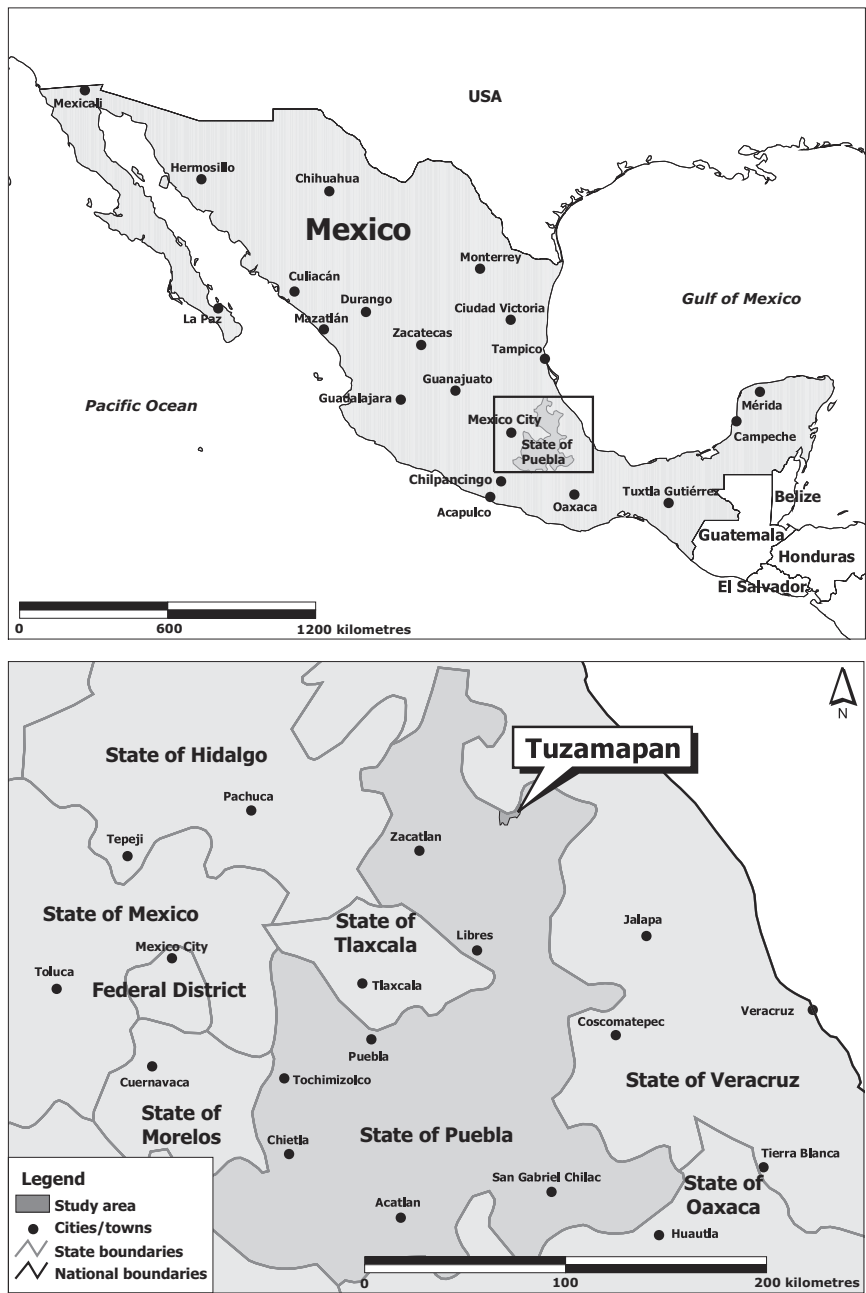
The case study

Sierra Norte de Puebla is located in the northern part of its state namesake, that is, in central east Mexico, between 19°46'00" and 20°32'00" N, and 96°26'00" and 98°24'00" W. To the north and east, the region is bounded by the coast of the Gulf of Mexico (Atlantic Ocean), and to the south and west by the Central Plateau. The *sierra*, or mountains, which was formed during the Cenozoic and Mesozoic Eras, is part of two of Mexico's three principal mountain systems. The region thus ranges in altitude from 70 m to 2800 m above sea level (masl), and has a variety of soil types and climates with high biodiversity.

Within Sierra Norte de Puebla, the study was conducted in the municipality of Tuzamapan de Galeana (Figure 2). The targeted area was situated between 20°03'00" and 20°10'19" N, and 97°28'00" and 97°35'36" W, spreading over 45.92 km², with altitudes ranging from 250 m to 500 m. At the time of study, the municipality had a population of 6125 (INEGI 2000) mostly mestizos, but also including Totonaco and Nahua Indians. The municipality's soils are eutric Cambisols, calcaric Regosols, and Litosols (INEGI 1987). Vegetation is rain forest (Holdridge *et al.* 1971), with an annual precipitation of 2500 mm. The principal land use of this region is seasonal agriculture and coffee plantations, the latter agro-ecosystem being the one with which allspice is associated.

The municipality of Tuzamapan de Galeana was selected for the study because its area and population were adequate for analytical purposes, including socio-economic surveys, and vegetation samplings. The municipality was also chosen for its rural organisations, which have existed since 1972, producing and selling allspice. Information was compiled during 2000 and 2001.

Figure 2. Study area



Source: ESRI (Environmental Systems Research Institute, Inc.) 2002. Data and maps.

Within the municipality, in three communities that concentrate 70% of the population, we surveyed 10% of family units to discover the number of members, their occupations, family income, economic activities, and the importance of allspice. To discover the density of allspice in the agro-habitats (coffee plantations and maize fields, or *milpas*), we took 60 transects, measuring 50 m × 2 m, and measured the height and canopy of all individual trees taller than 1 m. We also carried out open interviews on different aspects of managing and marketing allspice with producers, wholesale distributors, exporters, and regional and national intermediaries.

Allspice is seen in the region as a promising alternative crop for the economy. It is well known to small farmers, and its agro-habitats are associated with common agricultural practices, thus facilitating the maintenance of this species. Even with these advantages, the lack of financial resources and training, and corrupt practices, have induced divisions among allspice producers' unions at the regional level, thus affecting this product's development.

THE PRODUCTION-TO-CONSUMPTION SYSTEM

Resource base

The natural distribution of *P. dioica* includes the Caribbean, Central America, and Mexico. In Mexico, it grows in the humid tropical lowlands and dry coastal plains of the Pacific and Atlantic in high and medium perennifoliar and subperennifoliar forests, forming part of the middle and lower strata (Pennington and Sarukh n 1998), or the life zone of tropical humid forests (Holdridge *et al.* 1971) between 0 and 800 masl. It is a heliophile species, which means that it is found in forest clearings, developing well in the advanced successional phases within 10 to 15 years of disturbance. It can also develop well in fallow land and coffee and cacao plantations. The country's major allspice-producing states are Tabasco, Puebla, Veracruz, and Chiapas.

Table 1. Characteristics of the life cycle of allspice (*Pimenta dioica*)

Characteristic	Data
Seed viability	One year
Germination	Nine to ten days (Purseglove 1974)
Flowering	March to May
Reproductive system	Dioecious
Pollinators	Wasps and bees, during spring
Fruiting	May to August
Dispersers	Birds and mammals, during summer and autumn
Age at which production starts	Fourth or fifth year
Depredators or pests	Squirrels and insects, all year
Diseases	Fungi and viruses, all year

Source: field data.

Other states producing on a smaller scale are Oaxaca, Quintana Roo, San Luis Potosí, Campeche, and Hidalgo (INEGI 1998).

Pimenta dioica is a dioecious species, with scented flowers that are pollinated by wasps (Vespidae), bees (Meliponidae, Trigonidae, and Apidae), and bumble bees (Bombidae). The berries are dispersed by bird species such as the robin (*Turdus rufopalliatu*s), the oropendola or *papan* (*Psarocolius montezuma*), and the *chachalaca* (*Ortalis vetula vetula*). Table 1 lists the principal data of the allspice life cycle.

In the study area, the coffee plantations where allspice grows are polycultural. Various *Inga* species (legume family) are used for shade. Other commercial products also enrich the plantations such as mamey sapote [*Pouteria sapota* (Jacq.) H.E. Moore & Stearn]; banana (*Musa acuminata* Colla × *M. balbisiana* Colla); citruses like orange [*Citrus sinensis* (L.) Osbeck], mandarin (*Citrus reticulata* Blanco), and lime [*Citrus aurantifolia* (Christm.) Swingle]; timber species such as cedar (*Cedrela odorata* L.) and mahogany (*Swietenia macrophylla* King); and some species representing remnants of rain forests.

Managed populations present few pests or diseases, their care is inexpensive, and production is fast, beginning at 5 years and lasting over 30 years. Density is from 70 to 110 productive adult trees per hectare of coffee plantation, accompanied by many young plants in various stages of development. These traits are taken into account by farmers and stimulate the crop's promotion or ready cultivation.

Harvesting managed populations, either cultivated or wild, does not affect resources or the wild or cultivated flora of the sites where allspice is found. Nor does it affect the ecosystem or agro-ecosystem, as the spice is already growing in disturbed, heavily deforested sites.

The structure of allspice populations in coffee plantations is managed by the producer, who protects seedlings and juvenile plants, and eliminates most male plants, leaving one or two individuals per 10 females. Usually, harvest sites are accessible, being found near villages and tracks for draught animals or vehicles.

In coffee plantations, producers take advantage of the spice's natural germination rather than plant it. Seedlings are protected either *in situ* with small enclosures or by transplanting them to other sites within the same coffee plantation. Farmers take care not to cut them down with the machete when weeding. Some producers also create small nurseries within the coffee plantation. A practice favouring allspice production is *desombre* (lit. de-shade), where branches of nearby trees throwing shade are cut down.

Harvest technology is limited to cutting the sprigs and then manually picking the berries off the twigs on which they form bunches. This practice is known as *despique* (lit. de-spike). Harvesting lasts three months, from June to August.

The berries are dried in the sun or in the rotating driers used for coffee, as no special driers exist for this crop. An important stage in drying is the 'sweating' of the fruit after the first sunny day, so that it acquire its characteristic black colour and odour. During sweating the fruits are covered with plastic so they may dry rapidly and uniformly. To be thoroughly dried,

Photo 1. Cutting, together with drying, are the agricultural practices that demand most time and labour (photo: M. Mendoza)



they need, in total, four to five days of sun or nine hours in driers.

Impurities such as twigs, pieces of leaves, and spoiled fruits are removed from the dried grain using screens or a ventilator. Where screens are used, the fruits are separated by size, eliminating the defective ones.

Allspice is not processed industrially in the production areas; instead, producers sell the fruit either green (90%) or dried (10%). An average of 39 working days per hectare per year are needed to maintain and harvest a crop of allspice. Investment in inputs is low at US\$20 per hectare.

Allspice producers and their socio-economic context

Mestizos and the Totonaco and Nahuatl Indians inhabit the municipality of Tuzamapan. The Totonacos were the original inhabitants, and were invaded in the fourteenth and fifteenth centuries by the Chichimecos and Nahuas migrating from central Mexico. The area had, and maintains, a great trading tradition (García 1987). At the beginning of the twentieth century, sugar cane dominated as a crop, while citrus, coffee, and banana were introduced in the 1950s as cash crops. The area became one of the five principal coffee-producing areas of the country (Velázquez 1995). This situation meant that the region developed a commercial and capitalistic agriculture, with consequent social polarisation, today manifested by landless workers migrating to the cities of Puebla, Mexico, or Poza Rica. Although many migrants are permanent

in that they do not return to their villages, most migrate on a seasonal basis, when little work is available in their area. In the last 10 years, people have begun migrating to the United States of America.

Most of the population lives in the two communities that have services such as water, light, sewerage, schools, clinics, and paved streets. Land tenure is private ownership (90.84%), with only 8.75% being community land. About 70% of production units have less than 2 ha (INEGI 1994). Land values, according to surveys, are around US\$1,768 per hectare, which is close to the average family annual income in the study area. Of the economically active population, 83% is dedicated to agriculture, with coffee being the principal crop, followed by maize, which is planted for household use. Another 7% of the working population is employed in construction, furniture manufacture, and the textiles industry. The remaining 9% is involved in trade and services (SEG 2001).

In recent years, with coffee prices being low, allspice has become significant, particularly as prices in the international market have been high, ranging between US\$1,900 and \$5,900 per ton of dried spice. According to data obtained in the socio-economic survey, of the total family income, 17% derived from allspice, whereas only 11% came from coffee.

While 55.8% of families produced allspice, 69.0% participated as producers, cutters, wholesale distributors, wage workers, or workers waiting for their own allspice crops to begin production. Work is differentiated by gender, with women carrying out only 10% of the work and men doing most of the cutting. Women participate more in stripping the berry sprays and cultivating the spice.

The low value of the average family income in the study area indicates the degree of economic and social marginality suffered by allspice growers, with local wages averaging US\$3.68 per day. In 2000 the average family income was US\$1,812.77, well below the national average of US\$8,767.37 (Table 2).

Table 2. National averages of family income (in US\$)

Year	National average	Average for study area
1998	6,489.90	
2000	8,767.37	1,812.77
2001	9,819.46	

In a country with high political centralism, the study area is peripheral and marginal for many projects of social or economic development. Even so, in the last 20 years, the road network, electricity grid, and communications services (telephony and radio) have increased, connecting the region with the rest of the country. Mexico, as a Third World country and dependent on large world economies, does not escape the economic fluctuations that come with specialising in agriculture. Coffee, the region's principal crop, now has very low prices, both within and outside the country, of US\$0.09 to US\$0.20 per kilogramme. In contrast, allspice has a price of US\$2.20 per kilogramme.

Allspice producers organised 23 years ago into unions of local producers. Four of these unions exist in the municipality of Tuzamapan, together integrating 180 producers, that is, 18% of farmers. The unions receive economic support from state and federal governmental agencies and from institutions such as the National Fund to Support Social Companies (FONAES), the Indigenous National Institute (INI), and the Inter-American Development Bank (IDB) for the bulk handling and marketing of allspice. At the regional level, the unions are part of the State Union of Allspice Producers, which relies on the agro-export company Xochitl Ukum to send their product to international markets. Local producers can sell their spice to this organisation whether or not they are affiliated. The producers frequently request more training and more technical and financial support to develop this crop more adequately.

In terms of its political situation, Mexico is going through a transition, which is having political and economic repercussions in the study area. The Producers' Union itself is also suffering political conflicts, affecting both the organisation and the economic potential for other NTFPs.

In this social and economic panorama of the study area and country, allspice is becoming a complementary product in the small-farming economy, representing 17% of total income. Farmers are already familiar with cash crops for export, which facilitates acceptance of cash cropping by Indian and mestizo producers. The small-farming nature of the area's agriculture means land tenure is a problem that affects not only allspice but all local crops. Some governmental agencies have therefore even suggested replacing coffee plantations in the sierra foothills with allspice. Currently, farmers must face intermediaries who pay poor prices or the bureaucracy of their organisations. Farmers therefore need greater orientation towards NTFP markets.

Processing allspice

Processing involves picking the berries (i.e., eliminating floral peduncles), sweating and drying, fermenting to blacken the fruit, selection and cleaning, and packing in 50 kg sacks. Exporters and national wholesale merchants then market it. For selling at retail, allspice is presented as a dried or ground fruit, these being the forms in which it is used. The spice is not further processed in Mexico. Outside Mexico, the spice is ground for human consumption as condiment or it undergoes further processing to extract essential oils or oleoresins.

The picking, blackening, and drying of the fruit can be carried out by the family unit, or it can be sold green to first-order merchants, who take charge of these procedures and also select, clean, and pack. The dried spice has a shelf life of one year without losing quality. Thus, when abundant, surpluses can be kept until the following year, although this may cause a drop in prices.

The production area has minimal infrastructure and conducts little experimentation to obtain oils or oleoresins. Only the Cooperative Tosepan Titataniske in Cuetzalán (a municipality that borders the study area) has attempted to extract oils from the fruits. But the oils ended up being stored,

Photo 2. Drying allspice berries should be quick to maintain the quality of their aroma and texture (photo: M. Mendoza)



as no progress was made in industrialising the activity because of a lack of capital and training.

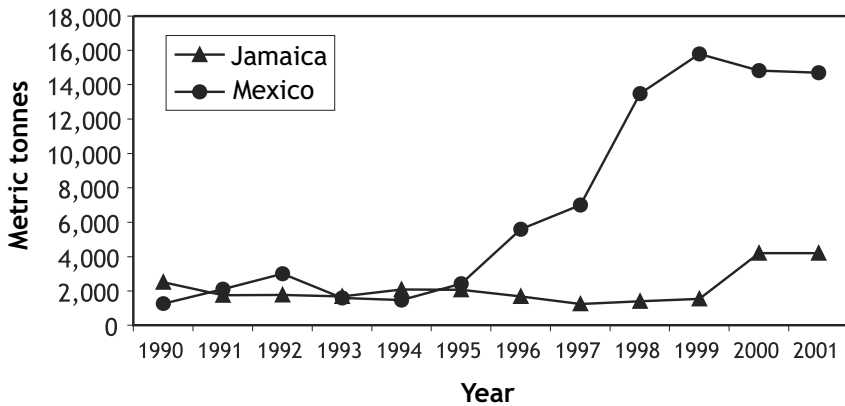
Fuentes and Montes (personal communication) indicated that essential oils and oleoresins can be used as medicines (antitumoural, control of blood pressure), food additive, or flavouring, and for industrial uses such as antioxidants, insecticides, fungicides, and in perfumery (Grainge and Ahmed 1988; Okuyama *et al.* 1995; Montes *et al.* 1997; Suárez *et al.* 1997; Brown *et al.* 1998; Nakatani 2000).

Trade and marketing

The spice has a complex marketing system, as the countries that most purchase it, such as Germany, the Netherlands, France, England, and USA, in turn resell it to other countries of Europe and Africa (Fuentes personal communication). Mexico is already the leading exporting country in America and, according to Food and Agriculture Organisation data (FAO 2001), the world, as Jamaica has ceased to be world leader in producing this crop (Figure 3). From the national and international marketing viewpoint, national sales for allspice are US\$301,135, and exports US\$12.87 million (G. Barreda personal communication).

The national market for allspice is stable and small, as demand in the country is low and industrial processing is unavailable. Mexico's share in the international market increased in the last 10 years, exporting mainly to the

Figure 3. Exports of red pepper (*Capsicum* spp.) and allspice from Jamaica and Mexico



Source: FAO 1990-2001.

Netherlands, Germany, England, USA, France, Switzerland, Poland, Peru, and Egypt (BANCOMEXT 2001).

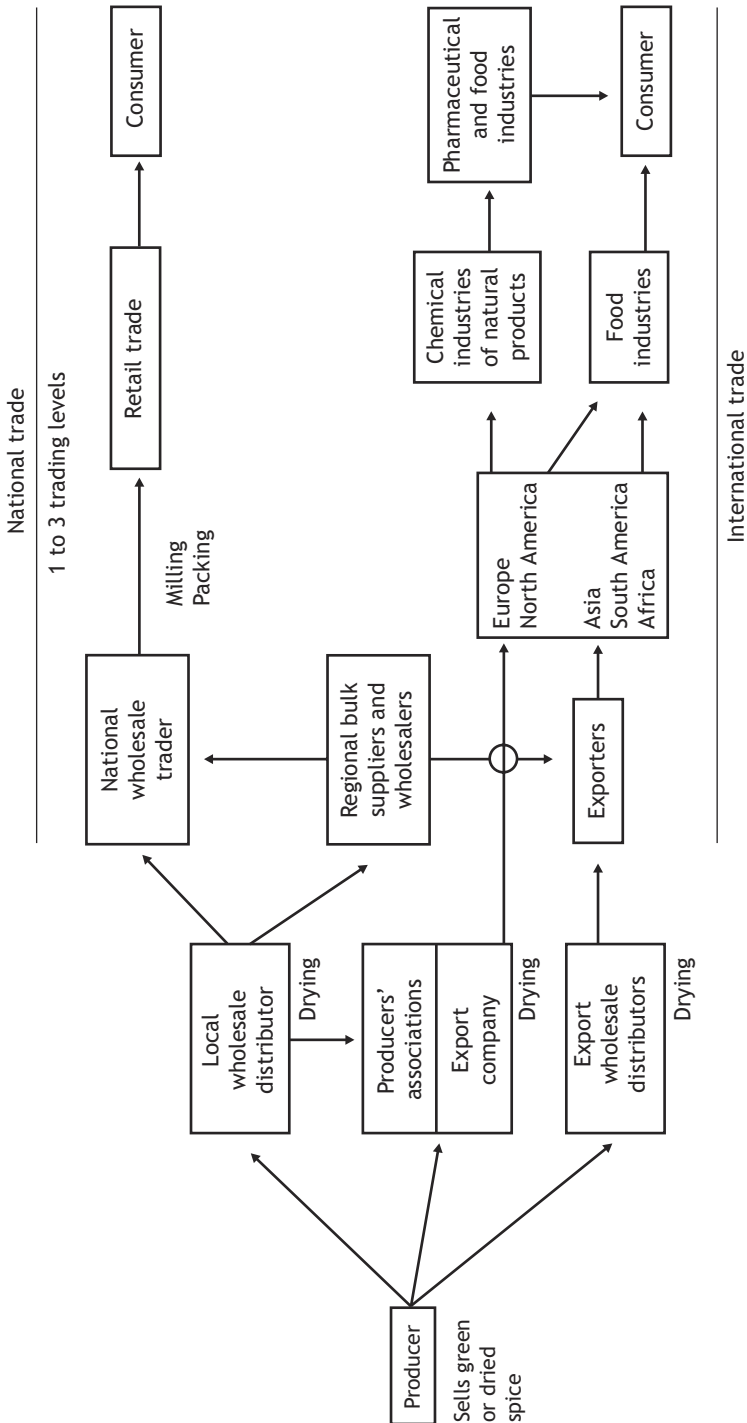
Demand fluctuates and, sometimes, because of climatic disturbances (e.g., excess or shortage of rains during key periods of crop development), supplies of the spice from the study area are inconsistent. Trade is increasing but, at the international level, the market is sensitive to changes in product offer, generating sharp variations in price. This can be beneficial to exporters—and thus also to producers—depending on timely presence on the market and product quality, when prices are high. When prices are low, however, the effect is highly detrimental, forcing supplies to be stored until prices improve, thus affecting both wholesale distributors and producers.

The commercial chain of Mexican allspice is two-pronged, one prong being the domestic market and the other being the international market (Figure 4). In the former instance, the producer sells green or dried pepper to first-order merchants (local wholesale distributors), who sell it dried to second-order merchants (regional and national wholesalers). The spice then reaches the consumer via two or three commercial levels, where it is ground and packed.

Access to the international market is through producers' associations (with the export company) and commercial exporters who send the product to Europe, Asia, Africa, USA, and Canada. In all the consuming countries, allspice is ground as a condiment and, in some European countries, more sophisticated industrial processing is carried out.

Within the commercial sector at the local level, the presence of intermediaries favours monopolistic practices by some of the region's merchants, who offer immediate payment and collect the product directly from the producer, thereby purchasing at lower prices. The existence of

Figure 4. Allspice marketing channels in Mexico



these practices will persist until the producers' organisations unite to avoid both the intermediary and the bureaucracy and corruption of leaders, and until producers are trained in marketing their product. The state government should also legislate for commercial policies that favour NTFP producers. At national and international levels, we do not know the sites, quantities, or to whom local intermediaries sell.

Policies and institutional aspects

In the forest sector, current Mexican policy aims to conserve forests, thus supporting farmer groups that care for or sustainably exploit forests, both in temperate and tropical areas. The instruments the government uses are, on the one hand, the forest law, which invites reforestation with exploited species and, on the other, the nurseries of the Secretariats of Agriculture and the Environment.

One problem in exploiting allspice and many other NTFPs is that the Mexican government has not enunciated a clear definition of or concern for their importance and potential. The government recognises only coffee, cacao, and cinnamon (Coordination for Promoting Agricultural Markets, SAGARPA³, personal communication). Although this situation does not affect allspice production in either a sensitive or negative way, neither is there a policy to promote and market this NTFP.

Ten years ago, the study area used to have a prohibition against cutting down allspice trees for firewood, building materials, or other ends. The restriction no longer exists and, currently, the country permits and promotes this type of forest use. At the national level, no special development plans for this NTFP have been formulated, although, as mentioned above, a suggestion was made to substitute coffee plantations in the low-lying parts of the study area, where quality coffee, either in aroma or yield, is not produced. Some producers and associations, with the support of federal governmental agencies (e.g., INI), are interested in cultivating black pepper (*Piper nigrum* L.). They are launching a pilot program to cultivate this species, but the market for this crop is very competitive.

From a commercial viewpoint, 15 large buying companies exist, providing an outlet for the national allspice production, as this country's consumption of the spice is relatively low. These companies sell mainly to Europe and USA, and are given commercial or legal advisory services on exporting. In association with the Mexican Bank of Foreign Trade (BANCOMEXT), they also have the possibility of publicising their product outside the country. Although the producers may approach the bank for advice, they lack organisation, capital, and knowledge, resulting in their delivering their produce to intermediaries or the large buyers. The structure of commercial practices favours intermediaries above producers. Otherwise, the impact of local and national policies is sufficient to promote this crop.

No specific policies for the conservation or use of this species in protected areas exist. In agricultural terms, it is regarded as a commercial product, easy to cultivate and belonging to few other agro-ecosystems. The producers respond spontaneously to price rises for the condiment by

increasing the number of trees in their coffee plantations, both by protecting the seedlings that germinate spontaneously and by creating small nurseries of allspice within the coffee plantation itself.

Among the factors that negatively affect the marketing and production of allspice in the study area is the lack of timely credit for producer associations, thus favouring the presence of private merchants and price variations for allspice in the production area. This same lack of clarity in prices, both within and outside the area, induces dissatisfaction of producers with their organisations.

Political patronage, purchase of influence, or support that favours friends or acquaintances among rural organisations is another factor that influences the unequal distribution of profits, leading to corruption and one-party political control. Such a situation leads to divisions among producers, who neglect training and collaboration, and adopt a self-managing approach that separates them from the political groups that manipulate them. Such is the situation in the areas where this resource grows that, for as long as there is domination by petty leaders (*cacicazgos*), there will be no equitable distribution of the wealth this product generates.

LESSONS FOR CONSERVATION AND DEVELOPMENT

Allspice is managed in coffee plantations with high plant diversity, including the existence of other NTFPs. It contributes to local producers' income and well-being, and offers high levels of confidence in the agro-ecosystem's conservation and sustainable management of the resource. The strategy small farmers follow in managing NTFPs based on diversification adapts to models that seek to procure sustainability to conserve local resources. Allspice cultivation with sustainable management has the following characteristics.

- The spice plant is part of the natural vegetation, but it can grow in disturbed sites, unaffected by current agricultural or livestock management conditions of the area; indeed, agriculture tends to increase the crop's density by favouring its presence in coffee plantations, maize fields, paddocks, and household gardens.
- It has few natural enemies or pests, and does not need agrochemicals.
- It is a multipurpose crop (medicinal, condiment, building materials, and ceremonial).
- Its cultivation does not induce soil erosion, nor is the plant a host of pests or diseases.
- Harvesting does not destroy the plant nor its environment.
- Its population structure encompasses all stages from seedling to adult.
- Use of the resource demands little input of labour or capital.
- As part of a diversified agro-ecosystem, it does not interfere with the use of other resources.

Our concept of sustainability refers to the management of a natural resource that does not present problems of extinction, is adapted to the ecological and socio-economic environments of the study area, has promising potential in terms of traditional or industrial use, and enriches the plant

structure of some agro-ecosystems. Finally, it can permit a partial restoration of the forests of which it once was a part.

Until now, the marketing of allspice has benefited its development and conservation, and its agro-ecosystem. Market saturation and the consequent decline in prices could negatively affect the producers, however.

CONCLUSIONS

Among the problems and recommendations that appeared upon the study of this resource are the following.

- Mexican rural development is typically development-oriented, whereby it is tackling technological problems without providing the social and political linkages that are, in fact, what modify the situation of a producer group and special crops. No specialisation exists in agrarian policies by crop or producer, as occurs in countries such as USA, Germany, or France. The forestry laws and regulations of the Mexican government do not emphasise the importance of NTFPs, although recently this has begun to change.
- Given the social, cultural, and economic conditions of the area, it would be more desirable to base the income of the rural producer on a diversified production that includes allspice and other NTFPs, that is, on more than one product. This strategy would afford producers various options to complement their income and to resist market fluctuations.
- Although the marketing of allspice has benefitted the producers in the study area, the distribution of the wealth it generates is inequitable, as intermediaries and exporters obtain the greatest profits.
- In Sierra Norte de Puebla, use of allspice has so far been shown to be sustainable. Its future development will depend on production conforming to demand. Fluctuations in supply and demand in the international market cause produce to be sometimes stored, awaiting better prices. A policy of support for export is therefore needed and should include the search for and promotion of new markets.
- The political patronage of rural organisations results in corruption and one-party political control.
- Plant breeding should be promoted, together with the search for aroma types, implementation of propagation techniques by grafting, and fostering of industrialisation of allspice, as this would require considerable labour and would help slow down migration, a worldwide problem in the humid tropics.

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NOTES

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2. The physiocrats were part of a movement that centred economic development on agriculture.
3. Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación (Secretariat of Agriculture, Livestock, Rural Development, Fishing, and Food).

REFERENCES

- Ashton, P.C. 1990. Species richness in tropical forests. *In*: Holm-Nielsen, L.B., Nielsen, C. and Balslev, H. (eds.) Tropical forest: botanical dynamics, speciation and diversity, vol. 3, 287-295. Academic Press and Harcourt Brace Jovanovich Publishers, London.
- Balslev, H. and Renner, S.S. 1990. Diversity of east Ecuadorian lowland forest. *In*: Holm-Nielsen, L.B. Nielsen, C. and Balslev, H. (eds.) Tropical forest: botanical dynamics, speciation and diversity, vol. 3, 239-252. Academic Press and Harcourt Brace Jovanovich Publishers, London.
- BANCOMEXT (Banco Mexicano de Comercio Exterior) 2001. Directorio comercial de México; Bancomext directorio de exportadores disponible (available at www.bancomext.com/Bancomext2001/Diex/index.jhtml).
- Brown, H.A., Minott, D.A., Ingram, C.W. and Williams, L.A.D. 1998. Biological activities of the extracts and constituents of pimento, *Pimenta dioica* L. against the southern cattle tick, *Boophilus microplus*. *Insect Science and Its Application* 18: 9-16.
- Budavari, S. (ed.) 1989. The Merck index. Merck, Rahaway, NJ, USA.

- FAO (Food and Agriculture Organization of the United Nations) 1990-2001. FAO statistical databases; agriculture (available at www.apps.fao.org/page/collections?subset=agriculture).
- Fuentes, S. de la F. 1985. Contribution a l'étude de deux plantes aromatiques mexicaines: *Pimenta dioica* et *Cymbopogon citratus*. Faculté de Sciences Pharmaceutiques et Biologiques, Université René Descartes, Paris.
- García, B. 1987. Los pueblos de la Sierra; El poder y el espacio entre los indios del Norte de Puebla hasta 1700. Colegio de México, Mexico City, DF.
- Grainge, M. and Ahmed, S. 1988. Handbook of plants with pest-control properties. John Wiley and Sons, New York.
- Hernández, F. 1959. Historia natural de la Nueva España: obras completas de Francisco Hernández, vol. II. Universidad Nacional Autónoma de México, Mexico City, DF.
- Herrera, A. 1896. La pimienta gorda. Progreso de México 3: 311-312.
- Heywood, V.H. 1978. Flowering plants of the world. Oxford University Press, Oxford.
- Holdridge, R.L., Grenke, C.W., Herheawt, H.W., Liang, T. and Tosi, J. 1971. Forest environments in tropical life zones, a pilot study. Pergamon Press, Oxford.
- INEGI (Instituto Nacional de Estadística, Geografía e Informática) 1987. Síntesis geográfica, nomenclátor y anexo cartográfico del Estado de Puebla. Mexico City, DF.
- INEGI (Instituto Nacional de Estadística, Geografía e Informática) 1994. VII censo agropecuario (Consulta electrónica de tabulados, Puebla). Aguascalientes, Mexico.
- INEGI (Instituto Nacional de Estadística, Geografía e Informática) 1998. Cultivos perennes de México: VII censo agropecuario. Aguascalientes, Mexico.
- INEGI (Instituto Nacional de Estadística, Geografía e Informática) 2000. Censos preliminares 2000. Aguascalientes, Mexico.
- Langman, I. 1964. A selected guide to the literature on the flowering plants in Mexico. The University of Pennsylvania Press, Philadelphia, PA, USA.
- Landrum, L.R. 1986. *Campomanesia*, *Pimenta*, *Blepharocalyx*, *Legrandia*, *Acca*, *Myrrhinium*, and *Luma* (Myrtaceae). Flora Neotrópica 45: 1-178.
- Macía, M.J. 1998. La pimienta de Jamaica (*Pimenta dioica* (L.) Merrill, Myrtaceae) en la Sierra Norte de Puebla (México). Anales del Real Jardín Botánico, Madrid 56: 337-349.
- Martínez, M.A., Evangelista, V., Mendoza, M., Morales, G., Toledo, G. and Wong, A. 2001. Catálogo de plantas útiles de la Sierra Norte de Puebla, México. Cuadernos 27. Instituto de Biología, Universidad Nacional Autónoma de México, Mexico City, DF.
- McVaugh, R. 1956. Tropical American Myrtaceae, notes on generic concepts and descriptions of previously unrecognized spices. Fieldiana Botany 29: 145-228.
- Merrill, E.D. 1947. The technical name of allspice. Contributions from the Gray Herbarium of Harvard University CLXV: 30-38.
- Montes, R., Carvajal, M., Figueroa, R. and Méndez, J. 1997. Extractos sólidos,

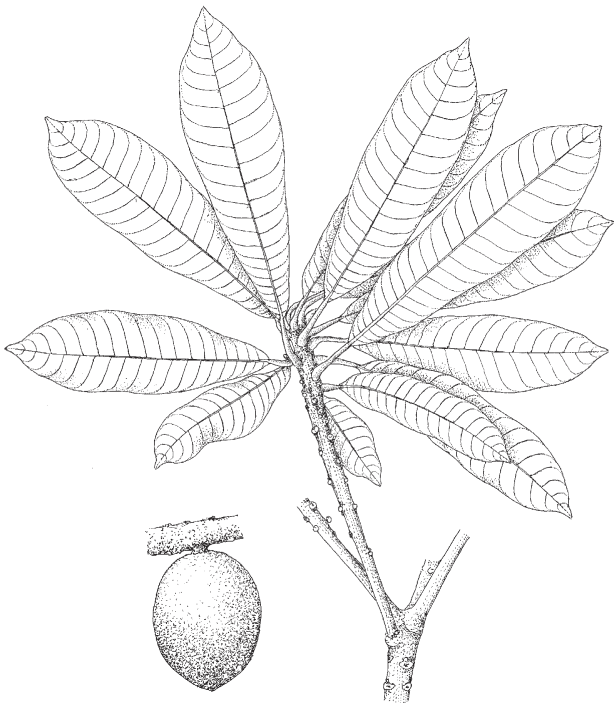
- acuosos y hexánicos de plantas para el combate de *Aspergillus flavus* Link, en maíz. *Revista Mexicana de Fitopatología* 15: 26-30.
- Mori, S.A., Boom, B.M., de Carvelino, A.M. and do Santos, T.S. 1983. Ecological importance of Myrtaceae in an eastern Brazilian wet forest. *Biotropica* 15: 68-70.
- Nakatani, N. 2000. Phenolic antioxidants from herbs and spices. *BioFactors* 13: 141-146.
- Okuyama, T., Matsuda, M., Masuda, Y., Baba, M., Masubichi, H., Adachi, M., Okada, Y., Hachimoto, T., Zou, L.B. and Inishino, H. 1995. Studies on cancer bio-chemoprevention of natural resources, X: inhibitory effect of spices on TPA-enhanced (3)H-choline incorporation in phospholipids of C3H10T1/2 cells and TPA-induced mouse ear edema. *Chinese Pharmaceutical Journal* 47: 421-430.
- Ortega, D. 2001. Local pimento in demand (available at <http://www.jamaica-gleaner.com.gleaner/20010202/business/business1.html>).
- Pennington, T.D. and Sarukhán, J. 1998. Árboles tropicales de México: manual para la identificación de las principales especies. Universidad Nacional Autónoma de México and Fondo de Cultura Económica, Mexico City, DF.
- Purseglove, J.W. 1974. Tropical crops: dicotyledons. Longman, London.
- SAGARPA/SIAP (Secretaría de Agricultura, Ganadería, Desarrollo Rural, Pesca y Alimentación and Servicios de Información y Estadísticas Agroalimentarias y Pesquera) 1990-2001. Anuario estadístico de la producción agrícola de los Estados Unidos Mexicanos. Mexico, DF.
- SAM (Sociedad Agrícola de México) 1897. Productos agrícolas. Boletín de la S.A.M. 21: 438, 441, 458, 469.
- SEG (Secretaría de Gobernación) 2001. Enciclopedia de municipios de México. Mexico.
- Standley, P.C. 1953. El nombre de la pimienta gorda de Centro-América. *Ceiba* 3: 171-172.
- Suárez, A., Ulate, G. and Ciccio, J.F. 1997. Cardiovascular effects of ethanolic and aqueous extracts of *Pimenta dioica* in Sprague-Dawley rats. *Journal of Ethnopharmacology* 55: 107-111.
- Velásquez, E. 1995. Cuando los arrieros perdieron sus caminos: la conformación regional del Totonacapan. El Colegio de Michoacán, Mexico City, DF.

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Chapter 3

Mamey Zapote [*Pouteria sapota* (Jacq.) H.E. Moore & Stearn],
A Mexican Forest Fruit of High
Commercial Value

Yolanda Nava-Cruz and Martín Ricker¹



(*Pouteria sapota*)

Common name	Product part used	Dominant form of management	Degree of transformation	Commercial scale	Geographic distribution
Mamey, Zapote mamey	Fruit	Wild	Low	National	Wide

ABSTRACT

Pouteria sapota (Jacq.) H.E. Moore & Stearn (Sapotaceae), commonly known as ‘sapote mamey’ or simply as ‘mamey’, is native to tropical Meso-America, ranging from southern Mexico to Nicaragua. Its fruits are harvested from adult trees, growing in humid rain forest, family gardens, forest fragments, or occasional remnant trees in pasture or fallow land. Fruits are sold throughout central and southern Mexico, including the supermarkets of Mexico City. This species is also grown in Guatemala, South America, Cuba, USA (Florida), the Philippines, and Indonesia. Currently, the Mexican fruits are not exported. In this chapter, we analyse mamey production in an area of 50 km², with about 1850 people living in two communities situated in the Municipality of San Andrés Tuxtla (919 km²) on the eastern coast of Mexico. We estimate that this 50 km² area produces about 25 tons of commercial mamey per year, about 0.6% of the 4024 tons produced in the entire country. Our study highlights (1) the under-utilization of this native forest species within the municipality of San Andrés Tuxtla, and (2) the possibility of producing high-quality fruits within a semi-natural forest system.

INTRODUCTION

Pouteria sapota (Jacq.) H.E. Moore & Stearn (Sapotaceae) is a rain forest tree with fruits the size of avocados. Its common name ‘sapote mamey’ is probably derived from the indigenous Nahuatl language (*çapotl* /*tzapotl* = ‘fruit with bone’; *mama* = ‘hands’, probably an allusion to the spirally arranged leaves) (Siméon 2002). The pulp has a characteristic salmon red colour, known as ‘mamey colour’, and is highly valued for its typically sweet flavour. The fruit also contains high levels of proteins and amino acids, including aspartic and glutamic acids (Hall *et al.* 1980). The pulp is eaten directly from the fruit.

In Mexico, the mamey has been exploited and consumed for centuries. Its ancient use is indicated by the existence of many different indigenous names: Pennington & Sarukhán (1998), for example, list 20 names in 11 indigenous languages of Mexico. In the pre-Columbian accounts of New Spain, mamey was described as a fruit tree, from whose seeds oil was extracted to make the hair shiny, and to polish *jícaras* (gourds used to store liquids) and wood (Hernández 1943, Acuña 1984).

Today, people in Mexico and other countries use mamey to prepare drinks and desserts such as jellies, ice cream, and cakes. Seeds are used by the cosmetics industry to extract oils (Takeda *et al.* 1997). As mentioned above, it is still used locally in Mexico to make hair shinier. In Trinidad and Tobago, seed extract is used to control ectoparasites in dogs (Cheryl *et al.* 2000). The wood is used in construction (Pennington 1990), although in commercial terms, the species in Los Tuxtlas is classified as a ‘common tropical wood’, and so its price, unlike precious woods, is low.

The *Pouteria* genus contains other species with edible fruits, also valued for their taste and locally or regionally commercialized. Examples in the Amazon include *P. caimito* (Ruíz & Pavon) Radlk., *P. macrocarpa* (Huber) Baehni, *P. macrophylla* (Lam.) Eyma, *P. pariry* (Ducke) Baehni, *P. speciosa*

(Ducke) Baehni, and *P. ucuqui* Pires & Schultes (Pennington 1990, Cavalcante 1996).

An analysis of the *P. sapota* production system is of interest because this species represents a tree from primary rain forest, with edible fruits that are sold as a luxury product (that is, they are relatively expensive) in the supermarkets of Mexico City. Mexico has an estimated annual trade of more than 4000 tons (INEGI 1999), which corresponds to an annual total value of US\$2,892,000 to the consumer in Mexico City.² Based on our estimates at Los Tuxtlas, this involves about 1,600 small producers, each with an annual average production of 2.4 tons.

In this chapter, we review the literature on *P. sapota*, and report research, from over 10 years on this species in the Los Tuxtlas region, where a research station of the Universidad Nacional Autónoma de México (UNAM) is situated. We also include data from interviews conducted in the year 2000 with two mamey traders (*mameyeros*), who collected fruits from an area of 50 km² in the region. Furthermore, we interviewed authorities of the Municipality of San Andrés Tuxtla. We must point out that the mamey trade in this region is small and informal. No organizations exist, nor are statistical data available. Moreover, the few people involved are not always receptive to being interviewed.

Characteristics of the study site

Our study focused on an area of about 50 km², belonging to the Municipality of San Andrés Tuxtla, of 919 km² in the region of Los Tuxtlas, in the state of Veracruz (Figure 1). Los Tuxtlas is a volcanic region, extending over about 80 km by 40 km, with an altitude ranging between 0 and 1680 meters above sea level. Temperatures and annual rainfall average 24°C and 4000 mm, respectively. The soil is an Andosol and the climate is humid, with a dry season from March to May, and a rainy season from November to February (Álvarez del Castillo 1997, Martínez Del Pozzo 1997, Soto & Gama 1997).

The low altitude vegetation has been described as ‘evergreen high forest’ (“selva alta perennifolia” in Miranda & Hernández 1963), ‘evergreen tropical forest’ (Rzedowski 1986), ‘tropical moist forest’ (Holdridge 1967), and ‘tropical rain forest’ (Richards *et al.* 1996). Deforestation in the region has been severe, with most of the forest having been converted to grazing land. Eighty-four percent of the original forest cover, in an area of 850 km², was lost between 1967 and 1976 (Dirzo & García 1992). A list of currently or potentially commercially valuable non-medicinal plants in UNAM’s 644-hectare reserve is provided in Ibarra-Manríquez *et al.* (1997). An inventory of the medicinal plants in the reserve was carried out by Mendoza-Márquez (2000).

Characteristics of the study and methodology

Our data is derived from the testimonies of two mamey collectors (*mameyeros*), operating in the municipality of San Andrés Tuxtla: Donato Quino from Xoteapan, a town of 1703 people (INEGI 2000), and Gregorio

Figure 1. Area targeted by the study on the mamey trade in southern Mexico



Sources: ESRI (Environmental Systems Research Institute, Inc.). Data and maps. 2002. Map prepared by Alejandro Flamenco (Institute of Ecology, Universidad Nacional Autónoma de México [UNAM]) with data from the Institute of Geography (UNAM), the Geographic and Statistics Information Laboratory at El Colegio de la Frontera Sur (ECOSUR), and the Instituto Nacional de Estadística, Geografía e Informática (INEGI).

González from Colonia Lázaro Cárdenas, a town of 145 people. We chose to work with these two people because they operate in two different areas of the municipality and because interviews indicated that they were the most active and best informed of the local mamey collectors. Unlike the other *mameyeros* interviewed, during the harvest season both these *mameyeros* dedicate themselves exclusively to harvesting, collecting, and selling these fruits in the local market. Donato Quino collects fruits mostly from trees in family gardens, whereas Gregorio González collects primarily from trees in areas of remnant primary and secondary forests, as well as remaining trees in grazing lands.

Donato Quino's area of influence includes the communities of Cerro Amarillo de Arriba, Cerro Amarillo de Abajo, Colonia Buena Vista, El Polvorín, La Ceiba, and margins of the city of San Andrés Tuxtla. Gregorio González operates in the environs of the communities of Colonia Lázaro Cárdenas, La Perla, Laguna Escondida, Ruíz Cortinez, and near Balzapote. The area of collection of the *mameyeros* comprises about 25 km² each (Figure 1).

THE PRODUCTION-TO-CONSUMPTION SYSTEM

Biology of the species

*Pouteria sapota*³ is a tree that can grow to 40 m, with a trunk diameter measuring up to 1.5 m at breast height, although more typically trees reach 20 m with a 0.5-m diameter (Azurdia & Ortiz, in press). The trunk is straight and may be buttressed. The wood has a pinkish-to-greyish coffee colour, and is hard and heavy, with a specific gravity of 0.83 (Barajas-Morales *et al.* 1997).

The simple leaves are spirally arranged and the solitary flowers, greenish-cream in colour, cluster in the leaf axillae. The fruits, reddish brown with a rough texture, measure up to 20 cm long, are ovoid, and hang from new branches. The mesocarp is sweet, fleshy, orange to red, and with small quantities of latex when immature. The fruit usually contains one, occasionally two, and rarely three seeds, which can be as long as 10 cm (Pennington & Sarukhán 1998).

In the Los Tuxtlas region, flowering begins in July. Fruits take more than a year to develop. Hence, in any one harvest, which takes place between May and July, small fruits already exist that will reach maturity in the following harvest (Davenport & O'Neal 2000, Ricker 2000, 2001). Some individual trees do not follow the general pattern, with some fruiting shortly before or after the usual harvest time, stretching the harvest time from April to September. The reproductive period of a mamey trees normally begins after 10 to 20 years, depending on individual growth rate. Life expectancy is at least 100 and possibly over 200 years.

The species is introduced in Florida, where growers- unlike in Mexico- distinguish between different varieties (Morton 1987, Balerdi 1991, Campbell *et al.* 1998). Ibarra-Manríquez (1985) reports that the flowers are monoclinal, that is, they possess masculine and feminine organs. In contrast, Pennington (1990) reports that the flowers are unisexual (i.e., dioecious plant) or bisexual.

Photo 1. A mamey collector or *mameyero* transports harvested fruits to San Andrés Tuxtla, using a dirt road (photo: M. Ricker)



In Los Tuxtlas, male and female trees of *P. sapota* are not distinguished.

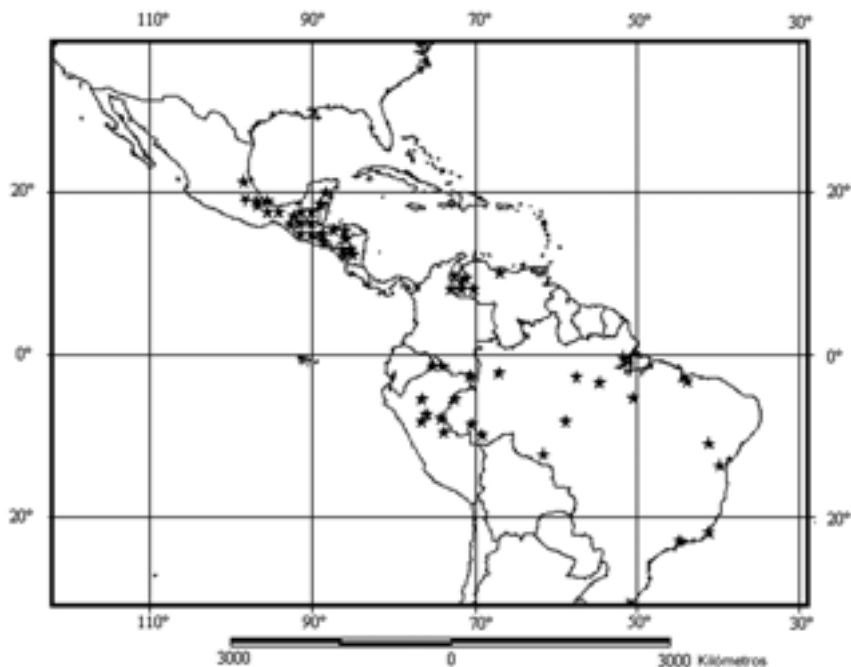
No studies have been published on pollinators for *P. sapota*, although flowers in the *Pouteria* genus are reported to be pollinated by bees or other insects (Pennington 1990, Ortiz & Cabello 1991, Knight *et al.* 1993). Possible predators and dispersors of fruits and seeds include the rodent agouti or *tepezcuintle* (*Agouti paca nelsoni*) and other larger mammals such as the kinkajou or *martucha* (*Potos flavus prehensilis*) (Martínez-Gallardo & Sánchez-Cordero 1997, Brewer & Rejmanek 1999).

A study of two populations of *P. sapota* in Guatemala showed that, typical of a preferentially allogamous species, genetic diversity is greater within, rather than between, populations. The authors of the study found that both young and mature plants show higher heterozygosity¹ than expected, suggesting the presence of a selection pressure for this state (Azurdia *et al.* 1999). This highlights the need to conserve the greatest possible genetic diversity, as well as selecting and cultivating the best commercial varieties.

Distribution and ecology

P. sapota is naturalized in many regions, making its original distribution uncertain. It is probably native to Meso-America, with a distribution ranging from southern Mexico to Guatemala, Belize, and northern Honduras, and spreading into the Atlantic forest of Nicaragua. In Costa Rica and Panama, it is naturally replaced by *P. viridis* (Pittier) Cronquist ("green sapote") and *P. fossicola* Cronquist, which also possess valued edible fruits (Pennington 1990). In Mexico, natural populations grow in the States of Oaxaca, Puebla,

Figure 2. Collections of herbarium examples of mamey (*Pouteria sapota*) in Mexico



The map was based on a revised version from the Herbario Nacional MEXU (Institute of Biology of the Universidad Nacional Autónoma de México [UNAM], Mexico City). Data were compiled by Lydia Ramírez Martínez (Institute of Biology, UNAM). The map was prepared by Gabriela Guerrero (Institute of Ecology, UNAM).

Guerrero, Veracruz, and San Luis Potosí (Figure 2). In addition, *P. sapota* is found in gardens in practically all the southern states of Mexico (Pohlan *et al.* 2000, González 2001).

Internationally, *P. sapota* is cultivated from Florida (USA) to Brazil and in the Caribbean (Cuba), between altitudes of 0 and 600 masl (Campbell & Lara 1982, Morton 1987, Hoyos 1989, Campbell 1994, Granados & Campbell 1994, Azurdia *et al.* 1995, Cruz & Deras 2000, Jaimez & Franco 2000). The species has also been introduced to the Philippines and later to Indonesia, Malaysia, and Vietnam (Oyen 1991), as well as India (Singh *et al.* 1997). According to Oyen (1991), the tree can survive light frosts. Low temperatures and dryness cause leaves to change colour to yellow and red, and eventually fall. We have observed the slow growth of a potted eight-year old mamey seedling in Mexico City (2400 masl), where in December temperatures to almost 0°C. In Los Tuxtlas, *P. sapota* is naturally found in evergreen high forest, over volcanic soil. In Guatemala and Belize, the species inhabits sub-perennial forest growing in calcareous soils (Pennington 1990). Morton (1987) suggests that *P. sapota* tolerates a range of soils but grows best in heavy, clay soils.

Peña-Ramírez (2002) found that seedlings are very sensitive to acidity and salinity, with a pH of less than 5.5 and salinity (conductivity) greater than 0.7 mS/cm will cause seedling death. Applying fertilizer in the field can increase mortality by increasing salinity around the roots, thus drying the seedlings by retaining water in the soil (Li *et al.* 2000, Martínez-Bravo 2001). In natural forest, the species is scarce, with 0.25 to 1 adult trees per hectare, and a reproduction rate of 7.8 new individuals per year and hectare (Miguel Martínez-Ramos 2002, personal communication).

Management and cultivation

In the study area, *P. sapota* fruits are primarily harvested in extraction systems, from trees in gardens, fragments of primary forest, and remaining trees in grazing lands. In addition, people also plant and graft trees in their gardens. The preference for cultivation probably helps reduce the risk of over-harvesting wild populations (Peters 1996), even though it may entail a loss in genetic diversity. Home gardens with mamey trees have on the average 1 to 3 productive trees, whereas in primary forest fragments, secondary forests, and grazing lands, trees average less than 1 per hectare.

Fruit maturation in the tree is asynchronic, meaning that the same tree can be harvested again after some weeks (Heredia *et al.* 1998). To bring together a harvest of 1 ton of fruit and take it to the local market, a *mameyero* must harvest between 3 and 5 trees, covering an average distance of about 30 km.

The production system for mamey in Los Tuxtlas differs from that of other localities. For example, in the Sierra Norte de Puebla, in addition to collecting mamey in home gardens, pastures and forest, it is also grown in association with coffee, by farmers who are organized in cooperatives. In this region, each family has between 1 and 75 trees- with an average of 9; a higher number than in the Municipality of San Andrés Tuxtla. Furthermore, farmers also sell their mamey harvests in the States of Hidalgo, Tlaxcala, Puebla, and Mexico, as well as in Mexico City itself (Miguel-Ángel Martínez-Alfaro 2001, personal communication).

The species can be cultivated in the shade, in groves, or in the sun, in grasslands. When cultivated, a distance of 8 to 12 m between each tree is recommended (Morton 1987, Oyen 1991). As part of a forest enrichment planting experiment in the Los Tuxtlas forest, Ricker *et al.* (2000) planted seedlings under different degrees of canopy opening, and found the optimal opening to be 60% for seedlings in their first two years. This level of canopy cover ensures that seedlings are protected from drought by the surrounding vegetation. During the first years of cultivation, cleaning and thinning are recommended to prevent competition with other plants (Meyer & Motohashi 1989).

Ricker *et al.* (1999a) projected the survival curve for *P. sapota* in Los Tuxtlas, estimating a 56% survival rate after 20 years, though mortality rates vary according to the type of management. We deduced from our field observations that *P. sapota* grows better and is more productive when planted close to bodies of water. In some cases furrows are used to ensure

Photo 2. Fruits of mamey (*Pouteria sapota*) for sale in San Andrés Tuxtla, Mexico (photo: M. Ricker)



the soil remains moist. Initial seedling growth also depends on seed size, as larger seeds contain more nutrients (Ricker *et al.* 2000).

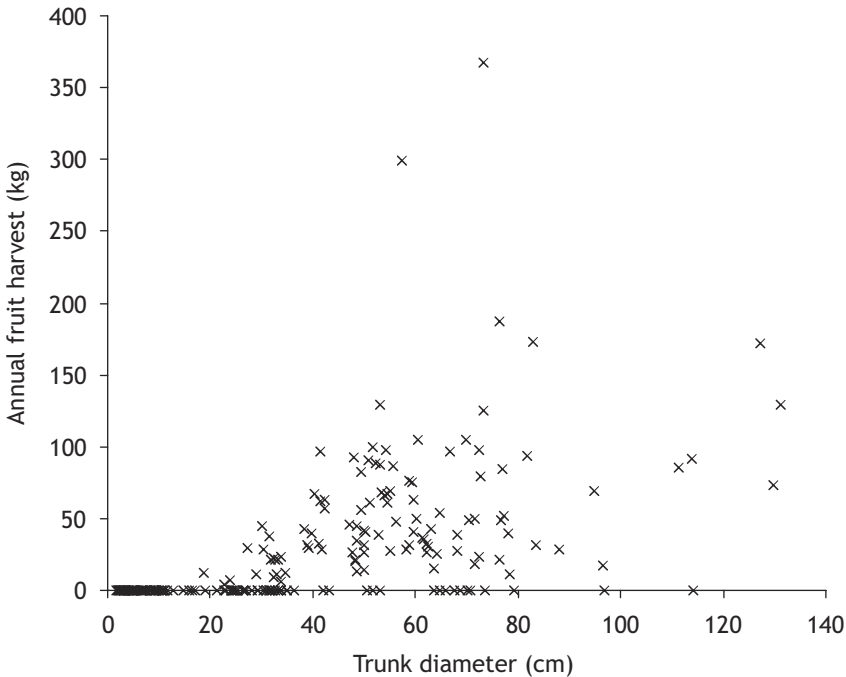
Diseases and pests do not pose a major problem for *P. sapota*. The main pest is probably the fruit fly *Anastrepha* spp. (Diptera: Tephritidae), whose larvae develop in the fruit pulp, discouraging potential customers (Knight *et al.* 1985, Hernández & Pérez 1993, Gould & Hallman 2001). Other pests are mentioned by McMillan (1990), Oyen (1991), Pérez-Morales *et al.* (1997), and Vázquez *et al.* (1999). To control the genetic quality of fruits in plantations, grafting is commonly practised, using branches from trees of known quality (Kulwal *et al.* 1985, Buisson 1986).

Production levels

The annual trade of mamey in Mexico is estimated at 4024 tons (INEGI 1999). The average annual production over the last 5 years in the Municipality of San Andrés Tuxtla is estimated at 24 to 25 tons (SNIIM 2002), or 0.6% of the national reported commercial production. These figures are rough estimates only, given that most of the trade is informal.

In a three-year study, Ricker (1998) estimated that the annual fruit production of 100 trees with a median trunk diameter of 43 cm averaged 43.6 kg, 29.3 kg, and 28.2 kg per tree, for 1995, 1996 and 1997, respectively. However, the variation between years and between trees even though of the same size is large (Figure 3). Possible factors contributing to this variation may include, for example, differences in weather conditions and the presence of pollinators between sites and years, variation in the availability of nutrients between trees, and inter annual periods of rest in fruit production of individual trees.

Figure 3. Annual harvest of the arboreal fruit mamey (*Pouteria sapota*) in relation to trunk diameter.



Wide fluctuations in production between trees and between years were found among 79 trees harvested over 3 years (1995, 1996, and 1997). The trees were located in an area of about 225 hectares (1.5×1.5 km) surrounding the 'Los Tuxtlas' Tropical Biology Station. A tree with a 130-cm diameter was estimated as being 189 years old (Ricker *et al.* 1999b, Ricker 2000).

In a study measuring 182 fruits from 6 *P. sapota* trees in Los Tuxtlas, Ricker (1998) found the average fruit weight to vary from 273 g in the trees with the smallest fruits to 527 g in trees with the largest fruits. These figures correspond to those reported in three sites in Guatemala (Leiva *et al.* 2002). Azurdia & Ortiz (in press) report a range of fruit weight between 85 and 1434 g, also in Guatemala. According to Morton (1987), the fruits of cultivated *P. sapota* trees in Florida weigh 0.2 to 2.3 kg- very much above the average observed in wild and semi-wild trees of Los Tuxtlas. It should be pointed out, however, that in terms of their marketing, maximum-sized fruits are often not desirable. In Mexico, for example, consumers tend to prefer medium-sized fruits because there is always a risk that a fruit may be past its peak quality, or not particularly palatable. Buying a larger, and more expensive fruit, is therefore riskier than buying a smaller fruit. This in turn is related to the fruit's perishable nature: fruits have a shelf life of 10 days and are best when consumed after three days. An estimate of mamey production levels in the 50-km² study area (5.4% of the municipality's 919 km²) can be made

on the basis that one third of the study area has forests with mamey trees occurring at a density of 0.5 trees per hectare. Since each tree produces on average 30 kg of mamey per year (Ricker *et al.* 1999b, Ricker 2000), then the area produces on average about 24.75 tons of mamey per year. In other words, 5.4% of the municipality's area can potentially produce and sell a larger quantity than is currently reported for the entire area. This in turn suggests that there are no precise figures on the volumes of harvested mameys or the numbers of active *mameyeros* in the municipality. Accordingly, we cannot specify trends in extraction activities or current trade of mamey fruits in the area, although demand appears to have remained relatively stable over the last 10 years.

The socio-economic context of the *mameyeros*

The natural vegetation of Los Tuxtlas once included broad extensions of high evergreen forest. The known human settlements occupying the region 500 to 1500 years ago belonged to the Olmeca culture, famous for its large stone figures of human heads (Medel 1963, Bernal 1968). Pre- and post-conquest groups, the descendants of whom are restricted to localities such as Xoteapan and Santa Rosa Loma Larga in southern Tuxtleca region, are Popolucas and Mexicas (Andrle 1964).

Most people in the region's rural towns—Catemaco, San Andrés Tuxtla, and Santiago Tuxtla—trade in agriculture and livestock (INEGI 2000). The following information on the municipality of San Andrés Tuxtla comes from INEGI (2000): The municipal capital is the city of San Andrés Tuxtla, with about 50,000 inhabitants. As a whole, the municipality includes 150 villages, covering an area of 919 km², with a total population of 142,000, and an average of 4.6 people per family. The minimum wage in the region is US\$4 per 8-hour working day. The average annual household income in the municipality is \$1560, which is below the national annual average of \$1782. Most land (67%) is communally owned in *ejidales*, with the remaining land being privately owned (32.3%), or federal (0.7%). The value of non-urban land, with or without forest (with a prohibition to fell) and not at the beach, fluctuates between \$650 and \$2200 per hectare. Land rental costs range between \$30 and \$100 per hectare and year.

The main economic activity in the region is extensive livestock production, mostly for beef, and to a lesser extent for dairy products. In recent decades, a series of commercial monocrops have been introduced, the most important being tobacco, for both national and international markets. Other important cash crops are coffee and sugar cane. In addition, rural communities continue practising subsistence agriculture, growing maize and beans (Barrera-Bassols *et al.* 1993).

The household economy of mamey producers

Mamey production in Los Tuxtlas is low compared to other fruit crops, such as orange, mango, or papaya. Mamey provides an additional source of income—between 20% and 30% of the annual family income—to both tree owners and

fruit collectors in the region, partly because fruit production lasts only about 4 months. *Mameyeros* complement their household economy with the harvest of other fruits, such as orange, mango, and papaya. They also harvest a fruit related to *P. sapota*, the “marmalade tree” or *chicozapote* (*Manilkara zapota* (L.) van Royen, Sapotaceae). In addition, they occasionally sell their labour as masons or day labourers, or barter with their neighbours to obtain other products. Overall, only about 60% of the *mameyero* household economy is in cash, and linked to the market economy.

Women are minimally involved in harvesting mamey, perhaps because of the strenuous physical demands of climbing trees, and cutting and transporting the fruits. The children of *mameyeros* also do not seem to participate in fruit harvesting. Thus, in most cases only the father carries out the work, assisted by day labourers who are paid wages according to the time, type of work, or tasks assigned. According to our interviews, *mameyeros* have to perform the following tasks:

1. Locate productive trees with an adequate number of harvestable fruits, often covering 10 to 20 km between sites;
2. Negotiate the price with the trees’ owners;
3. Climb the trees, and cut and collect the fruits in such a way that they are not damaged by falling and striking the ground;
4. Collect the fruits into sacks for transport to the closest roads, travelling between 2 and 5 km, either on foot or using draught animals, such as horses, mules, or donkeys; and,
5. Leave the fruit to mature in the house to subsequently transport them to either the local market or to the intermediary, usually travelling 1 to 3 hours in a pick-up truck.

Processing mamey

The fruits are always cut when they are immature. In the wild, they also fall from the tree while still immature, and ripen on the ground. When they are collected, they take several days to mature in a warm environment. Once mature and smooth, they maintain their quality for consumption only for a few days.

In the Los Tuxtlas region, mamey is not processed commercially, except by a few people who prepare, in small quantities, ice-cream or iced popsicles (*paletas de hielo*) from the pulp. Natives of the area also pound the seed to extract oil, which is used to add shine to their hair.

Some commercial processing occurs at a national level, such as the use of the seed oil in cosmetics, and the sporadic sale of mamey-flavoured yoghurt, cakes, and jellies in supermarkets. The scale of production, processing, and marketing of mamey fruits and seeds in other countries such as Guatemala (Azurdia & Ortiz, in press) illustrates the high commercial potential of this species.

Commercialization and marketing

The two *mameyeros* interviewed sell their harvest to local and foreign

merchants. The most common trade path is from the owners of the tree to the mamey collectors, who then sell the fruits to merchants in the marketplace in Catemaco, San Andrés Tuxtla, and Santiago Tuxtla, the main market towns

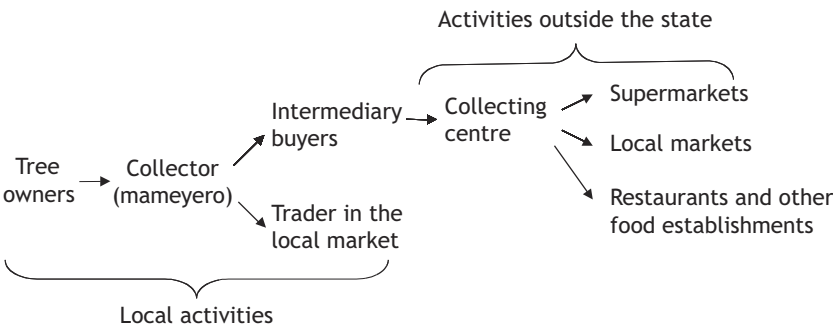
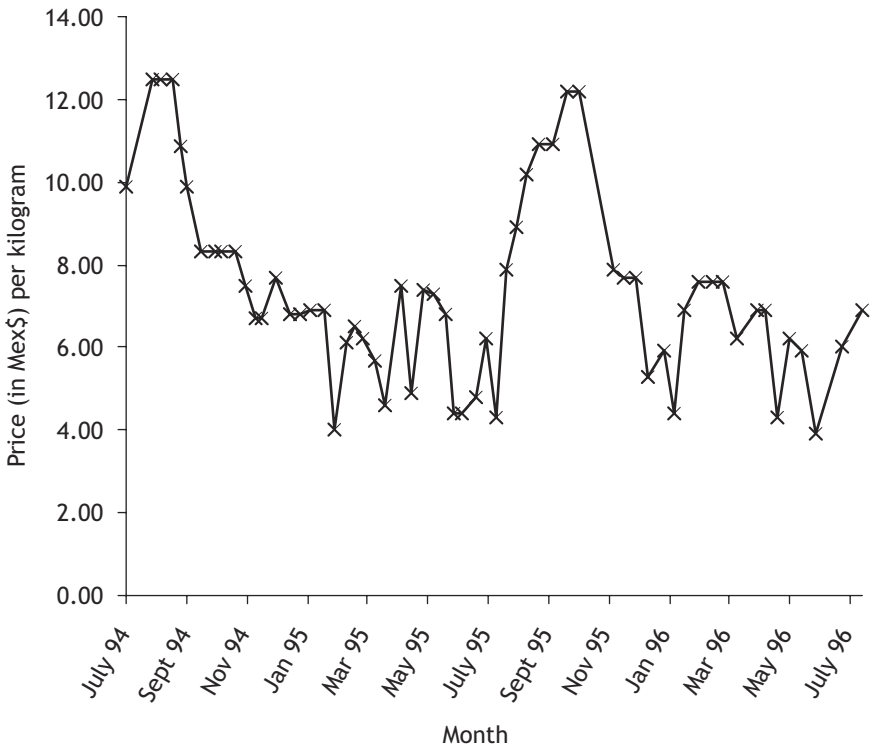


Figure 4. Price trends per kilogram of mamey sapote fruits (*Pouteria sapota*) in a supermarket in Mexico City



Data received from the supermarket 'Gigante', corner of Calle Eugenia and Calle Gabriel-Mancera, Mexico City. This supermarket sells mamey throughout the year, although the fruit comes from different states of Mexico and even from Guatemala, depending on the season. The exchange rate rose between 1994 and 1999 from about 4 Mexican pesos per U.S. dollar to 10 pesos to the dollar.

in each of three neighbouring municipalities. These merchants sell the fruits directly to the final consumer.

A second trade pathway involves wholesale intermediaries, who usually take the produce to the *Central de Abastos*, the main food wholesale market in Mexico City. From here, the mamey is distributed to large supermarkets, restaurants and local merchants, and sometimes directly to the final consumer. The following diagram shows the two marketing chains.

Figure 4 shows the supply of mamey over a two-year period in a supermarket of Mexico City. Clearly, it is not a sporadic product, as fruits harvested from different parts of Mexico with different harvest seasons are sold year-round. Its high price, compared to fruits such as strawberries and grapes, also suggests it is not considered an 'inferior' product. In contrast, the prices in Los Tuxtlas are considerably lower, and the fruit is only available during the harvesting season.

Political and institutional aspects

To date, there have been no policies or programs encouraging the production of mamey or the organization of its collectors. For some decades now, local and regional policies have been directed to promote livestock and, in the case of the area surrounding the city of San Andrés Tuxtla, tobacco. No governmental institution has considered promoting mamey production as part of its rural development plans. The lack of incentives, programs to promote cultivation, and the lack of a legal framework that adjusts to the needs of mamey commercialization have all served as constraints to the development of mamey production in the region. The lack of an organization of producers has limited the opportunities of designing a comprehensive strategy that serves to improve cultivation of the species and establish the distribution channels to allow them to capture a greater part of the product's final price.

CONCLUSIONS

Ricker *et al.* (1999b) and Ricker (2000) emphasize that forest enrichment in Los Tuxtlas with *P. sapota* seedlings would generate commercial gains of enough significance as to compete with livestock-raising, a land use which currently prevails in the area. The study concludes that forest enrichment with mamey can provide an economically viable alternative to livestock production or other forest-destroying forms of land use. The forest fragments that remain, currently threatened by the expansion of livestock-raising, are suitable sites for such enrichment plantings. This would also provide an incentive to land owners to protect what remains of the original forest. The mamey production system in Los Tuxtlas region would also benefit from programs that strengthen the levels of available infrastructure and technical know-how. Programs are needed to help establish high-quality cultivation systems based on genotype selection and management regimes that favour growth rates. For example, mamey trees seem to grow faster when being close to water bodies. It is also necessary to improve the level of organization among producers, improving marketing skills and increasing the efficiency of mamey distribution and

trade. This in turn requires increasing production, improving distribution, lowering costs, and decreasing the number of intermediaries involved in the trade chain. One option for increasing the final value of mamey is promoting a higher degree of transformation, which in turn requires of investment, training and an entrepreneurial economic and political environment. Finally, activities directed at commercialization should be complemented by a program to conserve the rich natural diversity of this species in the Sierra de Los Tuxlas.

NOTES

1. Estación de Biología Tropical “Los Tuxlas”, Universidad Nacional Autónoma de México, Apartado Postal 94, San Andrés Tuxtla, Veracruz 95701, Mexico. Phone: +52-2001255404 or 5408, e-mails: ynava@ate.oikos.unam.mx; mricker@ibiologia.unam.mx

2. Value estimated from the average in Figure 4.

3. Some synonyms for *Pouteria sapota* are *Achradelpha mammosa* (L.) O.F. Cook, *Calocarpum mammosum* (L.) Pierre, *C. sapota* (Jacq.) Merr., *Lucuma mammosa* (L.) C. F. Gaertner, *P. mammosa* (L.) Cronquist, and *Vitellaria mammosa* (L.) Radlk. (Pennington 1990). Common Spanish names are “zapote mamey”, “zapote”, “quaicuma”, “mamey colorado”, and “mamey”. In other languages, common names include “grand sapotillier” and “grosse sapote” (French), “mamey” (English), and “sapoti” (Portuguese) (Pennington 1990, Balerdi & Shaw 1998).

REFERENCES

- Acuña, R. (ed). 1984. Relaciones geográficas del siglo XVI: Antequera, Vol. 1. Universidad Nacional Autónoma de México (UNAM), Mexico City, DF.
- Álvarez del Castillo, C. 1997. Estudio ecológico y florístico del cráter del volcán San Martín Tuxtla, Veracruz, México. *Biotica* 2: 3-54.
- Andrle, R.F. 1964. A biogeographical investigation of the Sierra de Tuxtlas in Veracruz, Mexico. Doctoral dissertation. Louisiana State University, Baton Rouge, LA.
- Azurdia, C. and Ortiz, A. In press. Sapotáceas de Guatemala: Diversidad genética, conservación y utilización. Editorial Universitaria, Universidad de San Carlos, Guatemala.
- Azurdia, C., Martínez, E., Ayala, H., and Campbell, R.J. 1995. Some Sapotaceae of Petén, Guatemala. *Proceedings of the Inter-American Society for Tropical Horticulture* 39: 119-126.
- Azurdia, C., Ayala, H., Mejía, L., Grum, M., Figueroa, F., Colindres, N., and Ayala, S. 1999. Tasa de cruzamiento y estructura genética de una población de zapote (*Pouteria sapota*). *Tikalía* (Guatemala) 17(1): 59-80.
- Balerdi, C. 1991. More choice, an update on mamey sapote cultivars in Florida. *Tropical Fruits World* 2: 18-19.
- Balerdi, C.F. and Shaw, P.E. 1998. Sapodilla, sapote and related fruit. In: Shaw, P.E., Chan H.T., and Nagy S. (eds.) *Tropical and subtropical fruits*, pp. 78-136. Agscience, Auburndale, FL.

- Barajas-Morales, J., Ángeles-Álvarez, G., and Solís-Sánchez, P. 1997. Anatomía de maderas de México: Especies de una selva alta perennifolia. Publicaciones Especiales 16. Instituto de Biología, Universidad Nacional Autónoma de México (UNAM), Mexico City, DF.
- Barrera-Bassols, N., López, C.B., and Palma, R. 1993. Vacas, pasto y bosque en Veracruz 1950-1990. In: Barrera, N. and Rodríguez, H. (comps.) Desarrollo y medio ambiente en Veracruz: impactos económicos, ecológicos y culturales de la ganadería en Veracruz, pp. 35-71. Fundación Friedrich Ebert, Mexico City, DF.
- Bernal, I. 1968. El mundo Olmeca. Editorial Porrúa, Mexico City, DF.
- Brewer, S.W. and Rejmanek, M. 1999. Small rodents as significant dispersers of tree seeds in a Neotropical forest. *Journal of Vegetation Science* 10(2): 165-174.
- Buisson, D. 1986. Architectural analysis of some species of tropical fruit trees. *Fruits* 1(7-8): 477-498.
- Campbell, C.A. 1994. Handling of Florida-grown and imported tropical fruits and vegetables. *Hortscience* 29: 975-978.
- Campbell, C.W. and Lara, S.P. 1982. Mamey sapote cultivars in Florida. *Proceedings of the Florida State Horticultural Society* 95: 114-115.
- Campbell, R.J., Zill, G., and Mahdeem, H. 1998. New mamey sapote cultivars from tropical America. *Proceedings of the Inter-American Society for Tropical Horticulture* 41: 219-222.
- Cavalcante, P.B. 1996. Frutas comestíveis da Amazônia. Museu Paraense Emílio Goeldi, Belém, Pará, Brazil.
- Cheryl, L., Harper, T., Georges, K., and Bridgewater, E. 2000. Medicinal plants used for dogs in Trinidad and Tobago. *Preventive Veterinary Medicine* 45: 201-220.
- Cruz, E. and Deras, H. 2000. Colecta de frutales tropicales en El Salvador. *Agronomía Mesoamericana* 11(2): 97-100.
- Davenport, T.L. and O'Neal, J.T. 2000. Flowering and fruit set of mamey sapote [*Calocarpum sapota* (Jacq.) Merr.] cv. Magaña in South Florida. *Scientia Horticulturae* 83: 61-70.
- Dirzo, R. and García, M.C. 1992. Rates of deforestation in Los Tuxtlas, a Neotropical area in Southeast Mexico. *Conservation Biology* 6: 84-90.
- González, R.J. 2001. Zapotec science: farming and food in the northern Sierra of Oaxaca. University of Texas Press, Austin, TX.
- Gould, W.P. and Hallman, G. 2001. Host status of mamey sapote to Caribbean fruit fly (Diptera: Tephritidae). *Florida Entomologist* 84(3): 370-375.
- Granados, F.J.C. and Campbell, R.J. 1994. The cultivation of sapote in Guatemala: research, development and industry. *Proceedings of the Inter-American Society for Tropical Horticulture* 38: 142-149.
- Hall, N.T., Smoot, J.M., Knight, R.J., and Nagy, S. 1980. Protein and amino acid compositions of ten tropical fruits by gas-liquid chromatography. *Journal of Agricultural and Food Chemistry* 28(6): 1217-1221.
- Heredia, J.B., Siller, J.H., Baez, M.A., Araiza, E., Portillo, T., Garcia, R., and Muy, M.D. 1998. Changes in the quality and content of carbohydrates in tropical and subtropical fruits at the supermarket level. *Proceedings of the Inter-American Society for Tropical Horticulture* 41: 104-109.

- Hernández, F. 1943. Historia de las plantas de Nueva España, Vol. 1. Imprenta Universitaria, Mexico City, DF.
- Hernández, O.V. and Pérez, R.A. 1993. The natural host plants of *Anastrepha* (Diptera, Tephritidae) in a tropical rain forest of Mexico. *Florida Entomologist* 76: 447-460.
- Holdridge, L. 1967. Life zone ecology. Tropical Science Center, San José, Costa Rica.
- Hoyos, F.J. 1989. Frutales en Venezuela. Sociedad de Ciencias Naturales La Salle, Caracas, Venezuela.
- Ibarra-Manríquez, G. 1985. Estudios preliminares sobre la flora leñosa de la Estación de Biología Tropical "Los Tuxtlas", Veracruz, México. B.Sc. thesis in Biology. Faculty of Sciences, Universidad Nacional Autónoma de México (UNAM), Mexico City, DF.
- Ibarra-Manríquez, G., Ricker, M., Angeles, G., Sinaca, C.S., and Sinaca, C.M.A. 1997. Useful plants of the Los Tuxtlas rain forest (Veracruz, Mexico): considerations of their market potential. *Economic Botany* 51(4): 362-376.
- INEGI (Instituto Nacional de Estadística Geografía e Informática). 1999. Anuario estadístico de la producción agrícola. Aguascalientes, Mexico.
- INEGI (Instituto Nacional de Estadística Geografía e Informática). 2000. Censo general de población. Aguascalientes, Mexico.
- Jaimez, R.E. and Franco, W. 2000. Producción de hojarasca, aporte en nutrientes y descomposición en sistemas agroforestales de cacao y frutales. *Agrotropica* 11(1): 1-8.
- Knight, R.J., Jr., Spalding, D.H., King, J.R, von Windeguth, D.L, Benschoter, C.A., Burditt, J.R., and Fons, J. 1985. Results of fumigation of fruits and vegetables of southern Mexico to control the Mediterranean fruit fly. *Proceedings of the Tropical Region of the American Society for Horticultural Science* 24: 117-125.
- Knight, R.J., Jr., Campbell, C.W., and Campbell, R.J. 1993. Pollination requirements for successful fruiting of tropical fruit species. *Proceedings of the Inter-American Society for Tropical Horticulture* 37: 167-170.
- Kulwal, L.V., Tayde, G.S., and Deshmukh, P.P. 1985. Studies on softwood grafting of sapota. *PKV Research Journal* 9(2): 33-36.
- Leiva, J.M., Azurdia, C., Ovando, W., López, E., and Ayala, H. 2002. Contributions of home gardens to *in situ* conservation in traditional farming systems - Guatemalam component. In: Watson, J.W. and Eyzaguirre, P.B. (eds.) *Proceedings of the Second International Home Gardens Workshop: contribution of home gardens to in situ conservation of plant genetic resources in farming systems*, 17-19 July 2001, Witzenhausen, Germany, pp. 56-72. International Plant Genetic Resources Institute (IPGRI), Rome.
- Li, Y.C., Crane, J., Boman, B., and Balerdi, C. 2000. Fertilizer management survey for tropical fruit crops in South Florida. *Proceedings of the Florida State Horticultural Society* 112: 172-176.
- McMillan, R.T., Jr. 1990. Alga blight of *Pouteria sapota* caused by *Cephaleuros virescens*. *Phytopathology* 80: 975.
- Martínez-Bravo, R.D. 2001. Reforestación con diez especies arbóreas nativas bajo fertilización en Tabasco. M.Sc. thesis. Postgrado en Ciencias Biológicas,

- Instituto de Biología, Universidad Nacional Autónoma de México (UNAM), Mexico City, DF.
- Martínez Del Pozzo, A.L. 1997. Geología. In: González, E.S., Dirzo, R., and Vogt, R. (eds.) Historia natural de Los Tuxtlas, pp. 25-31. Universidad Nacional Autónoma de México (UNAM), Mexico City, DF.
- Martínez-Gallardo, R. and Sánchez-Cordero, V. 1997. Historia natural de algunas especies de mamíferos terrestres. In: González, S.E., Dirzo, R., and Vogt, R. (eds.) Historia natural de Los Tuxtlas, pp. 591-609. Universidad Nacional Autónoma de México (UNAM), Mexico City, DF.
- Medel, A.L. 1963. Historia de San Andrés Tuxtla, Veracruz 1532-1950. Editorial Citlaltepetl, Mexico City, DF.
- Mendoza-Márquez, P.E. 2000. Las plantas medicinales de la selva alta perennifolia de Los Tuxtlas, Veracruz: Un enfoque etnofarmacológico-químico. B.Sc. thesis in Biology. Faculty of Sciences, Universidad Nacional Autónoma de México (UNAM), Mexico City, DF.
- Meyer, R. and Motohashi, N. 1989. The cultivation conditions for new fruit crops in California. *Agriculture and Horticulture* 64(10): 1147-1152.
- Miranda, F. and Hernández, E.X. 1963. Los tipos de vegetación de México y su clasificación. *Boletín de la Sociedad Botánica de México* 28: 29-179.
- Morton, J.F. 1987. Fruits in warm climates. Published by Julia F. Morton, Miami, FL.
- Ortiz, S.F.J. and Cabello, G.T. 1991. Use of insects in the pollination of subtropical crops. *Agrícola Vergel* 10(119): 692-694.
- Oyen, L.P.A. 1991. *Pouteria sapota* (Jacq.) H.E. Moore & Stearn. In: Verheij, E.W.M. and Coronel, R.E. (eds.) Plant resources of South-East Asia, 2: Edible fruits and nuts, pp. 259-262. Pudoc, Wageningen, Netherlands.
- Peña-Ramírez, V.M. 2002. Fertilización de *Pimienta dioica* (pimienta gorda) y *Pouteria sapota* (Mamey): Un experimento en invernadero. M.Sc. thesis (under review). Posgrado en Ciencias Biológicas, Instituto de Biología, Universidad Nacional Autónoma de México (UNAM), Mexico City, DF.
- Pennington, T.D. 1990. Flora Neotropica, Monograph 52: Sapotaceae. The New York Botanical Garden, Bronx, NY.
- Pennington, T.D. and Sarukhán, J. 1998. Árboles tropicales de México. Universidad Nacional Autónoma de México (UNAM) and Fondo de Cultura Económica (FCE), Mexico City, DF.
- Pérez-Morales, J.V., Pinzón, P.L.M., and Echenique, M.R. 1977. Ensayo de laboratorio sobre resistencia natural de la madera de especies tropicales mexicanas al ataque de hongos xilofagos. *Boletín de la Sociedad Mexicana de Micología* 11: 99.
- Peters, C.M. 1996. Observations on the sustainable exploitation of non-timber tropical forest products. In: Ruiz, P.M. and Arnold, J.E.M. (eds.) Current issues in non-timber forest products research, pp. 19-39. Center for International Forestry Research (CIFOR), Bogor, Indonesia.
- Pohlan, J., Borgman, J., Gehrke, V.M.R., and Blanke, M. (eds.) 2000. Perspectives of Sapotaceae species for fruit production in the Soconusco Region, Chiapas, Mexico. *Acta Horticulturae* 531: 45-52.
- Richards, P.W., Walsh, R.P.D., Baillie, I.C., and Greig-Smith, P. 1996. The tropical rain forest. Cambridge University Press, Cambridge.

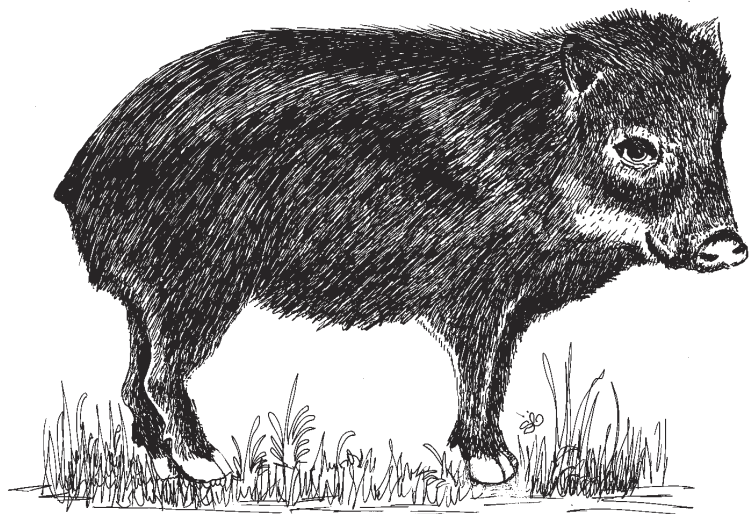
- Ricker, M. 1998. Enriching the tropical rain forest with native fruit trees: a biological and economic analysis in Los Tuxtlas (Veracruz, Mexico). Ph.D. dissertation. School of Forestry and Environmental Studies, Yale University, New Haven, CT. (Also available through UMI Dissertation Services, Ann Arbor, MI.)
- Ricker, M. 2000. Enriquecimiento de la selva con árboles nativos: Un análisis de costo-beneficio con tres especies en Los Tuxtlas, Veracruz. In: Escalante, R. and Aroche, F. (comps.) El sector forestal en México, pp. 85-113. Faculty of Economics, Universidad Nacional Autónoma de México (UNAM), Mexico City, DF.
- Ricker, M. 2001. Manejo y evaluación económica de una especie arbórea de la selva tropical: El mamey (*Pouteria sapota*). In: Rendón, A.B., Rebollar, S.D., Caballero, J.N., and Martínez-Alfaro, M.A. (eds.) Plantas, cultura y sociedad: Estudio sobre la relación entre seres humanos y plantas en los albores del siglo XXI, pp. 287-307. Universidad Autónoma Metropolitana (Iztapalapa), Mexico City, DF.
- Ricker, M., Bye, R., Ibarra-Manríquez, G., Martínez-Ramos, M., Siebe, C., Palacio, J.L., Valenzuela, R., and Angeles, G. 1999a. Diversidad y manejo de los bosques mexicanos: aspectos microeconómicos. *Investigación Económica* 59: 77-109.
- Ricker, M., Mendelsohn, R.O., Daly, D.C., and Ángeles, G. 1999b. Enriching the rainforest with native fruit trees: an ecological and economic analysis in Los Tuxtlas (Veracruz, México). *Ecological Economics* 31: 439-448.
- Ricker, M., Siebe, C., Sánchez, S.B., Shimada, K., Larson, B.C., Martínez-Ramos, M., and Montagnini, F. 2000. Optimizing seedling management: *Pouteria sapota*, *Diospyros digyna*, and *Cedrela odorata* in a Mexican rainforest. *Forest Ecology and Management* 139: 63-77.
- Rzedowski, J. 1986. Vegetación de México. Editorial Limusa, Mexico City, DF.
- Siméon, R. 2002. Diccionario de la lengua Náhuatl o Mexicano. Siglo XXI, Mexico City, DF. (First edition in French, 1885.)
- Singh, G., Dagar, J.C., and Singh, N.T. 1997. Growing fruit trees in highly alkali soils: a case study. *Land Degradation and Development* 8(3): 257-268.
- SNIIM (Sistema Nacional de Información e Integración de Mercados). 2002. (At <http://www.secofi-sniim.gob.mx>)
- Soto, M. and Gama, L. 1997. Climas. In: González, E.S., Dirzo, R., and Vogt, R.C. (eds.) Historia natural de Los Tuxtlas, pp. 7-23. Universidad Nacional Autónoma de México (UNAM), Mexico City, DF.
- Takeda, T., Gonda, R., and Hatano, K. 1997. Constitution of lucumin and its related glycosides from *Calocarpum sapota* Merrill. *Chemical and Pharmaceutical Bulletin* 45(4): 697-699.
- Vázquez, L.L., Pérez, I., Navarro, A., and Casin, J.C. 1999. Occurrence and management of fruit flies in Cuba. *Bulletin of the European Organization for Protection of Plants* 29(1-2): 163-166.

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Chapter 4

Taming Wild Peccaries (*Tayassu tajacu* and *Tayassu pecari*) in Peru

Carlos Cornejo Arana¹



(*Tayassu pecari*)

Common name	Product part used	Dominant form of management	Degree of transformation	Commercial scale	Geographic distribution
Pecari, Sajino y Huangana	Meat	Wild	Low	National	Wide

SUMMARY

The chapter analyses the current status of peccary hunting in the Nanay river basin, Peruvian Amazon. It discusses the major factors that influence peccary hunting and trade, and the impact of the practice on the region's economy and environment. Where appropriate, the analysis is extended to the rest of the Peruvian Amazon. The chapter briefly describes the socio-economic profile of the Nanay river basin, and the history and characteristics of the peccary trade, including peccary ecology, the different stages and aspects of the peccary production chain, its actors, the hunting methods used, production costs involved, and the commercialisation of meat and hides. The current national policies regarding peccaries and their commercial utilisation are analysed in terms of both what the law states and what actually happens on the ground. Finally, lessons learned and options for development, conservation, and legislation related to this activity are presented.

INTRODUCTION

Peccaries, known in Peru as *sajino* (collared peccary, *Tayassu tajacu*) and *huangana* (white-lipped peccary, *T. tajacu*), are widely distributed throughout much of the tropical lowlands of South America, particularly the Amazon basin. Peccary hunting is an old, socially and economically important activity. Peccaries are and have been hunted for meat and hides for both household consumption and trade.

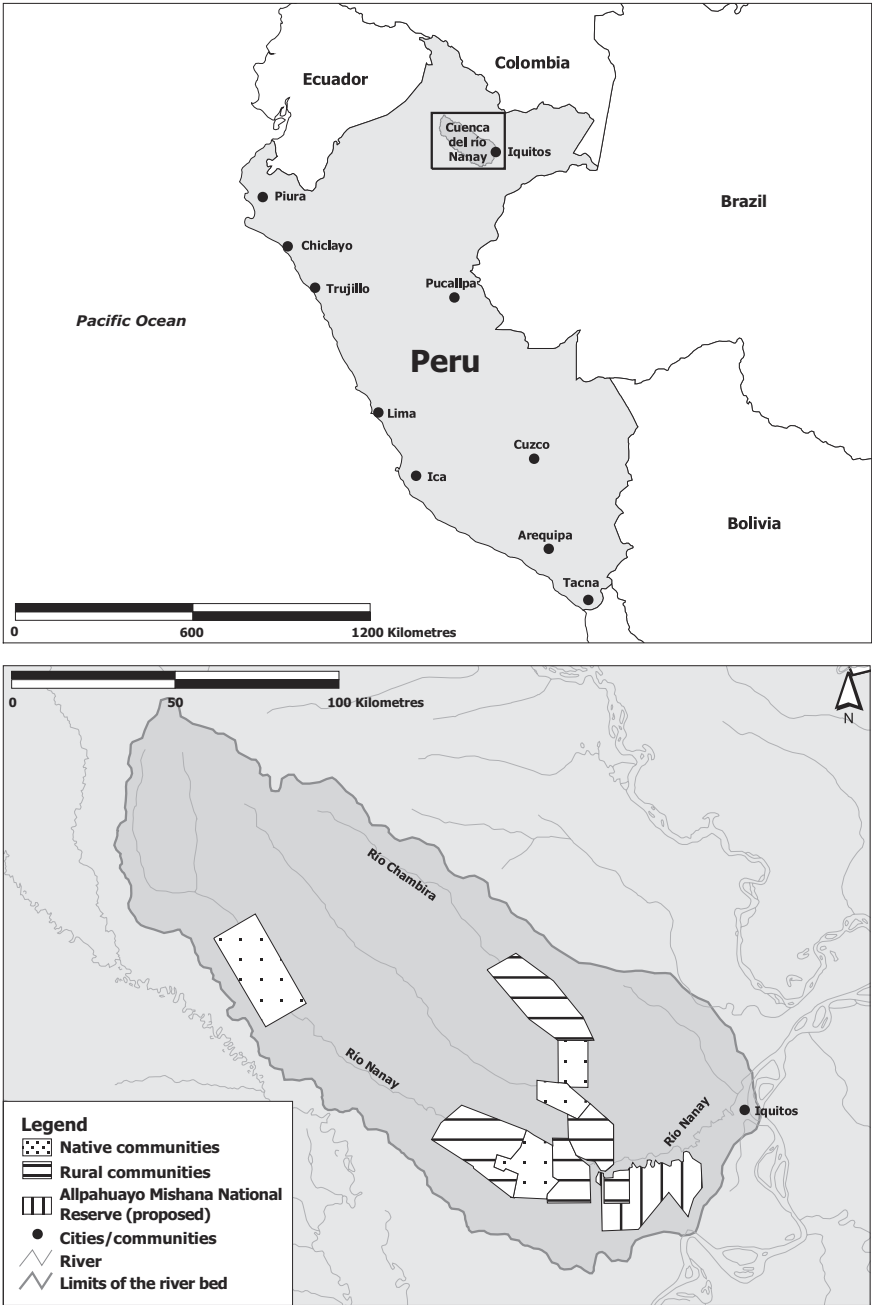
Commercial hunting began in the late nineteenth century, when the rubber boom fostered the rapid growth of Amazonian cities. Commercial peccary hunting supplied meat for the populations of these cities and hides for high-quality clothing markets, mainly in Europe. Hides were exported in large numbers, particularly since about 1920, when the rubber boom faded, and peaking in the 1950s and 1960s. Today peccary hunting continues to be part of a highly diversified production system and to constitute a complementary source of income within the rural economy in the Peruvian Amazon, but the export of peccary hides dwindled to minimal levels.

Based on a case study carried out in the Nanay river basin in the Loreto region, this paper presents an analysis of the hunting, consumption, and trade of peccaries in Peru, its economic contribution, and its impact on natural populations and the tropical rainforest. As such it seeks to complement a data matrix, in which the characteristics of the production chain, from extraction to consumption, are quantified.

The study area

The Loreto region in the Peruvian Amazon has an extension of 370,000 km² and a population of 900,000 (INEI 1998). The predominant forms of vegetation are wet tropical forest and very wet tropical forest, as well as transitions between the two, as classified by Holdridge (1967) (INRENA 1995). In the entire Loreto region there are only 570 km of roads, only one of which connects to the national road system, and then for only 44 km inside Loreto.

Figure 1. Study Area



Source: ESRI Data and Maps 2002.

Most of the roads are in bad condition and nearly always impossible to use during the rainy season.

A minor tributary, the Nanay flows into the Amazon just north of Iquitos, the most important urban and market centre of the Loreto region with more than 400,000 inhabitants. The accessibility and location of the Nanay makes this river basin a natural supply area for Iquitos. Because of the city's geographical isolation, its population depends to a large part on the natural resources the surrounding tropical forest provides. Though the Nanay river basin has not recovered its former importance as one of the main suppliers of peccary meat and hides, the activity is still relatively important, which is why it was chosen as a study area.

The Nanay river basin is located in the western part of the Peruvian Amazon (IGN 1989), in the heart of the ecological region of the Napo, and has an area of 17,500 km² (Figure 1). Its confluence with the Amazon lies at about 120 metres above sea level. The terrain of the area is fairly uniform, with a few hilly areas no more than 50 m high. The vegetation is mainly tropical forest. The soil is typically poor, in many areas sandy, with some patches of more fertile soil, especially around the Mazan river. Natural resources are currently under great pressure, in part because of the impact of shifting agriculture, but mainly because of selective exploitation of certain target species, which are consequently often also at risk. Poverty is at a critical level among the population, and the average annual family income in the study area is US\$2,500.

Hunting takes place in the relatively undisturbed forests at the upper reaches of the river, along underpopulated secondary rivers, and in areas far away from villages and roads. There are hardly any roads in the Nanay river area, probably totalling less than 50 km, and only one of the roads—at the southern border of the region—is paved. The main form of transport is by boat. The lack of adequate infrastructure in terms of ports is exacerbated by poor organisation of transport routes by river, so that the more distant areas have erratic and expensive transport as well as high communication costs. The difficulty and cost of transport is also the reason why there is little commercialisation of fresh meat. Since there are no means of refrigeration, the only way to preserve meat until it reaches the market is by smoking or salting.

Importance of the activity

While the peccary meat and hide trade has generated significant total revenues over the past century in the Nanay region as in much of Amazonia, the distribution of profits has always been unequal, with rural producers receiving a small proportion of the total gains. Today, production levels are lower, and while not abusive, the distribution of profits continues to be unequal. One of the reasons for this inequality is that the commercialisation of meat is illegal, which diminishes producers' bargaining power, even though hides or furs can be marketed as long as they are a by-product of subsistence hunting. Meat is sold mainly smoked and salted, while hides or furs are air-dried and then taken to tanneries in Lima and Arequipa, where they are

transformed into high quality dress articles for export, mainly to Europe. Entire hides are also exported.

Hunting is carried out mainly by small rural producers to complement their main activities. Groups of hunters living in Iquitos, most of them financed by businesses in the city, also participate in the production to some extent, occasionally spending short periods in the forest to hunt. The activity provides producers with sporadic income, helping them cover basic expenses, such as for the health or education for their children, the purchase of industrially produced foods, fuel, etc. Hunting contributes an estimated 8% to the family economy, fluctuating according to market conditions.

After thriving for years, the hide market is currently in decline. The meat market, however, is much more stable, with predictable seasonal variations. For many years the price of meat has been stable between S/7.00 and S/9.00 per kilogramme (US\$2.00 to US\$2.57).

THE PECCARY PRODUCTION CHAIN

The ecology of peccaries

Most of the hunting in the study area is carried out in old growth forests, either on terra firma or in the floodplains or *varzea*. Secondary growth forests are an additional but minor source of production. *T. pecari* prefers moister habitats, while *T. tajacu* prefers dry habitats. Both species are well adapted to terra firma forests, but *T. pecari* uses *varzea* forests more efficiently than *T. tajacu*. The different use of habitats is reflected in numbers hunted in each type of habitat (Bodmer *et al.* 1997).

Male and female *T. tajacu* attain sexual maturity after about one year of life, *T. pecari* a little later. Peccaries of any age may be hunted for meat, but only adults provide hides apt for sales, as these require a minimum stretched width of 80 cm. Determined according to habitat, demographics, land use, and hunting pressure, the authorised hunting quotas for Loreto have remained at sustainable annual levels in the last few years (OFIRENA Loreto 1996, 1997, 1998). The annual quota in Loreto is 26,040 and 32,494 animals for *T. tajacu* and *T. pecari*, respectively (Bodmer *et al.* 1997).

The people benefiting from peccaries

The Nanay river basin area has a population of 25,200, most living in the lower reaches of the river (53 people/km²). The upper region with a density of 0.2 people/km² is practically uninhabited. The population includes five indigenous communities, 19 centres inhabited by mestizos and river dwellers (*ribereños*), as well as the district capital. The family size averages 5.8 members. The total number of people involved in hunting is difficult to estimate, because there is no clear specialisation of peccary hunting. Most people hunt peccaries as an additional source of income whenever prices are attractive. Otherwise, hunting of peccaries is a subsistence activity. Estimates suggest that about one third of the rural population of the Nanay basin hunt peccaries occasionally. Traditionally, the relative number of hunters is highest

among indigenous communities. If meat and hide prices increase significantly, all except the oldest and the disabled members of the community go out to hunt. In other words, there is no fixed or stable number of peccary hunters. Potentially, more than 90% of the families in the study area could become hunters, but to date only a few, nearly all located in remote areas, sell meat or hides.

Household productive strategies, which are always diversified, can be grouped according to the relative importance of different activities (for example, Agreda 1993). Despite the differences in productive strategies of different households in the study area, the most important activity in terms of gross income generated is agriculture, followed by fishing (although in some groups this order is reversed). In areas where hunting is most commonly practised, households derive an estimated 37.5% of total (that is, both monetary and nonmonetary) income from the forest. Peccary hunting contributes 8% of this total income, and 11% of the income earned in cash. There is no of formal or informal organisation among producers, except that a few people may go on hunting expeditions together. There is, however, a certain degree of seasonality in how activities relating to agriculture, hunting, and fishing are organised. Fishing, for example, becomes particularly important during the periods of mass-migration, referred to as *mijano*, a common phenomenon in the Amazon river system. Likewise, the agricultural cycle demands greater attention during some parts of the year. Peccary hunting during these periods is minimal.

Hunting methods

Peccary hunting is carried out using simple methods. The hunter, or group of hunters, travel for several days, setting up temporary camps and shelters built with materials from the forest. A thorough understanding of peccary biology and ecology, including feeding habits, range, routes, and behaviour when threatened, is key to hunting success. The herds are tracked following spoors, or ambushed in feeding areas or clay depressions. Known locally as *colpas*, the latter areas are visited by many animals in search of scarce nutrients. Rifles, nearly always bought second hand, are the most important tool. Since none of the rifles used for hunting are legally registered, peccary hunters are, strictly speaking, operating illegally. Dogs are sometimes used to track and hunt the animals. Other materials used are cartridges, batteries, torches, food, salt, and field equipment such as mosquito nets, boots, machetes, and knives.

Production costs

The amount of time required for hunting varies, and depends on the season, weather, remoteness and topography of the area covered, population density of the animals, degree of experience of the hunters, as well as a fair amount of luck. On average, one sixth of a day is needed to obtain one kilogramme of peccary meat, and four and a half days are needed to obtain one hide.

The investment in capital—namely the materials outlined above—is a

small part of the total. Most of the investment is in time and effort. Costs vary depending on where the materials are bought. The farther away the hunting area is from Iquitos, the higher the costs. Hunters do not buy much food (mainly rice and sugar) as they take supplies produced in their own fields. In 2000 the average investment per kilogramme of harvested peccary meat was S/.2.30 (US\$0.66).

The market and commercialisation of peccary meat

With the possible exception of some indigenous groups, most of the people who hunt peccaries trade the larger part of whatever they produce. However, in the case of bush meat, including peccary, the opposite is true: more than half the production is for consumption, while only a few groups reserve most of the meat for sale. At one extreme are people who sell only 15% of the gross value of hunted game meat, while at the other extreme 85% of the gross value is sold (Agreda 1993).

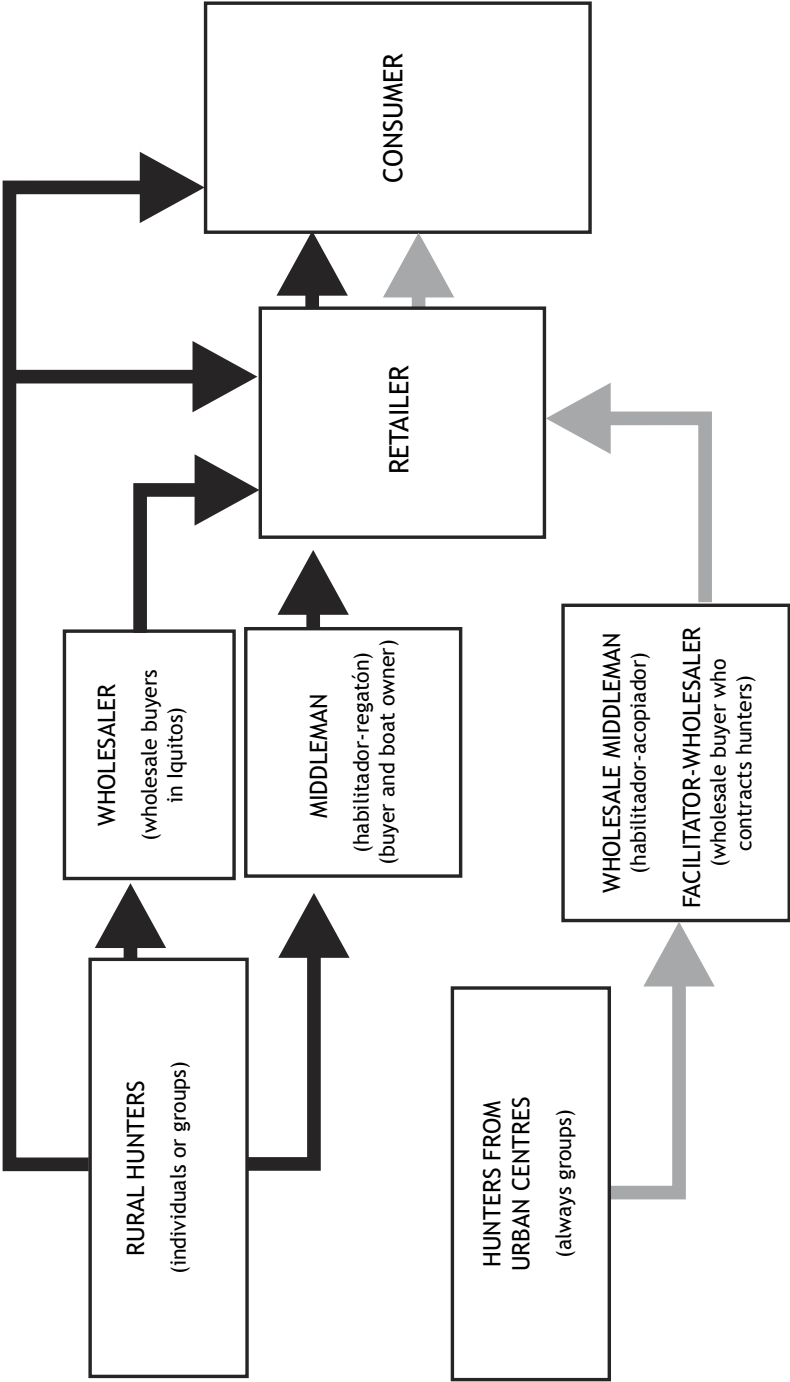
The market for peccary meat is almost exclusively regional, with negligible amounts being shipped outside the area. People in the region highly value peccary meat and prefer it to other game. While peccary is frequently eaten in the rural areas where it is hunted, it is consumed only occasionally in the city, and then mostly by people in lower income strata. (The main source of protein in the region is usually fish.) The meat is usually sold smoked and it is unusual to find fresh game meat in the major markets in urban areas.

Hunters that mainly focus on selling their kill have various options to do so. The commonest route is to take it oneself to the ports supplying Iquitos on the Nanay and sell it to an intermediary, who then sells it to a retailer, who in turn sells it to the consumer (Figure 2). Some of the intermediary steps in the trade chain are occasionally omitted. In some communities hunters sell the product to middlemen who did advance cash or equipment and who may either come to the community or wait for the hunters in the main ports. In some cases, these middlemen travel in their own boats, leaving supplies for the hunters on the way up and collecting the peccary products as payment in kind on the way down. The prices these middlemen pay to hunters are low, though still worthwhile for hunters, fluctuating between S/.3.50 and S/.4.50 (US\$1.00-1.29) per kilogramme of smoked, dry meat. When hunting in the more accessible areas, hunters can transport their produce on commercial boats. Otherwise they need to use their own transportation—small motorised canoes, paddle canoes, or even rafts. Hunters from urban areas, who always work in groups, are usually contracted in advance by a middleman, though the marketing chain is the same as for rural hunters.

Annual production and consumption of meat

The annual commercial production of bush meat, mostly peccary, in the study area is 18 metric tons. At an average price of US\$1.79 per kilogramme, this amounts to a total value of US\$32,000. Total production of bush meat, that is, including meat procured for consumption by households, is estimated at double this amount.

Figure 2. Chain of commercialisation of peccary meat



While there is no precise first-hand data for the rest of the region, estimates can be calculated by extrapolating from secondary sources. For example, a survey on family consumption in the main cities of the region, conducted by the Instituto Nacional de Estadísticas e Informática (INEI 1991), estimated that 285 tons of bush meat per year are purchased in the local markets of the main urban centres. Only two types of meat were included in the survey—*T. tajacu* and various species of turtle. Total urban consumption is thus likely to be double this amount, suggesting total consumption in the region to be more than four times this value. According to the same study, families in the main urban centres spent more than US\$1.25 million on game meat that year, which sum represents 3.2% of total family expenditure.

Current demand for peccary meat depends on its low market price as a price increase would result in a drop in consumption. As a result, variation in consumption of peccary meat is currently a function of the increase in population, which is about 3% per year (IIAP 1996). As already noted, however, the current market for peccary meat in Peru is fairly limited in size.

Commercialisation of hides

The study area produces about 3,000 hides per year. Currently a by-product of hunting for meat, almost the entire production of hides is used for sale. One hide is obtained for every 10 kg to 15 kg of smoked meat. Given that, unlike

Photo 1. Collared peccary skin air-dried on a typical frame
(Photo: C. Cornejo)



meat, hides can be legally sold, most of the hides marketed originate from animals hunted for domestic consumption. The Peruvian legislation allows commercialisation of hides from specimens hunted for self-consumption to avoid wasting a valuable subproduct that would otherwise go unutilised.

Hides are prepared by cleaning the skins and stretching them on a wooden frame in order to dry them. While not ideal, air-drying is vital given that the product has to be kept for several months before it reaches the tanneries located in the Pacific coast region of Peru. The ideal situation would be to transport the hides directly to the tanneries after killing the animal, but this rapid delivery is impossible for producers living in remote areas and given that the commercial chain is quite long.

All hides that are traded are exported. The initial steps of the marketing chain are similar to the chain for meat, until the hides reach the ports that supply the main markets. Wholesalers in Iquitos then collect the dry hides and sell them to tanners in Lima (one) and Arequipa (two), where they are processed further. In some cases the processing is completed to produce leather used to make high-quality articles of clothing. In other cases the process covers the first stages of tanning and the hides are then exported, mainly to Germany, where they are made into clothing and different accessories (Figure 3).

The gross value of exports in hides from the whole region is between US\$0.8 million and US\$1.2 million per year. The annual values tend to decrease, not only because of reasons detailed below, but also because of the decrease in the net buying price. This situation could change, however, if production were to change from hunting of wild populations to rearing of peccaries. This shift, in turn, would increase product quality and could increase the total market size.

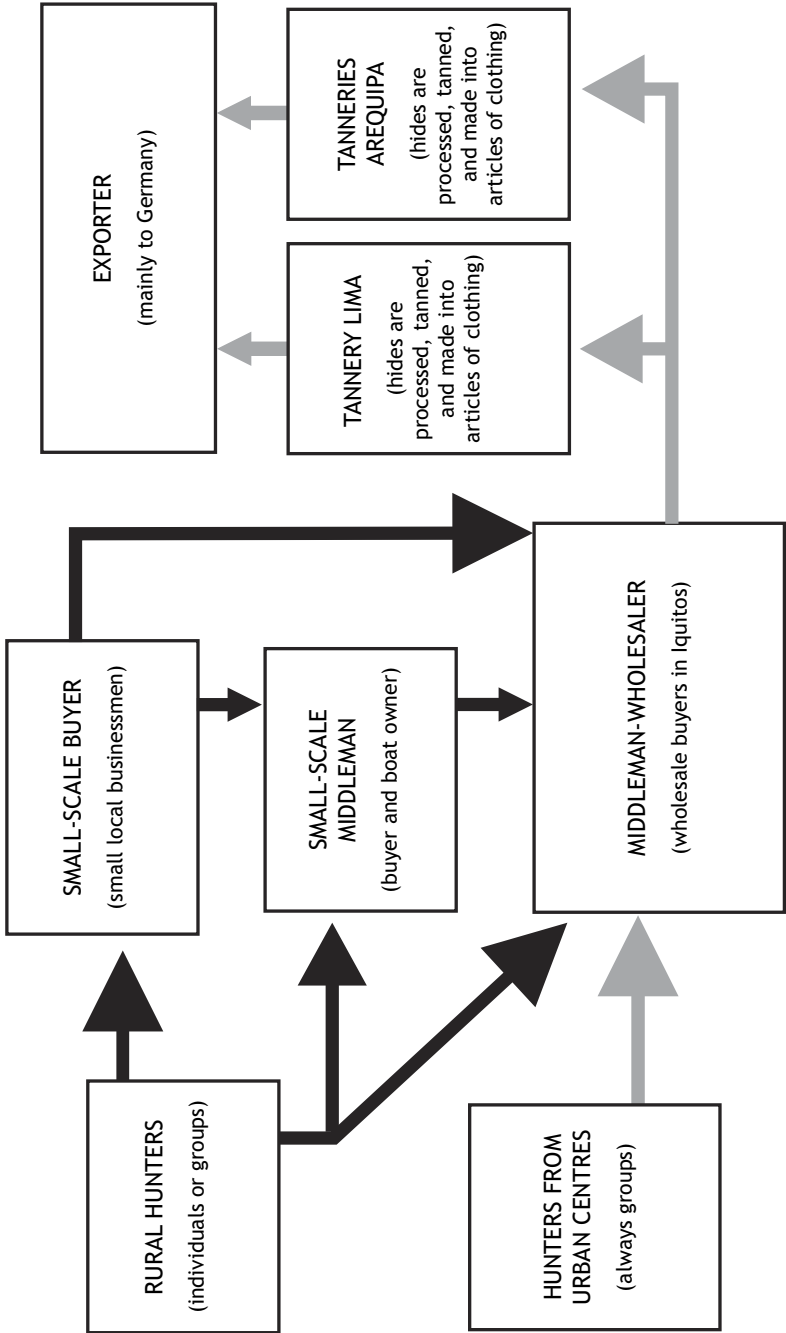
In the last three years, Peru has exported about 100,000 hides a year, but the market is extremely competitive, and in decline. Until 10 years ago 300,000 hides were exported annually. One key factor contributing to the decline is a reduction in export quotas by 30% in the year 2000. In addition, during the second half of 2003 a drop in prices resulted in many producers giving up hunting, as the activity was no longer economically attractive. An important result is that Peru is progressively losing its market share in the international trade in peccary hides.

The presence of gunshot holes in the hides and the undesirable effects of air-drying hides in the forest contribute to the low quality of the hides currently exported from Peru. As a result, other hides in the international market compete with peccaries both in terms of price and quality, for example, *Hydrochaeris hydrochaeris* ('carpincho' leather) from Argentina and reindeer hide from Europe.

OPTIONS FOR PECCARY PRODUCTION

There is currently consensus in Peru regarding the need to stop the misuse of non-timber forest products and to start managing them for long-term sustainable production. We present various, though not necessarily officially accepted, options for the commercial management of peccaries.

Figure 3. Chain of commercialisation of peccary hides



Extensive wildlife farming

Extensive wildlife farming is a fairly new activity in Peru. This production system entails a higher degree of risk compared to other well-established methods, particularly given that many of the technical protocols regarding feeding, sanitation, reproduction, and management are still incomplete. This option also entails a long-term investment, as breeding groups have to be established and then reared to marketable size. This process takes time due to the low reproductive rate of the species. If peccaries were endangered, which currently they are not, wildlife farming would have a positive impact at a species conservation level, particularly given the many factors reducing wild populations.

Intensive raising allows production of prime-quality hides that can achieve prices many times higher than those paid for hides from wild-sourced animals. Meat would also have better quality guarantees than that from wild animals and could be sold at higher prices in specialised markets. These prices could make the activity economically viable.

Despite the problems still facing farming, it remains the most promising option, particularly given the potential market value of the products and the fact that being a native species, breeding would not involve making major alterations to the environment.

Extensive household-level farming

Household-level farming is an interesting, small-scale, low-cost option for peccary farming. This option can complement larger production units, acting as sources to enrich or increase the genetic input of their breeding groups. Outsourcing the rearing of peccaries to families could also serve to cut costs of larger farms that produce peccaries. Buying the animals from individual families, the larger farms could serve as centres of reproduction of animals and processing. In this way, families would have a guaranteed market and good prices for a product that would supplement their income. As it stands, however, current legislation does not allow this activity. Restrictions on family farming should thus be lifted, the only requirement being that they remain small in scale.

Managing of wild populations

Though allowed by current legislation, of the management of wild populations production system lacks the prerequisite technical and scientific know-how and experience in the entire Amazon. Although there is some knowledge about peccaries, like the vast majority of the Amazonian fauna, details on their reproductive biology, natural history, or even taxonomy are largely unknown. There are no reliable methods of assessing population density for most of the species in their natural environment, and their capture for marking and monitoring purposes is extremely difficult. The high mobility of peccaries, which allows them to easily move into and out of managed areas, coupled with the difficulty of keeping illegal hunters out, make this kind of production system more difficult. In addition, it may open the door to illegal

trafficking of wild animals in Peru. If this happened, neighbouring countries would also be affected, as would the efforts made over the past 25 years to remove the country from the blacklist of international illegal trafficking of wild animals. In view of this, hunting of peccaries in wildlife management areas should only be allowed when the objective is self-consumption and should be banned for commercial purposes.

Intensive farming

Intensive farming of peccaries presents the same problems of lack of capacity, knowledge, and experience. Farms where peccaries are intensively farmed would need to be linked to animal supply sources. This in turn implies the need to have secure rights over the supply area, posing potential conflicts with traditional users of the land. The only cases where these conflicts could not occur would be those of indigenous communities or well established villages using their own lands. For these reasons, the farms should probably not be licensed for peccary management except for self-consumption and for certain communal cases where supply areas are owned by the community or are used traditionally.

Photo 2. Young peccaries



POLICIES AFFECTING PECCARIES

Table 1 summarises the Peruvian policies that regard peccaries. The first column outlines the policy, the second one the reality on the ground, including how the policy is implemented, while the third column lists recommendations in the light of the previous two. Table 2 presents a list of and briefly describes

the current legislation in Peru regarding peccaries. This core legal framework has subsequently been used to generate a group of complementary, though hierarchically inferior, norms.

Based on studies done by specialists and funded by INRENA, the state agency that regulates natural resources, wild populations of peccaries are in good shape, which means the extraction rate is lower than the rate of population increase. For example, whereas the sustainable annual hunting quota in Loreto is estimated at 26,000 for *T. tajacu* and 32,500 for *T. pecari*, the number extracted is between 80% and 90% of these figures (Aquino *et al.*

Table 1. Current and recommended policies for development of the peccary production chain

Current Policy	Real Situation	Recommendations
Hunting for commercial purposes is prohibited. Commercialisation of meat is not permitted, but sale of hides obtained from subsistence hunting is allowed. Annual quotas are set below the annual normal increases in wild population. Sporadic market inspections are done and bush meat found is confiscated.	Around half of the meat from hunting is commercialised illegally. Given the government's low control capacity, this commercialisation is done in broad daylight in the Iquitos markets. Ill feeling amongst the rural producers because of confiscations. Commercialisation of hides is fairly well controlled.	Hunting quotas should be set for commercial bush meat, though limiting sale to the regional market. This would formalise a <i>de facto</i> situation and allow rural producers to increase their bargaining capacity. In the case of hides, the current policy should be maintained.
Control of hunting and trapping by means of licences.	Few licences are issued in the area, and none for peccary hunting. In practice, all hunters are illegal, although the hunt is a traditional activity deeply rooted in the local culture.	Simplification of procedures for obtaining licences, so that the number of licensed hunters increases and allows better control.
Permanent control of transport of peccaries at Iquitos airport and in the major ports.	Illegal trafficking of peccaries is under acceptable control.	The policy should be maintained.
Seven options for peccary management are permitted—three for commercial purposes (wildlife farming, management areas, and hunting precincts) and four for noncommercial purposes (zoos, rescue centres, temporary holdings, and pet breeding).	The options permitted have been designed from an academic point of view, unrelated to the reality of rural producers. In this way, management of wild areas is allowed for commercial purposes, but cannot be controlled, and options that already exist, such as family-based farming, have been ignored.	Formalise and promote family-based farming of peccaries. Ban the option of management of wild areas for commercial ends, only allowing it for purposes of subsistence.

Current Policies	Real Situation	Recommendations
Producers are obliged to manage peccaries under commercial systems that prohibit the hunting, extraction, transport, and export of specimens that do not come from these systems. The objective is to end the exploitation without management of wild populations.	There are few wildlife farms and management areas for peccaries and there are no hunting precincts. Illegal hunting for commercial reasons still exists and is practically the only source of supply of peccary products.	The policy should be maintained until wildlife management is consolidated. At the same time, give incentives for wildlife management.
Legal requirements do not establish differences between endangered and non-endangered species. There are more stringent requirements for control of wildlife farming than for other options of management.	Requirements are too stringent for a production line that is still emerging and presents high overheads. Apparently the requirements were designed for protecting endangered species, which is not the case for peccaries. There are few investment initiatives in wildlife farming and other permitted management options. Rural communities and individual producers cannot formally access management in other ways. There is a feeling of disappointment amongst wildlife farmers.	Simplify requirements for managing peccaries, making them accessible and attractive to rural producers in the region. Reduce requirements for peccaries, and in general for species that are not endangered. Balance the control requirement standards for all forms of management.
Bio-commerce initiative aims to promote forms of commercial management of peccaries with a view to foreign markets.	The bio-commerce initiative is stagnating due to lack of input from the private business sector and rural producers, especially the communities.	The bio-commerce initiative should be maintained, but with greater participation of producers.
There is no clear policy supporting research and development.	Incomplete technological packets increase management risks and make it more difficult to attain economic viability.	A policy to complete technological packets should be formulated and aggressively pursued with the help of producers.
There are no policies to promote the transformation of peccary products or to improve the quality of products.	Producers sell their products with little additional value, and these have poor quality.	Establish incentives to add value to the primary production and to increase product quality.

Current Policies	Real Situation	Recommendations
The private business sector participates in the decision making, financing, legislating, and benefits of the activity in a decentralised manner.	The private business sector does not participate.	The policy should be enforced.
The rights granted to use biological resources do not grant rights to the genetic resources contained within them.	There is no investment in genetic improvement of species.	The laws should be reviewed and conditions of access to genetic resources should be simplified for regional producers.
There is no policy to promote entry of peccary meat to markets outside of Amazonia.	Meat consumption is nearly exclusively local, although it has great export potential as it is of very high quality.	Fresh peccary meat should be promoted in the national markets, especially Lima.
There is no policy to open channels of soft funding for peccary management.	Investments made to date are entirely business capital, which limits the expansion of the activity and delays production programmes.	The opening of channels for soft funding for wildlife farming of peccaries should be promoted.
Permits for wildlife farming and other management alternatives for peccaries are granted in Lima.	Excessive delays in applications due to unjustified centralisation.	Processes to obtain permits should be decentralised.

Table 2. Legislation related to peccary management

Law	Description
Decree N° 611	Natural resources and environmental code
Law N° 27308	Law on forestry and wild animals
Law N° 26839	Law on conservation and sustainable use of biodiversity
Law N° 26821	Organic law on the sustainable use of natural resources
Supreme Decree N° 014-2001-AG	Ruling on the law of forestry and wild animals
Supreme Decree N° 013-99-AG	Prohibits hunting, extraction, transport and/or export for commercial purposes of wild animal species not authorised by the INRENA, from 2000. Established categories of endangered species and protects them.
Supreme Decree N° 013-2002-AG	Approves single text of administrative procedures of INRENA.

Law	Description
Ministerial Resolution N° 0164-93-AG	Establishes list of protected and/or endangered species of wild animals that may be extracted from their natural environment for reproduction in wild life farms and/or managed in natural areas. Fixes prices for rights of extraction.
Ministerial Resolution N° 750-2002-AG	Approves calendar of commercial hunting 2002-2003 of non-endangered wild animals.
Director's Resolution N° 065-2000-INRENA	Establishes use of remains of wild animals from subsistence hunting.
Director's Resolution N° 516-2002-INRENA	Fixes quotas of use of furs from subsistence hunting.

1998). The impact of hunting on the population is therefore low, although its effect on other species in ecosystems of the region is unknown. The impact of habitat destruction on wild populations in the region is thought to be significant, and on the increase, mainly because of demographic growth.

In theory, the productive activity based on peccary hunting could continue as it has to date in Loreto. This seems unlikely, however, for various reasons. These include (1) regional and international market conditions, (2) state policies ending the unmanaged use of wild populations, (3) restrictions that will be imposed by conservationist tendencies in Peru and worldwide, and (4) the habitat destruction of over 250,000 ha per year in the Peruvian Amazon. The combination of these factors will clearly have an impact on wild populations and their accessibility. As a result, it is necessary to define strategies so that peccary meat and hide production does not disappear, but rather becomes an important component of sustainable development in the region.

A Supreme Decree issued in 1999 prohibited as of 1 January 2000 the hunting, extraction, transport, and export for commercial purposes of all specimens, products, and by-products of species of wild animals, with the exception of those from farms or areas of wildlife management. This prohibition also affects peccaries. The ruling aims to promote production using managed systems by closing the option of extraction of products from wild populations. In principle the ruling is beneficial, as it reduces pressure that results from an increasing human population and the growing economic attractiveness of exploiting these products. At the same time, however, promoting the commercial management of wildlife requires a clearer statement on the part of the government, a statement that at the moment appears contradictory. It also requires more support for research as well as the decentralisation of administrative decision making and an improved technical expertise amongst government personnel in charge of administration and control of activities related to wildlife.

Towards a policy for the development of peccary production

Given the current situation, a truly promotional policy should not be excessively controlling or result in additional costs to producers, as this would have an overall negative effect. Requirements should differ according to species; they cannot be the same for endangered and non-endangered species alike. The requirements for control should be strict for species listed in Appendix A of the Convention on the International Trade in Endangered Species of Flora and Fauna and for others that are known to be endangered. Greater flexibility should be allowed for other species, including peccaries, in order to promote their use.

The ultimate effect of government requirements and controls are additional costs for producers, which onus negatively affects economic viability and decreased competitiveness. Costly government control measures eliminate the possibility of participation by small and medium private investors, which to date have shown most interest in wildlife farming. It still seems doubtful that larger firms will invest in this sectors, given the costs and the high risks entailed.

The costs derived from requirements like the preparation of detailed and complicated management plans are often out of the reach of communities and small investors. These plans need to be certified by a civil engineer, who in turn charges considerable fees. This problem is exacerbated by the dearth in Peru of professionals with the kind of expertise and experience required by the government norms. What makes the proposition even riskier is that this investment needs to be made in advance, that individuals or companies have to invest money even before they know whether a permit will be granted. In addition to these start-up costs, norms require the tagging of animals and monitoring of farms, which according to regulations need to be carried out by specialist firms. A better alternative would be to provide authorisation on the basis of the breeding potential of each farming unit, using random inspections as a way of checking.

Financing and credit is another important area that needs to be developed in order to promote peccary farming. Until now, farming has been based on private capital, as there are no opportunities for credit because of the high risk. In 1995, the regional government of Loreto came close to creating a credit line with soft conditions that included wildlife farms as possible beneficiaries. The proposal never materialised, however, because for reasons unknown it was not approved at the central government level. It is necessary to establish credit lines with easy terms for wildlife farming of species with good prospects, such as peccaries.

LESSONS AND OPTIONS FOR DEVELOPMENT AND CONSERVATION

Peccaries and regional development

Peccaries are important sources of food, especially in rural areas, but also in Amazonian cities like Iquitos. Although the current rate of hunting does not exceed the rate of reproduction for either of the two species, it is likely that peccaries have become rarer near human settlements. At the same time,

however, there is a trend in rural areas towards decreasing dependence on forest products, as shown by a decline in their contribution to family income, which in turn could lead to a relative decrease in bush meat consumption in rural areas.

The situation is different in urban areas, where significant amounts of peccary meat are consumed. Legislation prohibiting the commercialisation of any wild animals could significantly reduce the chance of obtaining any bush meat, including peccary meat. It is unclear whether the reduction in availability of bush meat will be compensated by other sources of protein.

If peccary production in wildlife farms becomes a reality, it will be possible to ensure a legal source of bush meat in urban areas. It will also be possible to significantly increase the income of an important sector of the rural population of the region, especially if the international demand for hides is assured. As we have explained previously, the role played by state agencies, research, and promotion are of extreme importance towards making the peccary potential a reality.

Contribution to conservation

The use of peccaries has not contributed to the conservation of the species or to that of the tropical forest. Although the level of hunting has not exceeded the sustainable annual quota for the two species, hunting has clearly had some effect on the natural populations, implying a negative impact from the conservationist point of view.

The conservation implications of raising peccaries in farming units are unclear. One possibility is that pressure on natural populations decreases, which could contribute to producers maintaining certain areas of the forest for peccary production. These assumptions are highly speculative, however. Setting up wildlife farms does not necessarily imply cutting down trees, as all that is needed is to fence them in while maintaining the natural environment of the species. The positive effect production in wildlife farms could have on the income of large sectors in the region merits more attention and aid towards this line of production.

NOTES

1. Biodiversidad Amazonica S.R.L.—Asociacion Tropicós, Iquitos, Peru. E-mail: tropicos@terra.com.pe

2. The Loreto region itself has an extension of 370,000 km² and a population of 900,000 (INEI 1998). The predominant forms of vegetation are wet tropical forest and very wet tropical forest, as well as transitions between the two, as classified by Holdridge (1967) (INRENA 1995).

3. In the entire Loreto region there are only 570 km of roads, only one of which connects to the national road system, and then for only 44 km inside Loreto. Most of the roads are in bad condition and nearly always impossible to use during the rainy season.

4. The average annual family income in the study area is US\$2,500.

5. Household productive strategies, which are always diversified, can

be grouped according to the relative importance of different activities (for example, Agreda 1993).

REFERENCES

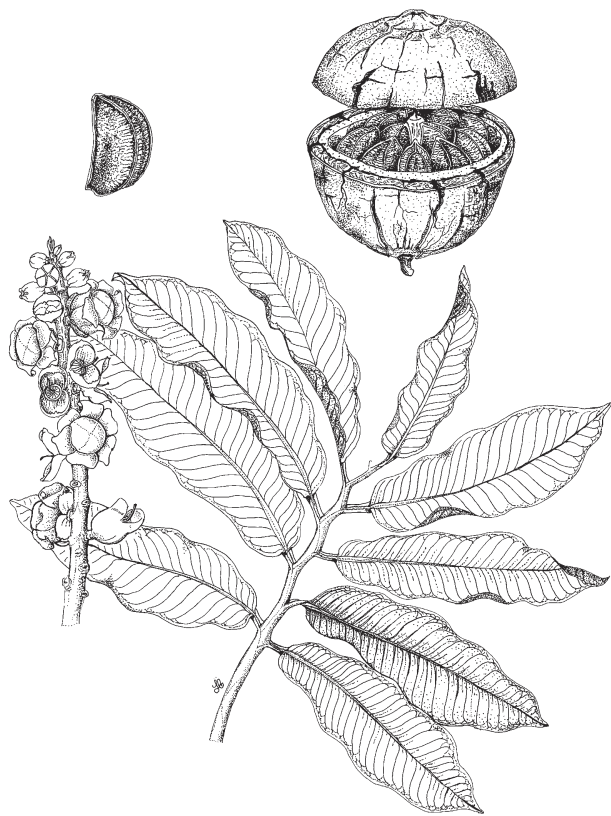
- Agreda, V. 1993. El impacto del ajuste en la economía y recursos naturales de los productores ribereños. Sepia V, Peru.
- Aquino, R., Bodmer, R. and Pezo, E. 1998. Evaluación de las poblaciones del pecari de collar (*Tayassu tajacu*) y pecari labiado (*T. pecari*) en la cuenca del río Pucacuro, alto río Tigre, INRENA-IIAP, Lima, Peru.
- Bodmer, R., Aquino, R., Puertas, P., Reyes, C., Fang, T. and Gottdenker, N. 1997. Manejo y uso sostenible de pecaries en la amazonia peruana. Occasional Paper N° 18. Comisión de Supervivencia de Especies de la UICN.
- Holdridge, I.R. 1967. Life zone ecology. Tropical Science Center, San Jose, Costa Rica.
- IGN 1989. Atlas del Peru, Instituto Geografico Nacional, Lima, Peru.
- IIAP 1996. Amazonia peruana. Principales indicadores. Instituto de Investigaciones de la Amazonia Peruana, Programa de Ordenamiento Ambiental, Iquitos, Peru.
- INEI 1991. Encuesta de seguimiento del consumo de los hogares en las principales ciudades del país (ENSECO 91): estructura de ingresos y gastos de los hogares. 25 vols. INEI, Lima, Peru.
- INEI 1998. Compendio estadístico departamental 1997-98. Instituto Nacional de Estadística e Informática, Lima, Peru.
- INRENA, 1995. Mapa ecológico del Peru. Lima, Peru.
- OFIRENA Loreto 1996. Memoria anual, año 1996. Ministerio de Agricultura, Instituto Nacional de Recursos Naturales, Iquitos, Peru.
- OFIRENA Loreto 1997. Memoria anual, año 1997. Ministerio de Agricultura, Instituto Nacional de Recursos Naturales, Iquitos, Peru.
- OFIRENA Loreto 1998. Memoria anual, año 1998. Ministerio de Agricultura, Instituto Nacional de Recursos Naturales, Iquitos, Peru.
- WWF 2000. Global 2000 World Wildlife Fund Plan (map).

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Chapter 5

Harvesting windfalls: the Brazil nut (*Bertholletia excelsa*) economy in the Bolivian Amazon

Dietmar Stoian¹



(*Bertholletia excelsa*)

Common name	Product part used	Dominant form of management	Degree of transformation	Commercial scale	Geographic distribution
Pecarí, Sajino y Huangana	Meat	Wild	Low	National	Wide

ABSTRACT

Extractivism has played a dominant role in the economy of the northern Bolivian Amazon for the last two hundred years. For more more than a century, and until its collapse in the early 1990s, rubber (*Hevea brasiliensis*) formed the pillar of this extractive economy. Following the demise of the rubber industry, Brazil nut (*Bertholletia excelsa*) collection, which had begun in the 1920s, emerged as the main commodity in the regional economy. Annual export values have fluctuated around US\$ 30 million since the mid 1990s, due to an increase in production and the value added through shelling in the expanded processing industry. Gathering, processing and commercialization of Brazil nuts provide employment and income for one third of the region's 170,000 inhabitants. Each year between 6,000 and 6,500 rural households participate in the Brazil nut harvest. They are accompanied by a similar number of gatherers from the peri-urban neighborhoods from the region's urban centers, who often depend on permanent or temporal employment in one of the 25 processing plants. The case of Brazil nut in Bolivia exemplifies the importance of NTFPs as the principal source of income for the rural population and as the basis for the economic survival of rural-urban migrants, who constitute the major part of the region's peri-urban population. In order to fully understand the benefits derived from their gathering, processing and commercialization of NTFPs, I suggest that it is crucial to take into consideration the rural-urban continuum underlying the related supply chains.

INTRODUCTION

Brazil nuts in the Amazonian context

The Brazil nut, locally known as *castaña* or, when shelled, *almendra*, is the seed of *Bertholletia excelsa* H.B.K., an emergent tree of the Lecythidaceae family. Along with rubber (*Hevea brasiliensis* H.B.K.), the trees of *B. excelsa* -whose trunks reach diameters of up to 2.5 m and 50 m height- constitute conspicuous elements of the humid tropical forest zone in the Amazon (Rosengarten 1984; TCA 1996).² Müller *et al.* (1980) and Balée (1989) have suggested that the high density of emergent Brazil nut trees in dense groves and the concomitant rarity of juveniles indicate human promotion hundreds of years ago. Brazil nuts have long constituted an essential element in the diet of forest-dwelling peoples (Taylor 1998), and for some continue to do so today (Posey 1985; Boom 1987).

As early as 1633, Europe imported Brazil nuts as luxury items, the first shipment from Pará being realized aboard a Dutch vessel (Taylor 1999). Significant trading began in the Tocantins watershed in the latter half of the nineteenth century (Smith *et al.* 1995a). Over the past decades, the durable and lustrous red-brown wood of *B. excelsa* has also attracted the attention of rural dwellers and entrepreneurs. Notwithstanding bans to cut down the tree in the main producing countries, landowners in need of cash frequently allow loggers to remove Brazil nut trees (Smith *et al.* 1995b).³

The chief commercial value of the Brazil nut tree, though, lies in the non-timber forest product (NTFP) it supplies in form of its edible nut.

Photo 1. Castaña tree (*Bertholletia excelsa*), remnant in a chacra enclosed by fallow land; at the back castaña trees died after burnt, in front of an intact high hill (Santa María, Pando, Bolivia) (Photo: D. Stoian).



Though Brazil nuts contribute no more than 1% to 2% to the total volume of international trade in edible nuts (Collinson *et al.* 2000), they provide the basis for the livelihoods of tens of thousands of households involved in their extraction, commercialization, and processing. Throughout the 1970s and 1980s, global annual production of in-shell and shelled Brazil nuts oscillated between 28,000 and 65,000 metric tons (MT), with Brazil's share averaging eighty percent (LaFleur 1992). LaFleur (1992), Mori (1992), and Ohashi *et al.* (1995) have suggested that increased deforestation has led to a steady decline in Brazil nut production, but this pessimistic view holds true only for the Brazilian Amazon, where annual output has dropped from the all-time high of 65,000 MT in 1972/73 to around 25,000 MT at the end of the twentieth century. In addition to a host of other reasons⁴, this decline results from exchange rate distortions and other competitive disadvantages of nut production in Brazil. For instance, lower labor and operating costs in Bolivia and Peru favored a significant rise in production in the adjacent Beni, Pando and Madre de Dios regions.⁵ Today's global production hovers around 65,000 MT annually (in raw material equivalent), half of which originates from Bolivia and the remainder from Brazil (37%) and Peru (13%).⁶ Taking into account that kernel or shelled nut output has gained importance over crude or in-shell nut production, these figures illustrate that overall Brazil nut production has slightly increased rather than decreased.

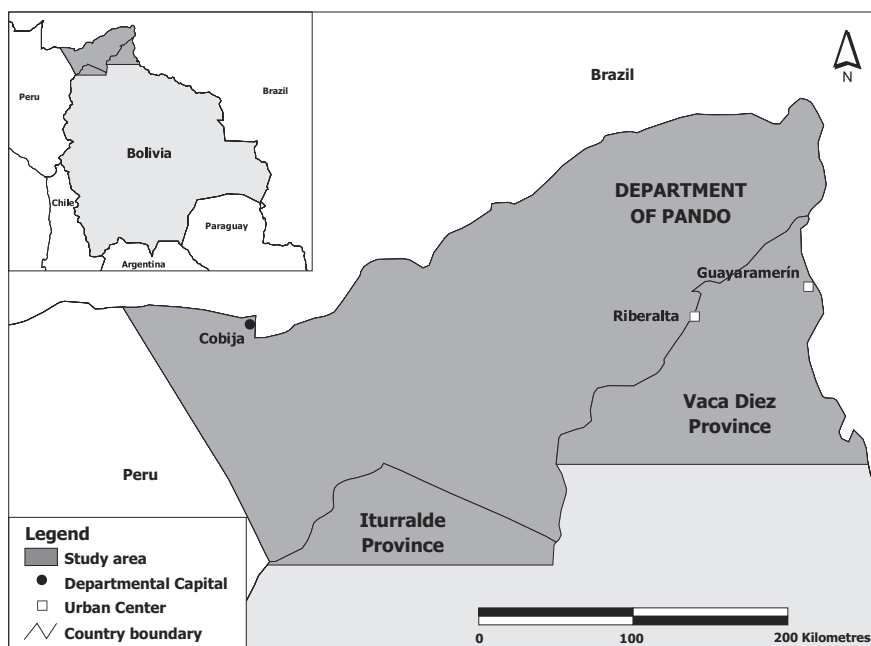
Without further processing, in-shell nuts are in high demand in overseas markets during the Christmas season. Shelled nuts are used year round as component of nut mixes and as ingredients in ice cream, baked goods, cereal, candy, and desserts, or else are consumed raw, roasted, and salted. Broken nuts are processed into oil⁷, flour, salad dressings, cooking sauces, soaps, and shampoos, among others (Rosengarten 1984; Mori and Prance 1990; Ortiz 2002). At the domestic level, Brazil nut seeds serve to produce milk, oil, and flour (TCA 1996). The industry's shelling debris has recently become an important by-product in Bolivia, where Brazil nut shells serve as efficient, low-cost fuel in local power generation.

The case study region

Though trade in Brazil nuts from the Brazilian Amazon dates back to the seventeenth century, it was not before the late 1920s that nuts were exported from the adjacent northern Bolivian Amazon (CIDOB 1979). This region, here also referred to as northern Bolivia, encompasses the natural distribution of *B. excelsa* in Bolivia (Figure 1). Lying between 9°41' and 12°30' south latitude and 65°17' and 69°34' west longitude, the region covers about 100,000 km. Bordered by Peru to the west and Brazil to the north and east, northern Bolivia includes the Department of Pando, the Province of Vaca Diez (Beni Department), and the northernmost part of the province of Iturralde (La Paz Department). This area is predominantly covered by Amazonian moist forest (94%), but also includes patches of forest fallows (3%), and agricultural land or pastures (3%) (Beekma *et al.* 1996). The high level of forest preservation is remarkable since widespread human clearing presumably persisted until shortly after European colonization, at least on upland sites in Western Pando (Alverson *et al.* 2000).

Over the past two centuries, the regional economy has largely been based on the extraction, processing, and commercialization of NTFPs, requiring rather intact forest areas. Commencing with the extraction of Peruvian bark at the beginning of the nineteenth century, NTFP-related activities shifted towards rubber after 1880; in the aftermath of the Bolivian rubber boom (1898-1919), extractive activities diversified and Brazil nuts emerged as an alternative NTFP. Following an ephemeral revival of the rubber industry during World War II, when most capital and labor was redirected to rubber, Brazil nuts have assumed a key role in an expanded NTFP portfolio ever since (Stoian 1999). In the wake of the rubber collapse in the early 1990s, the Brazil nut industry became the most important source of employment and income throughout northern Bolivia (Stoian 2000a, b).

At the turn of the twenty-first century the region's population numbers around 170,000, two-thirds of whom reside in the region's three urban centers; Cobija, Guayaramerín, and Riberalta. Most of the northern Bolivian Amazon is orientated towards Riberalta, the region's undisputed economic and socio-cultural centre. In addition to employment opportunities in the urban-based processing plants, the Brazil nut economy provides temporary employment in the forest for about 12 to 13 thousand gatherers and 1,500 contractors, intermediaries, and transport agents. As much as 70% of the approximately

Figure 1. Location of the study area

Source: ESRI Data and Maps 2002.

9,000 rural households and around one-third of an estimated 19,000 urban households are involved, one way or another, in the Brazil nut economy of northern Bolivia.

The recent Brazil nut boom has provided increasing employment and income opportunities in both rural and urban areas. Its socio-economic impact, though, has been perceived ambiguously. Some authors hold that NTFPs such as rubber and Brazil nuts are a poor prescription to elevate local communities to new levels of prosperity (Homma 1994; Smith et al. 1995b; Assies 1997), while others stress their contributions to local development in view of lacking alternatives (DHV 1993a, b; Stoian 2000b; Bojanic 2001).

This chapter aims at contributing to a better understanding of the development potential of Brazil nuts. First, the salient features of the production-to-consumption system are provided, before highlighting market trends as well as current and future challenges facing the Brazil nut economy. Finally, conclusions are drawn regarding the lessons learned for socio-economic development and forest conservation based on NTFPs.

THE PRODUCTION-TO-CONSUMPTION SYSTEM

Resource base

Northern Bolivia harbors around 17 million reproductive Brazil nut trees (DHV 1993a), equivalent to 1.7 adult individuals per hectare. Local densities are

highly variable, ranging from less than one adult individual per hectare, in areas close to rivers, to 10 or more, on favorable upland sites in eastern and southern Pando (cf. ZONISIG 1997). In fact, *B. excelsa* prefers well-drained sites (*terra firma*) and is virtually absent on floodplains.

In the region, it typically flowers at the end of the dry season in September and October. The zygomorphic nature of its flowers precludes insects other than large-bodied bees from pollinating them (Mori 1992); the genera *Bombus*, *Centris*, *Epicharis*, *Eulaema*, *Xylocopa*, and *Exaerete* have frequently been observed to visit the flowers (Müller *et al.* 1980; Moritz 1984; Nelson *et al.* 1985; Ortiz 2002). Euglossine or orchid bees, in particular the genus *Euglossa*, are also known to play an important role in the plant's pollination biology. Male euglossine bees are rewarded with fragrances from orchids, which they use to attract females. Since all these bees are nonsocial or semi-social, they cannot be as easily manipulated by humans as social bees like *Apis*, *Melipona* and *Trigona* (Mori 1992). A further impediment to plantation cultivation is the fact that cross-pollination is needed for most seed set in *B. excelsa* (Mori and Prance 1990). Virtually all Brazil nuts in northern Bolivia, as elsewhere in the Amazon, are gathered from wild stands in the forest, which explains the increased interest in *B. excelsa* as a keystone species for conservation and development (cf. Clay 1997).

The fruits need around 15 months to mature. At the time of fruit fall and the concomitant Brazil nut harvest from December to March, next year's harvest is already discernible. The coconut-size fruit capsules (*cocos*) contain between 15 and 25 angular seeds, each protected by a hard woody shell (Photo 1).

The distribution and abundance of Brazil nut seedlings is largely controlled by small forest rodents, locally called *jochi pintado* (*Agouti paca*) and *jochi colorado* (*Dasyprocta variegata*), which act both as seed predators and principal dispersal agents. *Jochis* and some squirrels are perhaps the only animals that have teeth strong enough to open the tough husk and liberate the seeds so that those that are not eaten can germinate from forgotten caches after 12 to 18 months (Mori 1992). Brazil nuts constitute important components in the nutritional regime of rodents, wild boar, and some monkey species. The greatest impact of Brazil nut gathering on the forest fauna, though, is indirect, in the form of widespread hunting that accompanies the harvest, rather than in removal of animal food supplies (Rumiz 1999).⁸ Still, the fact remains that Brazil nut gatherers and small forest rodents effectively compete for the nuts as a source of food. Increased harvesting levels in northern Bolivia have therefore raised the concern that nut removal might adversely affect the populations of *B. excelsa* (Clay 1997). Recent in-depth studies on the harvesting impact conclude, however, that effects are noticeable but on the whole rather insignificant (Zuidema 2000, 2003). It could be argued that the current Brazil nut boom spurs the exploitation of ever more distant stands with long-term adverse effects on population structure. But it needs to be borne in mind that the region's total production is estimated at 420,000 MT of raw nuts a year, only 30% of which are considered economically accessible (DHV 1993a). Even the latest record harvest made use of barely one-third of

the economically available production potential, or little more than 10% of overall production.⁹

In a given exploitation area, however, collectors may remove up to 90% of total seed production, posing questions on the impact harvesting has on the natural regeneration of *B. excelsa*, its population dynamics, future availability of seeds, and the ecosystem as a whole (Zuidema 2003). Investigations of heavily exploited Brazil nut stands in northern Bolivia, even if small in scale, failed to provide evidence for significant adverse effects on natural regeneration; likewise, intensive harvest on the study sites had little impact on the population dynamics of *B. excelsa* and future seed availability (*ibid.*). The impact on the ecosystem, especially that induced by intensive hunting as a typical concomitant of the Brazil nut harvest, is more difficult to determine; so far, no evidence has been found suggesting mayor disturbances (*cf.* Ortiz 2002; Zuidema 2003).

The long-term impact of any perceived or real overexploitation of the natural resource base may be a minor problem when compared to the possible impact of Brazil nut plantations established on a large scale. Until recently it was widely held that the difficulty in guaranteeing pollination outside of Brazil nuts' native environment rendered the establishment of commercial plantations unlikely (see FAO 1995). Yet these problems can be overcome, as shown by successful cultivation near Manaus (Bratschi 1999) as well as in Sri Lanka, Malaysia, and Ghana (Mori 1992). Plantation development is still in its infancy, but plantation technology has become readily available (see Mori and Prance 1990; Mori 1992; TCA 1996; Gutiérrez and Leigh 1999). Some authors hold that Brazil nut plantations have been characterized by good vegetative growth but poor fruit yield (Ortiz 2002), probably because of the reluctance of some bee species to visit fragmented or modified habitats (Powell and Powell 1987). Others report rather encouraging plantation development, for example on the Fazenda Aruanã close to Itacoatiara in Brazil. Here, on an area of 12,000 ha, different clones of *B. excelsa* were planted which, according to a study by Empresa Brasileira de Pesquisa Agropecuária, are expected to yield 5,000 liters, equivalent to 2,750 kg, per hectare when fully grown (Bratschi 1999). Plantation yield would thus be roughly 100 times that of the natural forest. It remains to be seen whether improved plantation technology will indeed spur increased domestication, eventually resulting in most of the world's Brazil nuts being provided by plantations, as anticipated by Smith *et al.* (1995b). In any case, this process would take decades rather than years.

Brazil nut gatherers and socioeconomic context

To better understand the current situation of those involved in the Brazil nut economy, it is important to take into account the evolutionary trends of the extractive economy in northern Bolivia. Since its beginnings in the 1920s, the ups and downs in the Brazil nut economy have been closely linked to the fate of the rubber industry. The three rubber crises experienced during the last century benefited the Brazil nut economy through reinvestment of capital and labor set free from the rubber industry. The Brazil nut harvest was integrated

in an agro-extractive cycle, combining swidden agriculture with the extraction of rubber and Brazil nut (Assies 1997). Due to the high costs of wild rubber production, it provided a means of living only as long as Bolivia could benefit from Brazilian rubber subsidies¹⁰. Following the withdrawal of these subsidies in 1986, Bolivian rubber faced fierce competition from plantation rubber from Southeast Asia and non-Amazonian Brazil. Thus, trade in wild rubber from Bolivia vanished by the early 1990s.

The collapse of the rubber industry spurred rural-urban migration and induced a differentiation of rural settlements and related production modes (Stoian and Henkemans 2000). A collapse of the extractive economy could be prevented through the massive expansion of the Brazil nut and, to a lesser extent, timber and palm heart industries (Stoian 2000a).¹¹ As a result, the rubber-based economy was effectively converted into an economy based principally on Brazil nut.

Today, every year between December and March some 12-13 thousand people in northern Bolivia leave for the forest to gather Brazil nut. Unlike the Madre de Dios Department in Peru where individual households have been granted some 1.2 million ha as Brazil nut concessions of up to 1,000 ha each (Ortiz 2002), the access to the resource base in Bolivia varies greatly. Brazil nut is collected on *barracas*, that is forest areas controlled by a landlord (*patrón*), or in independent communities (*comunidades libres*), where individual producers work their plots of land. Two principal groups of Brazil nut gatherers can thus be distinguished: approximately 7,000 rural collectors who extract Brazil nut in the communities from their personal plots, with areas ranging from 20-500 ha; and some 5,500 urban collectors (*zafreiros*) hired by landlords or contractors to gather Brazil nut on the *barracas* during the three-month harvesting season, locally known as *zafra*.

The livelihoods of the rural gatherers are mainly based on agricultural and extractive activities, in some cases combined with daily labor. The relative importance of agriculture and extractive activities depends largely on the distance between a given rural settlement and the closest town. In communities close to a town, market-oriented agriculture is dominant. In contrast, the farther away a settlement is from a town, the more important are extractive activities and subsistence agriculture (Stoian and Henkemans, 2000). The economy of households in remote communities show a strong dependency on income derived from NTFPs, which may contribute up to 90% of total cash income. The corresponding amounts can be considerable, given that households with plots of 500 ha can receive up to US\$2,500 per harvest. Considering that most rural collectors have plots ranging from 50 to 100 ha, the average Brazilian nut income of a rural collector varies between US\$500 and US\$650 a year, contributing between one third and half of total household income.¹²

Urban collectors, locally called *zafreiros*, are mainly from the peripheral neighborhoods of Riberalta and, to a lesser extent, from Cobija and Guayaramerín. Many of them are rural-urban migrants that lived in the forest as long as rubber production was viable. Currently, these people live most of the year in urban areas (see Picture 2), where they work as day laborers, small retailers, and workers in the Brazil nut processing plants or sawmills.

Photo 2. Peripheral neighborhood of Riberalta '1º de Diciembre', where castaña harvest and processing constitute one of the main sources of income for peri-urban households.



A *zafretero's* net income ranges from US\$500 to US\$700 per harvesting season or *zafra*, but the cost of living in the forest is higher because the landlord or contractor add a surcharge of 30% or more on foodstuffs sold in *barracas*. Even after taking this into account, the *zafra* is still a viable economic activity, mainly because opportunities on the urban labor market are scarce. Harvesting and processing of Brazil nut and palm heart contributes between 28 and 51% of the total income in the majority of households living at the Riberalta's periphery. There is a high correlation between the dependency on NTFP income and the educational level of the household head: the lower the education level, the higher the relative and absolute income generated through the collection and processing of NTFP (Stoian, 2005).

Processing industry

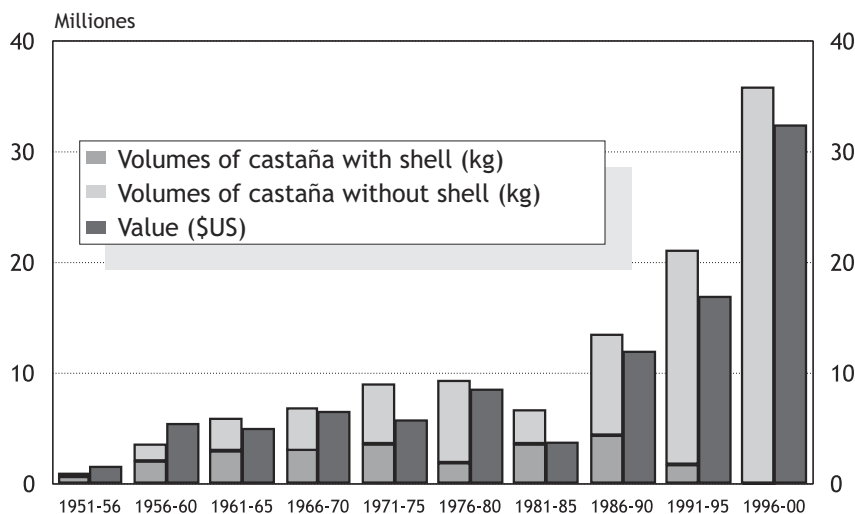
The Brazil nut processing plants (*beneficiadoras*) are the pillars of the urban economy in the region, employing about 6,000 people in Riberalta alone, equivalent to 10% of its population. The infrastructure of the processing plants is rudimentary: sheds for the storage of raw material, scales, boilers, a large hall with tables and equipment for shelling, ovens and drying chambers, packing areas, and an administrative office. The Brazil nut undergoes the following processing steps: storage, pre-selection, cooking, shelling, selection, dehydration, packaging in vacuum bags and boxes for shipping. The most important task is shelling the Brazil nut with hand-operated machines. This monotonous job, carried out by some 3,000 persons (mostly women, called *quebradoras*, and their assistants), requires extreme care in order not to compromise the quality of the product (*almendra*). Remuneration of the piece-

rate work is based upon the quality produced, with 96% of the *quebradoras*' average income being derived from production of high quality nuts.¹³

The number of processing plants in Riberalta increased from two in the early 1980s to 20 in the late 1990s. Nowadays, there are around 25 processing plants in northern Bolivia. Due to an increase in demand for raw material that cannot be from Bolivia alone, the supply channels have been extended to the adjacent regions in Brazil and Peru, i.e. Acre and, to a lesser extent, Rondonia and Madre de Dios. Concomitantly, there has been a strong reduction in contraband of in-shell Brazil nuts to these regions. Since the 1990s, the Brazil nut has been Bolivia's principal forest product for export. This reflects increases in the production of raw material and in the value added through in-country processing (Fig. 2).

Except during the mid-1980s, when Bolivia's Brazil nut economy suffered from the repercussions of the country's severe monetary and economic crisis, the volume of Brazil nut harvested from the forest and exported has continuously increased over the last 50 years (Fig. 2).¹⁴ Up until the mid-1980s, most of the Brazil nut was exported un-shelled to Brazil from where it was re-exported as shelled or un-shelled nuts. Since then, increasing efforts have been made to add value to the Brazil nut through shelling so that, since 1996,

Figure 2. Average volumes and annual values of official exports of Bolivian castaña 1951-2000



Sources: Own elaboration based on Comité Cívico de Riberalta (1972), López (1993), CNF (1997), Pacheco (1998) and INE (2003).

Note: Volumes of castaña without shell expressed as equivalent in raw material (EMP), where one kilo of castaña without shell equals to 3.2 kilos of castaña with shell; for the period 1951-1970, the EMP derive from the total export volume, supposing a participation of the 15% and 25% of castaña without shell during the years 60 to 70, respectively. EMP of 1970-2000, based on official statistics that distinguish among castaña with and without shell. Values adjusted to inflation.

virtually all Bolivian exports have been as shelled nuts. The mean annual export volume tripled from 8,727 metric tons (raw material equivalent - RME) in the 1980s, to 26,364 metric tons (RME) in the 1990s. In 2000, Brazil nut exports from Bolivia reached an unprecedented 43,995 metric tons (RME), worth US\$33.8 million.¹⁵ Brazil nut exports thus accounted for 29.1% of Bolivia's forest product exports or 2.6% of total export value (cf. Moreno, 2001).

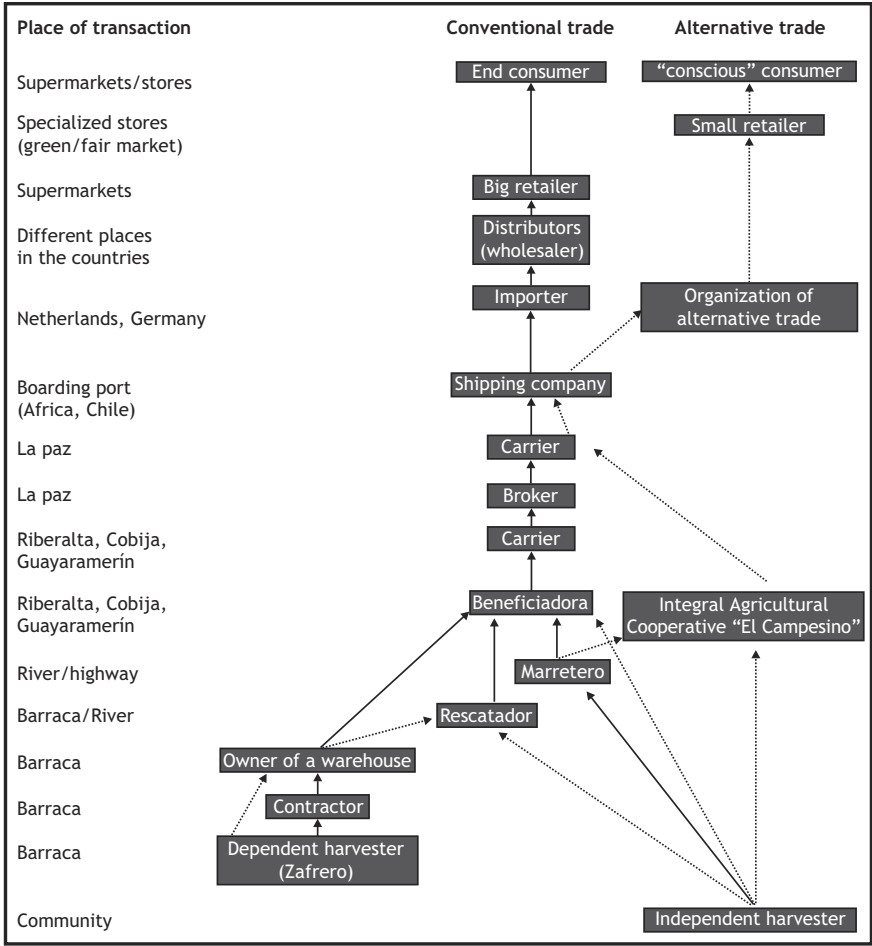
Mechanization, using high-pressure vapor, mechanical breaking and vibration has recently begun to threaten many jobs in the urban-based processing plants.¹⁶ However, the costs of manual and mechanized shelling turn out to be similar (Palacios, 1998), and it remains to be seen which process produces better quality products. The leftover seed coats have become an important by-product. In past years, when not dumped into the river, they were used to pave roads in Riberalta's peripheral neighborhoods. Since 1996, however, they have been used as a fuel for electricity generation. Over 50 tons of Brazil nut shells are used daily as a highly energetic fuel to supply Riberalta with 40% of its electric power (McAllister, 1998).

Commercialization, marketing and certification

The Bolivian Brazil nut is geared almost exclusively towards the international market, with less than 2% of the production traded domestically. In 2002, four countries purchased 85% of the total export volume of Brazil nuts from Bolivia: United States (37.7%), United Kingdom (33.7%), the Netherlands (7.5%), and Germany (6.0%) (INE, 2003). Transporting the raw material from the collection centers in the forest (*payoles*) to the riverbanks and roads, and from there to the processing plants and then to the port of shipping in Arica, Chile, entails great logistic difficulties. Due to the region's deficient road network, fluvial transport is key for delivering the Brazil nuts to the urban processing plants. Most of the roads connecting Riberalta, Guayaramerín, and Cobija with La Paz are not paved, resulting in increased transport costs that amount to 5% of the F.O.B. price. Even though La Paz is not the final destination, it is a key point in the supply chain, as the two brokers who virtually control all Brazil nut exports operate from here. The actors in the supply chain and their respective transaction sites can be distinguished between conventional and alternative trade (Figure 3).

The most important links in the supply chain are the *barraca* owners, the hired and independent collectors in the forest, the urban-based processing plants, the brokers in La Paz, and the importers and retailers in the importing countries (Figure 3). The first links are tightly linked through a series of advance payments (*habilito*) that guarantee the flow of raw material from the forest to the processing plants. The *habilito* is an informal contracting system, through which the processing plants pay the *barraca* owners and contractors, who in turn make an advance payment to *zafreiros* in cash or in provisions. Even though the *habilito* is an essential requirement within the extractive economy in the Amazon, it also represents a source of reciprocal cheating. Non-compliance with the informal rules of the game stipulated by the *habilito* is notorious all the way from the collectors, via the contractors and *barraqueros*, to the owners of the processing plants (Bojanic, 2001).¹⁷ Despite

Figure 3. Commercial chain of castaña from Bolivia distinguishing main (—>) and secondary channels (.....>)



its deficiencies, the *habilito* is the only institution capable of organizing so many different people in order to extract NTFPs from a vast, inaccessible and effectively uncontrollable area.

Equally as essential, are the land and fluvial transportation services along the chain. The processing plants receive raw material from river traders who gather the production from the *barracas*, and roadside traders who compile the production originating from the independent communities.

A certification system is another service that could be offered to the supply chain. Ortiz (2002) suggests that forest certification could play an important role to stimulate sound management of the Brazil nut forests. Under the scheme of the Forest Stewardship Council (FSC), certification standards have been established for Peru (CPCFV 2001) and Bolivia (CFV 2002). It remains to be proven that the cost incurred in this type of certification is compensated

by higher benefits. On the other hand, the existing certification systems for organic production and fair trade could be viable alternatives. Both organic and fair trade certification costs can be reduced through group certification schemes. In the case of Bolivia, most of the production meets the standards for organic certification since no chemicals or synthetic fertilizers are used. Currently, however, only the Cobija-based Tahuamanu Company has been certified according to organic standards (by IMO, Switzerland), resulting in a 15-20% price premium. Taking into account the social criteria of fair trade, this type of certification would only be accessible to the 40% of Brazil nut production that comes from community-based production systems, while excluding the remaining 60% that comes from the *barracas*. By the early 2000s, only the Riberalta-based “El Campesino” Cooperative had achieved fair trade certification and the volumes it handles barely make-up for 1% of the total production in Bolivia. The cooperative’s notorious lack of capital greatly hinders its growth as the ability to provide advance payments is a prerequisite for attracting more collectors to the cooperative.

Political framework

Government support to the northern Bolivian Amazon has been historically erratic. Low population density, difficult access, and the scarcity of traditional export products may explain why the government has neglected this region. Due to the lack of efficient government institutions, access to the resource base is based on an informal system of customary rights. After the formulation of the new agrarian reform law (*Ley INRA*), it turned out that only 1% of communal lands had a legally valid title. Likewise, the *barraca* sector lacked legal recognition of land ownership, as only 2.5% had a property deed. Taking into account that 8% of the land surface of region is under protection (Manuripi Heath Reserve), it can be deduced that almost 90% of the region is comprised of state land under a public access regime. The National Agrarian Reform Institute (INRA) is in charge of demarcating lands and settling related disputes, in a process called “land sanitation” estimated to last at least 10 years.

Several indigenous and peasant groups have requested over 1.6 million hectares as a multi-ethnic territory, under the figure of a Native Communal Territory (*Territorio Comunitario de Origen* - TCO). In addition, peasant communities have filed their petitions for several hundred thousands of hectares, and the *barraca* owners claim as much as 2-3 million hectares. The forest legislation, also from 1996, foresees forest concessions for extracting NTFPs based on the payment of forest royalties of US\$0.30/ha/year. Neither the communities nor the *barraca* owners are used to being charged to access forest resources and, consequently, this levy has not been widely accepted. Land tenure remains insecure throughout most of the region to this day, which in turn is reflected in contradictions and tensions that exist between customary rights and formal laws and their rules and regulations.

Despite the absence of the State in the region, there were programs that supported the conversion of the rubber into a Brazil nut industry. Under the auspices of the World Bank, soft loans were provided to stimulate domestic

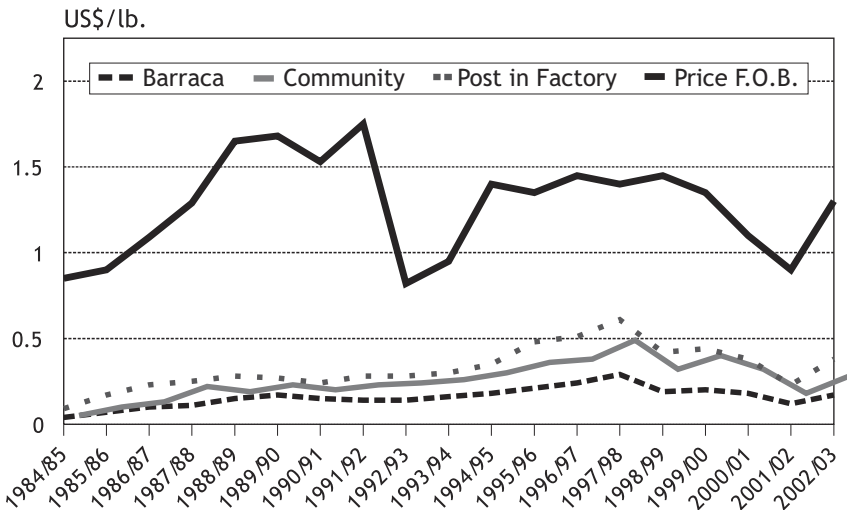
processing of Brazil nut. The Bolivian New Economic Policy, promulgated during the second half of the 1980s, opened up the country to foreign direct investment, suspended price controls, and devaluated the national currency to stimulate exports, among other things. More recently, the Interamerican Development Bank's (IDB) Interamerican Investment Corporation allowed the Cobija-based Tahuamanu Company to expand in such a way that it accounted for nearly 10% of the world's Brazil nut market at the turn of the century (Mangurian, 1998).

The recent Brazil nut boom has raised the State's interest. The importance given to non-traditional export products has been reflected in the statistical data produced by the Ministry of Foreign Trade and Investment. Since 1996, the Ministry makes a distinction in its export statistics between "in-shell Brazil nut, fresh or dry" and "shelled Brazil nut, fresh or dry". In early 2003, the government commissioned an in-depth study of the Brazil nut supply chain, with the aim to develop it for generating higher benefits for the numerous actors involved.

Market trends and distribution of benefits

Although the Brazil nut market is fairly stable, its prices are variable. In fact, Brazil nut prices depend upon the prices of other edible nuts, such as hazelnut, cashew, and macadamia, as well as on annual fluctuations in the supply of Brazil nuts, which can only be buffered partially through stock management. Similar to the markets of other basic products, speculation has a bearing on price fluctuation. The long-term trend in export prices (F.O.B. Arica) reveals fluctuations between US\$0.82/lb and US\$1.75/lb (Figure 4).

Figure 4. Average price of castaña in Bolivia (US\$/lb) according to place of transaction, harvest 1984/85-2002/03



From the mid-1980s to the early 2000s, export prices of Brazil nuts from Bolivia have fluctuated around an average of US\$1.27/lb (Figure 4). In the period 1984-1998, these oscillations in export price were not transmitted directly to the raw material collectors. On the contrary, the prices paid in the different transaction sites inside Bolivia showed a positive trend, with the raw material providers capturing ever higher shares of the export price. Hired collectors on the *barracas* have captured relatively lower shares, as they have to share the benefits with the *barraca* owners and contractors. Independent collectors in the communities fetched better prices, with the highest prices paid to those who sold their product directly to the processing plant. During the Brazil nut harvest of 1997-98, *zafreros* on the *barracas* and independent collectors in communities that sold to middlemen or directly to processing plants attained 20%, 35%, and 44% of the F.O.B. price, respectively. In comparison, contractors, employers, and processing plant owners received 2%, 14%, and 11% respectively; middlemen and *quebradoras* received a mere 8% each (Stoian, 2000b). All raw material providers benefited by the increase in competition among the processing plants. In order to fulfill futures contracts and avoid being penalized with fines, processing plants have paid increasingly higher prices to secure raw material supplies before the harvest ends.

More recently, the distribution of benefits gained through payments for raw material has changed. During the harvests 1998-99 to 2002-03, international price fluctuations were passed on directly to the raw material collectors. Processing plants and *barracas* owners alike have sent more *zafreros* to their *barracas* to extract the largest Brazil nut volume possible. As a result, the harvested volume has increased, but at the same time competition for raw material among processing plants has decreased, making it easier to pass on the cost associated with lower international market prices to the collectors. The most vulnerable link in this process is still the hired collectors, who not only suffer from the lower prices, but also from the increased competition among them. A greater number of *zafreros* in the forest helps the processing plants to secure their raw material supplies, but at the same time decreases the benefits of each *zafrero*.

Dynamic changes

The history of more than two centuries of extractivism in the northern Bolivian Amazon has proven that the region is highly resilient to NTPF market fluctuations (Stoian, 1999). The Brazil nut has a trajectory of more than 70 years in Bolivia, but it was not until recently that it has emerged as the principal product of the nation's extractive economy. The increase in the volumes extracted and the benefits captured have not yet shown a negative ecological impact. Competing land uses exist, but at a smaller scale and in well-defined areas, such as in the vicinity of the urban centers and along the major highways. The limiting factor for future development is not the resource base, that is the supply of raw material, but the relatively stagnant demand.

Over the past decade, Bolivia has increased its share in the international Brazil nut market by capitalizing on its competitive advantages over Brazil

(e.g., cheaper labor, processing capacity installed, and exchange rate adjustments). In general, however, this market has shown few signs of growth. The Brazil nut is an easily replaceable product, reflected in its low share in the international market for edible nuts. The strong competition of other nuts in this market, characterized by little or no price and income elasticity (Clay, 1997), decreases the possibilities for the Brazil nut to obtain a larger share. It will also be difficult for Bolivia to expand its current share in the Brazil nut market vis-à-vis its competitors. Another alternative is more value added through the production of high quality and value products, such as Brazil nut oil, candies, etc. However, the Brazil nut industry in Bolivia currently shows little capacity to add value to the product other than through the shelling process.

In addition to its importance for the regional economy, the Brazil nut plays a vital role in rural and peri-urban livelihoods. Given the loss of rubber as an important source of income, which was substituted partially by palm heart only during a few years (see Stoian, this volume), the Brazil nut has over the last 15 years become the main source of employment and income for some 10 thousand households, representing about 55 thousand people. Considering the scarcity of alternative sources of income, regional and household economies will likely continue to depend upon Brazil nut for many years to come.

Important changes in terms of gender have taken place within the households. As long as the extractive economy depended on the agro-extractive cycle based on rubber and Brazil nut as the economic and social pillars of rural households, gender-wise patterns of labor division and decision making were dominated by the “household head”. The collapse of the rubber industry fuelled out-migration from the *barracas* to the communities and, more importantly, to the urban centers. The concomitant growth of the Brazil nut industry, especially in Riberalta, brought about new job opportunities that were quickly taken advantage of by the women in the migrant households. While these women readily find jobs as *quebradoras* or quality sorters in the Brazil nut processing plants, the urban labor market offers few job opportunities to their husbands due to their low level of formal education. The limited access of these men to employment other than casual labor, makes the women equally, if not more, important in terms of terms of household income generation. Shifts in the economic role of women has led to social, cultural, family, and even emotional changes in their respective households (Coesmans and Medina, 1997). In terms of gender, the distribution of power and decision making have become more equitable. At the same time, it is true that in addition to the economic activities, women have upheld their “traditional” responsibilities, such as child care, reproductive duties, and organizational activities.

The role of children has also changed in the migrant households: in the rural areas they took part in agricultural and extractive activities according to their age and gender. Opportunities to obtain schooling past the elementary school level were very limited. In urban centers, the possibility of attending secondary school is much greater and more rural-urban migrant children take advantage of this and acquire secondary education. Likewise, they often

also help their mothers with the shelling process at the processing plants. Their dual role of going to school and helping to meet household income needs requires them to mature more quickly, and at the same time, opens up more opportunities for their future, given that the level of schooling is a key determinant for the peri-urban households' access to the urban labor market (Stoian, 2005).

Challenges and future perspectives

One of the major challenges for the Brazil nut industry is to comply with the phytosanitary standards of the European Union that became more rigid through the Regulation 1525-98 EC, approved on July 16th, 1998. According to this regulation, 4 ppb (parts per billion) is the maximum acceptable content of aflatoxins, a mycotoxin - i.e., a toxic substance produced by fungi - with carcinogen effects (Newig and Harrop, 2000). The occurrence of aflatoxins in Brazil nut is well-known (see Castrillón and Purchio, 1988), and the previous regulation allowed a maximum contamination of 20 ppb, which was not a problem for the producing countries. The new regulation is not only more difficult to comply with, but also, according to the same authors, it lacks support from scientific evidence, given that Brazil nuts are eaten in very low quantities compared to other basic products. It is worth mentioning that both the United States and the international food code "Codex Alimentarius" have kept 20 ppb as the maximum allowed content. The European Union emphasizes that the prevention principle is their main reasoning, but accepts that only about half of the samples comply with the new requirements and recognizes transitory procedures (ibid). A specialized laboratory is yet to be set up in Riberalta, which will control the level of contamination before the product leaves the production zone. Likewise, measures are being taken to increase the quality of the product from its source in the forest, where high levels of humidity favor contamination, requiring better storage and transportation systems.

Obtaining better access to market information is another challenge for the development of the supply chain. Due to the lack of access to new communication and information technologies, out-of-date, incomplete and even erroneous information is distributed among the first links in the chain - aggravated by the gap in access to digital technology. The collectors and their respective organizations, in particular, lack adequate market information, which makes them more vulnerable in their negotiations with the owners of the processing plants. For example, to increase the bargaining power of the Peasants' Labor Union Federation in the tripartite discussions with the National Association of Brazil Nut Processing Plants (ABAN) and the local Labor Inspectorate at the beginning of the Brazil nut harvest in December, with the aim to stipulate higher minimum prices to be paid for the Brazil nut on the *barracas*, it is vital to establish market information systems that are available to all stakeholders. Price reductions stipulated in this manner, especially those for the harvest 2000/01, were only partially justifiable by the decline of Brazil nut prices in the international market. As a matter of fact, representatives from the processing plants associated with ABAN also took advantage of

the situation to lower their total costs by significantly reducing the costs of raw material. This means that collectors do not only need to be organized, but their respective organizations must also strengthen their marketing and business management skills in order to work more independently along the supply chain.

LESSONS LEARNED FOR DEVELOPMENT AND CONSERVATION

The Brazil nut is considered a “cornerstone species for conservation and development” (Clay, 1997). Its impact on conservation will be discussed below. Before that, its impact on the socio-economic development of the region will be determined.

Lessons for socio-economic development

There is no doubt that the Brazil nut is currently the principal forest product originating from the northern Bolivian Amazon. Its extraction and processing represent the main source of income for most rural and peri-urban households, respectively. However, most households involved in the different stages of the supply chain are still relatively poor. Poverty is, at the same time, relative. Most rural households own their private plots of land, with a high potential for being self-sufficient in food production through staples as rice, maize, manioc, and plantain. The persistence, if not the prevalence, of bartering in the rural areas reveals that there are few opportunities for obtaining cash. The income derived from Brazil nut extraction thus is crucial for satisfying basic household necessities.

Perhaps more important than the current “success story” of the Brazil nut is the fact that, despite the ups and downs in NTFP markets, rural livelihoods have been built upon a careful balance between extractive and agricultural activities for many decades. Changes in the agro-extractive cycle have been brought about by market forces. These changes have been absorbed by the resilience of livelihoods that orientate family labor to agricultural activities in times when NTFP markets contract, and reinvest it in extractive activities when NTFP prices are favorable again. This agro-extractive continuum may be considered the basis for the sustainability of rural livelihoods in the region.

Most peri-urban households lack access to agricultural plots and need to reproduce themselves by selling their labor in the urban labor market. While women have ready access to work in the Brazil nut processing plants, men depend on casual labor and extractive activities, in particular the Brazil nut harvest. Notwithstanding the precarious situation in the peripheral neighborhoods, especially that of rural-urban migrants, there are signs of a consolidation process reflected in improved housing, diversified job and income sources, and the increase of children’s schooling levels. For many peri-urban households, especially the ex-forest dwellers among them, the participation in the extraction and processing of Brazil nuts constitute prerequisites for their economic survival in town.¹⁸ In order to assess all benefits resulting from NTFPs, it is vital to take into account the rural-urban continuum underlying peri-urban livelihoods and NTFPs supply chains in general.

Lessons for conservation

There is no doubt that the forests in the northern Bolivian Amazon are in an excellent state of conservation; the same applies to the Brazil nut forests in Peru and, although not in all areas of its natural distribution, Brazil. Brazil nut forests cover an estimated 325 million hectares in the Amazon, shared principally between Brazil (300 million hectares) (see Rosengarten, 1984), Peru (2.5 million hectares) (CPCFV, 2001), and Bolivia (10 million hectares). However, the area intervened annually by the collectors is much lower. Assuming an annual Brazil nut production of 65 thousand metric tons (RME) and an average production of 20 kg/ha, the actual intervened area is likely no more than 3.25 million hectares, equivalent to a mere 1% of the total area. If we further take into consideration that the Amazon forest is a blend of different ecosystems, some which favor more and others less the occurrence of *Bertholletia excelsa*, it is likely that the forest area affected by Brazil nut extraction is in the magnitude of some 20 million hectares, as suggested by Clay (1997).

At a first glimpse these figures may come as a surprise, as they do not confirm the general perception that vast extensions of the Amazon forest owe their conservation to the economic value of NTFPs, such as the Brazil nut (see Clay, 1997; Newing and Harrop, 2000; Ortiz, 2002). We should then ask ourselves, whether or not it is true that a higher economic value due to the extraction of NTFPs has led to the conservation of the Brazil nut forests. Some authors emphasize the importance of institutional agreements resulting from social movements that govern the access to forest products of a certain value (see Allegretti, 1994; Broekhoven, 1996; Henkemans, 2001). Others point to poverty as a key element in the conservation of biodiversity in Bolivia, as it hinders the access of local communities to forest resources for their rapid exploitation (Ibisch, 1998). According to Ortiz (2002), millions of hectares in the Amazon have been “unintendedly” protected by the utilization of Brazil nut. In fact, it is hard to ignore that in a region notoriously poor in capital, with little access to markets because of a lacking road network, and limited communications and transportation facilities, few incentives exist for forest conversion or other depredatory uses of forest resources.¹⁹

Forest conservation in the northern Bolivian Amazon therefore needs to be understood within the context signaled by Vayda (1998) who describes one of the most common misunderstandings regarding the factors that favor the preservation of tropical forests the following way: to see its dwellers as conservationists imbued with a conservation ethic, rather than as people lacking the numbers, technological capability, and market incentives to destroy their forests. There is ample evidence that the urgent need for obtaining cash forces both the *barraca* owners and peasants to sell their forest resources in an opportunistic manner. It is easy for local timber companies to identify sites for wood extraction in the *barracas* or communities, with the owners willing to allow logging machinery onto their forests. Although the remuneration for precious woods such as mahogany (*Swietenia macrophylla*) and tropical cedar (*Cedrela* spp.) and some secondary species is minimal, the payment of a few hundreds of dollars in cash is perceived as receiving a small fortune.²⁰

To date, the impact of timber extraction from the forests in northern Bolivia has been relatively modest, as it is geared toward few species of which relatively low volumes are extracted. However, a study that takes into account the damage to the residual stand for each cubic meter extracted would yield a different picture. It also needs to be taken into account that timber extraction in the region increased from 20,000m³/year in the mid-1980s (Salas, 1987) to over 100,000m³/year at the end of the 1990s (Stoian, 2000b). Given that valuable woods are being depleted in other parts of the country, it is expected that wood production in northern Bolivia will increase significantly in the future.

Another threat to forest conservation in the northern Bolivian Amazon is the termination of the Northwestern Transport Corridor that will connect Northwest Brazil, via Cobija, Guayaramerín, and Riberalta, with La Paz and the Pacific Coast. Although it is unlikely that it will be ready before 2020, it is anticipated that it will denote a “high impact corridor” for the region’s forest resources (*cf.* Sierra and Stallings, 1998). For the time being, road construction in northern Bolivia has not caused major ecological impact due to the lack of large numbers of colonizers advancing the agricultural frontier. The existence of zones of colonization - directed as well as spontaneous - in other parts of the country, has prevented conversion of forests to other land uses.

Forest conservation in the northern Bolivian Amazon needs to be understood in a comprehensive context. On one hand, extraction of NTFPs such as Brazil nut and palm heart, and previously rubber, has increased the forest’s value and, hence, the opportunity cost of converting it to other land uses. On the other hand, the opportunity cost of maintaining forest cover has been minimal, when considering that most soils are not suitable for permanent agriculture, that livestock has its place in the natural savannas of Beni and Santa Cruz, and that the advance of the agricultural frontier and demographic pressure are much more pronounced in the colonization zones in the La Paz, Cochabamba and Santa Cruz Departments.

However desirable it may be, the value added to forests through NTFP extraction is but one among many factors that all combined have contributed to forest conservation in northern Bolivia. These factors are in a fragile balance that due to external reasons, such as the termination of the Northwestern Transport Corridor and the resulting significant increase of cross-border traffic, could lose their importance and jeopardize conservation efforts.

Extraction of NTFP alone will not guarantee forest conservation in the northern Bolivian Amazon. In fact, a proper institutional framework is needed that includes formal institutions, such as laws and regulations, as well as informal institutions that govern the interactions among the various stakeholders involved. The land sanitation process, regulating land ownership in the region, will be of vital importance in this regard.

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NOTES

1. Dietmar Stoian heads the Centre for the Competitiveness of Ecoenterprises (CeCoEco), based at the Tropical Agriculture Research and Higher Education Centre (CATIE), in Turrialba, Costa Rica. Most of the data this chapter is based on were compiled within the framework of the project “Contributions of non-timber forest products to socio-economic development,” financed jointly by the German Federal Ministry of Economic Cooperation and Development (BMZ) and CIFOR. The author can be contacted at CATIE 7170, Turrialba, Costa Rica, or by e-mail: stoian@catie.ac.cr.

2. The distributional range of *B. excelsa* comprises Bolivia (Pando and northern Beni/La Paz), Peru (Madre de Dios), Brazil (Acre, Amapá, Amazonas, Maranhão, Mato Grosso, Pará, Rondônia), Colombia (Amazonas), Venezuela (Amazonas), and the Guyanas.

3. “A Brazil nut tree can be legally cut down if it is dead or dying, or in the way of urban expansion. Along the Transamazon, some colonists in the early 1970s deliberately set hot fires at the base of Brazil nut trees so that a cash windfall could be obtained by inviting loggers to remove the damaged trees” (*ibid.*).

4. Mori (1992) himself argues that Brazil nut production has declined not only because of deforestation but also because of rural-urban migration of Brazil nut gatherers, the flooding of some traditional Brazil nut stands, and perhaps the disruption of pollinators caused by fires.

5. In Peru’s Madre de Dios Department, about 4,500 families gather Brazil nuts on an area of about 2.5 million ha (Arana *et al.* 2002).

6. These shares refer to the 1997 production of 63,579 MT in raw material equivalent, whereby 3.2 kg of in-shell nuts are equivalent to 1 kg of shelled nuts. Brazil continues to be the largest exporter of in-shell nuts, but Bolivia has surpassed its neighbour in terms of raw material and kernel nut production since 1992 (*cf.* Man-Producten 1998).

7. Brazil nut oil sells at US\$34.8 per kg, as an agreement between two Brazilian trade companies and the Body Shop stipulates (Lescure *et al.* 1994). This essential oil, however, is not to be confused with the far cheaper cooking oil produced from broken nuts for local consumption.

8. While *jochi* populations are rather resistant to hunting pressures that accompany nut harvest, adverse effects are noticeable for large monkey species and other medium-sized animals (Ortiz 2002).

9. These figures are in stark contrast to those provided by Zuidema (2003), who estimates that around 50% of total seed production is collected. Departing from the about 17 million reproductive Brazil nut trees inventoried by DHV (1993a) and an average production of 20-25 kg per tree (*ibid.*; Ortiz 2002), overall Brazil nut production in Bolivian forests can safely be

estimated at 340,000 to 425,000 metric tons a year. In the period 1996-2000, raw material equivalents of annual Brazil nut offtake averaged 36,000 metric tons, roughly equivalent to 10% of overall production in the forest.

10. The 1958 Treaty of Roboré granted governmental assistance to both Brazilian and Bolivian rubber producers.

11. Bolivia's New Economic Policy, promulgated in 1985 to mitigate a severe monetary and financial crisis, led to export liberalization and tax incentives which, strengthened by investment programs under the auspices of the World Bank, helped expand local processing facilities. More recently, a loan and equity investment from Inter-American Development Bank's Inter-American Investment Corporation enabled the Cobija-based Tahuamanu Company to expand in such a manner that today it holds nearly 10% of the world's Brazil nut market (Mangurian 1998).

12. Rural households in the northern Bolivian Amazon reveal the following variations of average household income: Brazil nut \$650 (\$0-2,500), palm heart \$400 (\$0-1,500), bushmeat and fish \$30 (\$0-500), other NTFPs \$10 (\$0-50), timber \$70 (\$0-250), agriculture \$120 (\$0-1,600), horticulture \$30 (\$0-170), extractive activities outside the own plot \$70 (\$0-700), and daily labor \$25 (\$0-500).

13. Five classes of shelled Brazil nuts are distinguished: first class (whole nuts), second class (chipped), third class (broken or with cut off pieces, more than half a nut), fourth class (broken or with cut off pieces, less than half a nut), fifth class (rotten). First class nuts are classified according to size (large, medium, small, midget, and tiny, which are locally referred to as *grande*, *mediano*, *pequeño*, *enano* and *diminuto*). The first three classes are meant for consumption, the fourth is used for cooking oil, and the fifth for soap production (Coesmans and Medina, 1997). In 2000, the *quebradoras* received the following prices per kilo of shelled nuts: \$0.20 (first), \$0.08 (second), \$0.06 (third), \$0.04 (fourth), and \$0.02 (fifth). The average income was \$0.18/kilo as a *quebradora* usually produces 85% of first class nuts, and the remainder of other classes.

14. It needs to be borne in mind that these figures represent official statistics. The decrease over the period 1981-1985 is likely to stand for increased contraband, rather than a real decline of exports. While Brazil received the bulk of illicit trade in Brazil nuts, Peru was another important destination, in particular from 1985 to 1988 (Dominguez, 1994). Towards the mid-1980s the share of contraband in Brazil nuts was estimated at one-third of overall production (cf. Vivado, 1984).

15. In 2002, the export volume was even higher, reaching 44,796 metric tons (RME). The export value, though, did not exceed \$27.5 million (INE, 2003).

16. Tahuamanu (Cobija) and Amazonas/Manutata (Riberalta) are the processing plants with a mechanized production system.

17. The ways of cheating are manifold: among the hired *zafreiros*, two out of ten leave the forest without delivering the established amount of Brazil nuts; numerous contractors and *barraca* owners do not pay the positive balance gathered by a *zafretero*; among the transporters, it has been noticed that raw material "disappears" and is later on found again in the market; and

in the processing plants not all scales are calibrated such that they would show the correct weight of the raw material.

18. A secondary benefit of the Brazil nut industry is that foodstuffs and other basic supplies from outside the region can be acquired at lower costs. Before the current Brazil nut boom, transporters would go back to La Paz with empty trucks, but nowadays they take back Brazil nuts, lowering transportation costs and allowing to offer goods at lower prices (Mangurian, 1998).

19. In contrast to the adjacent Brazilian Amazon, the conversion of forests into cattle pastures has been discouraged by the occurrence of vast natural savannas in the Beni and Santa Cruz Departments. These lands are ideal for cattle ranching and comprise 32.9 million hectares suitable for these practices (Bojanic, 2002).

20. Valuable species such as mahogany and tropical cedar are usually paid at \$15-30 per trunk while other species fetch \$10 or less.

REFERENCES

- Allegretti, M.H. 1994. Policies for the use of renewable natural resources: the Amazon region and extractive activities. *In*: Clüsener-Godt, M. and Sachs, I. (eds.) *Extractivism in the Brazilian Amazon: perspectives on regional development*, 14-33. MAB Digest 18. UNESCO, París.
- Alverson, W.S., Moskovits, D.K. and Shopland, J.M. (eds.) 2000. *Bolivia: Pando, Río Tahuamanu. Rapid Biological Inventories 1*. The Field Museum, Chicago.
- Arana, A., Sequeira, V.A. and Torres, J. 2002. Mejoramiento del sistema de cosecha de castaña (*Bertholletia excelsa*) en Madre de Dios y sus impactos en la economía del productor castañero. Asociación para la Conservación del Cuenca Amazónica (ACCA) y Proyecto Conservando Castañales, Puerto Maldonado, Perú.
- Balée, W. 1989. The culture of Amazonian forests. *In*: Posey, D.A. and Balée, W. (eds.) *Resource management in Amazonia: indigenous and folk strategies*, 1-21. *Advances in Economic Botany* 7. New York Botanical Garden, New York.
- Beekma, J., Zonta, A. and Keijzer, B. 1996. Base ambiental para el desarrollo del departamento de Pando y la provincia de Vaca Díez. Cuadernos de Trabajo 3. W Producciones, La Paz.
- Bojanic H., A.J. 2001. Balance is beautiful: assessing sustainable development in the rain forests of the Bolivian Amazon. PROMAB Scientific Series 4. Ph.D. Dissertation. University of Utrecht, the Netherlands.
- Bojanic H., A.J. 2002. Comercialización de productos forestales no maderables: factores de éxito y de fracaso. Marco legal y políticas relevantes para la comercialización interna y exportación de productos no maderables en Bolivia. PNUMA/UNEP-WCMC & ODI/DFID-FRP, La Paz.
- Boom, B.M. 1987. Ethnobotany of the Chácobo Indians, Beni, Bolivia. *Advances in Economic Botany* 4. New York Botanical Garden, New York.
- Bratschi, D. 1999. Product path and aspects of its market analysis of a non-timber forest product within the rainforest of the Rio Negro Region in the

- Amazon. Based on the example of *Bertholletia excelsa* H.B.K. Unpublished M.Sc. Thesis. University of Zurich, Switzerland.
- Broekhoven, G. 1996. Non-timber forest products: ecological and economic aspects of exploitation in Colombia, Ecuador and Bolivia. IUCN Forest Conservation Programme 16. IUCN, Gland, Switzerland.
- Browder, J.O. and Godfrey, B.J. 1997. Rainforest cities: urbanization, development, and globalization of the Brazilian Amazon. Columbia University Press, New York.
- Castrillón, A.L. and Purchio, A. 1988. Ocorrência de aflotoxinas em Castanhas do Pará (*Bertholletia excelsa*, Humb. & Bonpl.). Acta Amazónica 18 (1-2): 49-56.
- CFB - Cámara Forestal de Bolivia 2000. Resumen de la actividad exportadora forestal realizada en la Gestión 1999. Bolivia Forestal 2 (5): 3-5.
- CFV - Consejo Boliviano para la Certificación Forestal Voluntaria 2002. Estándares para la certificación forestal de la castaña (*Bertholletia excelsa*). CPCFV, Santa Cruz, Bolivia.
- CIDOB 1979. Diagnóstico social del norte boliviano - Volumen I. Centro de Información y Documentación de Bolivia (CIDOB), La Paz.
- Clay, J.W. 1997. Brazil nuts: the use of a keystone species for conservation and development. In: Freese, C.H. (ed.) Harvesting wild species: implications for biodiversity conservation, 246-282. Johns Hopkins University Press, Baltimore and London.
- Coesmans, K. and Medina I., C. 1997. Entre contradicciones y suerte - una mirada en la realidad cotidiana de las mujeres campesinas y quebradoras de Riberalta y sus alrededores. W Producciones, La Paz.
- Collinson, C., Burnett, D. and Agreda, V. 2000. Economic viability of Brazil nut trading in Peru. Natural Resources Institute, University of Greenwich, Kent, UK.
- CPCFV - Consejo Peruano para la Certificación Forestal Voluntaria 2001. Estándar para la certificación del manejo forestal con fines de producción de castaña (*Bertholletia excelsa*) en Perú. CPCFV, Lima.
- DHV 1993a. Desarrollo de la Amazonía boliviana - de la actividad extractiva hacia un desarrollo integral sostenible. Estudios Agro-Ecológicos, Forestales y Socio-Económicos en la Región de la Castaña de la Amazonía Boliviana. Resumen Ejecutivo. DHV, La Paz.
- DHV 1993b. Sistemas de recolección de castaña en la Amazonía boliviana. Estudios Agro-Ecológicos, Forestales y Socio-Económicos en la Región de la Castaña de la Amazonía Boliviana - Volumen C. DHV, La Paz.
- Domínguez, J. 1994. Distribution of production costs of Brazil Nut (*Bertholletia excelsa*) in Peru and Bolivia: Its relevance for forest conservation. TRI Working Paper 70. Tropical Resources Institute (TRI), New Haven, Connecticut.
- FAO 1995. Edible nuts. Non-Wood Forest Products 5. Food and Agriculture Organization of the United Nations (FAO), Rome.
- Gutiérrez M., H. and Leigh, J. 1999. Promoting agroforestry in Regional Peru. ITTO Tropical Forest Update 9 (4): 10-11.
- Herrera, J.C. 1999. Uso de fauna silvestre durante la extracción de palmito. Boletín BOLFOR 17: 4-5.

- Holt, J. (sin año) Brazil nuts and market forces. Amazonia Trading Company, Liverpool. <http://www.nri.org/TFF/TFFnews/issue2/tff2newc.htm> (21 Mayo 2001).
- Homma, A.K.O. 1994. Plant extractivism in the Amazon: limitations and possibilities. *In*: Clüsener-Godt, M. and Sachs, I. (eds.) Extractivism in the Brazilian Amazon: perspectives on regional development, 34-57. MAB Digest 18. UNESCO, Paris.
- Ibisch, P.L. 1998. Bolivia is a megadiversity country and a developing country. *In*: Barthlott, W. and Winiger, M. (eds.) Biodiversity: a challenge for development research and policy, 213-241. Springer, Berlin.
- INE - Instituto Nacional de Estadística 2003. Bolivia - Estadísticas Económicas: Sector Exportaciones (2002). <http://www.ine.gov.bo/cgi-bin/PIWDIECOMEX.EXE/CUADROCOMEX> (15 Agosto 2003).
- LaFleur, J.R. 1992. Marketing of Brazil nuts. A case study from Brazil prepared for the Forest Products Division. FAO, Rome.
- Lescure, J.P., Pinton, F. and Emperaire, L. 1994. People and forest products in Central Amazonia: the multidisciplinary approach of extractivism. *In*: Clüsener-Godt, M. and Sachs, I. (eds.) Extractivism in the Brazilian Amazon: perspectives on regional development, 58-88. MAB Digest 18. UNESCO, Paris.
- Mangurian, D. 1998. Cracking the Brazil nut market: Bolivian company boosts income and jobs. IDB America Online (Mayo 1998). <http://www.iadb.org/exr/IDB/stories/1998/eng/e598g1.htm> (23 abril 2001).
- Man-Producten. 1997. Edible Nut Market Report 144 - July 1997. Man-Producten, Rotterdam, the Netherlands.
- Man-Producten. 1998. Edible Nut Market Report 146 - October 1998. Man-Producten, Rotterdam, the Netherlands.
- McAllister, J.A. 1998 Electrifying remote regions of Bolivia. Transmission & Distribution World. <http://www.fsa.ulaval.ca/personnel/vernag/GPI/Textes/McAllister.html> (23 abril 2001).
- Moreno S., H. 2001. Exportaciones forestales de Bolivia crecieron 3.87% en comparación al año 1999. Bolivia Forestal 3 (16): 2.
- Mori, S.A. 1992. The Brazil nut industry - past, present and future. *In*: Plotkin, M. and Famolare, L. (eds.) Sustainable harvest and marketing of rain forest products, 241-251. Island Press, Washington D.C.
- Mori, S.A. and Prance, G.T. 1990. Taxonomy, ecology, and economic botany of the Brazil nut (*Bertholletia excelsa* Humb. and Bonpl.; Lecythidaceae). *In*: Prance, G.T. and Balick, M.J. (eds.) New directions in the study of plants and people, 92-102. Advances in Economic Botany 8. New York Botanical Garden, New York.
- Moritz, A. 1984. Estudos biológicos da castanha-do-Brasil (*Bertholletia excelsa* H.B.K.). EMBRAPA, Centro de Pesquisa Agropecuária do Trópico Umedo. Documentos 29: 1-82.
- Motta Maués M. 2002. Reproductive phenology and pollination of the Brazil nut tree (*Bertholletia excelsa* Humb. & Bonpl. Lecythidaceae) in Eastern Amazonia. *In*: Kevan P. and Imperatriz Fonseca V.L. (eds.) Pollinating bees - The conservation link between agriculture and nature, 245-254. Ministry of Environment, Brasília.

- Müller, C.H., Rodriques, I.A., Müller, A.A. and Müller, N.R.M. 1980. Castanha-do-Brasil. Resultados de pesquisa. EMBRAPA, Centro de Pesquisa Agropecuária do Trópico Umido. Miscelânea 2: 1-25.
- Nelson, B.W., Absy, M.L., Barbosa, E.M. and Prance, G.T. 1985. Observations on flower visitors to *Bertholletia excelsa* H.B.K. and *Couratari tenuicarpa* A.C. Sm. (Lecythidaceae). Acta Amazônica 15 (1/2): 225-34.
- Newing, H. and Harrop, S. 2000. European health regulations and Brazil nuts: Implications for biodiversity conservation and sustainable rural livelihoods in the Amazon. Journal of International Wildlife Law and Policy 3(2): 109-124.
- Ohashi, S.T., Daniel, O. and Costa, L.G. da S. 1995. A castanha-do-Brasil - *Bertholletia excelsa* H.B.K. Faculdade de Ciências Agrárias do Pará, Belém, Brasil.
- Ortiz, E.G. 2002. Brazil Nut (*Bertholletia excelsa*). In: Shanley, P., Pierce, A.R., Laird, S.A. and Guillén, A. (eds): Tapping the green market: certification and management of non-timber forest products, 61-74. Earthscan, London and Sterling, VA.
- Palacios V., A. 1998. Propuesta para la creación de un sistema de aprovisionamiento de castaña en cáscara. Unpublished Master Thesis, University "NUR", Santa Cruz, Bolivia.
- Posey, D.A. 1985. Indigenous management of tropical forest ecosystems: the case of the Kayapo Indians of the Brazilian Amazon. Agroforestry Systems 3: 139-158.
- Rosengarten, F. 1984. The book of edible nuts. Walker and Company, New York.
- Powell, A.H. and Powell, G.V.N. 1987. Population dynamics of male Euglossine bees in Amazonian forest fragments. Biotropica 19 (2): 176-179.
- Rumiz, D.I. 1999. La explotación de recursos no maderables en el norte de Bolivia y su impacto sobre la fauna silvestre. Boletín BOLFOR 17: 6-9.
- Salas C., A. 1987. La propuesta de Riberalta. Apuntes del subdesarrollo II. Informe no publicado. Riberalta, Bolivia.
- Sierra, R. and Stallings, J. 1998. The dynamics and social organization of tropical deforestation in Northwest Ecuador, 1983-1995. Human Ecology 26 (1): 135-161.
- Smith, N.J.H. 1999. The Amazon river forest: a natural history of plants, animals and people. Oxford University Press, New York y Oxford.
- Smith, N.J.H., Serrão, E.A.S., Alvim, P.T. and Falesi, I.C. 1995a. Amazonia: resiliency and dynamism of the land and the people. UNU Studies on Critical Environmental Regions. United Nations University Press, Tokyo.
- Smith, N.J.H., Alvim, P.T., Serrão, E.A.S. and Falesi, I.C. 1995b. Amazonia. In: Kasperson, J.X., Kasperson, R.E. and Turner II, B.L. (eds.) Regions at risk: comparisons of threatened environments. United Nations University Press, Tokyo, New York, Paris.
- Stoian, D. 1999. Change and adaptation as keys to sustainability: extraction-based livelihood systems in the Bolivian Amazon. In: ATSAF (ed.) Seminar Proceedings 'Knowledge Partnership: Challenges and Perspectives for Research and Education at the Turn of the Millennium', 1-12, held in Berlin

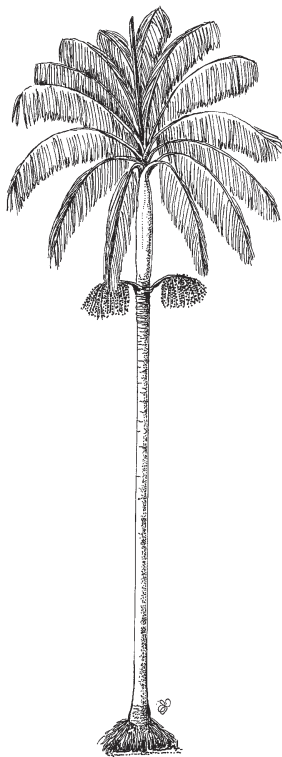
- on 14-15 October 1999. Council for Tropical and Subtropical Agricultural Research (ATSAF), Bonn.
- Stoian, D. 2000a. Shifts in forest product extraction: the post-rubber era in the Bolivian Amazon. *International Tree Crops Journal* 10 (4): 277-297.
- Stoian, D. 2000b. Variations and dynamics of extractive economies: the rural-urban nexus of non-timber forest use in the Bolivian Amazon. Ph.D. Dissertation. University of Freiburg, Germany.
- Stoian, D. 2005. Making the best of two worlds: rural and peri-urban livelihood options sustained by non-timber forest products from the Bolivian Amazon. *World Development* 33 (9): 1473-1490.
- Stoian (this volume). What goes up must come down: the rise and fall of the palm heart (*Euterpe precatoria*) industry in the Northern Bolivian Amazon.
- Stoian, D. and Henkemans, A.B. 2000. Between extractivism and peasant agriculture: differentiation of rural settlements in the Bolivian Amazon. *International Tree Crops Journal* 10 (4): 299-319.
- Taylor, L. 1998. Herbal secrets of the rainforest: the healing power of over 50 medicinal plants you should know about. Prima Publishing, Rocklin, Canada.
- Taylor, D. 1999. Tasty Brazil Nuts stun harvesters and scientists. *Smithsonian Magazine*, April 1999. http://www.smithsonianmag.si.edu/smithsonian/issues99/apr99/object_apr99.html (24 abril 2001).
- TCA 1996. Frutales y hortalizas promisorios de la Amazonía. Tratado de Cooperación Amazónica (TCA), Lima.
- Vayda, A.P. 1998. Anthropological Perspectives on Tropical Deforestation? A Review Article. *Anthropos* 93: 573-579.
- Vivado P., M. 1984. Proyecto de asistencia a la comercialización externa de productos agropecuarios de exportación no tradicional de Bolivia: Castaña. Estudio Preliminar. Asociación Latinoamericana de Integración (ALADI), La Paz.
- ZONISIG 1997. Zonificación agroecológica y socioeconómica y perfil ambiental del departamento de Pando. Proyecto de Zonificación Agroecológica y Establecimiento de una Base de Datos y Red de Sistema de Información Geográfica en Bolivia (ZONISIG), La Paz.
- Zuidema, P.A. 2000. Demography of exploited tree species in the Bolivian Amazon. Ph.D. Dissertation. University of Utrecht, the Netherlands.
- Zuidema, P.A. 2003. Ecología y manejo del árbol de castaña (*Bertholletia excelsa*). PROMAB Serie Científica 6. PROMAB, Riberalta, Bolivia.

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Chapter 6

What Goes Up Must Come Down:
The Economy of Palm Heart
(*Euterpe precatoria* Mart.) In the
Northern Bolivian Amazon

Dietmar Stoian¹



(*Euterpe precatoria*)

Common name	Product part used	Dominant form of management	Degree of transformation	Commercial scale	Geographic distribution
Asai, Palmito, Palm heart	Meristema apical	Wild	Average/ middle/half	International	Wide

ABSTRACT

Most of the palm hearts traded in the international market originate from South America. Although plantation production of this luxury food item has been growing since the 1990s, significant volumes are still being extracted from wild populations. *Euterpe precatoria*, locally called *asaí*, is one of the three most important palm species harvested for this non-timber forest product (NTFP). However, the single-stemmed nature of the palm implies its death upon extracting the palm heart. Within a decade, the northern Bolivian Amazon experienced an exponential increase in its exploitation, which was followed by a sharp decline. In 1997, at the height of the ephemeral boom, more than 7 million palm hearts were extracted, creating employment for some 3700 collectors and about 800 workers in processing plants. The official value of exports amounted to US\$7.1 million, destined mainly for the Brazilian market. The palm heart boom provoked concern that extraction rates were not sustainable, but the Brazilian market for palm hearts from Bolivia contracted before the State could take measures to restrict exploitation. As a result, overall export values dropped to less than \$1 million in 2002. Palm heart from northern Bolivia thus followed the boom-and-bust cycle typical for NTFPs in the Amazon. I show how market forces tend to determine the destiny of NTFPs more than efforts to reach sustainable extraction rates, no matter how desirable these may be.

INTRODUCTION

According to an old legend, the sap of the *asaí* palm (*Euterpe² precatoria* Mart.) inflamed the passion of a mermaid for a stranger (Coimbra 1993).³ The fact is that the fruits of this palm constituted an important element in the diet of indigenous groups in central Amazonia before the arrival of Europeans (de Castro 1996). The palm also produces a palm heart (*palmito*) of high quality which, together with that of other *Euterpe* species, is one of the principal non-timber forest products (NTFPs) of South America. The edible apical meristem of palm trees, known as *palmito* or palm heart, is obtained mainly from three forest species: *E. oleracea* Mart., *E. precatoria*, and *E. edulis* Mart. (A. C. Fantini, Chapter 7, this volume), in their approximate order of economic importance (Johnson 2002).

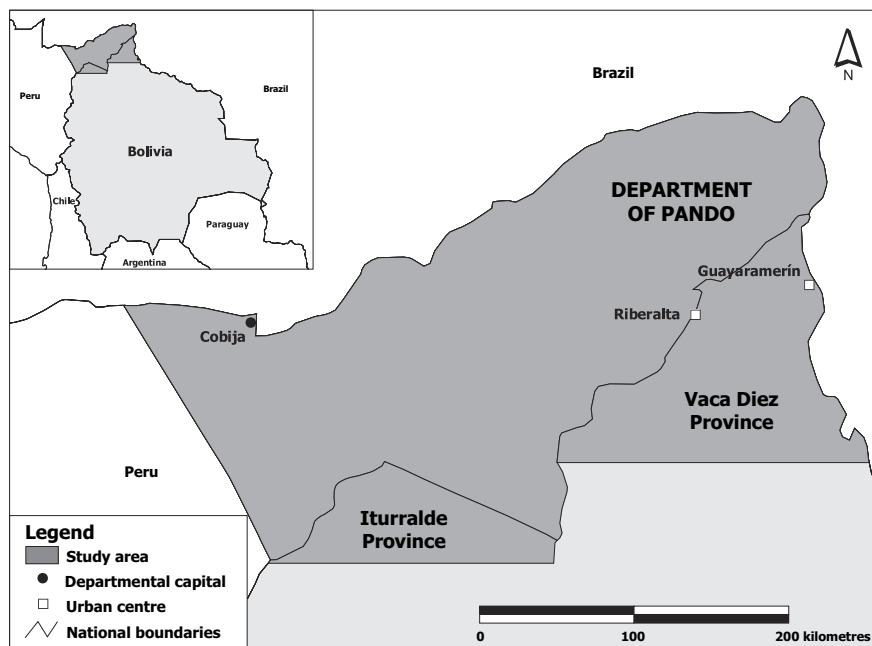
Despite increased competition from plantation-grown *Bactris gasipaes* Kunth or peach palm (C. Clement and van Leeuwen, Chapter 9, this volume, Mora-Urpi 1994), major industries continue exploiting the natural stands of *E. oleracea* and *E. precatoria* in Bolivia, Brazil, Colombia, Ecuador, Guyana, and Venezuela, while *E. edulis* sustains palm-heart industries in Argentina, Brazil, and Paraguay (Johnson 1997). Almost no industry is reported to acquire palm heart sustainably. As the availability of raw material near processing plants declines, smaller and smaller palms are harvested, harvest cycles become progressively shorter, and palm heart is extracted from increasingly distant sites.⁴

Within South America Brazil accounts for 90% of the commercial production of palm heart (Clay 1994), most of which is for domestic consumption. Commercial extraction and processing of palm heart began

in the 1940s, in southern and south-eastern Brazil (Johnson 1996). The raw material was obtained from natural stands of *E. edulis* in the Atlantic forest. In the 1970s, the exhaustion of the resource base motivated a relocation of the industry towards the Amazon Estuary, where extensive stands of *E. oleracea* are found (Richards 1993).⁵ Commercial production of palm heart was initiated elsewhere in the South American tropics during this time as well, incorporating stands of *E. precatoria* as an additional source of raw material.

In Bolivia, the palm heart industry dates from the late 1960s, when the first processing plants were established in the Department of Santa Cruz (Peña-Claros 1996). It was not until the 1990s that palm heart extraction and processing was carried out on a large scale in northern Bolivia. This study area, here also referred to as the northern Bolivian Amazon, encompasses the Department of Pando, the Vaca Díez Province (Department of Beni), and the northernmost part of the Iturralde Province (Department of La Paz) (Figure 1). For a long time, *E. precatoria* had been the only source of raw material of the Santa Cruz-based industry, but nowadays an ever-increasing proportion is obtained from peach palm plantations in the Department of Cochabamba.⁶ Its counterpart in northern Bolivia, however, continues to depend on palm heart extracted from wild stands of *E. precatoria*.

Figure 1. Study area of the palm heart industry in the northern Bolivian Amazon



Source: ESRI (Environmental Systems Research Institute, Inc.). 2002. Data and maps.

Like other species of its genus, *E. precatoria* is an excellent example of a multipurpose palm tree. In the northern Bolivian Amazon, in addition to hearts, the palm provides leaves for roofing; fruits for pulp, refreshments, and palm wine; roots for natural remedies; inflorescences for brooms; and trunks for construction. Unlike *E. oleracea* in Brazil, in Bolivia the fruits of *E. precatoria* are destined for household consumption, while the palm heart is commercialized. Like Brazil nut (*Bertholletia excelsa* H.B.K.; D. Stoian, Chapter 5, this volume), the asaí palm provided an important source of jobs and income for rural and peri-urban households during most of the 1990s. After the decline of wild rubber (*Hevea brasiliensis* (Willd. ex A. Juss.) Muell.-Arg.) in the late 1980s and early 1990s, palm heart replaced rubber in extraction-based livelihood systems (Stoian 2000).

In 1998, official export figures for palm heart from the northern Bolivian Amazon reached the unprecedented figure of US\$7.8 million.⁷ Recently, however, export values have dropped dramatically to less than 15% of what they were during the boom. Market forces, and not resource overexploitation, were responsible for the drastic decline in palm heart trade and, consequently, for the increased vulnerability of livelihoods that had grown dependent on it.

This chapter examines to what extent the palm heart economy in the northern Bolivian Amazon follows the boom-and-bust cycles typical of NTFP economies. We begin with a description of the production-to-consumption system, which encompasses the entire marketing chain from raw material production in the northern Bolivian Amazon to its final destination in the principal cities of Brazil. We then analyse the principal forces driving the ups and downs of the economy. Finally, we will draw some conclusions on the role of palm heart in extraction-based livelihood strategies and the implications for rural development.

THE PRODUCTION-TO-CONSUMPTION SYSTEM

The resource base

Euterpe precatoria is a monoecious, moderate to large-sized palm tree, conspicuous in both on upland and floodplain forests sites. It is a sun-loving understorey species, capable of persisting in shady areas (Moraes 1996). Its altitudinal and longitudinal range is wide, growing from Bolivia to Belize at altitudes as high as 2000 m above sea level (masl). Two varieties are distinguished: *E. precatoria* var. *longevaginata*, which grows in forested areas on mountain slopes and ridges, and occasionally in lowland areas, at elevations between sea level and 2000 masl; and *E. precatoria* var. *precatoria*, which is found in lowland rain forest, particularly along rivers, below 350 masl elevation, occasionally reaching 600 masl in the Andes and the Guyana Highland (Henderson 1995). In the study area, *E. precatoria* var. *precatoria* predominates.

Unlike the multistemmed *E. oleracea*, *E. precatoria* is a solitary palm whose trunk reaches a maximum height of 20 to 25 m and a diameter at breast height (dbh) of up to 20 cm. The crown shaft is composed of 14 to 19 pinnate leaves, each 3.5 to 4.5 m long. A large number of pendent leaflets

confer a unique, ornamental appearance to this palm, adding to the scenic beauty of forests dominated by asaí. The infrafoliar inflorescences carry numerous rachillae (sometimes more than 100), 80 to 90 cm long, which bear staminate and pistilate pale flowers, usually yellowish pink (male) or light brown (female). Geitonogamy is possible thanks to the synchronization of the male and female phases among the different inflorescences on the same trunk. The period of greatest abundance of fruits is December to August. Fruits are globose, 1.0 to 1.8 cm in diameter, and dark purple when mature. The mesocarp is thin (0.5 to 1.5 mm thick) and juicy. Each fruit holds one seed, which has a solid and homogeneous endosperm (Bovi and de Castro 1993).

Population density of *E. precatoria* in the northern Bolivian Amazon is highly variable, ranging from a few to 260 individuals per hectare (DHV Consultants 1993a, b, Peña-Claros and Zuidema 1999, Zuidema 2000).⁸ Floodplain forests tend to have larger populations than upland forests. An extensive inventory of forest resources, carried out in 1992, indicated an average density of 23 individuals per hectare (DHV Consultants 1993b), of which 40%, that is, 9.1 individuals per hectare, had reached maturity (Weerdena, personal communication). Considering that only adult palm trees produce commercially viable hearts, this translates into a reserve of about 91 million commercially valuable individuals.

We still lack a clear understanding on growth and recruitment rates for this species. According to research carried out on seasonally flooded forests in the Department of Santa Cruz, it takes at least 100 years for *E. precatoria* to mature following germination (Peña-Claros 1996). Sexually mature individuals on well-drained soils in the Department of Beni were found to be at least 70 years old, with an average age of probably more than 90 years (Zuidema 2000). According to most studies, palm hearts can be obtained from much younger populations of asaí palms. Some authors suggest that wild populations of *E. precatoria* in Bolivia can be harvested after 8 years (Zonta and Llanque 1994, Moraes 1996) or between 10 and 15 years old (Johnson 1996). In plantations, *E. precatoria* reaches maturity at 5 to 6 (Villachica 1997) or 12 years old (Kahn and de Granville 1992). Semi-cultivated asaí palms in the northern Bolivian Amazon had grown to 4 m, 2 years after transplanting (Photo 1).

The high variability of growth rates makes it hard to assess the impact of exploitation. The heterogeneity of the western Amazon Region and the broad range of sites that can sustain populations of *E. precatoria* prevent generalizations from small-scale research. Probably, the cited data reflect extremes of the range of growth rates. Even so, we need to study if the average rates come closer to one extreme than the other. Curiously, in surveys carried out separately to this study, owners of processing plants and palm heart collectors in the northern Bolivian Amazon estimated the reproductive age as being 13.2 (± 4.3) and 12.9 (± 4.2) years, respectively (Stoian and Hoffmann 1998). The entrepreneurs were aware that sources for raw material supplies would be exhausted within some years. In a study of 26 palm-heart processing plants operating in the region in 1997 (Hoffmann 1997),⁹ 22 owners estimated that the time left for exploiting the wild populations of asaí palm in the plant's vicinity as being 2 to 15 years, with an average of 7 years.

Photo 1. Asaí palm (*Euterpe precatoria*), 2 years after transplanting to the homegarden in the forest (photo: D. Stoian)



Extraction rates rose from less than half a million palm hearts in 1993 to more than 7 million in 1997 (Stoian and Hoffmann 1998). Based on an estimated reserve of 91 million mature individuals in 1992 and considering that around 22 million palm hearts were extracted between 1993 and 1997, this means that by 1998 the total reserve was 69 million mature individuals, without including new recruits. Assuming a stabilization of extraction rates after the peak in 1998, the raw material supply would have been exhausted in a little less than 10 years. Obviously, the great question in this simplified equation is the natural regeneration rate. In the absence of further data, it is unsurprising that suggestions on the cycles and intensities of cutting vary considerably. Johnson (1996), for example, suggests 10-year cutting cycles, with retention of 10% of the mature individuals as seed trees. Peña-Claros and Zuidema (1999), on the other hand, note that only the retention of 70% to 90% of mature individuals or much longer cutting cycles would ensure the long-term development of a palm heart industry based on wild populations of *E. precatoria*.

Market forces, rather than silvicultural considerations, brought the palm heart industry back to reality. Most probably, during the palm heart's boom years in the mid-1990s, extraction rates exceeded those of recruitment. In any given site, the extraction of palm heart lasted, on average, 3½ years until all harvestable individuals were exhausted (Stoian 2000). Consequently, sites at increasingly farther distances from the processing plants were brought

under extraction. Given that palm heart is a perishable product,¹⁰ the distance between supply areas and processing plants is limited. Starting off from urban centres, and in order to ensure its supply of raw material, the palm heart industry occupied progressively more remote sites. By 1997, most sites that were suitable for establishing a processing plant had been occupied (Hoffmann 1997). The imminent exhaustion of the raw material in the region was finally prevented by a strong contraction of the market. Nowadays, the number of palm hearts extracted annually does not exceed 1.5 million. The regional population of *E. precatoria* is recovering from the supposed over-exploitation that took place during the boom years.

In view of the changing panorama of palm heart extraction, evaluating its environmental impact is difficult. Because it is a single-stemmed palm, extraction of the heart kills the plant. The need for more data notwithstanding, it is likely that the high extraction rates that occurred during the boom years had a negative impact on asaí populations (cf. Peña-Claros 1996, Peña-Claros and Zuidema 1999, Zuidema 2000). Considering that the alleged over-exploitation did not last more than five years, we should ask ourselves what the short- and medium-term impacts were, and what the long-term impacts would have been. In spatial terms, the immediate impact became particularly manifest in the supply zones around the processing plants. These varied in area according to the size of the processing plants and the respective duration of operations. Without doubt, local populations of asaí palm suffered severe losses of mature individuals, with unknown effects.

In addition to the pressure exerted on the reproducing individuals of asaí palm, palm heart extraction had an impact on wild fauna. The fruits of asaí palm are an important food for macaws, monkeys, and other animals. Hunting often accompanied palm heart extraction (Herrera 1999). The populations of animals such as agoutis (*Agouti paca* and *Dasyprocta variegata*) are sufficiently resilient against hunting, but other mammals, such as the giant armadillo and the tapir, are highly susceptible (Johnson 1996). In the absence of studies with greater scope in space and time, quantifying the impact of palm heart extraction on wild fauna or on the broader ecosystem is difficult.

However, we can presume with some certainty that the current reduced extraction rates will permit recovery of asaí palm populations, a process that is being facilitated by programs of local nongovernmental organizations (NGOs) to promote the cultivation of peach palm (*Bactris gasipaes*) as an alternative source of raw material and income.¹¹ Although the volumes produced so far are small and mostly destined for local consumption, these programs help further alleviate the pressure on wild populations of asaí palm.

Palm heart collectors and their socio-economic context

As with Brazil nut (D. Stoian, Chapter 5, this volume), palm heart is extracted by independent and dependent collectors, mostly men. The first group includes rural inhabitants who extract palm heart from their own plots and, whenever the opportunity arises, from adjacent forests. Palm heart extraction fits in their agro-extractive cycle, which includes agriculture based on four staple crops (rice, maize, manioc, and plantain) in different parts of the year, and

the extraction of Brazil nut and palm heart from December to March and from April to November, respectively. During the 1990s, palm heart effectively replaced wild rubber, locally called *goma*, as principal NTFP extracted during the dry season. In 1997-1998, when palm heart extraction was at its peak in the region, the average income earned from palm heart by an independent collector was US\$400. While some collectors made as much as US\$1500 per year, most were satisfied with earning a few hundred dollars to supplement their income.

The dependent collectors come from the peripheral neighbourhoods of Riberalta, Guayaramerín, and Cobija. They join collectors groups, formed by contractors, as they seek an alternative to the arduous search for occasional employment in the urban labour market. The migrants among them, in their majority people who had previously made a living in the forest by extracting rubber and Brazil nut, have had little schooling, which restricts their access to more permanent urban employment. Women find employment in the processing plants for Brazil nut (D. Stoian, Chapter 5, this volume), while men spend an average of 3 months per year in the forest where they extract Brazil nut, palm heart, and, to a lesser extent, timber.

Contractors take groups of collectors to sections of forest accessible from roads or rivers and which are subject to an open-access regime. Alternatively they may seek agreements with *barraqueros*, that is, owners of more or less large extensions of forest, to extract palm heart from their land (*barracas*), upon paying a comission.¹² Under this modality, the income of the collectors is relatively low, as it must be shared with the contractors and *barraqueros*. In absolute terms, however, income from palm heart can be significant, depending on the density of *asaí* palm populations and their distance from a road or river, transport facilities, and individual performance.

A typical individual load includes 20 palm hearts, weighing a total of 20 to 30 kg. Under favourable conditions, as when a collector finds an accessible and previously unexploited stand, he may extract three to five loads per day. As these favourable sites have decreased considerably, most collectors must content themselves with 20 to 40 palm hearts per day. Even so, an average collector, extracting 30 palm hearts per day, will easily cover the opportunity costs of his labour (Stoian and Hoffmann 1998).¹³ However, the recent decline in the market has limited this interesting opportunity for income generation. Of the 3700 collectors involved in palm heart extraction during the 1997-1998 boom, fewer than 1000 remain who still generate significant income from palm heart.

The processing industry

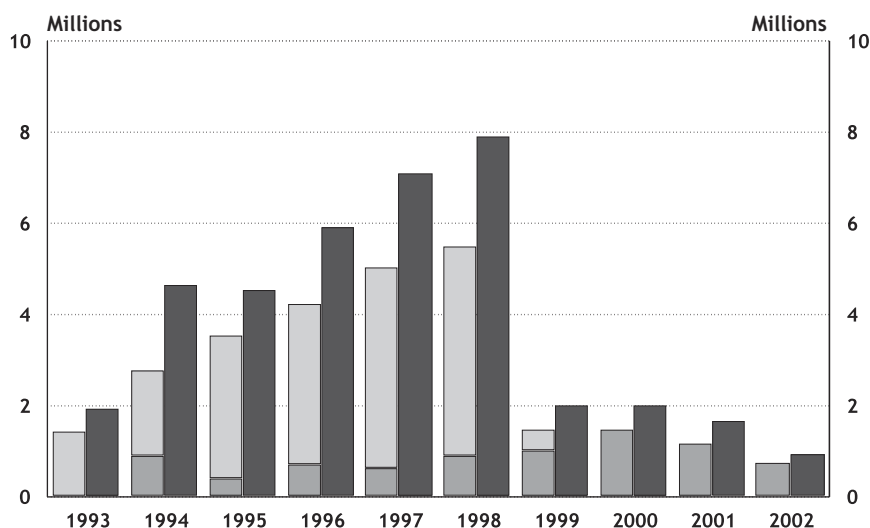
Processing palm heart is simple: upon arrival at the processing plant the exterior layers of the shoot are removed, leaving the edible palm heart. Black spots and deformed parts are cut off, and the length of the palm heart is cut to the size of the receptacle.¹⁴ Palm hearts that do not reach the minimum length are sliced, leading to a product of secondary quality as compared to entire palm hearts. After cleaning with cold water, the receptacles are filled

with palm hearts, water, salt, and citric acid. Once sealed, the receptacles are subjected to a bain-marie with temperatures of 100°C for the first 20 minutes and 70°C for another 30 or 40 minutes. Where an autoclave is available processing is shortened by about 20 minutes. After cooling, the receptacles are packed in cardboard boxes of 15 jars or 12 tins per box (Hoffmann 1997).

Palm heart processing began in the northern Bolivian Amazon in the mid-1960s. In 1965, a palm heart processing plant was opened in Rosario de la Yata, 45 km west of Guayaramerín, on the border with Brazil. Difficulties in obtaining the empty containers limited production to less than 3000 palm hearts per month. The plant closed in 1967 due to the high costs of transporting the containers by river from Belém (State of Pará, Brazil). A second attempt between 1973 and 1975 failed again for the same reasons. Palm hearts extracted near Guayaramerín by the end of the 1970s were exported for processing to Brazil. The palm heart industry as such was established in the northern Bolivian Amazon at the beginning of the 1990s, where it experienced an ephemeral boom between 1994 and 1998, before declining again to pre-boom levels (Figure 2).

Up until 1998, Brazil was by far the most important importer of Bolivian palm heart. Two events in this year led to a sudden drop in demand: the devaluation of the Brazilian currency and an outbreak of botulism, a serious disease caused by a neurotoxin. The Brazilian financial crisis, manifested as continued devaluations of its national currency, the real,¹⁵ resulted from the overvaluation of the national currency, aggravated by repercussions from

Figure 2. Volumes in kilograms of official exports of palm heart to Brazil (■) and other countries (■) from the northern Bolivian Amazon, 1993-2002, and their values in U.S. dollars (■). Prepared by author, using statistics from INE (2003)



the Asian crisis. As a luxury food item, palm heart consumption declined accordingly. The Bolivian palm heart industry suffered from diminishing profits also because payments were made in Brazilian reals.

In the middle of this crisis, an outbreak of botulism occurred in Brazil. The outbreak was traced back to a lack of hygiene in Bolivian processing plants of palm heart, where containers were contaminated with the bacillus *Clostridium botulinum*, the causal agent of botulism. Plants operating outside of urban centres, in particular, were found harboring conditions that did not meet minimal standards of hygiene (Photo 2). The ensuing sanctions from Brazil (see Bojanic 2002) meant that the value of palm hearts exported there decreased from US\$5.9 million in 1998 to \$0.5 million in 1999. Ever since 2000, Brazil has not imported Bolivian palm heart (INE 2003).

Between 1999 and 2001 Argentina became the main importer of Bolivian palm heart, but—as with Brazil—a recent financial crisis and the devaluation of its own currency has made imports more expensive and, consequently, has led to luxury products losing their market share.¹⁶ With the loss of Brazil and Argentina as principal markets for Bolivian palm heart, Chile emerged as the principal importer in 2002 (INE 2003), partly as a result of the free trade treaty signed with that country.

The number of factories in northern Bolivia peaked in 1997, when 26 plants operated throughout the region (Hoffmann 1997). By 2003, only 5 to 8 factories were still operating. The exact number is difficult to determine,

Photo 2. Cleaning palm heart shoots (*Euterpe precatoria*) in a rural processing plant, Peña Amarilla, Vaca Diez Province, Bolivia (photo: Kerstin Hoffmann)



because some plants suspend operations for months, if not an entire year, before operating again. At the height of the palm heart boom, there were three types of companies in operation: (1) 11 small plants, with an annual production of less than 200,000 palm heart units; (2) 8 medium-sized plants, with an annual production between 200,000 and 400,000 palm heart units; and (3) 7 large factories, with an annual production of more than 400,000 palm heart units (Stoian and Hoffmann 1998).

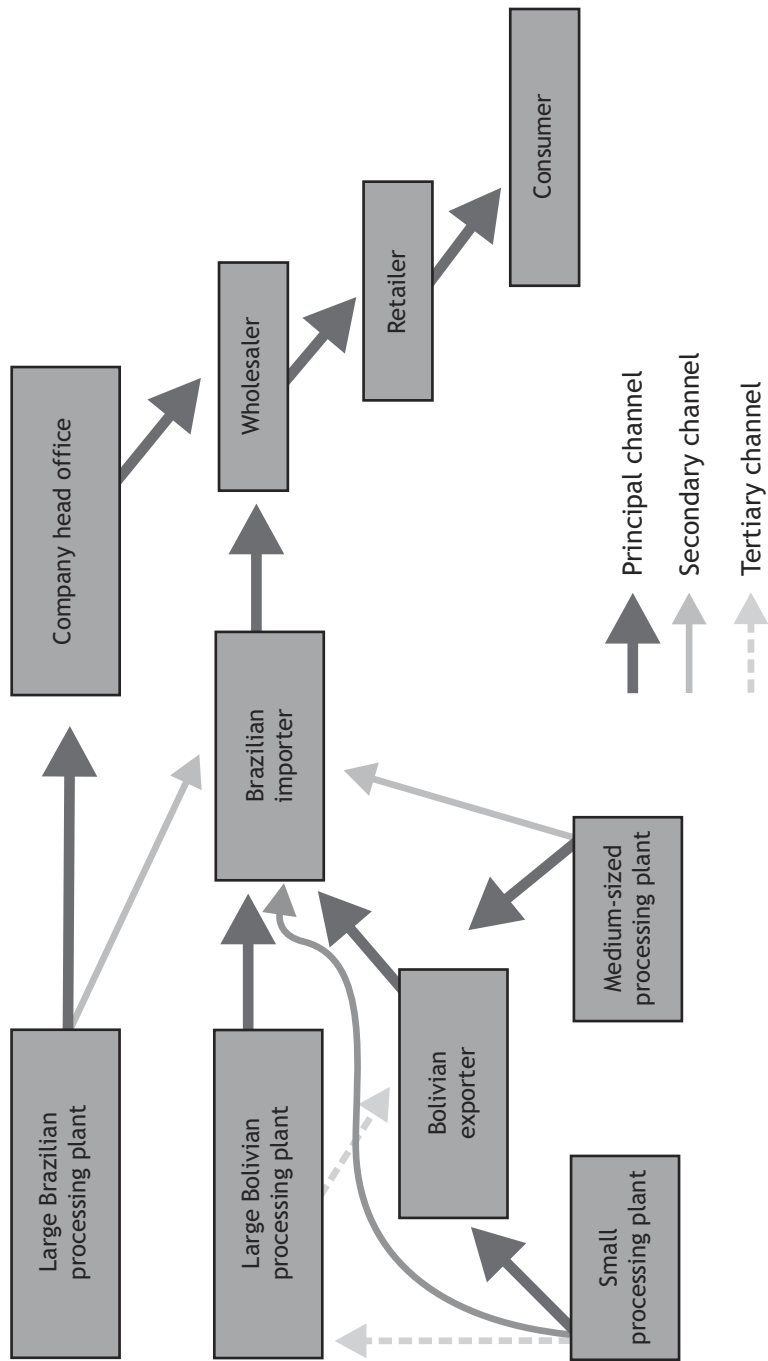
The small plants were located in the rural outposts, near the sources of raw material. Most belonged to *barraqueros* who complemented their income from Brazil nut with that derived from palm heart extraction and processing. Investments in these plants, mostly equipped with rudimentary infrastructure, ranged between US\$1000 and \$15,000. The medium-sized plants, property of entrepreneurs who worked with rubber and/or Brazil nut and who invested between \$5000 and \$45,000, included the basic infrastructure necessary for processing. Finally, the large plants were established with investments between \$50,000 and \$125,000, and therefore had the infrastructure and technology needed to comply with hygiene requirements. Four of these large plants were Bolivian, belonging to horizontally integrated companies (e.g. timber companies, with installations for processing Brazil nut and palm heart). The other three plants were owned by Brazilians, as branches of companies headquartered in São Paulo, Belém, or Curitiba (Hoffmann 1997).

Marketing chain

Key actors within the marketing chain for Bolivian palm heart include collectors, itinerant merchants, owners of processing plants, brokers who facilitate export and import, wholesalers, as well as retailers, through whom the product reaches the final consumer. During the boom in palm heart extraction, the most important chain was that linking palm heart collectors through a series of intermediate links to final consumers in Brazil (Figures 3 and 4).

Palm heart from the northern Bolivian Amazon is marketed along three types of channels, according to the volumes involved (Figures 3 and 4). Independent harvesters, located along roads and rivers, and dependent harvesters, recruited by urban contractors or owners of extractive estates (*barraqueros*) each use different means and routes to transport the raw material from the forest to the processing plant. Likewise, the type and availability of transportation available and the contracting modality determine whether the raw material is processed in a rural or urban plant. As with the Brazil nut chain (D. Stoian, Chapter 5, this volume), harvesters are linked to processing plants through a system of advance payments (*habilitos*). Processing plants, in their turn, are linked to wholesalers through a series of intermediaries, the number of which depends on the liquidity of the companies, their transport facilities, and their bargaining power. The procedures involved in cross-border trade require certain kinds of know-how and access to personal contacts, so that only the large plants are able to export directly without requiring brokers in Bolivia or Brazil.

Figure 4. Marketing chain for palm heart from the northern Bolivian Amazon, from the processing plant in Bolivia to the final consumer in Brazil



The different types of intermediaries demand their share of benefits generated along the chain. In terms of gross benefits, most are generated in Brazil. The first links in Bolivia must content themselves with smaller shares. Contrary to popular belief, though, it is not the plant owners or intermediaries in Bolivia who capture the greatest gross benefits, but the raw material producers (Table 1).

Table 1. Distribution of profits in the marketing chain for palm heart from the Bolivian Amazon

Actor	Sale price (US\$/jar)	Share of consumer price (%)	Gross income (US\$/jar)
Collector (Bolivia)	0.23-0.57	2.3-5.7	0.23-0.57
Intermediary (Bolivia)	0.41-0.57	4.1-5.7	0.11-0.34
Palm heart processing plant (Bolivia)	1.4-2.1	14.0-21.0	0.14-0.44
Exporter/importer (Bolivia/ Brazil)	2.4-3.5	24.0-35.0	0.67-1.20
Wholesaler (Brazil)	4.8-6.0	48.0-60.0	3.3-4.7
Retailer	10.0	100.0	2.5-3.7

Source: Adapted from Hoffmann (1997).

Note: Gross income based on the price of a jar of palm heart, with a gross weight of 900 g, which, before the real was devalued, was equivalent to US\$10. Gross income of palm heart collectors based on raw material equivalent (1.2 palm hearts per jar).

Marketing chains of an internationally traded NTFPs are often assumed to generate few benefits for local harvesters and progressively higher profits for importers, wholesalers, and those actors closest to the final consumer (Clay 1997). Table 1 confirms this trend, but only in terms of the share of the final sales price, and not according to net profit per unit. Given the difficulty of determining the costs associated along the commodity chain in the importing country, chain analyses tend to focus on captured gross income from the product's final price. The fact remains, however, that within the domestic portion of the commodity chains for palm hearts and Brazil nuts in the northern Bolivian Amazon, it is the harvesters who capture the largest segment of gross income. The different kinds of intermediaries capture smaller gross income per unit, drawing their financial benefit through economies of scale, that is, by manipulating larger volumes. In this context, it is important to bear in mind that the gross profits obtained by the collectors do not differ greatly from their net profits, as their opportunity costs tend to be low.¹⁷

In the Bolivian palm heart industry, the large processing plants capture most (64%) of the profits before tax, compared with intermediaries (24%), and small processing plants (12%). In absolute terms, the small, medium-sized, and large palm-heart processing plants in Bolivia receive profits before tax of US\$20,000, \$52,000, and \$160,000 per year, respectively (Stoian and Hoffmann 1998). These are comparable with the profits obtained by palm-

heart processing plants in Brazil which range from US\$30,000 to US\$50,000 per year (Pollak *et al.* 1995). Small processing plants in particular barely break even, making them more vulnerable to price fluctuations in the international market. At the same time, however, they have fewer fixed costs, allowing them to suspend production until prices recover.

Political and legal framework

Palm heart extraction is subject to the payment of an area-based concession fee. The Forest Law of 1996 (Law 1700) stipulates US\$0.3 ha⁻¹ as the annual payment for concessions for the extraction of NTFPs. In areas where extractivism predominates, timber concessions are not granted in order to give preference to the collection of Brazil nut or palm heart.¹⁸ The allocation of concessions is oriented towards the sustainable use of forest resources, requiring a strict system of control and application of forest audits to confirm compliance with management plans (Pacheco 1998). However, the open-access regime prevailing throughout most of the northern Bolivian Amazon hinders the collection of concession fees. Thus, officially granted concessions do not reflect the true area under extraction of NTFPs. In addition, very few management plans for NTFPs exist, let alone mechanisms for supervising their implementation.

In Bolivia, few NTFPs are subject to tax, except those formally exported, such as Brazil nut and palm heart. Taxes, often paid to Municipal Offices, are nominal as they are not based on volumes but on the right to sell in a given place. A lack of state controls and sanctions to enforce compliance with tax laws and the habitual under-reporting of profits by NTFP processing plants means that most avoid paying taxes on their profits (Bojanic 2002).

The processing plants of palm heart and Brazil nut must be registered with the National Service of Trade Registration (SENAREC). Registration is a prerequisite for acquiring legal personality, for legally performing the activities of production and trade, and even for exporting (Bojanic 2002). The administrative and bureaucratic procedures required for exporting NTFPs are extensive,¹⁹ which is why many processing plants rely on the services of brokers.

Besides requiring permits for extraction, processing, and export of palm heart, the State shows little interest in the palm heart industry, except in those areas subject to Alternative Development Programmes, which provide incentives to grow peach palm as an alternative to the illegal cultivation of coca. Given that the northern Bolivian Amazon is exempt from these programmes, the palm heart industry is a product of efforts and investments by the private sector. Research institutions, alarmed by the high rates of extraction in the mid-1990s, petitioned for increased regulation of wild palm heart extraction, which was, however, ignored.²⁰ The drastic reduction in volumes of extraction that followed were thus not a consequence of State intervention, but the product of market forces.

Recently the Bolivian Government, with support from international donors and the private sector, has intensified its efforts to promote supply chains of non-traditional export products. Through a Supreme Decree passed

on 8 November 2001, the Bolivian System of Productivity and Competitiveness (SBPC) was established. It identifies 14 commodity chains, including those of Brazil nut and palm heart, as a priority for poverty alleviation. Since issuing Supreme Decree 26973 on 27 March 2003, the Ministry for Economic Development has coordinated and reorganized the corresponding production processes to strengthen companies and promote exports. Analyses of the selected chains are about to conclude and the findings will determine the next steps to follow.

Dynamic changes

"There seems no reason to doubt that palmito extraction from *E. precatoria* in Bolivia will go the same way it went for *E. edulis* in coastal Brazil: massive destruction of wild stands followed by the collapse of the industry" (Kahn and Henderson 1999). This quotation reflects the predominant concern that the use of single-stemmed palm trees, such as *E. precatoria* or *E. edulis*, is not sustainable. In the Brazilian case, several authors have accused the palm heart industry of degrading, if not of bringing to commercial extinction, the natural stands of *E. edulis* in the country's southern regions (Warren 1992, Richards 1993, Henderson 1995, Johnson 1997). Despite the excessive exploitation in many regions, wild populations of *E. edulis* continue being exploited in southern Brazil (A. C. Fantini, Chapter 7, this volume), Paraguay, and Argentina (Johnson 1997). Other authors refer to palm hearts from *E. edulis* as the 'white gold' of the Brazilian Atlantic forest, given the high profits accrued from its extraction and trade (Orlande *et al.* 1994, 1996, Galetti and Fernández 1998).

While the palm heart industry in the northern Bolivian Amazon has suffered a strong contraction, this was not due to excessive exploitation of wild populations of *asaí* palm. Rather, it was caused by the loss of the Brazilian market, followed by the subsequent contraction of the Argentinian market, and aggravated by increased competition from peach palm plantations in Ecuador and Costa Rica. Future trends are difficult to predict. The sanctions imposed by Brazil are unlikely to be lifted soon. At the same time, it remains to be seen if the recovery of the Argentinean economy will boost demand for Bolivian palm heart. Although plantation production of palm heart currently does not reveal the same growth rates as in the past, it is likely to respond rapidly to new opportunities as soon as market signals are favourable. The high production costs of the palm heart industry in the northern Bolivian Amazon²¹ result largely from the high costs of obtaining raw material from wild populations of *asaí* palm. Hence, over the long-term, the industry cannot compete effectively with plantation-produced palm hearts.

However, some potential exists to place more palm heart on the European and U.S. markets. At the moment, palm heart is little known in these markets, despite its high nutritive value and its easy use in buffets and other distinctive foods. Entering these markets would require professional promotional campaigns that would have to be financed by a series of actors from the private sector, as each processing plant alone does not have sufficient liquidity or scope. Organic and fair trade also constitute market niches with

considerable growth potential. Principally, there is potential for certifying palm hearts originating from wild populations, but it will be necessary to ensure their sustainable management through planning and compliance with minimum cutting diameters (Johnson 2002). The recent market crisis provides few incentives for entrepreneurs to invest in management plans. Only a lasting recovery in prices would encourage the preparation of and compliance with this prerequisite for the sustainable management of the resource and, thus, for forest certification.

LESSONS LEARNED FOR DEVELOPMENT AND CONSERVATION

Lessons for conservation

Because of its multi-stemmed nature, *E. oleracea* is seen as one of the most promising opportunities for the sustainable management of certain forests in the Amazon (Pollak *et al.* 1995). In contrast, *E. precatoria* is regarded as a species with little or no potential for sustainable management based on natural regeneration, given its single-stemmed nature: extracting the palm heart kills the plant, thus eliminating the source of seeds and preventing natural regeneration. Wild populations of asai palm are expected to follow, in one or two decades, the path of *E. edulis*, where populations were reduced to non-profitable levels (Johnson 1997). Although *E. oleracea* shows more potential for sustainable management as compared to *E. precatoria*, it is probably premature to exclude the possibility of sustainably exploiting the latter species. The simple fact that the palm tree dies upon extracting its palm heart is not an argument per se against the sustainability of extraction. The key variables determining sustainability are the number and distribution of remaining seed trees, the length of cutting cycles, and growth and recruitment rates. Without sufficient in-depth and wide-ranging data, it would be premature to deny the potential role of *E. precatoria* within the framework of sustainable forest management in the Amazon.

The supposed over-exploitation that took place during the boom years can be viewed differently if one takes into account the recent decline of the market as a consequence of changing demand patterns. Retrospectively, it seems highly rational to have (over)exploited a resource whose favourable prices were so ephemeral. Determining the sustainability of palm heart extraction requires one to consider longer spatial and temporal scales. While there most likely was local and short-term over-exploitation, its adverse effects are relative when viewing these within a larger space and time scale. There is little evidence that the boom years have had a major long-term impact on asai populations at a regional level, especially when considering the unexploited stands remaining and that natural regeneration is not likely affected by current low rates of extraction. In any case, the two species will not become extinct, regardless of how intensely *E. precatoria* and *E. edulis* are exploited, because extraction levels will adjust in accordance with the diminishing availability of the resource (Johnson 2002).

There appears to be a tendency to underestimate the resilience of the ecosystems in which *E. edulis* and *E. precatoria* grow, and of the production

systems associated with their exploitation. The extraction of these single-stemmed palm trees is considered destructive (Richards 1993, Broekhoven 1996). The palm heart industry, particularly that based on *E. edulis*, has been declared dead more than once. However, the extraction of palm heart from wild populations of *E. edulis* continues on a large scale because of the profitability to processors and intermediaries, the ineffective governmental interventions, and the relatively profitable income for collectors (Orlande *et al.* 1996). Given that the pressure on the Brazilian Atlantic forests is much higher than that on the forests in the northern Bolivian Amazon, we can conclude that the resource base of asaí palm will not be a constraint to recovery for the palm heart industry based on *E. precatoria*.

Lessons for socio-economic development

According to Homma (1994), the extractive economy in the Amazon is subject to a cycle of expansion, stabilization, decline, and plantation production. According to this model, the last phase is induced by the low competitiveness of wild sourcing when compared with cultivation or substitution with synthetic products. The first three phases of the model are readily discernible in the case of asaí palm heart. However, its decline was only partially induced by plantation production of, for example, *Bactris gasipaes* in Costa Rica and Ecuador. Rather, it was induced by changes in the main market, Brazil, where reduced purchasing power - a consequence of the national currency devaluation - and sanctions against contaminated receptacles constituted causes that are difficult to predict by simplified models like that proposed by Homma.

Although the case study of the asaí palm is yet another proof of the boom-and-bust cycles typical for NTFPs in the Amazon, it is likewise certain that, for several years, palm heart effectively compensated for lost income due to the rubber decline in northern Bolivia. As with rubber, palm heart extraction was readily integrated into the agro-extractive cycle of the rural population as a major dry season activity. In the absence of alternative sources of income, declining palm heart collection leaves few options to the rural population for adjusting their livelihoods. These options include agricultural expansion, both for subsistence and cash, and rural-urban migration, to take advantage of urban labour markets. A third option, although still indefinite, is expanding extractive activities towards both traditional and new NTFPs.

The history of the extractive economy in the northern Bolivian Amazon reveals that the region's population tends to take advantage of more than one commercial NTFP at a time. It is precisely the array of different NTFPs that has sustained the population's livelihoods for almost 200 years. Taken alone, palm heart extraction does not provide an example of the sustainable exploitation of an NTFP. However, viewed as one among several extractive and agricultural activities, we can conclude that the conscious combination and continual recombination of extractive and agricultural activities, along with multiple migration patterns, are the basis for the sustainability of livelihoods based on NTFPs.

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NOTES

1. Dietmar Stoian is Leader of the Centre for the Competitiveness of Ecoenterprises (CeCoEco), based at the Tropical Agriculture Research and Higher Education Centre (CATIE), in Turrialba, Costa Rica. Most of the data on which this chapter is based was compiled within the framework of the project "Contributions of non-timber forest products to socio-economic development", financed jointly by the German Federal Ministry of Economic Cooperation and Development (BMZ) and CIFOR. The author can be contacted at CATIE 7170, Turrialba, Costa Rica, or by e-mail: stoian@catie.ac.cr.

2. In Greek mythology, *Euterpe* was the muse of music, one of the nine muses of the fine arts.

3. *Chicha*, an alcoholic drink prepared from the purple pulp of fruits from the asaí palm, is said to cure the sorrows of love: *vino de Pará, paró; tomó asahí, quedó*, that is "he came from Pará, he stopped; he drank asaí, he stayed" (Coimbra 1993).

4. This trend has also been documented for the Peruvian Amazon near Iquitos (Kahn and de Granville 1992), the Island of Marajó in the Amazon Estuary (Pollak *et al.* 1995), northwestern Guyana (Johnson 1994, van Andel and Reinders 1999), the Brazilian Atlantic forest, the upper basin of the Paraná River in Paraguay, northern Misiones in Argentina (Chediack 1994), and Ecuador (Broekhoven 1996). The impact of palm heart extraction from natural populations in Colombia (Bernal 1992) and Venezuela (WRI 2000) is yet to be evaluated.

5. The management and economy of *E. oleracea*, the economically most important species exploited for palm heart, are well documented (see Anderson 1988, Anderson and Jardim 1989, Strudwick 1990, Pollak *et al.* 1995, Muñoz-Miret *et al.* 1996, Clay 1997).

6. Within the framework of the so-called Alternative Development Programmes, the cultivation of *Bactris gasipaes* is being promoted as an alternative to illegal coca production. Many producers involved in this programme, however, see it as a failure because of a lack of markets for palm heart.

7. This amount derives from subtracting the exports of the Department of Santa Cruz, which included production from the Department of Cochabamba,

from total exports of palm heart from Bolivia, which amounted to US\$12.1 million (cf. CFB 1999).

8. This variability is similar to that found in the Peruvian Amazon, where densities of 50 to 260 plants per hectare have been reported (Kahn 1988).

9. This number compares with the 120 processing plants exploiting palm heart of *E. oleracea* in the Amazon Estuary, the world's most important source of palm heart (Clay 1997).

10. Palm hearts need to be processed within 3 days of extraction.

11. For about 5 years, the Instituto para el Hombre, Agricultura y Ecología (IPHAE) and the Centro de Investigación y Promoción del Campesinado (CIPCA), both headquartered in Riberalta, Department of Beni, have provided credit and technical assistance for the cultivation of peach palm.

12. For more information on the differences in land tenure between the so-called *barracas* and independent communities, see D. Stoian, Chapter 5, this volume.

13. The opportunity cost of labour was equivalent to a wage of US\$3.80 in 1997. To cover this cost, dependent and independent collectorshave to extract 13-20 and 8-13 palm hearts per day, respectively.

14. Two main types of receptacles are used: jars and tins, with gross weights of 900 and 980 g and net weights of 300 and 500 g, respectively. In both cases, palm hearts tend to be 15 cm long (Hoffmann 1997).

15. The American dollar rose from 1.08 Brazilian reals in mid-1997, to 1.80 reals in mid-1999 and then to 2.97 reals by mid-2003. The effects of the continuous devaluation were initially underestimated (Nunnenkamp 1999).

16. The prices paid to producers in *Bactris gasipaes* plantations. in tropical Cochabamba, whose principal market was Argentina, dropped from US\$0.57 to \$0.07-\$0.11 per palm heart.

17. Opportunity costs of labour are usually determined on the basis of a daily wage. However, since the collectors often do not have the opportunity to work as daily labourers the real opportunity costs, in fact, are much lower.

18. In other forest areas, timber concessions are subject to a payment of US\$1 ha⁻¹ year⁻¹.

19. The following documents and certificates must be presented: Commodity Trade Invoice, Company's Registration with the Departmental Forest Superintendence, a photocopied RUE or DUE (Registro Único de Exportación or Declaración Única de Exportación), Packing List, Declaration of Export, Conformity Advice, Transport Document, Health Certificates from the National Service for Agricultural and Livestock Health and Food Safety (SENASAG), and a Certificate of Origin (Bojanic 2002).

20. In view of the alleged over-exploitation of asaí palm in northern Bolivia, it was suggested that the palm heart industry be forced to launch a cultivation programme for peach palm to replace, within 5 years, 75% of the raw material with *B. gasipaes* and permitting only 25% to be harvested from wild asaí populations (PROMAB 1998).

21. In 1997, production costs varied from US\$16.5 to \$17.4 per box of 15 jars or 12 tins (Stoian and Hoffmann 1998).

REFERENCES

- Anderson, A.B. 1988. Use and management of native forests dominated by açai palm (*Euterpe oleracea* Mart.) in the Amazon estuary. In: Balick, M.J. (ed.) The palm—tree of life: biology, utilization and conservation. Proceedings of a symposium at the 1986 annual meeting of the Society for Economic Botany held at the New York Botanical Garden, Bronx, New York, 13-14 June 1986, pp. 144-154. Advances in Economic Botany 6. NY Botanical Garden, NY.
- Anderson, A.B. and Jardim, M.A.G. 1989. Costs and benefits of floodplain forest management by rural inhabitants in the Amazon Estuary: a case study of açai palm production. In: Browder, J.O. (ed.) Fragile lands in Latin America: strategies for sustainable development, pp. 114-129. Westview Press, Boulder, CO.
- Bernal, R.G. 1992. Colombian palm products. In: Plotkin, M. and Famolare, L. (eds.) Sustainable harvest and marketing of rain forest products, pp. 158-172. Island Press, Washington, DC.
- Bojanic, A.J. 2002. Comercialización de productos forestales no maderables: Factores de éxito y de fracaso, marco legal y políticas relevantes para la comercialización interna y exportación de productos no maderables en Bolivia. PNUMA/UNEP-WCMC, and ODI/DFID-FRP, La Paz, Bolivia.
- Bovi, M.L.A. and de Castro, A. 1993. Assaí. In: Clay, J.W. and Clement, C.R. (eds.) Selected species and strategies to enhance income generation from Amazonian forests, pp. 58-67. Food and Agriculture Organization of the United Nations (FAO), Rome.
- Broekhoven, G. 1996. Non-timber forest products: ecological and economic aspects of exploitation in Colombia, Ecuador and Bolivia. Forest Conservation Programme. The World Conservation Union (IUCN), Gland, Switzerland.
- CFB (Cámara Forestal de Bolivia). 1999. Estadísticas de exportación y ventas internas de productos forestales a nivel nacional—Gestión 1998. Santa Cruz, Bolivia.
- Chediack, S.E. 1994. El palmito: *Euterpe edulis*. Desarrollo Agroforestal y Comunidad Campesina 21: 23-25.
- Clay, J.W. 1994. A business plan for palm heart harvest, processing and distribution, 1995-2000. World Wildlife Fund (WWF). (Unpublished manuscript).
- Clay, J.W. 1997. The impact of palm harvesting in the Amazon estuary. In: Freese, C.H. (ed.) Harvesting wild species: implications for biodiversity conservation, pp. 283-314. Johns Hopkins University Press, Baltimore, MD.
- Coimbra, J.B. 1993. Siringa: Memorias de un colonizador del Beni. Juventud, La Paz, Bolivia.
- de Castro, A. 1996. L'exploitation de l'açaí en Amazonie Centrale. In: Empereire, L. (ed.) La forêt en jeu; L'extractivisme en Amazonie Centrale, pp. 123-129. ORSTOM and UNESCO, Paris.
- DHV Consultants. 1993a. Forest Resources Inventory; Estudios agro-ecológicos, forestales y socio-económicos en la región de la castaña de la Amazonia boliviana, Volumen B. La Paz, Bolivia.

- DHV Consultants. 1993b. Addendum to the Forest Resources Inventory: conclusions and recommendations. Estudios agro-ecológicos, forestales y socio-económicos en la región de la castaña de la Amazonia boliviana. La Paz, Bolivia.
- Galetti, M. and Fernández, J.C. 1998. Palm heart harvesting in the Brazilian Atlantic forest: changes in industry structure and the illegal trade. *Journal of Applied Ecology* 35(2): 294-301.
- Henderson, A. 1995. The palms of the Amazon. Oxford University Press, Oxford.
- Herrera, J.C. 1999. Uso de fauna silvestre durante la extracción de palmito. *Boletín BOLFOR* 17: 4-5.
- Hoffmann, K. 1997. Die Palmherzenindustrie in Nordost-Bolivien. M.Sc. thesis. University of Freiburg, Germany.
- Homma, A.K.O. 1994. Plant extractivism in the Amazon: limitations and possibilities. In: Clüsener-Godt, M. and Sachs, I. (eds.) *Extractivism in the Brazilian Amazon: perspectives on regional development*, pp. 34-57. MAB Digest 18. UNESCO, Paris.
- INE (Instituto Nacional de Estadística). 2003. Bolivia - estadísticas económicas: Sector exportaciones (1992-2002). Available at www.ine.gov.bo/cgi-bin/PIWDIECOMEX.EXE/ CUADROCOMEX (accessed 15 August 2003).
- Johnson, D.V. 1994. The palm cabbage industry in northwest Guyana. Unpublished report. Silver Spring, MD.
- Johnson, D.V. 1996. Sustainable management of assaí boliviano (*Euterpe precatoria*) for palm-heart production in the Tarumá Forest Concession Paraiso, Velasco Province, Santa Cruz, Bolivia. Report prepared for BOLFOR/USAID Bolivia. Tropical Research and Development Incorporation, Gainesville, FL.
- Johnson, D.V. 1997. Non-wood forest products: tropical palms. RAP Publication 1997/10. Non-Wood Forest Products 10. Food and Agricultural Organization of the United Nations (FAO), Bangkok.
- Johnson, D.V. 2002. Palm heart (*Euterpe* spp.). In: Shanley, P., Pierce, A.R., Laird, S.A., and Guillén, A. (eds.) *Tapping the green market: certification and management of non-timber forest products*, pp. 75-84. Earthscan, London.
- Kahn, F. 1988. Ecology of economically important palms in Peruvian Amazonia. In: Balick, M.J. (ed.) *The palm—tree of life: biology, utilization and conservation*. Proceedings of a symposium at the 1986 annual meeting of the Society for Economic Botany held at the New York Botanical Garden, Bronx, New York, 13-14 June 1986, pp. 42-49. *Advances in Economic Botany*, 6. NY Botanical Garden, NY.
- Kahn, F. and de Granville, J.J. 1992. Palms in forest ecosystems of Amazonia. *Ecological Studies* 95. Springer, Berlin.
- Kahn, F. and Henderson, A. 1999. An overview of the palms of the Várzea in the Amazon Region. In: Padoch, C., Márcio Ayres, J., Pinedo-Vasquez, and Henderson, A. (eds.) *Várzea: diversity, development, and conservation of Amazonia's whitewater floodplains*, pp. 187-193. *Advances in Economic Botany* 13. New York Botanical Garden, New York.
- Moraes, M. 1996. Bases para el manejo sostenible de palmeras nativas de

- Bolivia. Ministerio de Desarrollo Sostenible y Medio Ambiente, La Paz, Bolivia.
- Mora-Urpi, J. 1994. Peach palm (*Bactris gasipaes*). In: Hernándo Bermejo, J.E. and León, J. (eds.) Neglected crops: 1492 from a different perspective, pp. 211-221. Plant Production and Protection Series 26. Food and Agriculture Organization of the United Nations (FAO), Rome.
- Muñoz-Miret, N., Vamos, R., Hiraoka, M., Montagnini, F., and Mendelsohn, R.O. 1996. The economic value of managing the açai palm (*Euterpe oleracea* Mart.) in the floodplains of the Amazon estuary, Pará, Brazil. *Forest Ecology and Management* 87: 163-173.
- Nunnenkamp, P. 1999. Latin America after the currency crash in Brazil: why the optimists may be wrong. Kieler Diskussionsbeiträge/Institut für Weltwirtschaft Kiel 337. Institut für Weltwirtschaft, Kiel, Germany.
- Orlande, T., Laarman, J., and Mortimer, J. 1994. White gold: palmito sustainability and economics in Brazil's Atlantic Coastal Forest. Working Paper 55. Forestry Private Enterprise Initiative (FPEI), Research Triangle Park, NC.
- Orlande, T., Laarman, J., and Mortimer, J. 1996. Palmito sustainability and economics in Brazil's Atlantic Coastal Forest. *Forest Ecology and Management* 80: 257-265.
- Pacheco, P. 1998. Estilos de desarrollo, deforestación y degradación de los bosques en las tierras bajas de Bolivia. *Bosques y Sociedad* 2. CIFOR/CEDLA/TIERRA, La Paz, Bolivia.
- Peña-Claros, M.C. 1996. Ecology and socioeconomics of palm heart extraction from wild populations of *Euterpe precatoria* Mart. in eastern Bolivia. M.Sc. thesis. University of Florida, Gainesville, FL.
- Peña-Claros, M.C. and Zuidema, P.A. 1999. Limitaciones demográficas para el aprovechamiento sostenible de *Euterpe precatoria* para producción de palmito en dos tipos de bosque de Bolivia. *Ecología en Bolivia* 33: 3-21.
- Pollak, H., Mattos, M., and Uhl, C. 1995. A profile of palm heart extraction in the Amazon Estuary. *Human Ecology* 23(3): 357-385.
- PROMAB (Programa Manejo de Bosques de la Amazonía Boliviana). 1998. Producción de palmito: Limitaciones del manejo sostenible de poblaciones naturales de asaí (*Euterpe precatoria*) y el potencial del cultivo de tembe (*Bactris gasipaes*) como fuente alternativa. Riberalta, Bolivia.
- Richards, M. 1993. The potential of non-timber forest products in sustainable forest management in Amazonia. *Commonwealth Forestry Review* 72(1): 21-27.
- Stoian, D. 2000. Shifts in forest product extraction: the post-rubber era in the Bolivian Amazon. *International Tree Crops Journal* 10(4): 277-297.
- Stoian, D. and Hoffmann, K. 1998. The palm heart industry of northern Bolivia: structure, benefits, and viability. Paper presented at the 3rd CIFOR-BMZ Workshop 'Contributions of non-timber forest products to socio-economic development' held in Hot Springs, Zimbabwe, 11-17 October 1998.
- Strudwick, J. 1990. Commercial management for palm heart from *Euterpe oleracea* Mart. (Palmerae) in the Amazon estuary and tropical forest conservation. In: Prance, G.T. and Balick, M.J. (eds.) New directions in the study of plants and people: research contributions from the Institute

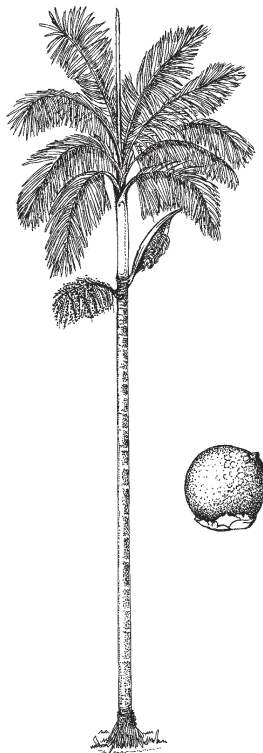
- of Economic Botany, pp. 241-248. Advances in Economic Botany 8. NY Botanical Garden, NY.
- van Andel, T. and Reinders, M. 1999. Non-timber forest products in Guayana's Northwest District: potentials and pitfalls. In: Ros-Tonen, M. (ed.). Seminar proceedings on 'NTFP research in the Tropenbos programme: results and perspectives', pp. 47-62. The Tropenbos Foundation, Wageningen, Netherlands.
- Villachica, H. 1997. Investigación y desarrollo de sistemas sustentables para frutales nativos amazónicos: El caso pijuayo. In: Toledo, J.M. (ed.) Biodiversidad y desarrollo sostenible de la Amazonía en una economía de mercado. Proceedings of the seminar-workshop held in Pucallpa, Peru, 11-15 October 1994. Stansa, Lima, Peru.
- Warren, L.A. 1992. *Euterpe* palms in northern Brazil: market structure and socioeconomic implications to sustainable management. M.Sc. thesis, University of Florida, Gainesville, FL.
- WRI (World Resources Institute) 2000. Frontier regions: indigenous communities and forest activities. <http://www.igc.org/wir/ffi/atg-eng/indigen.html> (accessed 21 February 2000).
- Zonta, A. and Llanque, O. 1994. Productos forestales no madereros en Bolivia, Plan de Acción Forestal. Ministerio de Desarrollo Sostenible y Medio Ambiente, La Paz, Bolivia.
- Zuidema, P.A. 2000. Demography of exploited tree species in the Bolivian Amazon. Serie Científica 2. Programa Manejo de Bosques de la Amazonía Boliviana (PROMAB), Riberalta, Bolivia.

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Chapter 7

Palm heart (*Euterpe edulis* Martius)
in the Brazilian Atlantic rainforest:
a vanishing resource

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(*Euterpe edulis*)

Common names	Part of the resource used	Dominant form of management	Degree of transformation	Scale of trade	Geographic range
Palmitero, jussara, palm heart	Stem (apical meristem)	Wild	Medium	National	Medium

SUMMARY

Palm heart (*Euterpe edulis*) is one of the main non-timber products of the Brazilian Atlantic forest. The abundance of the species and the high demand and prices commanded by the product as well as its simple processing has encouraged farmers and the palm heart industry to exploit intensively the natural stock of the species since the beginning of the 1960s. However, the felling of all individuals with a potential to produce palm heart, including the reproductive plants, caused a rapid decline of its natural populations. The uncontrolled exploitation also promoted a clandestine market for palm heart, disregarding the legislation specifically issued to regulate the production and commercialisation of the product. This article presents the production-to-consumption system of palm heart in the Atlantic forest with special focus on the clandestine production in the Ribeira Valley, São Paulo. The case study chosen for this project involves communities where palm heart is the principal forest product exploited both within their properties and within the limits of the neighbouring conservation areas. In most of the interviewed families only the head was involved in palm heart production, and the product is responsible for almost 90 percent of their cash income. Clandestine harvesting of palm heart compromised the conservation of natural populations of the species and its genetic variation. With the decline of *E. edulis* stocks, the palm heart made from açai (*Euterpe oleracea*), exploited in the Amazon, and other cultivated exotic species have gained market share.

INTRODUCTION

The 'palmiteiro' (*Euterpe edulis* Martius, Arecaceae), from which palm heart is extracted, is a native species of the Brazilian Atlantic forest. Palm heart is one of the most important non-timber forest products (NTFPs) of this ecosystem, which is attested by the extensive literature on the species and the product (Reis and Reis 2000). Despite having a low nutritional value, palm heart is a product with a refined flavour, a quality recognised by indigenous peoples, who have enjoyed it since the remote past. Palm heart, consumed mainly as a salad, has practically become a symbol of plenty at the table, being an essential item in good restaurants (Photo 1). Until not long ago, the success of celebrations, such as weddings and birthdays, was measured not by the number or even elegance of the guests, but by the amount and quality of palm heart offered to them. In Santa Catarina State, entire young palmiteiro palms were used to decorate streets and stages during festivities. Its trunks and leaves were often used as building material in rural areas, but this practice is uncommon nowadays.

Traditionally, smallholders extracted palm heart on a small scale on weekends (Romeiro *et al.* 1996) and sold it to processing factories, directly in farmers markets, or even at the roadside. The regular sale of the product constituted an important additional income to the farmers, but a good stock of palmiteiros was also a form of savings account that could be liquidated with ease to provide the necessary cash for emergencies. For this purpose palm heart was perfect: it could be harvested at any time and had a guaranteed market.

Photo 1. Palm heart is consumed mainly as salad (Photo: Alfredo C. Fantini)



Beginning in the 1930s, industrial exploitation of *Euterpe edulis* changed this scenario by introducing large-scale harvesting (Cervi 1996). The abundance of the species, the high demand for the product, and the ease of harvesting and processing stimulated a proliferation of factories in the region. Intensive exploitation of *E. edulis* occurred mainly on large rural properties, whose stocks were bought by preserve factories.

Lack of concern for the future of the forest production typical of this type of exploitation led to the devastation of natural populations of palmitreiro, while investments to favour their regeneration were rarely considered. The possibility of increasing their income in the short term stimulated farmers from the study site to adhere to this production-to-consumption system (PCS) and to abandon their crops to start extracting palm heart from their own land and from neighbouring properties, already by the 1950s (Andrade 1997). Although *E. edulis* is an aggressive species, repeated exploitation in the same area gradually eliminated its capacity to regenerate naturally, compromising the continuation of its profitable management. The increasing number of palm heart factories and the decline of natural populations of palmitreiro caused a strong shrinking of the sector by the end of the 1960s (Calzavara 1972). Most of the industry then moved to the Amazon region to exploit the indigenous stocks of açai (*Euterpe oleracea*).

Palm heart combines various desirable characteristics of an NTFP: (a) it commands excellent prices in a well-established domestic market; (b) production cycles are sufficiently short; (c) the species can be grown across a wide range of lot sizes, from smallholding to large industrial forests; (d)

local people are familiar with harvesting and processing using inexpensive equipment; (e) it requires a forest environment for successful regeneration and development. These conditions are important if palm heart is to be economically and socially attractive while also maintaining the forest resource base for important ecological functions of the ecosystem. Despite the large potential of palmitheiro for both conservation and development, however, sustainable production of palm heart is still elusive in all the regions of the Atlantic forest. Despite its potential and the large amount of scientific knowledge available on palmitheiro, which makes it a possible model for managing other NTFPs, the species continues to be exploited mainly in a predatory and clandestine way.

THE PRODUCTION-TO-CONSUMPTION SYSTEM

Region of the study

The Atlantic forest

The entire ecosystem of the Brazilian Atlantic forest originally occupied 1.1 million square kilometres (Fundação S.O.S. Mata Atlântica *et al.* 1998). Overexploitation of its resources, particularly the timber, and conversion of forests to other uses (Fonseca 1985; Dean 1995; Mittermeier *et al.* 2000) have reduced this ecosystem to 7% of its original area. The remnant forest is considered one of the most threatened ecosystems in the world, despite the enormous biodiversity and endemism (40% of the species) that it shelters (Mori *et al.* 1981; Mittermeier *et al.* 1998). Moreover, most of the remnant patches of this ecosystem are highly fragmented, and those fragments situated on private lands are predominantly composed of secondary forests, developed after the abandonment of formerly agricultural areas.

Rio Ribeira de Iguape Valley

The Ribeira Valley is situated in the south-west of São Paulo State, approximately 300 km from its capital of the same name. The region retains the largest continuous blocks of the remaining Atlantic forest, including 10 state conservation areas that amount to 400,000 ha. These forests extend from the coastal plains to the peaks of the Serra do Mar, with altitudes of up to 1,000 m above sea level (masl). The diversity of environments allows the maintenance of an enormous diversity of species. Although most of the remaining forests are protected areas owned by the state government, they are surrounded by small farms, communities of *quilombolas* (see below), and by small and medium urban centres. The majority of primary forests and of forests in advanced stages of regeneration are located in these conservation areas. The fragments of forests found on the properties of *quilombolas* and other smallholders are mainly secondary forests or highly disturbed forests left behind by predatory timber exploitation. These farmers routinely enter the parks and other properties in the region to look for NTFPs such as espinheira-santa (*Maytenus* spp.), pata-de-vaca (*Bauhinia forficata*), carqueja (*Baccharis*

trimera), guaco (*Mikanya* spp.), and erva-de-baleeira (*Cordia verbenacea*), amongst others (Reis *et al.* 2000)—and principally the palmitero.

Quilombos

Quilombos are communities of slave descendents, or *quilombolas*. In the Ribeira Valley alone there are nine of these communities, located between the municipalities of Eldorado and Iporanga (Figure 1), along the banks of the river Ribeira de Iguape, sheltering around 500 families. For this case study, we chose four of these communities: Ivaporunduva, Pedro Cubas, São Pedro, and Sapatu. Pedro Cubas and São Pedro are bordered by the Intervalles Park, and are adjacent to the two other communities. Together, the four communities occupy an area of approximately 107 km². For the purpose of this study we also considered part of the PCS area an additional area of the same size inside Intervalles Park as well as a large private property that we believe is used by *quilombolas* to exploit palm heart clandestinely.

A particular characteristic of these communities in relation to other communities of farmers in the Atlantic forest is collective ownership of land and forest resources. The choice of these communities for this case study within the CIFOR project was based on our familiarity with the region and its inhabitants, consequently making it easier to obtain qualitative and quantitative data necessary for the project purposes. Therefore, the choice of this PCS does not characterise a 'representative' palm heart production system, which also was not the objective of the project. It is possible, then, that some aspects of the PCS studied and some data presented in the matrix would be different were the study developed in another region. We believe, however, that the principal characteristics of the production system presented here, in particular the potential and the restrictions of growing the palmitero in a sustainable way, still reflect the situation in the whole Atlantic forest.

The resource base

The palmitero is a single stem palm that can reach 10 m to 20 m in height and a diameter at breast height (DBH) of 8 cm to 15 cm (Reitz *et al.* 1978) (Photo 2). The species occurs naturally throughout the Atlantic forest becoming less frequent in altitudes above 700 masl. Reproduction of the species is exclusively via seeds, with mainly crossed fertilisation (Reis *et al.* 1993)—a consequence of the strong protandric characteristic of the species. The flowering period extends for five months (Reis 1995), benefitting a large group of pollinator insects, especially small bees. The fruit is a drupe, with only one seed (Reitz 1974). In natural populations, the annual fruit production is abundant: 180,000 to 480,000 seeds per hectare, sufficient to produce 12,000 seedlings and to form temporary seedling banks (Reis 1995). Fruit dispersion is done by a large number of bird species, mammals, and rodents. Several populations of palmiteiros in a region hang ripe fruits for a period of up to six months (Reis 1995), characterising the species as an important food source for the local fauna.

Figure 1. Location of the study area



Source: ESRI Data and Maps 2002.

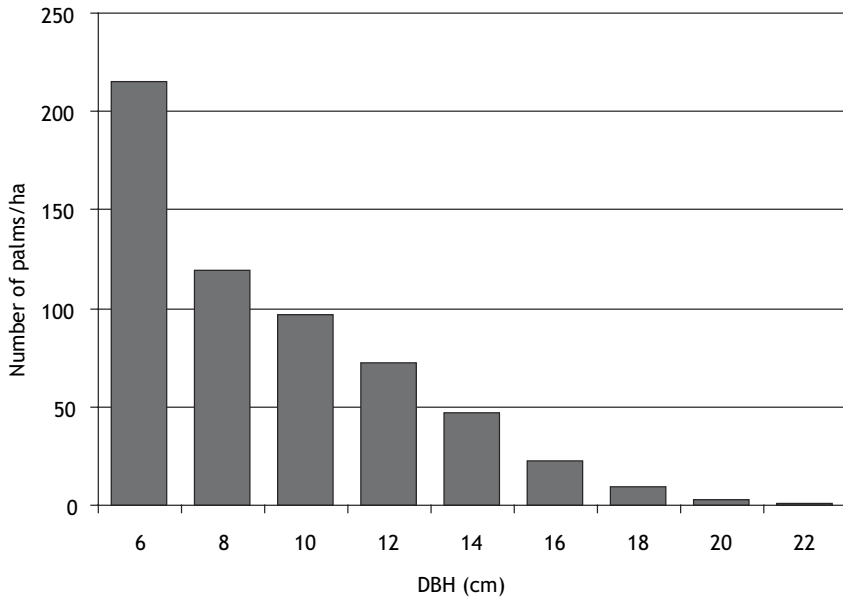
Photo 2. An adult palmitreiro plant (*Euterpe edulis* Mart.) (Photo: Alfredo C. Fantini)



The palmitreiro is one of the most abundant subcanopy species of primary forests of the Atlantic region (Reitz 1974). It can also grow in mid-successional secondary forests (Klein 1979), an indication of its potential for management in this type of ecosystem. In primary forests, natural populations of palmitreiro typically present a DBH distribution following an inverted J-curve (Figure 2), with 350 to 450 individuals per hectare higher than 1.3 m (a palm with this height has about 4 cm DBH). In a forest close to the study area, we found an average of 366 palms per hectare, equivalent to a basal area of 2.5 m² per hectare (Fantini 1999).

Populations of palmitreiro in the study area are extremely disturbed. Repeated short cycles of harvesting of all individuals bearing a commercial palm heart, including all the reproductive ones, have prevented the maintenance of the species population structure and made its sustainable management through natural regeneration unviable. Ribeiro and Odorizzi (1998) found only 161 *E. edulis* plants per hectare higher than 1.3 m in the study area, most of them smaller than 9 cm DBH, the minimum legal cutting diameter. They found no reproductive palm. After exhausting their own stocks of palmitreiros, palm heart harvesters started harvesting systematically the existing stocks in protected areas and neighbouring private forests. In the Carlos Botelho state park in São Paulo, for example, 70% of the area has already suffered intense clandestine exploitation (in this case also called poaching) of palmitreiro (Romeiro *et al.* 1996). Other parks, like neighbouring Intervalles, appear to

Figure 2. The DBH distribution of *Euterpe edulis* in a primary forest in Blumenau, Santa Catarina



be suffering the same fate as it is being intensively exploited by *quilombolas* and other palm heart poachers.

Palmiteiro growth and competition within the forest

The palmiteiro is a slow-growing, shade-tolerant species, which requires a forest environment especially for seedling growing. It is, then, poorly adapted to plantation culture, making it unsuitable for monocropping. In highly competitive forest environments, the number of seedlings as well as the DBH growth rates of the palms are inversely proportional to the number of other individual tree species and their basal area (Fantini 1999). In this paper, we refer to diameter growth of palmiteiro as ‘the secondary thickening’ of the palm stem (Tomlinson 1961: 20). The time needed for an individual to reach maturity under the conditions of a natural ecosystem is quite variable, and estimates vary between 10 and 25 years. According to our growth model for the palmiteiro in the region, a natural population from which all individuals with a DBH equal to or greater than 5 cm were cut needs 30 years to recover its original structure (Fantini 1999). Populations planted within a forest managed to reduce competition from other species were harvested at the age 8 to 10 years, however (Orival Dalfovo personal communication).

Raw material producers and the socioeconomic context

Because of its abundance in the forest, the palmiteiro can be managed on any scale, and we can find palm heart producers among smallholders as well as big

landowners. A third group of producers are the landless people who extract the product from private forests or state protected areas. These clandestine palm heart harvesters constitute a serious problem for landowners aiming to achieve sustainable management of *palmiteiro*, as well as for park managers responsible for conserving natural populations of *palmiteiro* within protected areas. Unfortunately, although the producers chosen for this case study—the *quilombolas* of the Ribeira Valley—have their own lands, they are mainly palm heart poachers.

The quilombolas

The *quilombolas* have lived in the Ribeira Valley region since the eighteenth century. *Quilombos*, the communities founded by fugitive or freed slaves, were grouped together in remote parts of the forest, seeking protection. *Quilombolas* maintain collective ownership of the land and its resources. Although they have their property rights recognised, *quilombolas* still have no property titles (Andrade 1997).

Once they had formed the *quilombos*, in addition to farming activities for subsistence, the *quilombolas* became increasingly dependent on forest products from timber for building houses to non-timber resources such as firewood, medicinal plants, bush meat, and fish. In the 1950s, their dependency on the forest peaked when harvesting palm heart became their principal activity, instead of agriculture, practically abandoned by many of them (Andrade 1997).

Quilombolas live under complex socioeconomic conditions, whose improvement challenges all policy makers. Despite being located in the richest state of the country, the Ribeira Valley is considered one of Brazil's 'poverty belts'. The stagnant regional economy offers few job opportunities for the local population. The main agricultural crops—corn, beans, and manioc—are grown exclusively for subsistence, yielding very low productivity. To aggravate the situation, three huge floods occurred in the valley during the 1980s, causing severe damage to these communities (Ribeiro e Odorizzi 1998).

In the study area, there are 183 families, averaging 4.7 persons per family. We estimated that 75% of the families are involved in palm heart production. In most families, only the head is a producer of palm heart raw material, and the activity remains exclusively a male occupation. The palm heart produced generated an annual income of around US\$700 per family, which represents almost 90% of their income. (The other 10% is derived from subsistence farming and the gathering of other non-timber products.) Only 50% of this income is received in cash; the rest is made up of basic goods necessary to remain in the business of harvesting palm heart. Virtually all clandestine harvesters have an agreement with a middleman, who buys the palm heart produced and supplies all the necessary working resources.

Clandestine palm heart harvesters or poachers

Harvesting palm hearts clandestinely is a tough and risky activity. The raw material is the green top of the palm, 0.8 m to 1.2 m in length, called 'head

of palm', from which the palm heart is extracted. One man can cut and transport a bundle of 30 to 60 palm heads per day (Orlande *et al.* 1996) depending on their diameter. Carrying only the food necessary for the journey and a machete, the harvester enters the forest once a week for a working period that can last up to four days, especially in remote forests or reserves. It may take up to four hours to carry the heavy load of up to 60 kg to the local processing factory or to the middleman. Often climbing steep slopes and working under difficult conditions, the harvester can cut and transport only one load per journey. Working at night and during rainy days lowers the probability of being caught but increases the chance of accidents.

An alternative used by poachers is to cut and process the palm heart right in the forest, the preferred option when the area to be exploited is remote, like the parks. Normally, a poacher harvests enough palm hearts to fill 15 jars in a journey, which corresponds to the harvesting of 15 palmiteiros, on average. The most worrying aspect of this practice is the precarious sanitary conditions under which the palm heart is processed, which exposes consumers to possible poisoning (botulism) caused by the bacteria *Clostridium botulinum*. Boiling the palm heart before consumption eliminates the bacteria, but consumers rarely do it. The best way to avoid being contaminated by bacteria from clandestinely processed palm heart is to buy the product from reliable traditional companies in the market.

While there is no doubt that poaching palm heart from remote areas is one of the toughest jobs a man can choose, the culture of palm heart cutting is so deeply rooted in the local communities that this option is generally preferred to the alternatives, when available, such as work on a banana plantation. While a worker would earn, in 1998, US\$10 a day on the plantation, he could make US\$30 cutting palm heart. Another reason for choosing palm heart poaching is the freedom to pick whatever day he prefers to work. Normally, the poacher is compelled to return to the forest only when the money from his last journey into the forest has been spent.

Despite the present enforcement of restrictions, the illegal extraction of palm heart continues to be practiced on a large scale, not only by *quilombolas*. To understand the dimensions of the problem, consider data provided by Romeiro *et al.* (1996), which indicate the existence of 585 illegal palm heart factories—small units of palm heart production, frequently located in the houses of middlemen—in 11 municipalities of the Ribeira Valley region, whereas in the entire state of São Paulo there were only 31 factories registered at the official environmental agency (Cervi 1996). The total volume of clandestine palm heart produced, by its very nature, is difficult to survey and until the middle of 2003 no other work had been published on the theme. But based on our own experience working for years in the Ribeira Valley, we affirm that the industry of clandestine production of palm heart remains strong.

Inspection of palm heart production is insufficient and ineffective. A survey of the archives of the environmental agencies and the forest police of the three largest producer states—São Paulo, Paraná, and Santa Catarina—for the years 1996 and 1997 revealed the registration of 491 incidents related to clandestine production of palm heart, resulting in the apprehension of the equivalent of 77 tons of processed product (Fantini 1999).

The processing of palm heart requires clandestine producers to remain stationary, at least temporarily, thus making them more vulnerable to detection. As the majority of inspections involve anonymous calls that provide the exact location of the factory, the work of inspectors becomes more efficient.

Clandestine palm heart is also confiscated during transportation, either *in natura* (heads of palm) or already processed. During 1996 and 1997, inspections on main and secondary roads resulted in the confiscation of an amount equivalent to 23 tons of processed palm heart, 30% of the total confiscated during this period. The chance of being caught by an inspection, generally assumed by the middleman, depends on the type of road used, but it can reach 25% (Galetti and Fernandez 1998) in areas with few roads and where inspections are frequent.

The most difficult and risky task in combating clandestine production and poaching is to catch clandestine producers and poachers right in the forest. These harvesters walk long distances within the forests, which they know quite well. Park rangers, on the other hand, use the trails to patrol the forests either systematically or at random and thus have a reduced chance of encountering poachers in action. Taking advantage of their skills in walking within the forest, poachers quickly escape when intercepted. Another trend in the business of clandestine harvesting and poaching of palm heart is group work, which makes the job of rangers and forest police even more difficult. The harvesters maintain watchers at strategic observation points and are informed, well in advance, of the approximation of any ranger or the police. Poachers have also become more violent, and confrontations with the police have resulted in deaths of both poachers and policemen.

According to our survey, the smallest number of cases involving clandestine palm heart production was verified during the storage and commercialisation phase. This result is likely a function of the small number of inspections done on establishments that commercialise the product and on consumers such as restaurants and *churrascarias* (restaurants specialised in roasted meat), and not because of the inefficiency of the strategy. Most of the 7.5 tons of palm heart confiscated in 1996 and 1997 were stored in the house of middlemen, ready for distribution. We believe that inspections at the commercial points where the product reaches consumers—supermarkets, bars, restaurants, and *churrascarias*—would be the best strategy to control clandestine palm heart production.

The processing industry

Palm heart processing is simple and requires little and relatively cheap equipment. In the forest, the palm is cut down and the top green part of the stem, the 'palm head', cut off. Some of the external sheaths of the palm head are removed and discarded, while the inner sheaths, those closest to the soft palm heart, are kept to protect the product during transport to the factory. It is important to have an interval of one day between the cutting of the palm head and the processing of the palm heart. During this period, the palm heart suffers a slight shrinkage, which prevents its longitudinal crack.

Once in the factory, the remaining leaf sheaths are removed, exposing the tender palm heart. This phase of the processing is quite delicate and requires experienced workers. The palm heart is then immediately cut into pieces 8 cm long. Cutting the heart of the palm into pieces is especially demanding, requiring from the workers much sensitivity and skill to determine the size of the useful part of the palm heart. This work is done almost exclusively by women. The pieces of palm heart are immediately immersed in a solution of citric acid (0.5%) and salt (5%) to preserve the product, avoiding its oxidation and darkening. Next, they are bottled with the same solution and cooked for an hour. The most important item to be observed in the quality control of the processing is the pH of the solution, which must be 4.5.

The amount of palm heart a palmiteiro can yield can be estimated with good precision through various nondestructive phenotypic characteristics of the palm. We recommend the use of DBH, a variable that can be measured with ease and that presents a high correlation with the industrial yield of palm heart (Fantini *et al.* 1997). These authors suggest that the industrial yield (IY, in grams of palm heart bottled) can be estimated by the equation, $IY = -18.879 \text{ DBH} + 4.667 \text{ DBH}^2$ ($R^2 = 0.93$). According to palm heart harvesters, a palmiteiro can be harvested when it is at least 6 cm DBH, but a palm tree with this diameter will produce only 55 g of palm heart. In order to produce a 300 g jar of palm heart, a palmiteiro must be at least 10.2 cm DBH. As the yield of palm heart is an exponential function of the plant diameter, a palmiteiro that is 18 cm DBH can produce approximately four jars of palm heart. After several short cycles of harvesting, populations of palm heart in the forests studied in this project are typically formed by young palm trees, small in diameter, and consequently with a low yield potential. This fact has stimulated *quilombolas* to exploit the forests of neighbouring parks, where natural populations of palmiteiros still have a large number of big individuals.

Industrial yield can also be estimated from the palm heads, which is useful to farmers who commercialise the product *in natura*. The model is: $IY = -34.022 \text{ DH} + 29.475 \text{ DH}^2$ ($R^2 = 0.96$), where DH is the diameter of the heart itself, visible from the top of the palm head (Fantini *et al.* 1997).

Trade and marketing

Official data on the production and consumption of palm heart in Brazil are scarce and unreliable. The existence of clandestine production and commercialisation of palm heart practically invalidates the official data on production. Cervi (1996) gives the most recent estimate, which reveals an internal annual consumption of 40,000 tons, correspondent to approximately US\$430 million at the final consumer price. Although most of this volume comes from palm heart from the Amazonian açai (*Euterpe oleracea*), the estimate is a good indication of the huge market potential for the palm heart from *Euterpe edulis*. Probably, most of the product reaches the final consumer through the supermarkets, but restaurants and *churrascarias* are big consumers of the product, mainly in São Paulo city.

The production chain can be better understood by dividing the producers into three groups: large forest owners, smallholders, and clandestine

harvesters including poachers (Figure 3). Large forest owners almost always sell their raw material (palm heads) to a factory that exploits the forest and processes the product, bringing it to the market legally. Nevertheless, the product is considered clandestine if the raw material does not come from a management project approved and inspected by environmental agencies. Normally, the palm heart produced by this industry is sold in supermarkets. In the case of small producers, the product is sold *in natura* (palm heads) to a factory or to middlemen, or it is processed at home and sold in farmers' markets or to restaurants. When middlemen buy the product *in natura*, they process it at home and sell it to a factory or, most commonly, directly to restaurants. Many factories buy clandestine product to mix it with legal product so as to lower the overall cost of raw material. Clandestine palm harvesters and poachers sell raw material or already processed product to intermediaries, which in turn sell the product to factories either raw or processed. The intermediary's third, and most commonly employed, option is to sell the processed product directly to restaurants (Fantini 1999).

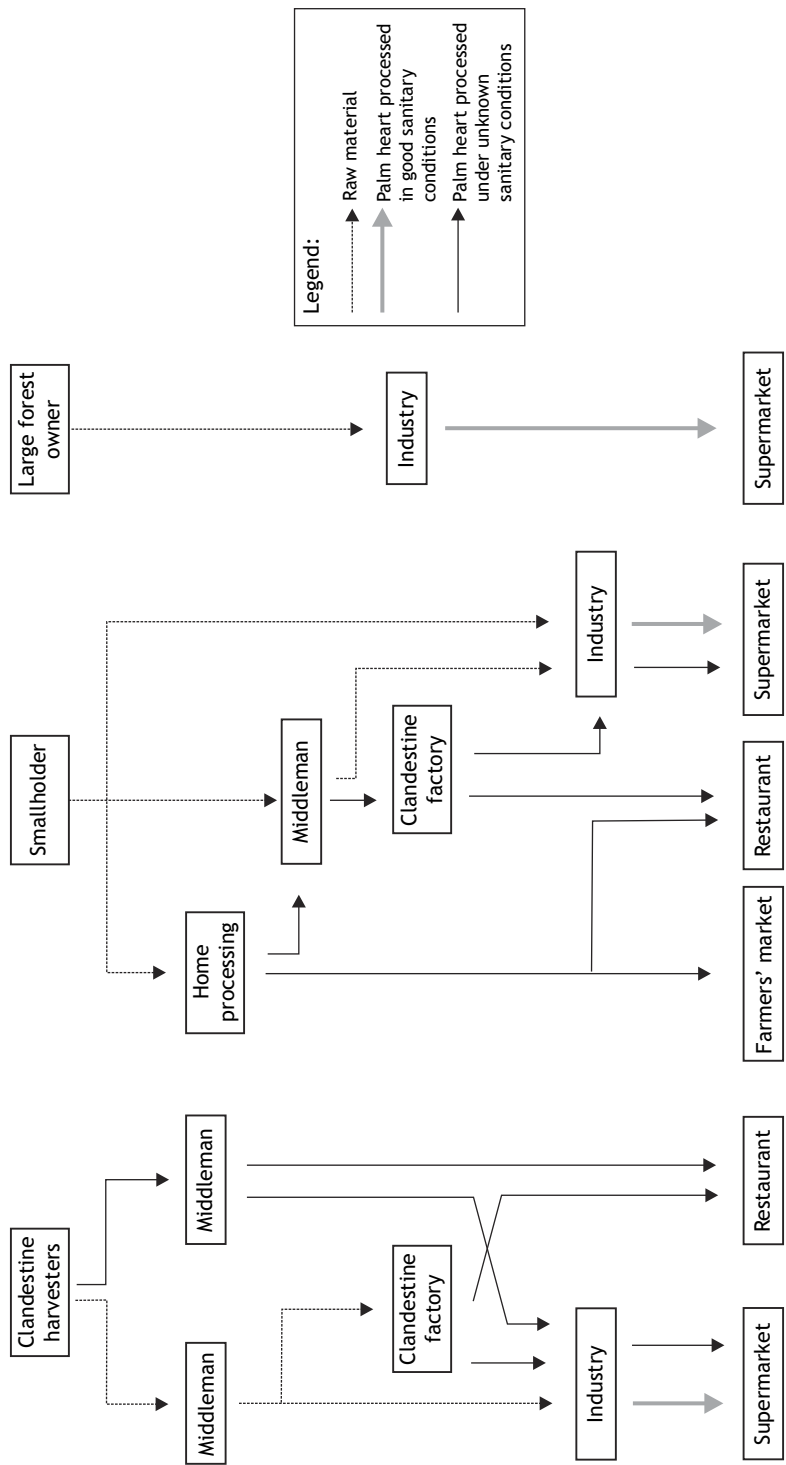
Product cost and price

The production cost of palm heart varies enormously depending on the production system, which may vary from poaching and predatory exploitation, where the only costs incurred are those for harvesting, transportation, and processing, to exploitation of a forest managed following a sustainable management project. When the forest is managed, project scale also has a significant impact on production costs because of the fixed costs. We estimate the fixed cost of a project approved by the environmental agency to be at least US\$300. Therefore, for a forest as small as four hectares, the fixed cost would be US\$75 per hectare, which practically makes a management project economically unviable for small farmers. On the other hand, the fixed cost per hectare of an industrial-scale management project is quite low.

The middleman pays the harvester around US\$0.35 per jar of palm heart, and sells it to restaurants for US\$0.70. The factory also pays the producer around US\$0.70 for each jar. Since the production cost of jar from an industrial-scale, managed forest is US\$1.20, it is straightforward to conclude that a large amount of the palm heart must be clandestinely produced, whereby the raw material has to pay only for its harvesting and transportation. Retail prices of palm heart from *Euterpe edulis* vary between US\$1.50 and US\$3.00 per jar. It is interesting to note that the large variation in price does not necessarily reflect the product quality (softness of the palm heart). Consequently, very low priced products are probably clandestine in origin and likely were produced under uncertain sanitary conditions, as well as perhaps being of low quality.

Many restaurants also buy clandestine palm heart in order to offer large quantities of the product to their costumers. This is a marketing strategy, for example, used by *churrascarias* in São Paulo. Most restaurants have a fixed supplier, only replacing it when another offers the product at a more advantageous price. A survey carried out in Florianópolis, Santa Catarina, looked at 65 restaurants. Among the 71% that had palm heart on the menu,

Figure 3. Production chain of palm heart from *Euterpe edulis*



64% had bought clandestine palm heart (Fantini 1999). Palm heart produced clandestinely forced the retail product price down and practically makes investment in forest management unfeasible.

The palm heart from the Amazonian açai plays the same role. In 1998, the açai palm heart arrived at south-western markets at very competitive prices (US\$0.30 per jar) compared to the retail price of palm heart from *Euterpe edulis* (Fantini 1999) and became an alternative product for low-income consumers. In supermarkets, the price of palm heart from *E. edulis* was approximately twice as the price of açai. To maintain the palm heart competitive in relation to açai, producers had to reduce either their profit margin or their production costs, that is, minimise their investment in sustainable production. Between 1998 and 2003, however, while palm heart from *E. edulis* practically maintained the same price in the supermarkets, there was a significant increase in the price of açai to the point where some brands reached the price level of palm heart from *E. edulis*.

Commercial product

Practically all palm heart destined for the internal market is sold in jars. The glass jar enables the consumer to evaluate the number of palm heart pieces and the quality aspect of the preserve, albeit not the softness of the pieces. Most product is sold in jars of 300 g drained weight. According to the current regulation, 2.5 cm is the minimum diameter of a piece to be bottled, so a jar contains between three and five pieces, on average. Factories usually mix softer and harder pieces in the same jar, a strategy to avoid the association of their brand with 'hard' palm heart. Another type of packaging is a jar with 1.2 kg drained weight of product. These jars include large pieces of up to 6.5 cm in diameter. Pieces shorter than 8 cm in length and the harder parts of the palm heart are chopped and sold at a lower price also in jars with 300 g or 1.2 kg of the product.

By the beginning of the 1990s, virtually 100% of the palm heart sold was processed product. In earlier years, however, the commercialisation of palm heart *in natura* to the final consumer was common. Such product was used in the preparation of pies and creams.

Policy environment

The alarming decline of palm heart in the Atlantic forest motivated the government to launch a program in the 1970s to finance the enrichment of exploited forests. But the program benefitted mainly the owners of large forests, and only a small part of the total resources made available were used for their intended purpose (Ferreira and Paschoalino 1987; Ferraz 1996). As a result, not only continued the palmiteiro to be devastated in the region, but the whole ecosystem itself was increasingly converted to other land uses. By 1990, the remnants of this type of forest covered no more than 10% of its original extent (Fundação S.O.S. Mata Atlântica *et al.* 1998). To counter the imminent destruction of the rest of the forest, the federal government issued Decree #99,547 that same year, imposing a moratorium

on the exploitation of the Atlantic forest. With the exception of authorised management projects already in progress, all exploitation of forest products in this ecosystem became illegal. Curiously, the palm heart, which was expected to practically disappear from the market, continued to be offered without any sign of volume decline. The situation thus confirmed what was widely known: the clandestine exploitation of forest products in Brazil was a rule, not an exception.

According to the regulations specific to *Euterpe edulis*, every jar of palm heart produced in the Atlantic forest must originate from an area being managed. A management plan prepared by an agronomist or a forester must be submitted to the environmental agencies. Only after the analysis, inspection, and approval of the project, an authorisation for managing the forest, valid for one year, is issued. Although the legislation was considered a revolution towards sustainable management of the resource, there is an evident lack of motivation for producers to get involved in the production of palm heart under such regulations, which is reflected by the small number of projects submitted to the environmental agencies. One important factor that discourages legal production is the cost of the management plan, especially for smallholders, whose cost per hectare is much higher than that of large forest owners. In Santa Catarina State, for example, where rural properties are typically small, only 11 management plans were approved in 1996 and 1997, only one for a relatively large project of 725 ha, while all others encompassed less than 35 ha (Fantini 1999). Another disincentive for legal production is the long time it takes for a project to pass all the processes, from its elaboration to final approval, which takes no less than six months.

The regulations require that management plans include (a) legal documentation of the area; (b) map of the forest to be harvested, locating the permanent plots on which the palmiteiro inventory was completed; (c) the results of the inventory, including a copy of the field book; and (d) an estimate of the palm heart production based on the inventory and the legal restrictions for harvesting. These restrictions include a DBH limit for harvesting of 9 cm and a requirement that at least 50 seed palms per hectare be maintained. These requirements vary slightly from state to State.

Other laws, not specific to palm heart, are also enforced, especially the Brazilian Forest Code. They include provisions that (a) only farms with at least 20% of the area under forest, also called a 'legal reserve', are eligible for harvesting plans; (b) areas included in the category of 'permanent preservation' cannot be included in the harvesting plan. These areas comprise steep slopes (>45°), tops of the hills, a 30 m buffer zone along streams, and a 50 m buffer zone around springs. Furthermore, any individual plant of whatever species can only be harvested under a management plan. Therefore, increasing the productivity of palmiteiro through silvicultural practices such as the reduction in the number or basal area of other species, is illegal.

The emphasis on regulations instead of incentives to promote sustainable forest management distorted the institutional mission of the Brazilian environmental agencies. The staff in these institutions spend practically all their time planning and enforcing regulations, having little time left to

discuss, propose, and implement plans to stimulate sustainable management of forest resources. It is not surprising, then, that farmers and other forest goods producers consider the Brazilian Institute of the Environment and other agencies enemies. Until this condition changes, the cycle of regulations, disobedience, and incapacity to impose regulations will persist.

TRENDS

We are pessimistic about the future of *Euterpe edulis*. While the market for palm heart continues to grow, many low-income farmers become more and more dependent on this resource as their main source of income. The inevitable consequence of this combination is an increasing pressure on the natural stocks of the species. The number of approved palmitero management projects has increased only slightly in the past years in comparison to any reasonable expectation, which suggests that exploitation without any acceptable ecological and social criteria will continue on private properties. The devastation of palmitero populations within protected areas will also continue. At present levels of exploitation the extinction of the species, from an economic point of view, is certain to occur in the short term.

One evidence of this trend is the growing substitution of palm heart from *Euterpe edulis* by other species of palms. In supermarkets, most of the product volume already consists of palm heart extracted from açai (*Euterpe oleracea*), coming mainly from Pará State in the Amazon. Even traditional preserve industries in the Atlantic region have started commercialising palm heart from the Amazon. Palm heart from *Euterpe precatoria* imported from Bolivia has reached southern Brazil, but it still has a restricted share of the market in part as the result of two cases of botulism that occurred in São Paulo and were widely exposed by the media. Nevertheless it is a candidate to have a good market share in the future. It is quite likely, however, that palm heart from species cultivated in high densities in open areas will dominate the market. The most promising species are the pupunha (*Bactris gasipaes*) and the palmeira-real (*Archontophoenix alexandrae* and *Archontophoenix cunninghamiana*).

A very recent alternative for *Euterpe edulis* is the production of 'açai wine', a thick juice made of the pulp extracted from açai fruits. The consumption of açai produced from *Euterpe oleracea* and *Euterpe precatoria* is common in the Amazon, but the market for this product is increasing rapidly in the south and southwest of Brazil. A pulp produced from *Euterpe edulis*, with the same quality as Amazonian açai has recently been produced in the Atlantic forest, and it proved able to generate an annual income for farmers. This product already showed potential to be an incentive for farmers to keep their palm trees standing—a renewed hope for the species.

LESSONS FOR CONSERVATION AND DEVELOPMENT

It is intriguing that palmitero, a species considered an excellent candidate for sustainable management within the forest while at the same time promoting the development of local communities, failed to fulfil the expectation. The

palmiteiro case is an example that science and technology are necessary, but insufficient, to promote sustainable development through the use of natural resources. In Brazil, the government agencies clearly are not prepared to accept this fact.

Despite the recognised evolution occurring in the recent past, environmental policy in Brazil still is synonymous with implementation and enforcement of regulations, only in the best cases founded on research data. In the forest sector, and particularly in relation to palm heart production, the work of environmental agencies is restricted to proposing regulations and inspection of production. These agencies have no programs to promote sustainable management of the resource, let alone programs aiming at the development of the communities involved in its production. The case of the palmiteiro is also evidence that this strategy cannot halt the growing clandestine production and poaching of palm heart.

Palm heart produced clandestinely or poached reaches the market at very low prices, which constitute a disincentive for the management of the species. But this is only one of the damages caused by such practices. Palm heart poaching has direct impact on private properties, reducing present and potential revenues; the biggest and most valuable palm trees left standing to produce the seeds necessary to guarantee the process of natural regeneration command the highest premium, therefore becoming the preferred target for poaching. Not only will farmers that have fallen victim to poaching have the extra burden of implementing artificial regeneration of palmiteiro, but they will also find it more difficult to have their management plans approved by environmental agencies as their forests lack the minimum number of seed trees as required by regulations. Controlling poaching imposes an extra cost on large forest management projects. Small farmers, on the other hand, cannot afford to hire guards and have to assume the risky task of protecting their own forests.

In the parks, the preservation of representative samples of the genetic variation of natural populations of palmiteiro is being seriously compromised. Moreover, the illegal harvesting also affects the capacity of the parks to produce seeds for programs designed to encourage the enrichment of other forests where palmiteiro populations were devastated. Scarce resources are being used to control poaching, resources that otherwise could be used to reach the goals of a protected area.

Recomendations

Quilombolas communities are highly dependent on the exploitation of palm heart, but they practice an illegal and disorganised exploitation of the resource. We believe that the situation is largely a result of the lack of coordinated work on forest management and harvesting. The problem could possibly be resolved by implementation of community forestry projects with the following objectives:

- to replenish stocks of palmiteiro in *quilombos* forests through artificial regeneration of the species, especially in secondary forests. Spreading fruits just harvested is the most efficient way to restore the populations

of palmitero in these forests, at a very low cost (other methods are described in Nodari *et al.* 2000);

- to submit to the environmental agency collective projects to manage the palmitero, which would significantly reduce their fixed costs to individual farmers;
- to process the palm heart in the community, under adequate sanitary conditions, adding value to the product locally. As this strategy requires a high level of community organisation, its implementation would require external aid from governmental or nongovernmental organisations;
- to eliminate the middleman from the marketing chain, increasing the local appropriation of product value and enhancing the bargaining power to achieve better market prices for the product;
- to certify the product in order to reach consumers willing to pay a premium price for a palm heart produced from a forest managed for sustainable production;
- to stimulate the production of pulp from *Euterpe edulis*, as an alternative or complement to the production of palm heart.

Another measure very important for *quilombolas* as well as other small producers would be the relaxation of forest regulations, especially allowing them to use silvicultural practices aiming at increasing the density and growth rates of palmiteros, particularly in secondary forests. Without this possibility, the low productivity of natural populations will make it more difficult to maintain the present income levels of families involved in palm heart production.

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NOTES

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REFERENCES

- Andrade, T. (org.) 1997. Quilombos em São Paulo: tradições, direitos e lutas. IMESP, São Paulo. 188p.
- Calzavara, B.B.G. 1972. As possibilidades do açazeiro no estuário amazônico. Boletim da Faculdade de Ciências do Pará 5: 165-206.
- Cervi, C.E. 1996. O market de palm heart: relatório para o Conselho Britânico. Universidade Estadual de Campinas, Campinas. 34p.
- Dean, W. 1995. With broadax and firebrand: the destruction of the Brazilian Atlantic forest. UCP Press, Berkeley, CA. 482p.
- Fantini, A.C. 1999. Palm heart (*Euterpe edulis*) production and management in the Brazilian Mata Atlântica. Doctoral Thesis, University of Wisconsin, U.S.A. 127p.
- Fantini, A.C., Nodari, R.O., Reis, M.S., Reis, A. and Ribeiro, R.J. 1997. Estimativa da produtividade de palm heart em plantas de palmito (*Euterpe edulis* Martius) a partir de características fenotípicas. Revista Árvore 21: 49-57.
- Ferraz, P. 1996. Paraná: guias frias esquentam palm heart frio. Jornal da Tarde, 9 May. p. 2D.
- Ferreira, V.L.P. and Paschoalino, J.E. 1987. Pesquisa sobre o palm heart no Instituto de Tecnologia de Alimentos. In: Anais do Primeiro Encontro Nacional de Pesquisadores de Palm Heart, 45-62. EMBRAPA, Curitiba.
- Fonseca, G.A.B. 1985. The vanishing Brazilian Atlantic forest. Biological Conservation 34: 17-34.
- Fundação S.O.S. Mata Atlântica, INPE and Instituto Socioambiental 1998. Evolução dos remanescentes forestais e ecossistemas associados do domínio da Mata Atlântica no período 1990-1995. Fundação S.O.S Mata Atlântica, São Paulo. 54p.
- Galetti, M. and Fernandez, J.C. 1998. Palm heart harvesting in the Brazilian Mata Atlântica: changes in the industry structure and the illegal trade. Journal of the Applied Ecology 35: 294-301.
- Klein, R.M. 1979. Ecologia da flora e vegetação do Vale do Itajaí. Sellowia 31-32: 9-389.
- Mittermeier, R.A., Myers, N., Gil, P.R. and Mittermeier, C.G. 2000. Hotspots. CEMEX/Conservation International, Mexico City.
- Mittermeier, R.A., Myers, N. and Thomsen, J.B. 1998. Hotspots and major tropical wilderness areas: approaches to setting conservation priorities. Conservation Biology 12: 516-520.
- Mori, S.A., Boom, B.M. and Prance, G.T. 1981. Distribution patterns and conservation of eastern Brazilian coastal forest tree species. Brittonia 33: 233-245.
- Nodari, R.O., Fantini, A.C., Reis, A. and Reis, M.S. 2000. Restauração de populações de *Euterpe edulis* Martius (Arecaceae) na Mata Atlântica. In: Reis, M.S. and Reis, A. (eds.) *Euterpe edulis* Martius (Palmito): biologia, conservação e management, 189-201. Herbário Barbosa Rodrigues, Itajaí.
- Orlande, T., Laarman, J. and Mortimer, J. 1996. Palm heart sustainability and economics in Brazil's Atlantic coastal forest. Forest Ecology and Management 80: 257-265.
- Reis, A. 1995. Dispersão de sementes de *Euterpe edulis* Martius - (Palmae) em uma floresta ombrófila densa montana da encosta Atlântica em Blumenau,

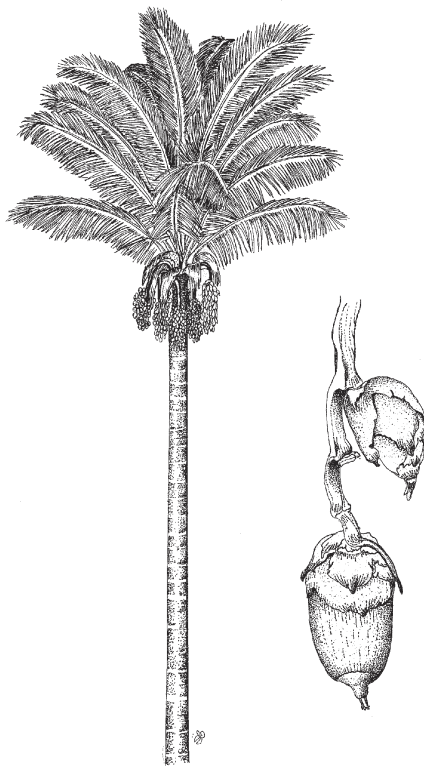
- SC. Doctoral Thesis, Universidade Estadual de Campinas, Brazil. 154p.
- Reis, M.S., Guimarães, E. and Oliveira, G.P. 1993. Estudos preliminares da biologia reprodutiva do palmito (*Euterpe edulis*) em mata residual do Estado de São Paulo. *In: Anais do Sétimo Congresso Forestal Brasileiro*, 358-360. Sociedade Brasileira de Silvicultura, Curitiba.
- Reis, M.S., Mariot, A. and Di Stasi, L.C. 2000. Manejo de populações naturais de plantas medicinais na Floresta Atlântica. *In: Diegues, A.C. and Viana, V.M. (orgs.)*, 95-102. São Paulo.
- Reis, M.S. and Reis, A. (eds.) 2000. *Euterpe edulis* Martius (Palmito) biologia, conservação e management. Herbário Barbosa Rodrigues, Itajaí. 335p.
- Reitz, R. 1974. Flora ilustrada Catarinense: palmeiras. Herbário Barbosa Rodrigues, Itajaí.
- Reitz, R., Klein, M.R. and Reis, A. 1978. Projeto madeira de Santa Catarina. Herbário Barbosa Rodrigues, Itajaí. 320p.
- Ribeiro, R.J. and Odorizzi, J. 1998. Projeto piloto de enriquecimento florestal com repovoamento de palm heart *Euterpe edulis* nas comunidades Quilombolas do Vale do Ribeira: relatório para a Mitra Diocesana de Registro. Registro-SP, Brazil. 33p.
- Romeiro, A.R., Fonseca, R.B. and Pinto, N.R. 1996. Projeto: a exploração do palm heart na Mata Atlântica na região do Vale do Ribeira. Conselho Britânico/FECAMP, Campinas. 27p.
- Tomlinson, P.B. 1961. Palmae. *In: Metcalfe, C.R. (ed.) Anatomy of the Monocotyledons*. Oxford University Press, Oxford.

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Chapter 8

The babassu palm (*Orbignya phalerata* Martius) and its exploitation in the Cocais region of Maranhão, north-eastern Brazil

Claudio Urbano B. Pinheiro¹



(*Orbignya phalerata*)

Common name	Product part used	Dominant form of management	Degree of transformation	Commercial scale	Geographic distribution
Babassu	Fruit	Wild/managed	High	National	Wide

SUMMARY

The babassu palm (*Orbignya phalerata* Martius; Palmae) grows in parts of Bolivia and on 18.4 million hectares in the Brazilian states of Maranhão, Piauí, Ceará, Goiás, Tocantins, Mato Grosso, and Pará. In Maranhão, babassu occupies 10.3 millions of hectares. Chosen for this case study, Cocais is the most important of the seven ecological regions of the state of Maranhão from a socio-economic point of view. The name Cocais is derived from the presence of babassu as the predominant species of vegetation in the region, with intense growth (2.9 million hectares) and exploitation. The region, a microregion of Médio Mearim, was selected for this study, and more specifically the municipalities of Bacabal, São Luís Gonzaga, Lago do Junco, and Lago dos Rodrigues (04°23'11" S; 44°07'825" W). This study principally examined the production chain of babassu and its impediments. The results indicate few changes: the traditional system of breaking by hand is still predominant, and it is still subsistence work for the people that work the babassu. The oil industry went into decline, and the commercialisation of this product has its highs and lows. Other products are still only potentially important and used by people as subsistence products.

INTRODUCTION

The babassu (*Orbignya phalerata* Martius) is part of the palm family (Palmae). The genus *Orbignya*, to which the babassu belongs, has 11 species widely distributed on the American continent, which grow from Mexico to Peru, Bolivia, and Brazil (Anderson and Balick 1988). *Orbignya phalerata* is the most widely distributed and economically important species of its genus.

The taxonomy of the babassu has been the source of great confusion since the palm was first described more than a century ago. The confusion began on the generic level. The babassu has traditionally been included in the genus *Orbignya*, of the subtribe Attaleinae (the Cocoeae tribe); however, the genus *Orbignya* and the other four subtribes of Attaleinae have been questioned, first by Wessels Boer (1965) and, most recently, by Henderson (1995) and Henderson and Galeano (1996). The results of a monograph study on the subtribe Attaleinae carried out by Pinheiro (1997) indicate, however, that the traditional generic definition (with five separate genera) may be correct. This work adopts the traditional classification, defining *Orbignya phalerata* Martius as the botanical identity of the babassu.

The babassu palm grows in parts of Bolivia and in the Brazilian states of Maranhão, which contains around 60% of the growing area, Piauí, Ceará, Goiás, Tocantins, Mato Grosso, and Pará. The total babassu growing area in Brazil is estimated to be 18.4 million hectares. In Maranhão, the *babaçuais*, as the forest of this species is called, occupies 10.3 million hectares (Table 1).

Table 1. Growing area and production of *babaçuais* in Brazil, 1980

State	Geographic growing area (1,000 ha)	Area effectively covered (1,000 ha)	Productivity (t/ha/year)	Production (t)
Maranhão	10,304	4,723	1.69	7,796,095
Mato Grosso	3,184	612	1.13	694,775
Goiás*	2,971	1,138	2.92	3,323,504
Piauí	1,978	503	1.24	626,111
Total	18,437	6,976	1.86	12,440,485

* Data recorded before Goiás was divided into the states of Goiás and Tocantins
Source: MIC/STI (1982).

Study areas

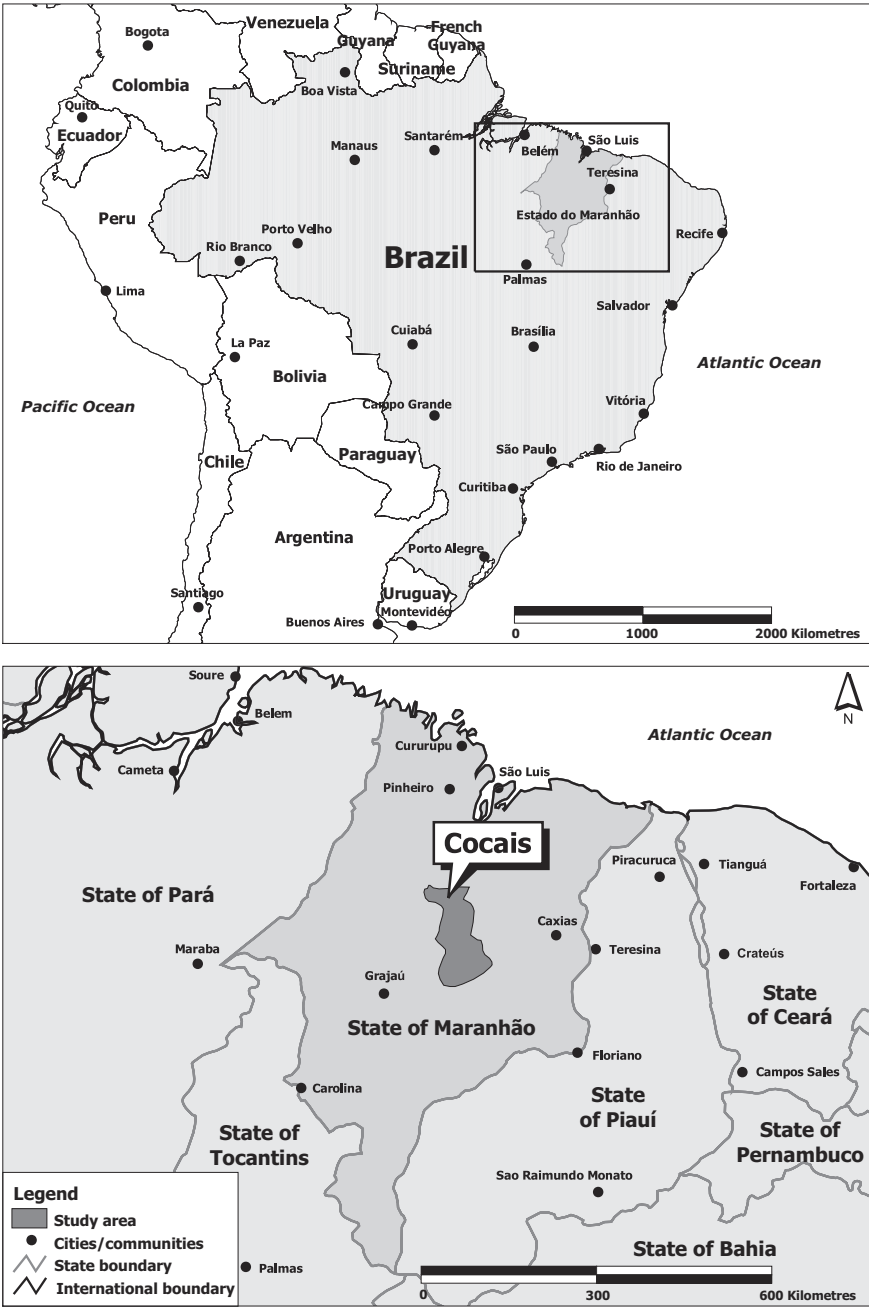
Chosen for this case study, Cocais is one of seven ecological regions of the state of Maranhão (SUDEMA 1970) and the most important from a socio-economic point of view. The name Cocais is derived from the presence of babassu as the predominant species of vegetation in the region, with intense growing (2.9 million hectares) and exploitation. Two other important growing and production regions (Table 2) are Cerrado (3.1 million hectares) and Baixada Maranhense (1.8 million hectares).

Table 2. Growing and production areas of babassu by region in Maranhão

Region	Area growing babassu (ha)	Area effectively covered by babassu (ha)	Average productivity (kg/ha)	Annual production per region (t)
Baixada	1,873,500	732,470	1,294.3	948,030.8
Cocais	2,970,000	1,841,450	2,148.9	3,957,009.0
Cerrado	3,162,000	1,378,510	1,235.3	1,702,809.0
Imperatriz	424,100	260,350	1,444.0	375,940.8
Contacto Chapadões	757,500	217,190	2,293.3	498,080.8
Contacto Pris-Amazonia	494,700	98,940	935.1	92,518.8
Enclave Areas (Special)	188,800	18,880	5,564.1	105,050.8
Plains and Plateau	371,247	146,568	1,696.1	248,593.5
Microregion 032	10,583	4,884	1,689.1	8,249.5
Microregion 029	51,073	23,570	1,689.1	39,812.1
Total	10,303,503	4,722,812	1,688.8	7,976,095.1

Inside the ecological region of Cocais (Figure 1), the microregion of Médio Mearim was chosen for this study, and more specifically the municipalities of Bacabal, São Luís Gonzaga, Lago do Junco, and Lago dos Rodrigues (04°23'11" S; 44°07'825" W). These four municipalities were selected for their importance in babassu production, for the concentration of a large number of results relevant to the survey applicable in this study, and for

Figure 1. Location of the study area



Source: ESRI Data and Maps 2002.

embracing biological and socio-economic aspects of the babassu as a vegetal resource and its production system.

In this region, because of the devastation of primary forest and the establishment of itinerant agriculture and pastures in previous decades, the babassu has emerged as the dominant species in secondary forests. Thus the babassu palm fulfils both an ecological and an economic role in its growing areas (Photo 1). The ecological role arises from its long-term maintenance of soil fertility under the extensive system conditions of farming and cattle raising (Anderson and Anderson 1983). The economic role takes the form of useful products derived from the fruit, leaves, and stem of the palm, which provide food, energy, and income. Subsistence products (charcoal, animal feed, oil, construction materials, etc.) obtained from the babassu contribute in innumerable ways to the economic survival of more than 1 million people in Maranhão state.

Photo 1. Forest devastation and soil management by annual cultivation and pasturing favour the babassu (*Orbignya phalerata* Martius) and have turned it into the dominant species in the Cocais zone (Photo: C. Urbano B. Pinheiro)



The natural picture

Soils

The Cocais region has reddish-yellow Podzolic soils (USDA system=Red-Yellow Podzolics, Ultisols) as its principal constituent. These soils are the principal support of the *babaçuais* in the region, and through the Podzolic the babassu achieves its prolific productivity. These soils also serve to support the large volume of subsistence farming, fruit culture, and today, principally, pastures for raising cattle. Plintosols (USDA system=Laterite), while less extensive than the Podzolic, are also important for the region. Generally, they have

low fertility and water percolation problems. In other regions of the state, Plintosols are also crucially important for the *babaçuais*. Latossols constitute the most important type of soil in the state, but are to be found only in small tracts in the Cocais. Sand (USDA system=Cambic Arenosols) also only appears in small tracts.

Climate

Type: Subhumid, tropical

Annual average rainfall: 1575 mm

Rainy season: December-May

Dry season: June-November

Average monthly temperatures: 27.5-28.4°C

Humidity: 67.8% (October)-85.2% (January)

Vegetation

Babaçuais constitute the most important vegetation in the region. They have replaced a large part of the original forest through their aggressive capability to colonise areas opened up by humans. They form large monospecific formations or are associated with secondary forests (*capoeiras*). Between the large *babaçuais* and the ever-increasing area of pasture for beef production, there are few areas of original forest left in the Cocais. As a consequence of the devastation of the original forest and the substitution of *babaçuais* with pastures, principally during the last decades of the twentieth century, profound soil changes in the region are apparent. With little vegetal cover, the Podzolic soils have lost their clay stratum and become sandier.

THE PRODUCTION-TO-CONSUMPTION CHAIN

Historically, the babassu economy in Maranhão was generated by kernel oil production (Amaral Filho 1990), although the mesocarp and endocarp also had commercial uses. The extraction of oil from the kernel by crushing of the fruit is still predominantly done by hand, although mechanisation and integrated processing also occur. Nonetheless, different forms of organisation to exploit the product can be identified. They include individual exploitation based on kernel extraction, a cooperative system for different products from kernels and mesocarp, small-scale mechanisation and integrated processing at the community level, and large-scale mechanisation for charcoal production. Different production conditions, even in the same geographical area, imply different markets, producing different barriers (economic, ecological, and regulatory), with different channels of commercialisation.

Aspects of the system and the data matrix construction

Most of the data used to construct the matrix was obtained in surveys carried out in different periods in the early 1980s. The biological and ecological data on the palm constitute the set of information obtained in surveys principally

carried out in the 1980s. The state and regional socio-economic implications for the production and commercialisation of babassu and its products reflect the situation in Maranhão from 1998 to 2003.

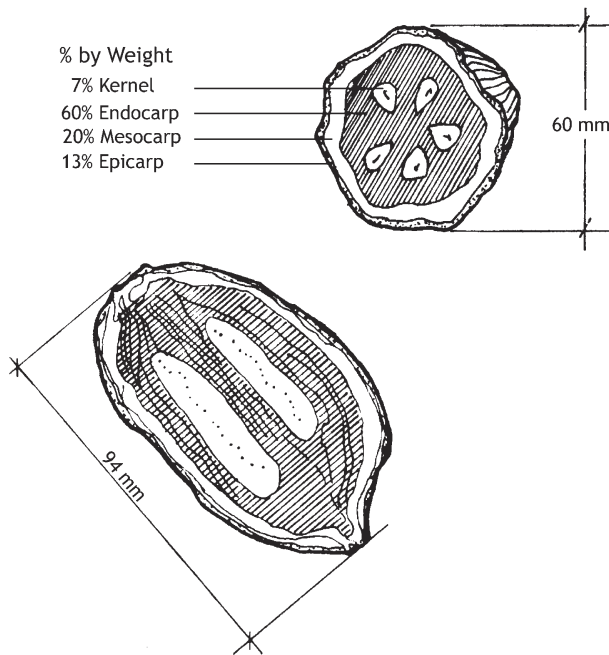
Practically all the areas planted in the region follow the rain patterns, as there is no significant irrigation in the Cocais. The regional soils are expressively occupied by natural or sown pastures (60%), resulting from the advance of cattle raising in the region. The forests of babassu, which still occupy a significant part of the regional soil (8%), appear to be associated with *capoeiras* or occur in virtually untouched formations or are associated with privately owned pastures. Whether or not babassu palms are kept in the pastures depends on the cattle farmers' decisions. In the case of the association of pasturage with babassu, the principal activity is cattle raising.

Regional itinerant farming is decreasing in the Cocais. The increase in population, the scarcity of available land, and the rise in the number of cattle farms have made this farming activity all the more difficult to maintain. The increase in the number of settlement areas in the region, however, has once more made this type of subsistence farming possible. Some of the subsistence farming is carried out in areas with *babaçuais*; others farm in the *capoeiras*, with ever shorter fallow periods.

Raw-material characteristics of the babassu fruit

The babassu fruit consists of four principal components: epicarp, mesocarp, endocarp, and kernel (Figure 2).

Figure 2. The babassu fruit and its components



The **kernel** of the babassu fruit constitutes around 7% of the entire fruit and contains more than 60% of the oil. This is the most intensively used part of the fruit, the oil from which is rich in lauric acids and is almost entirely used in the production of washing soap, toilet soap, and cosmetics in general. The extraction and sale of kernels to the oil industry, traditionally, is of major importance to the babassu economy in Maranhão.

The **endocarp** of the babassu fruit, the raw material for charcoal production, represents around 60% of the entire fruit. Although rural families have domestically used the charcoal derived from the endocarp for decades, it has only recently been recognised as a sustainable source for industrial combustion. Besides being a renewable resource, the babassu endocarp charcoal has a caloric value around 27% greater than that of wood charcoal, a consequence of the high content of fixed carbon. The pig iron industries and other related metallurgical activities installed in Maranhão and Pará have an estimated annual charcoal demand of 4.25 million m³ to produce 1.7 million t of pig iron, 88% of it in Maranhão.

The **mesocarp** represents around 20% of the fruit and is composed of up to 60% starch, around 20% fibre, 8% to 15% moisture, and 4% to 5% diverse substances including minerals, tannins, and a small quantity of protein. The use of babassu starch in human food still requires research into its purification and nutritional enrichment. In the pharmaceutical area, the starch has been indicated (and is sold in pharmacies) as a cure for many illnesses; yet, there have not been any pharmacological studies to prove the medicinal qualities attributed to the babassu mesocarp. Animal feed is a most promising application.

The **epicarp**, the external stratum of the fruit, is composed of fibres and represents about 13% of the entire fruit. It represents a powerful primary source of combustion with an excellent calorific value. It has industrial potential, but presently no defined market.

In this study, we consider the fruit a basic crude-state raw material and the extracted kernels a semiprocessed raw material. The analysis of the production system will consider only the oil extracted from the kernels, without analysing the charcoal and the mesocarp or additional products directed to different, presently nascent markets. The oil is considered a primary product. Lacking an adequate category in the matrix, it was allocated as a chemical—a source of fatty acids for the production of this type of product. The secondary use defined here for the oil is as human food, not a valuable commodity today, being unable to compete commercially with soy oil. As a complementary foodstuff for rural families in Maranhão, babassu oil, besides being used for cooking and frying food, is also used as a ‘milk’ additive to food. Other uses include the production of household soap, as an insect repellent and, in certain cases, a vermifuge. Taken generically, the various parts of the babassu palm give rise to more than 60 products; in this study only the oil is considered.

Production system characteristics

In most of the systems associated with the cultivation of babassu, the producers do not own or control the land. In the Cocais region, subsistence farming is mainly carried out on the vacant land of absent or unknown owners, small properties, and unexplored land. In this context, where squatters and small landholders predominate, the average area cultivated is 2.1 hectares per family. The following describes the principal figures that use and own land in the region connected to the exploitation of babassu.

Tenant farmers are small producers that, by agreement with the landowner, receive a dwelling, a tract of land to cultivate, and the right to extract resources in exchange for payment in kind, usually rice. In this system, the usufruct is related to land access according to traditional arrangements, in which small tenant farmers share the common rights to exploit a group of palms.

Occupants are inhabitants that occupy land from former times, which they make use of, without definitive ownership. The principal activities are grazing and felling; occupants have access to the babassu within the limits of the land occupied.

Settlers are workers installed on land confiscated by federal or state authorities as part of the agrarian reform program. These areas can be communal, for all the inhabitants, or individual plots. Family farming constitutes the principal activity and the babassu palms are for common use.

Large landowners and estates (???) are owners of huge tracts of land generally used for cattle raising. They do not work the land personally, nor exploit the babassu for commercial interests. Where pastures are fenced, access to the babassu coconut for families depends on the type of relationship established with the owners. In most cases large landowners restrict access, alleging that fruit collectors damage the fences when they enter the properties, set fire to the pasture, and leave holes in the soil whilst making charcoal, which exposes the animals to risk of physical injury (May 1990). Conflicts also arise when babassu exploiters believe that, even though the land is in private hands, the babassu thereon is for common use: not having been planted, it is a gift of nature.

In the cultivation systems associated with the babassu, producers thin out the palms, leaving between 50 and 100 units per hectare. The palm leaves remaining are burnt or used for diverse purposes (shelters, cribs, mats, fencing, etc.). After the annual burning, mature palms recuperate rapidly (in two to three years) to bear fruit once again, according to the producers. This hardiness is in part due to the fact that bracts resistant to the effects of fire protect the unopened flowers.

In the production systems of small farmers, the babassu functions principally as a biomass producer in the intensive burning of secondary forest, necessary to supply nutrients, reduce infestations of weeds, and clear the land for cultivation. The babassu is considered one of the most effective biomass producers among the forest species in tropical and subhumid ecosystems. Anderson and Anderson (1983) calculated that in a dense grove of babassu in Maranhão leaf biomass totalled 52.7 tons dry weight per hectare, and that the annual leaf production was in the order of 16.8 tons dry weight.

Regional cattle raising uses a certain level of technology. The pastures are fenced off, clearly defining the owner's domain. In pastures, around 50 to 120 palms per hectare are left standing; cattle raisers also tend to chop down unproductive palms. *Babaçuais* in pasture areas facilitate fruit collection. Cattle raisers believe that the palms contribute to moisture retention of the pastures, which then fosters higher productivity. On the other hand, the intensive growth of young babassu plants (*pindoveiras*) in the pastures constitutes a serious problem for the cattle raisers, so much so that today they use herbicides to eradicate these plants. Suppression of young babassu plants results in the total degradation of the stands for around 50 years, owing to the remaining palms' senescence (Anderson and Anderson 1983).

Even when *babaçuais* are managed by small farmers or cattle raisers, this is not necessarily done for the improvement of the babassu grove, but in order to clear the land for pasture, with both positive and negative effects on the *babaçuais*. Thus, no management exists of the natural babassu population directed towards improvement of its fruit production; instead, only the viability of the associated exploitation (e.g., pasture, subsistence cultivation) is considered.

Fruit collection and processing

The babassu fruit begins to mature and fall from bunches beginning in July and August. Fruit collection and kernel extraction is concentrated between October and March. During the farming period, fruit collection becomes

Photo 2. The traditional system of fruit breaking and extraction of the babassu kernel in the Cocais region, Maranhão (Photo: C. Urbano B. Pinheiro)



a secondary activity, limited by the need of manual labour for the annual cultivation. The collecting is carried out by all the family members in areas close to their homes. In areas far away from the homes, this work is predominantly done by the men. Normally, animal transport is used to remove the fruit from the fields. In the rainy season, access to the *babaçuais* becomes more precarious and collecting difficult.

Women carry out the breaking of the fruits. On average, a fruit breaker can extract about 5 kg of kernels per working day, although some individuals extract up to 15 kg. Being the only family income-generating activity carried out exclusively by women, the work has acquired a connotation of liberty in the feminine imagination (PENSA/USP 2000).

The babassu is integrally utilised by the families that survive from subsistence farming from palm exploitation. Kernels not sold are used to produce oil and 'milk' for domestic consumption. The mesocarp is used as much for human food as for animal feed. Charcoal is produced from the endocarp, and is used as cooking fuel. The dry leaves (*palha*) are used as a roofing finish for their dwelling and for making baskets, mats, fences, etc. These rural families use around 5% of the collected nuts for domestic consumption. The remainder is sold in exchange for foodstuffs.

The ecological implications of production

In the municipal area covered by this case study, the babassu density varies as a consequence of various factors, including the predatory actions of humans in areas used for farming and/or cattle raising. The average density in the area observed was 60 to 100 adult palms per hectare. Young palms also seem to be in abundance in the region, with a large number of *pindoveiras* (from 300 to 1000 per hectare) on land where pastures have not been established.

The singular dominance of the babassu palm over extensive areas has important ecological and socio-economic implications. From the ecological perspective, dominance by one unique tree species is an exception to the rule that tropical and humid regions generally exhibit extraordinarily high biological diversity. The dominance indicates that the babassu possesses unusual ecological characteristics, which allow it to compete so successfully. From a socio-economic perspective, its usage is facilitated by the occurrence of an economically important species in great number.

The babassu's longevity—from 150 to 180 years, on average—associated with its frequent and continual use and with disturbances and management by humans, provides us with the peculiar characteristics that have made some researcher call these entities 'oligarchic forests' (Peters *et al.* 1989). Linked to these forests, then, are a considerable number of regional life forms that require, for their equilibrium and survival, the conservation of the *babaçuais*.

Dominant forest palm species normally occur in marginal areas inappropriate for conventional agriculture. Many species dominate temporarily or permanently in flooded locations, where farming is minimal or nonexistent, while others develop on land degraded by anthropic action. The palms appear to be an important, and possible unique, contributor to the recuperation of

these degraded areas through their ability of absorbing nutrients deep in the soil (Anderson *et al.* 1991). *Babaçuais* also constitute an important food source for the animal communities.

Socio-economic characteristics of crude-state raw material (fruit) and semiprocessed (kernels) production

Fruit breaking and kernel extraction are considered 'women's work', as women and children do around 80% of that work, whereas men are more involved in farming. The allocation of hand labour to babassu processing depends on the time of year. During the farming season from January to June, agriculture uses about 35% of the total hand labour performed by members of a family unit, while the babassu uses only 25% as women reduce the time spent collecting and breaking fruit in order to help the men in the fields. During the dry season from June to December, babassu collecting and processing may occupy 80% of the women's time and 65% of the children's.

Babassu income is chiefly received by the women, who then buy essential items for the family's sustenance, especially foodstuffs. The babassu functions as an alternative insurance against poor agricultural harvests.

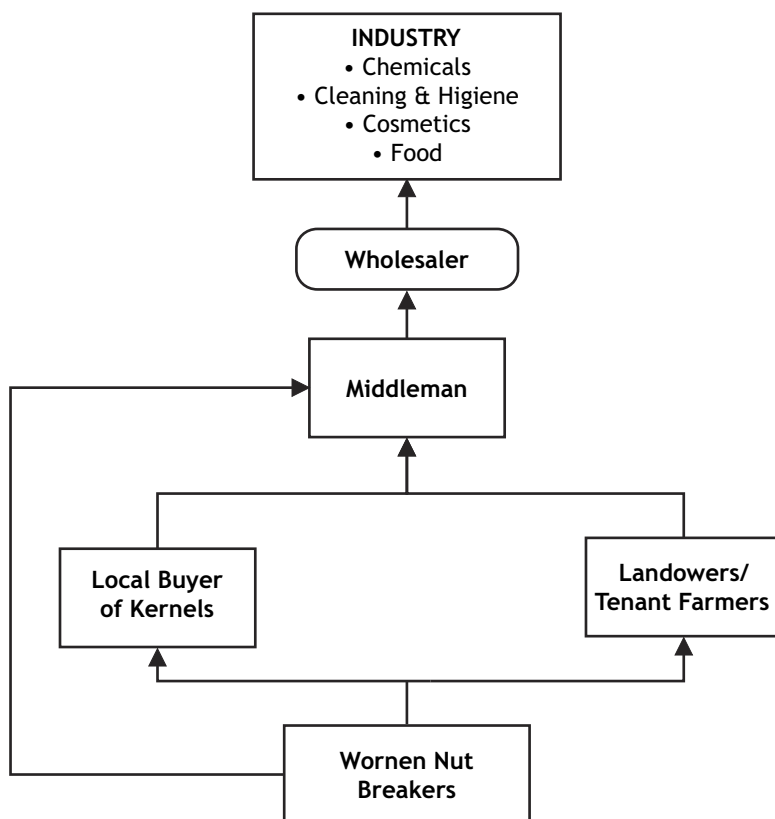
Product and consumption characteristics

The final product derived from babassu exploitation, lauric oil, competes in markets in which competitors possess cutting-edge technology as the agro-industry is highly competitive in both production and organisation. Lauric oils are those consisting of free fatty acids, lauric acid being the principal constituent (on average 46%). The principal competitors of babassu oil in the market are palm oil from the African oil kernel and coconut oil. The world market for lauric oil is estimated to be 5 million tons annually. Coconut oil constitutes 53% of this total, with an annual consumption of approximately 2.3 million tons. Consumption of palm oil is around 2.6 million tons per year, while the demand for babassu oil does not exceed 35,000 tons. Lauric oils have diverse uses, being commonly employed in the manufacture of washing soaps, hand soaps, shampoos, cosmetics, industrial emulsifiers, and margarines. The Brazilian market for lauric components (oils, acids, and fats) is estimated to be 150,000 tons. The principal consumers are the margarine industry and hygiene and cleaning products manufacturers located in the southwest of the country.

Babassu kernel production as raw material for oil production is extremely onerous, due to the low volumes negotiated, the decentralisation of the extractive units, the large number of middlemen, the long distances from the producer centres to the factories, and, finally, to the precarious infrastructure. The kernel offer is irregular, fluctuating according to the performance of the other farming activities of the family. Since the offering is irregular the organisational structure is complex and absorbs a significant part of the value generated in the chain (Figure 3). With low prices and high variability, the 'nut breakers', that is, the women dedicated to kernel extraction from the babassu fruit, have no incentive to provide regular supplies of the product.

Thus, babassu oil has lost market share to other oils, and the decline in the number of crushing units in Maranhão, and other Brazilian states, is the surest indicator of the loss of product competitiveness in the market.

Figure 3. Flowchart of the raw material (kernels) from the production area to the oil extraction factories



TRENDS AND QUESTIONS

The extractive character of the babassu produces high production costs, originating principally from the palm's low productivity, the scattered nature of the individual production areas, which makes access to the *babaçuais* difficult, and the irregular availability of kernels. The collection has a high locational specificity (PENSA 2000), as collectors are able to travel only relatively short distances from their dwellings. The exploitation of *babaçuais* in third-party areas causes uncertainty in the system as a result of problems arising from the poor definition of property rights.

Besides these problems at the heart of the production system, babassu oil, as already explained, faces stiff competition from other products in all the present and potential markets by the restricted specific characteristics

valued by consumers. One of the possibilities of differentiating the product is an appeal for a socio-ecologically correct product. Even so, the present market for oil, soap, and charcoal from babassu with an environmental and/or social certification is small, but promising nationally and internationally. For it to take off, however, the processing technology has to improve, in view of the low quality of the final products.

The market for charcoal as a raw material input for the steel industry could be seen as an alternative way to revitalise the babassu economy, liberating steel makers from their dependency on the oil market. And indeed there is growing demand for charcoal in the steel and pig iron industry. The environmental stamp of approval would be of significant value in a production system where the babassu was recognised as an important renewable resource of raw material for charcoal production.

The fundamental problems that pervade the transactions of the babassu economy constitute an impediment to the development of a modern economy in Maranhão. Organised production depends on contracts that define property rights of each agent in the system, so as to encourage private investment.

IMPLICATIONS OF THE CASE STUDY FOR CONSERVATION AND DEVELOPMENT

After 80 years of exploitation of the babassu palm, numerous works on its products' high potential, and some two decades of surveys during intermittent periods, this economy has never developed as hoped. A historical evaluation of babassu exploitation allows us to identify certain social, technical-scientific, and environmental indicators. These indicators show fluctuation in the success and failure (partial or total) of development schemes and changes (positive or negative) in the lives of the people who exploit the palm and its products. These also offer elements to evaluate the balance between conservation and devastation of the *babaçuais* during almost a century of exploitation.

Indicators of the advances in organisation and social mobility

- a) There has been a significant increase in the level and capacity of the social organisation of the 'nut breakers' in all the Brazilian states in which the babassu grows, and particularly in Maranhão. The fight of the nut breakers for betterment of their working lives has given rise to heavyweight organisations in the rural sector in Maranhão. The Interstate Movement of Babassu Nut Breakers of Maranhão, Piauí, Pará and Tocantins (MIQCB), the Womens' Association of Rural Workers of Maranhão (AMTR), the Settlement Areas Association of Maranhão (ASSEMA), the Babassu Work Groups, Unions and Associations of Rural Workers operate in all the state municipalities. Politics in various forms and movements raise a common awareness, which in turn produces positive results.
- b) Production in co-operatives has also grown. In 1998, there already existed five agro-extracting cooperatives, the best examples being the Agro-extractive Cooperative of Small Producers of Lago do Junco (oil production), a soap factory (settlement of Ludovico, in Lago do

- Junco), the co-operative for mesocarp extraction (in the municipality of Esperantinópolis), and two initiatives of AMTR; all these examples are to be found in the Cocaís region.
- c) The number of conflicts over land rights in Maranhão has diminished over the past few decades. More than 500 settlements have been established in the state, but the problem of common resources in private areas still persists and these fundamental problems still hinder development. There has been little advance in conflict resolution between the formal rights (tied down babassu) and the traditional ones (free babassu).
 - d) The management capacity for commercial initiatives in the babassu rural communities has improved, reflected in the examples given above, such as the soap and oil factories and the mesocarp processing.
 - e) The human development indicators in the region of babassu production are unacceptable. The changes observed in the social organisation do not yet reflect the gains in the quality of life of these areas due to the resource's exploitation.

Indicators of the improvement in technical-scientific knowledge

- a) There have been advances in the creation of knowledge about the babassu palm and its production system. A great deal of information was generated since the beginning of the 1980s. Nevertheless, even with a large technical-scientific production, much of the information is restricted to the technical and academic sphere, with little dissemination of selected material directed to the productive base.
- b) There have also been advances in the creation of technological innovations with the potential to improve the integrated production system (collection, transportation, storage, and integral processing) in the characteristic rural community. Nevertheless, the capacity to create initiatives around the babassu is still incipient. There is resistance to innovation. The integral processing equipment is still of an experimental nature. Finally, there is the fear that the added value of the fruit and its products will limit, yet further, access to the raw material by awakening the economic interests of the landowners.

Economic indicators

- a) The export market share of the babassu from Maranhão State is insignificant, and the oil has an unstable internal market. The instability defined by the competition with the African oil palm and the coconut discourages industrial babassu oil production, and as a consequence, the productive base has reduced interest in the exploitation of the fruit. Estimates indicate that only 26% of the fruits produced annually in Maranhão are used.
- b) The number of oil factories in Maranhão has decreased dramatically between 1980 and 2000. Before 1980, there were 33 factories; presently, only 6.

- c) The market for lauric oil in Brazil is around 150,000 tons; babassu represents only 30,000 tons to 40,000 tons.
- d) On a positive note, new niche markets are appearing in Brazil, principally in natural products such as soaps, ecological charcoal, and other certified natural products.
- e) New market possibilities also include derivatives from both the endocarp—charcoal for steel manufacture, ecological charcoal, and activated charcoal—and the mesocarp—human and animal food, medicine (with large sales to pharmacies).

Enviromental indicators

- a) There is no present data on the situation of the *babaçuais* in Maranhão. At the same time that the devastation of the *babaçuais* in the Cocais region is noticeable, one can also observe the huge expansion of babassu forests in other regions of the state, notably in the Pre-Amazon. In general, however, devastation has increased, estimated to be total in 25% of the *babaçuais* areas (about 2,000,000 ha).
- b) There exists legislation to protect the babassu, but it is rarely applied.
- c) In areas where there has been an expansion of babassu growth, there has not been a corresponding interest in its extraction. In the areas where the extractive interest has fallen, the level of preservation has also fallen; cattle raising and land clearance, with less selective attention paid, has increased (thinning out).
- d) On a positive note, in 1992 three extractive reserves were created in Maranhão and one in Tocantins, with a total area of 36,322 hectares, and where 3,350 people live. Nevertheless, an extractive activity of babassu does not seem to benefit the model of these conservation entities, although there was also some progress in the activities in these areas.
- e) One of the environmental perspectives associated with the sustainable exploitation and conservation of the babassu is its ability to fix carbon. *Babaçuais* could be treated as energy forests.

The expansion of farming and cattle raising in Maranhão will continue to compete with *babaçuais*. The profitability of the diverse market segments that make up the babassu production system will, in the last instant, determine the preservation of the existing palms. In the event that the oil and charcoal markets do not guarantee an adequate remuneration for the productive agents, it is difficult for legislation to protect the babassu and counter the expansion of other economic activities in these areas.

After 80 years of exploiting this palm, innumerable works on its products' high potential, and some two decades of endeavours to carry out surveys during intermittent periods, one has to come to the conclusion that the babassu economy has not, in fact, developed. The traditional system of hand labour still predominates. The oil industry has entered into decline, and the commercialisation of this product has its highs and lows. Most products are not produced to their highest quality potential; and it is still a subsistence

activity for those people who exploit the babassu. The economic development perspectives of the babassu, nonetheless, continue.

NOTE

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REFERENCES

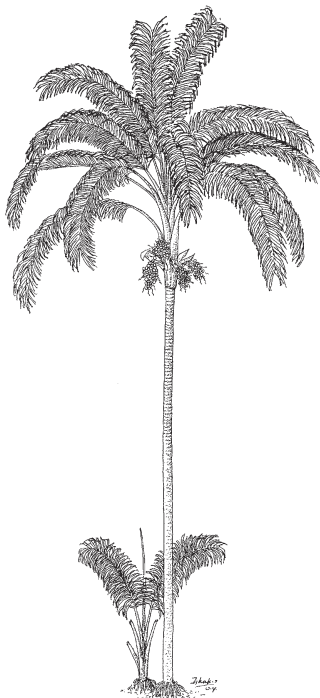
- Anderson, A. and Anderson, S. 1983. People and the palm forest: biology and utilization of babassu palm in Maranhão, Brazil. University of Florida, Gainesville.
- Anderson, A. and Balick, M. 1988. Taxonomy of the babassu complex (*Orbignya* spp.: Palmae). Systematic Botany 13: 32-50.
- Anderson, A.B., May, P.H. and Balick, M.J. 1991. The subsidy for nature: palm forests, peasantry, and development on an Amazon frontier. Columbia University Press, New York.
- Amaral Filho, J. 1990. A economia política do babaçu: um estudo da organização da extrato-indústria do babaçu no Maranhão e suas tendências. SIOGE, São Luís, Maranhão, Brazil.
- Henderson, A. 1995. The palms of the Amazon. Oxford University Press, New York.
- Henderson, A. and Galeano, G. 1996. *Euterpe*, *Prestoea*, and *Neonicholsonia* (Palmae: Euterpeinae). Flora Neotropica Monograph 72: 1-90.
- May, P.H. 1990. Palmeiras em chamas: transformação agrária e justiça social na zona de babaçu. EMAPA/FINEP/Fundação Ford. São Luís, Maranhão, Brazil.
- MIC/STI (Ministério da Indústria e Comércio/Secretaria de Tecnologia Industrial) 1982. Mapeamento do potencial das ocorrências de babaçuais. Estado do Maranhão, Piauí e Goiás. Brasília, Brazil.
- Pinheiro, C.U.B. 1997. Systematic and agroecological studies in the Attaleinae (Palmae). Ph.D. Thesis, City University of New York, USA.
- PENSA/USP (Universidade de São Paulo, Fundação Instituto de Administração) 2000. Reorganização do agronegócio do babaçu no Estado do Maranhão. GEPLAN/MA, São Luís, Maranhão, Brazil.
- Peters, C.M., Balick, M.J., Kahn, F. and Anderson, A. 1989. Oligarchic forests of economic plants in Amazonia: utilization and conservation of an important tropical resource. Conservation Biology 2: 18-38.
- SUDEMA (Superintendência do Desenvolvimento do Maranhão) 1970. Novo zoneamento do Estado do Maranhão. São Luis, Maranhão, Brazil.
- Wessels Boer, J.G. 1965. The indigenous palms of Suriname. Brill, Leiden.

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Chapter 9

Underutilization of pupunha (*Bactris gasipaes* Kunth, *Palmae*) in Central Amazonia: history, production-to-consumption system, implications for development and conservation

Charles R. Clement and Johannes van Leeuwen¹



(*Bactris gasipaes*)

Common name	Product part used	Dominant form of management	Degree of transformation	Commercial scale	Geographic distribution
Pupunha, Pejibaye, Peach palm	Fruit	Cultivated	Low	National	Wide

ABSTRACT

Pupunha (*Bactris gasipaes* Kunth, Palmae) was domesticated for its starchy fruit in south-west Amazonia and spread throughout the lowland humid neotropics as a subsistence staple before European conquest. Today it is underutilized in Amazonia, although research and development efforts attempt to restore its importance, with occasional success. A settlement in Manacapuru, Amazonas, Brazil, exemplifies the fruit's production-to-consumption system. Seventy percent of families with home gardens grow pupunha, as do 40% of families with agroforestry plots, but with 1-18 clumps (mean 4.9, each with 2.9 stems) in gardens and 20-50 clumps (mean 36, with 1.2 stems) in plots, it is not abundant. Maintenance is casual, manual, and low input; hence, yield (mean 5 bunches/stem and 2 kg/bunch) and farm-gate prices (US\$0.25-0.50/bunch) are low. Cooking of the starchy fruit before consumption is the only processing employed, although fermentation and flour preparation were once traditional processes. Most bunches are sold to Manacapuru urban markets (prices US\$0.50-1.00/bunch) or Manaus markets (US\$1-3/bunch). Approximately 50% of production is used in subsistence or commercialized, the rest is wasted. There are no policy barriers to enter this production-to-consumption system. Lack of processing alternatives, demand, and good production-to-consumption information inhibits entrepreneurial interest. The implications are continued genetic erosion and further underutilization.

INTRODUCTION

The first peoples of south-western Amazonia domesticated the pupunha, peijibaye, or peach palm (*Bactris gasipaes* Kunth, Palmae) for its fruit and spread it throughout the lowland humid tropics before the European conquest of the Americas (Clement 2000). After the conquest pupunha became a neglected or underutilized crop (Mora Urpí 1992), although today it is regaining importance as a new crop: heart-of-palm (Mora Urpí *et al.* 1997). As a domesticate it is unlike the majority of the other species included in this study, but offers a useful contrast and highlights many of the issues involved in developing markets for new crops, both extractive and agricultural, and conserving their genetic resources.

The notion that development of new markets contributes to enhanced species conservation is common to the fields of genetic resources utilization and development (Smith *et al.* 1992), new and underutilized crop development (Kiew 1996), and extractive products development (Belcher & Ruiz-Pérez 2001). It is unclear whether this view holds true or not, especially as intellectual property rights-driven biotechnologies are capturing the lion's share of world research and development (R&D) resources and globalization is homogenizing markets at the same time as it ignores questions of sustainability (Pistorius & van Wijk 2000; Wood *et al.* 2000). Nonetheless, there is reputed to be demand for new and underutilized crop and extractive products in world markets, at least in the rapidly growing green (Clay 1996) and solidarity segments. The pupunha has been the object of considerable Latin American R&D during the last 20 to 25 years, partially stimulated by a National Academy of Sciences study (NAS 1975). This R&D effort is designed to develop new markets and

conserve this tropical American heritage (Mora Urpi *et al.* 1997), although the obstacles to this development in Amazonia are significant (Clement 1997). This chapter provides an outline of the current use of pupunha and its importance as a fruit crop in one small part of Amazonia. Further information, including on its use and importance as a source of heart-of-palm, is available in Mora Urpi *et al.* (1997), Clement (2000), and references therein.

Before the European conquest, pupunha was a food staple in parts of the southern Mesoamerica and north-western South American lowland humid tropics. As a starchy staple it was used principally as an energy source and for fermentation, although all parts of the plant were used for something (Patiño 1992). It was probably not traded over great distances, since it was grown widely throughout the region. In some areas, such as south-eastern Costa Rica, it was so important that the European conquerors destroyed enormous plantations in order to subjugate their owners (Patiño 1992). As European dominance spread, pupunha became continually less important throughout its range; once dominance was assured and as local peoples adopted European food preferences, pupunha became further neglected by lack of preference and the introduction of competing foods, especially processed products in the last 50 years. By the mid-twentieth century, pupunha had arrived at its lowest importance in the last 1,000 years.

The native peoples of central Amazonia have certainly known pupunha for thousands of years, although it was probably not as important a staple as it was in north-western Amazonia, the Chocó of Colombia, and southern Mesoamerica. By the mid-twentieth century, pupunha had become merely a common component of home gardens and swiddens, generally as one part of a subsistence system that provides reasonably good food security. Its current cultural importance is minimal, a reflection of its neglected status, although it is the second most popular palm fruit in the Manaus market, trailing only tucumã (*Astrocaryum aculeatum* G. Mey., syn. *A. tucuma* Mart.). This apparent contradiction will become clear when the fruit's current uses are detailed below.

Although central Amazonian R&D institutions have worked extensively on pupunha and promoted it vigorously at various times in the last 20 years, its economic importance as a fruit crop remains minimal also—for example, it was not mentioned in the IBGE (1995) Agricultural Census in any Brazilian Amazonian state, although there are probably 7,000,000 trees in Amazonas state alone (Geraldo Couto Araujo, IDAM personal communication). Its impact on livelihoods is moderately important in rural areas, however, as it contributes to food security (via energy and vitamin A) in the subsistence economy. This lack of current economic importance is in remarkable contrast to pupunha's previous importance and is what continues to drive the efforts to transform its potential into market demand. The lack of importance is also what makes it an interesting subject for this study².

THE PRODUCTION-TO-CONSUMPTION SYSTEM

Unlike other species in this study, pupunha is an agricultural crop, grown principally in home gardens and various agroforestry systems (Clement 1986,

Photo 1. Pupunha has been domesticated in household orchards and around indigenous settlements (Photo: C.R. Clement)



1989, 2000). Nowhere in its range are natural populations managed or even used today (except very occasionally as ornamentals), although wild pupunha (*B. gasipaes* var. *chichagui*) are tolerated in traditional production systems (Clement *et al.* 1999); see Clement (2000) for a discussion of the probable sequence of domestication and why natural populations are not used. Hence, the ecological implications of pupunha production are deforestation—not primarily for pupunha, but for cassava (*Manihot esculenta* Crantz) and other current staples, amongst which pupunha is planted. Deforestation is generally followed by the swidden/fallow sequence, with numerous variations, where the presence of pupunha and other perennials is an advantage, as they prolong the useful life of the swidden and even of the fallow (Denevan & Padoch 1987). During the final phase of abandonment, pupunha disappears from the fallow (Clement 1990). As alluded to above, as an underutilized fruit crop pupunha is not as important as it once was in the subsistence production system nor is it well represented in the market production system. This will become dramatically clear in what follows.

***Bactris gasipaes* (Mora Urpí et al. 1997)**

The pejibaye is an allogamous, caespitose palm. The stem internodes are generally heavily armed with thin, strong black spines of different sizes, although there are some populations that have been selected by the Amerindians for spinelessness. Stem diameter varies from 12 cm to 30 cm and stem internode length from 5 cm to 40 cm during the early years, after which it becomes progressively reduced to about 1 cm to 2 cm in older plants, as these change from a purely vegetative to a fully reproductive stage. The plant may attain heights of 15 m to 20 m quite rapidly, which presents a major problem for harvesting (Clement 2000).

The leaves are pinnate, generally with a spiny petiole and rachis, and frequently spiny leaflet nerves. The leaf rachis ranges from 100 cm to 300 cm in length and curves downward with age. Leaflets number from 100 to 300 and are arranged in groups along the rachis, with each leaflet inserted at a different angle within the group, giving the frond a shaggy appearance. Leaflets range from 50 cm to 120 cm in length and 20 mm to 60 mm in width.

The inflorescences are monoecious, arising in the axil of each leaf and becoming visible as the leaf enters senescence or is already drying. In Manaus, Brazil, the major flowering season occurs at the end of the dry season, with fruiting three months later, extending from late December to late March. The inflorescence peduncle varies from 30 cm to 60 cm in length, and the rachis from 20 cm to 50 cm, with between 20 and 80 rachillae, which bear the flowers. Each rachilla has several to more than a dozen pistillate flowers and several hundred to more than a thousand staminate flowers. The inflorescence may contain anywhere from 25 to 1200 pistillate and 10,000 to 30,000 staminate flowers.

The spathe of the inflorescence opens in the late afternoon, at which time the pistillate flowers are already receptive. Pollination is entomophilic, carried out by small curculionid beetles, which arrive during the same afternoon and early evening. Twenty-four hours later the staminate flowers open, liberate their pollen and fall, at which time the beetles leave the inflorescence to find another. With this pollination sequence and a probable partial self-incompatibility, the pejibaye is principally allogamous, although some to considerable self-fertility has been observed.

Fruit set varies from nil to better than 85%, depending upon pollination, environment, and internal factors. The fruit weigh from 10 g to 250 g each, while fruit bunches weigh between 1 kg and 27 kg. Fruit size is negatively correlated with fruit number per bunch. Skin colour varies from yellow to dark red. Fruit mesocarp composition varies considerably: water, 25 g/100 g to 82 g/100 g (mean 53.5 g/100g); carotene, 0 to 70 mg/100 g; protein, 1.8% dry weight to 14.7% (mean 7.8%); fats, 2.2% dry weight to 61.7% (mean 15.8%); other carbohydrates, 14.5% dry weight to 84.8% (mean 67.8%); and fiber, 2.0% dry weight to 18.5% (mean 6.7%). Given this composition, it is clear that pupunha is more like sweet potato (*Ipomoea batatas* Lam.), cassava, or maize (*Zea mays* L.) than a fruit in the conventional sense: it's starchy rather than succulent, mealy rather than crispy or juicy. Like most other starchy foods, it must be cooked, both to denature a proteolytic enzyme

and to dissolve crystals of calcium oxalate in the exocarp and just below it. Pupunha is something of an acquired taste, although some people take to it immediately if introduced to one of the good ones. Just as with morphologic and chemical variability, organoleptic variability is abundant and seems to be determined by the various combinations of fatty acids, carotene, and volatile components (Andrade *et al.* 1998).

Geographical setting

Central Amazonia's climate is classified as 'Af' in the Köppen system. At Manaus, its largest city, the mean temperature is 25.6°C and mean rainfall is 2,478 mm (Ribeiro 1976). Its soils are mostly Oxisols and Ultisols, with lateritic horizons when located near the main rivers, and with reasonable areas of Humic Gleys along the flood plains of white-water rivers, although not black-water rivers (Sombroek 1966). The natural vegetation is tropical moist forest, in Holdridge's classification (Tosi & Vélez-Rodriguez 1983).

Central Amazonia is not a single political unit. It contains the eastern part of the state of Amazonas and the extreme western part of the state of Pará. Its major urban centre is Manaus, which had a population of about 1.4 million in 2000. Manaus is connected to other parts of Amazonia by the river system, including the main east-west Amazonas and Solimões rivers (Solimões is the local name for the Amazonas River above its confluence with the Negro River at Manaus up to the Colombian-Peruvian frontier), the north-west Negro River, the south-south-west Madeira River (now a hydrovia) and other large, but less economically important tributaries. It is also connected to Roraima (Brazil) and Venezuela via the all-weather federal highway BR 174, as well as to two minor urban centres by all-weather roads—Itacoatiara via AM 010 and Manacapuru via AM 070.

The community presented in this case study, São João Batista, is located in the municipality of Manacapuru, 62 km from Manaus and 17 km from Manacapuru (urban centre). São João Batista is a municipally-planned upland agrarian settlement along a side road (Ramal da Laranjal) that connects state highway AM 070 to the Solimões River³. The community has neither river edge nor highway edge properties, however, since the river edge has been occupied for centuries in this region and the highway edge is mostly owned by wealthy urbanites who maintain weekend 'farms' along the paved highways near urban centres like Manaus and Manacapuru. The settlement was created in 1986 by opening the side road and now contains 48 families of small farmers. Several members of the settlement collaborate with the Agroforestry Unit (van Leeuwen *et al.* 1994) of the National Research Institute for Amazonia (INPA), part of Brazil's Ministry of Science and Technology. Data previously collected by the Agroforestry Unit were used in this article.

Except for being a municipally planned settlement, São João Batista is typical of small communities near Manaus in that most residents are native to Amazonia (with some north-easterners) and have some access to transportation and, therefore, markets. As in most such communities, the lack of pertinent agricultural and entrepreneurial education, and especially market intelligence (which should be provided by the extension service),

limits economic activities⁴. As in most such communities, pupunha is only one component of their subsistence and market economies, generally an unimportant component. Some regional communities, such as those around the municipal centre of Rio Preto de Eva, 80 km north-east of Manaus, specialize in pupunha for the Manaus market. Concentrating on Rio Preto de Eva, however, would provide a biased examination of pupunha in central Amazonia, while São João Batista probably provides a less biased sample.

The resource base

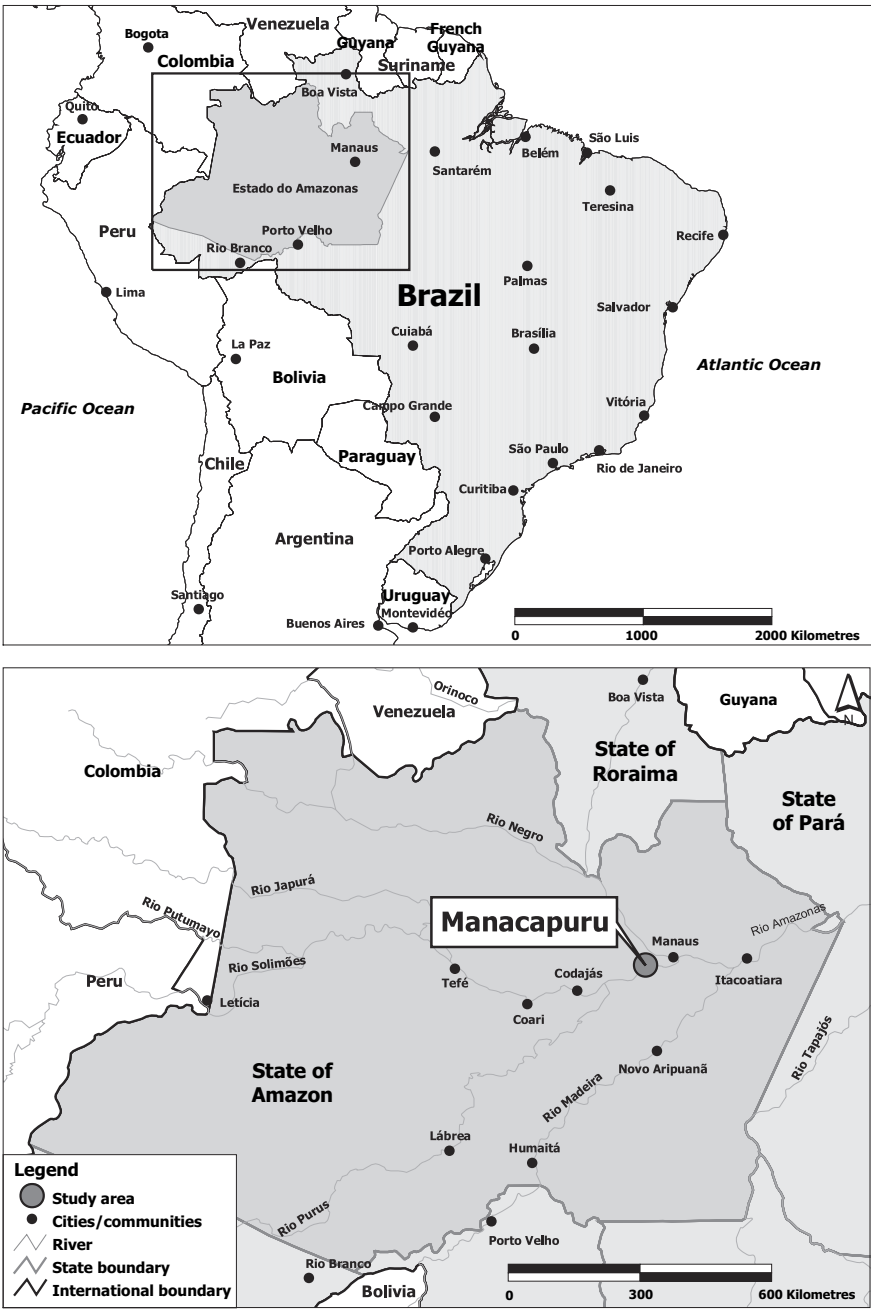
Unlike federally planned agrarian settlements, São João Batista has small and variably sized plots, averaging 15 ha (SD 7.3 ha; range 3 ha to 40 ha). The families that occupy these plots are also extremely varied, both in previous agricultural experience and in access to resources. Hence, agriculture has different importance to different families. This can be seen by the varied percentage of each major land use: 1% to 14% home garden (but 14% equals 1.2 ha on a 8.5 ha plot); 1% to 26% rain-fed crops (mostly cassava); 2% to 42% perennial crops (including agroforestry plots in collaboration with INPA's Agroforestry Unit); 0% to 33% pasture (but only one of the eight interviewed families has pasture); 1% to 73% fallow; 0% to 80% forest (according to Brazil's Forest Code no more than 50% of a property may be deforested, but only 25% of the families in this community have more than 50% of their property still in forest). In this community, pupunha is only found in the home gardens and perennial crop plots, especially agroforestry.

Most families have home gardens (87%), a traditional component of regional production systems (Noda *et al.* 2000). When present, these range in size from 0.25 ha to 1.2 ha (mean 0.44 ± 0.32 ha). Within these home gardens, pupunha is generally present (70% of families) but not abundant, with a mean of 4.9 clumps (maximum 18 clumps), each with 2.9 stems. Potential yields in these home gardens are estimated here at 142 kg (5 bunches/stem; 2 kg/bunch)⁵. The pupunha from home gardens is probably used principally for subsistence, since at this density there are unlikely to be more than a few ripe bunches on the same day during the three-month harvest season (late December to late March).

All families have perennial crop plots, and four have agroforestry systems planted in cooperation with INPA's Agroforestry Unit. However, less than half of the families have pupunha in these plots. When present (40%), they have 20 to 50 clumps (mean 36 clumps for the 40%; mean 16 clumps over all). These are the plants that are likely to have their bunches sold to market. Potential yields in these plots are lower because of fewer stems per plant (close to one, because most are younger plants whose offshoots have not yet attained fruiting age or have been pruned off). Assuming one stem, yields are estimated here at 390 kg per family. These yields could be substantially increased with fertilization (Clement 2000), but there is so little demand from the market and so little home use that these smallholders see no reason to fertilize.

Two of the surveyed families grow pupunha for heart-of-palm, having succumbed to the promotional effort of the local extension service, IDAM.

Figure 1. Location of the study area



Source: ESRI Data and Maps 2002.

One family has 550 plants and the other has 1150 plants. Neither knows what to do with these plots, since IDAM's promise of the local processing plant (Tapiré) buying their yield has not come true.

The families that produce pupunha for fruit generally treat it as just one among numerous components in their subsistence systems and as a minor component in what they grow for market. As mentioned above, pupunha is always planted. This does not mean, however, that it receives much care within the home garden or orchard. The home garden is generally kept relatively weed free, the work being done with hand tools. The orchards are maintained irregularly, with one or two weed cutting campaigns each year, also with hand tools (although a few farmers are starting to use herbicides).

Harvesting is the most expensive part of producing pupunha, since the trees grow tall quickly. Clement (2000) estimated that a 10 m tall tree can cost as much as US\$0.22/bunch to harvest. Since a bunch sells for US\$0.25 to US\$0.50 at the farm gate, the taller the tree the lower the profit margin, although it must be remembered that the opportunity cost of labour for harvest may often be much lower. This is the reason that many smallholders don't collect much of their yield, especially at peak season, and the further they are from market the less they harvest.

IDAM estimated statewide production at 13,600 tons of fresh fruit bunches in the 1999-2000 season, of which 50% was wasted. The problem of harvesting and the low demand for the product are the main reasons why so much never makes it to market. The municipality of Coari, 300 km upriver from Manacapuru, reported that 68 of their pupunha farmers had 102 ha (1.5 ha each) in production in the 2000-01 season and produced 224,400 bunches (Coari 2001). Assuming 400 trees per hectare (since these are plantations encouraged by the municipality), each tree produced 5.5 bunches (similar to our estimates here). Although IDAM estimated 4 kg/bunch (Coari 2001), we prefer a more conservative 2 kg because farmers tend to take their better (that is, larger) bunches to market and use small bunches for subsistence and animal feed or fail to harvest them. Assuming, then, a conservative 2 kg/bunch, each tree produced 11 kg and each hectare produced 4.4 tons of fresh fruit bunches, worth about US\$660/ha (assuming US\$0.15/kg because of distance to major markets); these 68 farmers produced about 3% of the pupunha in the state. These calculations show that our assumptions about yield are consistent with state data.

Raw material producers and socio-economic context

In the last half century, central Amazonia has changed dramatically from a rural-majority, very-low-density population to an urban-majority, moderate-density population. Only the rural population is still low density (Becker 1995), except for moderate density along the flood plains. The bust after the rubber boom left an impoverished Manaus and central Amazonia. In the 1950s, talk of the internationalization of Amazonia stimulated the first effort at regional development planning, but this effort received serious investment only under military rule (1964-85). In 1967, the Free Zone of Manaus was created, investment poured in, and the capital became a mecca, even more

so as the already low state and federal investments in the interior of central Amazonia were further reduced. Even today, the rural exodus continues, as the interior continues to receive minor investments compared to the capital. The federal government stimulated migration into Amazonia in the 1970s and this movement picked up strongly in the 1980s. Then the bubble started to deflate, as Brazil's debt became unmanageable, and in the late 1980s, the Free Zone started reducing its workforce both through increased productivity and because of lack of demand for its first generation products; the commercial side of the Free Zone also started to implode. In 1990, the Collor government opened Brazilian markets to the world and the labour market in Manaus contracted significantly.

In this geopolitical setting, Manacapuru also had its own peculiar problems. Especially important was the decline of fibre production, as Amazonian jute (*Corchorus capsularis* L.) and malva (*Urena lobata* L.) could not compete with Asian fibres in the late 1970s and 1980s and were also being substituted by plastic fibres. Also, the statewide rural exodus did not always end in Manaus, but it occasionally ended in environments familiar to the migrants, such as Manacapuru's flood plains. It was in this climate that the Manacapuru municipal government set up the Ramal da Laranjal agrarian settlement, and others like it, as an effort to offer work to the increasing number of under- and unemployed in the Manaus-Manacapuru region. This effort continues today in municipalities close to Manaus, such as Manacapuru, which is creating more agricultural settlements.

In the state of Amazonas, 5% of the population owns 80% of the wealth (IBGE 2000). The rural population is included in the 95% of the population that owns 20% of the wealth, although adequate planning and market evaluation can permit a reasonable quality of life. Unfortunately, the majority of the families in São João Batista do not plan or evaluate the market, so they depend upon low-input/low-output agriculture, day labour for neighbours (US\$5-6/day) and retirement benefits from the federal government (generally one 'minimum salary', or US\$75/month in 2000). Some of the families in São João Batista are better off because they have more fruit trees, better retirement benefits, and family members working in Manacapuru or Manaus. The estimated mean annual family income in São João Batista was about US\$2,170, about 40% of the national mean income in 2000.

In general, pupunha contributes an extremely small portion of the yearly income to those families that grow it, perhaps as little as 2% of income for the average family that has pupunha. In comparison, the pupunha promoted by the municipality of Coari generated about US\$990/family, potentially contributing very significantly to their income. However, this estimate is based on the assumption that all production was commercialized and it is unknown if this occurred, especially as IDAM was also responsible for estimating 50% wastage (Geraldo Couto Araujo, IDAM personal communication).

Perennial crops contribute quite a bit more than pupunha for some families in São João Batista. In general, each family has 7 to 10 perennial crops that they consider more important than pupunha, among which are cupuaçu (*Theobroma grandiflorum* Schumm.), orange (*Citrus sinensis* Osb.) and other *Citrus* spp., tucumã, guaraná (*Paullinia cupana* Kunth), avocado

(*Persea americana* Mill.), açai (*Euterpe oleracea* Mart.), and biribá (*Rollinia mucosa* Bail.). Some families have 20 or more species, especially those collaborating with INPA's Agroforestry Unit.

Processing industry

Typically, pupunha is consumed after having been cooked in salty water for 30 minutes, both to eliminate antinutritional factors (see above) and to enhance flavour. Today this is almost the only way the fruit are processed. After cooking they are eaten as part of breakfast or as a snack, both in rural and urban areas. They are popular for these two uses, and are often sold by street vendors at busy corners in urban centres or at the market. Nonetheless, with only these two uses, demand is essentially stagnant at about 50% of production and contrasts strongly with the variety of potential uses (Clement 2000; Kerr *et al.* 1997).

Traditionally, the fruit was fermented to make drinks, both nonalcoholic (one or two days of fermentation) and alcoholic (three to five days). This traditional use still occurs among the remaining first peoples and a small percentage of the peasants living near first peoples' villages, generally quite distant from Manaus. Efforts to reinvigorate this traditional use have been fruitless to date, although the fruit juice market continues to expand in Brazil as elsewhere.

Photo 2. Pupunha fruit is useful to prepare flour that can be used for candies, bread also to ferment and make beverages, or simply to be cooked and eaten (Photo: C.R. Clement)



Traditionally, the fruit was cooked and ground into flour also. In this form it was used for making traditional baked goods. Kerr *et al.* (1997) presented dozens of pupunha recipes based on flour or whole cooked fruit in an effort to stimulate interest in this processed product. In fact, interest has increased but few entrepreneurs have stepped forward to supply this incipient market with flour on a continual basis. In 1999, an entrepreneur from Manacapuru entered the Manaus market with a reasonable quality product and received quite a good price for her flour (US\$4.00/kg versus US\$0.50/kg for wheat or maize flour). She did not return to the market in 2000, however, and efforts to learn why she did not come back were fruitless.

With only rudimentary processing (cooking) and almost no demand for processed products, the pupunha production-to-commercialization system appears to be limited by lack of entrepreneurs interested in processing. Consequently, the major market is for fresh fruit, which are then processed at home. This also explains why pupunha is currently of such minor importance in central Amazonia: supply is seasonal and demand is limited to those consumers who know the fruit.

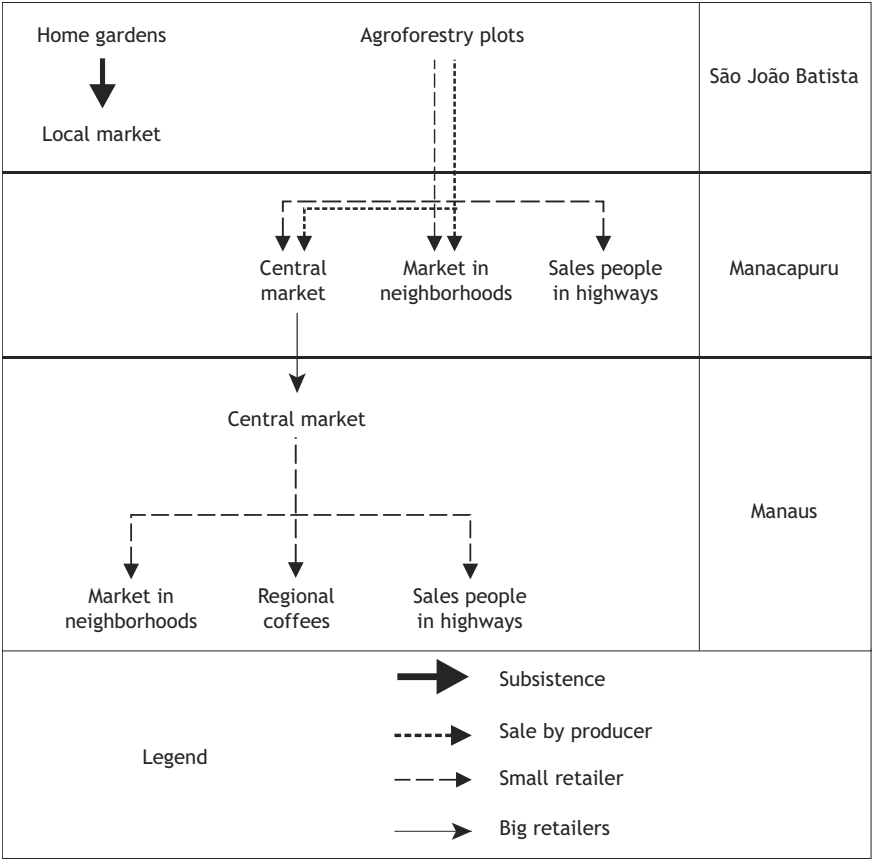
As mentioned earlier, the lack of processing in central Amazonia is in sharp contrast to the situation in Costa Rica and Colombia. It is similar to the situation in other parts of Amazonia, however, both in other parts of Brazilian Amazonia and in Amazonian Bolivia, Colombia, Ecuador, Peru, and Venezuela. In all of these areas, pupunha is of minor importance in subsistence systems, moderately to quite popular in urban markets, but limited to seasonably available fresh fruit for home processing.

Trade and marketing

Trade in fresh fruit bunches from São João Batista is limited, both by limited production and probably by a good equilibrium between local supply and demand in Manacapuru, since numerous other settlements also take fruit to market each weekend during the season. Because of limited supply, few outside traders come into São João Batista looking specifically for pupunha; in contrast, traders come looking for cupuaçu, which has a much stronger local demand because of processing alternatives. Consequently, farmers with pupunha to sell either take it to Manacapuru themselves (all do this occasionally), sell it to a neighbour going in (most do this weekly), or sell it to one of the two nonspecific fruit buyers who do buy in São João Batista (most do this sometimes also). Because of these direct and indirect contacts with the market, most residents of São João Batista have a good idea about how much their pupunha fetches in Manacapuru: US\$0.50 to US\$1.00/bunch. They also probably have a reasonably good understanding of what local consumers consider to be a good fruit, since they observe which bunches are sold first and which are left over; with so few trees each, they very probably know the qualities of each quite well. Curiously, however, there is no indication that they select seed from trees with the characteristics their buyers want.

Sometimes traders from Manaus will buy fresh fruit bunches in Manacapuru for resale in the Manaus markets, generally starting in the central market, called Manaus Moderno. In Manaus these bunches sell for US\$1.00 to US\$3.00,

Figure 2. The pupunha chain commercialization initiates in the production area, São João Batista, where part of it is used for subsistence, other go to Manacapuru market, supplied by farmers and small traders for distribution to neighboring markets and highway sales people, and finally to Manaus, by big traders for distribution to small distributions and trade points.



depending upon bunch size and fruit size, fruit appearance (preferences differ widely among consumers, who think that quality may be related to colour (exocarp and mesocarp), size, firmness, humidity, or apparent oiliness), phytosanitary condition, and apparent freshness. Small wholesalers buy in the central market and resell in neighbourhood markets, to recently popular *cafés regionais*, breakfast restaurants that specialize in Amazonian cuisine, including boiled pupunha and pupunha cake, and to street vendors.

As mentioned above, some municipalities specialize in supplying the fresh fruit demands of Manaus. Rio Preto de Eva is a municipality about 80 km north-east of Manaus, has a good reputation for fruit quality and sells 80% to 90% of its production to the Manaus central market. Fonte Boa is about

500 km west of Manaus and has an excellent reputation for fruit quality; in the minor harvest season of 2001, larger bunches of up to 15 kg sold for as much as US\$7.25.

Phytosanitary condition and apparent freshness decrease rapidly if bunches are not well ventilated and kept in the shade. Since most farmers taking fruit to market do not have a stall or other infrastructure, bunches are generally displayed on the ground wherever the farmer can find a place to stand. Also, since pupunha is perceived to be a low value product (because of low demand), the farmer and most small vendors do not worry much about ventilation and shade. Even in Manaus, fruit bunches are generally displayed on the ground, rather than hung. In Costa Rica, in contrast, fruit bunches are generally hung and shade is provided all day, so that quality is maintained as long as possible—up to seven days in these conditions. Because pupunha is sold as a fresh fruit, there is no chance for product adulteration, unlike processed cupuaçu, for example, to which banana (*Musa* spp.) and jackfruit (*Artocarpus heterophyllus* Lam.) are often added as adulterants.

If a farmer is unable to sell the pupunha bunches while in town, they are generally sold to vendors at the market, certainly at a substantial discount. Although this resale was not specifically discussed with farmers, the low value of the product makes this transaction likely, as the farmer generally sees little or no advantage in taking the bunches home.

Because of perishability and low-value, trade in pupunha between communities and urban centres is limited to the seasonal fresh fruit market. Few traders specialize in pupunha, so trade from Manacapuru to Manaus is limited. Manacapuru also does not have a reputation for pupunha quality, unlike Rio Preto de Eva, for example, which further limits demand for its fruit.

Policy environment

Although Manaus is a major city and somewhat cosmopolitan, central Amazonia remains definitely third world. Since pupunha fruit is an indigenous crop, it is essentially below the horizon of the state and federal governments' policy interventions, except for research and extension, although a new promotional effort is in the works at the Superintendency for the Free Zone of Manaus (SUFRAMA). There are no policy barriers to enter the production, processing, or commercialization segments of the pupunha fruit market in its current underdeveloped state.

State and federal research and extension interventions in the pupunha production-to-consumption system in central Amazonia have been numerous and generally unsuccessful during the last 20 years (Clement 2001). Much promotion took place and resulted in a considerable increase in supply, albeit without an accompanying increase in demand. The consequence was that small farmers had wasted their time and money increasing production, because they generally were unable to sell the increased production and get a return on their investment. The promotion was unsuccessful because it was unfocused; the production-to-consumption system was poorly known and was not used to identify research gaps to pave the way for successful promotion. A little history will make this clear.

Research and development of pupunha in central Amazonia started at INPA in 1975. The group that started this program included several inexperienced young agronomists and a biologist. Initial interest was stimulated by NAS (1975) and word that a similar program was starting in Costa Rica. The first experiment was a large agroforestry system, which came to be known as the 'fruit salad' (P.T. Alvim personal communication), since it included six fruit species (Clement *et al.* 1997; van Leeuwen *et al.* 1997). No preliminary research was done to identify the preferences of consumers in Manaus for pupunha; rather seed was brought from the Putumayo landrace (see Mora Urpí *et al.* [1997] on landraces) via a plantation in Belém, Pará. Luckily the fruit sold well in the Manaus market, probably because this market attracts consumers from all over the state and because variable quality is acceptable in this nonspecialized market.

As the INPA group's interest in pupunha increased, it started a germplasm collection, also with little initial planning. The late 1970s and early 1980s was the period in which international preoccupation with the loss of crop genetic resources came to the fore with the creation of the International Board for Plant Genetic Resources (now the International Plant Genetic Resources Institute [IPGRI]) and Brazil's National Centre for Genetic Resources (CENARGEN, a part of the Brazilian Agricultural Research Corporation [Embrapa] network). This collection, now called the Pupunha Active Germplasm Bank (BAG-Pupunha), soon grew to 10 ha and 450 accessions, becoming a major drain on project resources, and is now essentially a white elephant. As with the rest of the program, the germplasm collecting was unfocused, because the objective was to save pupunha's genetic resources from erosion, although it was unclear then that this was happening.

The excursions to fill the BAG-Pupunha soon identified a population in Yurimaguas, Peru, with a high frequency of spineless plants. Since heart-of-palm had been mentioned by NAS (1975) and a major market existed in southern Brazil, promotion of this germplasm became a priority and soon became a success story—a success, however, for southeastern Brazil, not Amazonia. There are now more than 30,000 ha of pupunha planted for heart-of-palm in Brazil, the majority in the central-south of the country (Clement 2000).

This successful promotion stimulated further promotion—this time for fruit, however. The INPA group, in collaboration with the extension service, distributed unselected landrace germplasm throughout central Amazonia and to Acre and Rondonia. Numerous small farmers planted, harvested, and failed to sell more than they normally did. A group of farmers in Acre, the RECA project, planted 600 ha of an agroforestry system based on pupunha, cupuaçu, and Brazil nut (*Bertholletia excelsa* H.B.K.) (see Smith *et al.* 1998). When harvest started, the bounty soon saturated the two nearby state capitals' demand for pupunha and the farmers ceased to harvest their full potential, much as occurs elsewhere in Amazonia. They have since cut much of this pupunha for heart-of-palm; some also sell seed to the southeastern heart-of-palm growers.

Unlike the heart-of-palm promotion, which promoted a new species into an established market, the fruit promotion suffered from several fatal

errors: lack of research into consumer preferences and, consequently, lack of germplasm selection for those preferences; lack of R&D on alternative uses; a concentration on production to the exclusion of the rest of the production-to-consumption system; and lack of entrepreneurs in central Amazonia interested in developing and commercializing new products based on the expanded production. This rather long list can be synthesized as a lack of understanding of the full production-to-consumption system and its implications.

This lack of understanding of the production-to-consumption system continues today, although the INPA group, now much reduced in size, is learning—albeit slowly. The group is now pursuing R&D on alternative uses and promoting these before promoting further production. There is interest from consumers, but the lack of entrepreneurs continues to be a limiting factor.

Other actors in pupunha promotion also tend to concentrate on production. The NGOs that support the RECA project, for example, continue to promote production of pupunha and other crops without considering processing and commercialization (Smith *et al.* 1998).

TRENDS AND ISSUES

Central Amazonia is about to undergo another period of accelerated change: the Free Zone will be terminated in 2013 (or earlier, if ALCA, the Free-trade Zone of the Americas, is negotiated carelessly). The main implication of this change is that the industrial district of the Free Zone of Manaus will have to become a major R&D centre to support current products (which is unlikely to happen, because R&D for these is concentrated in transnational firms) or concentrate on products that do not depend upon current subsidies. At this moment, many of the ideas for redirecting industrial output are based on using Amazonian biodiversity, including fruit crops. Extractive products are also being examined and the implications of this examination are not yet clear. As the state government finally starts planning for the end of the Free Zone (a full 33 years after the announcement of its end date), SUFRAMA has selected pupunha for a new round of promotion in Acre and Rondônia states, but not Amazonas, with few investments yet earmarked for R&D or a full analysis of the production-to-consumption system.

The key issue in meeting this challenge is adequate R&D, based on the production-to-consumption system, both for pupunha and for any other product based on Amazonian biodiversity. Adequate R&D requires adequate staff and financing, so that gaps in the production-to-consumption system that limit meeting the demands of consumers can be addressed expeditiously. There is currently no sign that the federal or state government is willing to address this funding issue seriously.

A major problem in developing processed pupunha products is the lack of entrepreneurs willing to take on this task and create new markets. Without these key actors, the pupunha market will continue to be a fresh fruit market supplied by small farmers. This lack cannot be resolved by federal or state investment, although entrepreneurs will certainly be more interested in

pupunha if the production-to-consumption system is completely analyzed and contains no gaps.

CONSERVATION AND DEVELOPMENT LESSONS

Twenty-five years after the beginning of INPA's pupunha R&D work in central Amazonia pupunha is still an underutilized crop. As such, it has now become clear that its genetic resources are eroding, as was suspected in the late 1970s. This erosion stems from both lack of use and inadequate and unfocused promotion to enhance use.

As a starchy fruit, pupunha competes with other starches, rather than other conventional fruits. Its lack of current use is thus partially a consequence of competition from other starches, both fresh (cassava, sweet potato, etc.) and processed (cassava flour, maize flour, etc.). Its use for fermentation would compete with beer. As these processed products become increasingly easy to obtain in areas where pupunha has traditionally been grown, it is no longer planted for these uses, only for use as a fresh fruit. As demand for this fresh fruit is limited, less pupunha is planted each generation, resulting in yet unquantified genetic erosion.

Efforts at promoting pupunha for fruit and heart-of-palm have resulted in introduction of germplasm with specific properties, especially spineless plants for heart-of-palm and high starch fruits. These introductions take space from the locally developed germplasm, resulting in further genetic erosion. This cause of erosion was what raised awareness about genetic erosion in the 1960s and 1970s, and led to the creation of IPGRI and CENARGEN.

Even if R&D on the production-to-consumption system entices an entrepreneur into becoming a pupunha champion, genetic erosion will continue throughout pupunha's distribution, because modern markets require uniform products. Hence, conservation of pupunha's genetic resources will require numerous entrepreneurs developing and commercializing numerous products based upon different parts of pupunha's ample variability. In an increasingly homogenized global marketplace, this vision looks increasingly difficult to attain.

NOTES

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2. If this study were carried out in some communities in Costa Rica or along the Pacific coast of Colombia, the results would be quite different. In both of these areas, pupunha is much more important in the local market. In Costa Rica, fresh fruit are commercialized year round from different ecological niches throughout the country; in Colombia, pupunha is thought to be an aphrodisiac and commands a high price for this reputed power.

3. J. van Leeuwen prefers to identify this settlement by the name of the side road (Ramal da Laranjal), because not all inhabitants are members of the community and some community members live outside the settlement. Since

the majority are members, however, C. R. Clement prefers to maintain the community name, even at the risk of political correctness.

4. J. van Leeuwen emphasizes that because residents are close to Manacapuru and on a side road, they receive some assistance from the extension service. The quality of this assistance and its pertinence to them, however, are questionable. The extension service tends to be paternalistic and has a limited repertoire of viable ideas to offer, many of which are not pertinent to undercapitalized smallholders.

5. Around Manaus, pupunha always has a major harvest season (generally mid to late December to mid to late March) and may have a minor harvest season (generally mid to late September to late October) during good years, which are defined as having less pronounced dry seasons.

REFERENCES

- Andrade, E.H.A., Santos, A.S., Zoghbi, M.G.B. and Maia, J.G.S. 1998. Volatile constituents of fruits of *Astrocaryum vulgare* Mart. and *Bactris gasipaes* H.B.K. (Arecaceae). *Flavour and Fragrance Journal* 13(3): 151-153.
- Becker, B.K. 1995. Undoing myths: the Amazon—an urbanized forest. In: Clüsener-Godt, M. and Sachs, I. (eds.) *Brazilian perspectives on sustainable development of the Amazon region*, 53-89. *Man and the Biosphere Series*, vol. 15, UNESCO, Paris; Parthenon, Carnforth, UK.
- Belcher, B. and Ruiz-Pérez, M. 2001. An international comparison of cases of forest product development: overview, description and data requirements. Working paper no. 23, CIFOR, Bogor, Indonesia. 30p.
- Clay, J.W. 1996. *Generating income and conserving resources: 20 lessons from the field*. WWF, Baltimore.
- Clement, C.R. 2001. Domestication of Amazonian fruit crops: past, present, future. In: Vieira, I.C.G., Silva, J.M.C., Oren, D.C. and D'Incao, M.A. (eds.) *Diversidade biológica e cultural da Amazônia*, 347-367. Museu Paraense Emílio Goeldi, Belém.
- Clement, C.R. 2000. Pupunha (*Bactris gasipaes* Kunth, Palmae). *Série Frutas Nativas*, 8, Fundep, Jaboticabal, SP.
- Clement, C.R. 1997. Environmental impacts of, and biological and socio-economic limitations on new crop development in Brazilian Amazonia. In: Smartt, J. and Haq, N. (eds.) *Domestication, production and utilisation of new crops*, 134-146. International Centre for Underutilised Crops, Southampton, UK.
- Clement, C.R. 1990. Regeneração natural de pupunha (*Bactris gasipaes*) [Natural regeneration of pejibaye]. *Acta Amazonica* 20: 399-403.
- Clement, C.R. 1989. The potential use of the pejibaye palm in agroforestry systems. *Agroforestry Systems* 7: 201-212.
- Clement, C.R. 1986. The pejibaye palm (*Bactris gasipaes* H.B.K.) as an agroforestry component. *Agroforestry Systems* 4: 205-219.
- Clement, C.R., Aguiar, J.P.L. and Aued-Pimentel, S. 1999. A pupunha brava (*Bactris dahlgreniana*) no Estado do Amazonas, Brasil [Wild pupunha in Amazonas state, Brazil]. *Acta Botanica Venezuelica* 22(1): 29-44.
- Clement, C.R., Alfaia, S.S., Iriarte-Martel, J.H., Yuyama, K., Moreira Gomes,

- J.B., van Leeuwen, J., Souza, L.A.G. and Chávez Flores, W.B. 1997. Fruteiras nativas e exóticas [Native and exotic fruit species]. In: Noda, H., Souza, L.A.G. and Fonseca, O.J.M. (eds.) *Duas décadas de contribuições do INPA à pesquisa agrônômica no trópico úmido* [Two decades of contributions by INPA to agronomic research in the humid tropics], 111-129. Instituto Nacional de Pesquisas da Amazônia, Manaus.
- Coari. 2001. Perfil sócio-econômico do município de Coari, AM [Socio-economic profile of the municipality of Coari, AM]. Prefeitura Municipal de Coari, Coari, AM (reported in A Crítica, 1 July. p. A-18).
- Denevan, W.M. and Padoch, C. (eds.) 1987. Swidden-fallow agroforestry in the Peruvian Amazon. *Advances in Economic Botany*, 5, The New York Botanical Garden Press, NY.
- IBGE. 2000. Anuário estatístico do Brasil, 2000. Instituto Brasileiro de Geografia e Estatística, Rio de Janeiro.
- IBGE. 1995. Censo agropecuário, 1995. Instituto Brasileiro de Geografia e Estatística, Rio de Janeiro.
- Kerr, L.S., Clement, R.N.S., Clement, C.R. and Kerr, W.E. 1997. Cozinhando com a pupunha [Cooking with pejibaye]. INPA, Manaus.
- Kiew, R. 1996. Biodiversity and its implications for genetic conservation. In: Quah, S.C., Kiew, R., Bujang, I., Kusnan, M., Haq, N. and de Groot, P. (eds.) *Underutilized tropical plant genetic resources: conservation and utilization*, 1-10. Universiti Pertanian Malaysia, Kuala Lumpur.
- Mora Urpí, J. 1992. Pejibaye. In: Hernández Bermejo, J.E. and León, J. (eds.) *Cultivos marginados: otra perspectiva de 1492* [Neglected crops: another perspective on 1492], 209-220. Food and Agriculture Organization and Jardín Botánico de Córdoba, FAO Plant Production and Protection Paper No. 26, Rome.
- Mora Urpí, J., Weber, J.C. and Clement, C.R. 1997. Peach palm. *Bactris gasipaes* Kunth. Promoting the conservation and use of underutilized and neglected crops. 20. Institute of Plant Genetics and Crop Plant Research, Gatersleben/International Plant Genetic Resources Institute, Rome.
- NAS. 1975. Underexploited tropical plants with promising economic value. National Academy of Sciences, Washington.
- Noda, H. *et al.* 2000. Pequena produção de terra firme no Estado do Amazonas [Smallholder production on uplands in Amazonas State, Brazil]. Série Documentos, no. 5, Instituto Nacional de Pesquisas da Amazônia, Manaus, AM.
- Patiño, V.M. 1992. An ethnobotanical sketch of the palm *Bactris (Guilielma) gasipaes*. *Principes* 36(3): 143-147.
- Pistorius, R. and van Wijk, J. 2000. The exploitation of plant genetic information: political strategies in crop development. CABI Publishing, Oxford University Press, New York.
- Ribeiro, M.N.G. 1976. Aspectos climatológicos de Manaus [Climatological aspects of Manaus]. *Acta Amazonica* 8(2): 229-233.
- Smith, N., Dubois, J., Current, D., Lutz, E. and Clement, C. 1998. Agroforestry experiences in the Brazilian Amazon: constraints and opportunities. Pilot Program to Conserve the Brazilian Rain Forest, Ministério do Meio Ambiente, Recursos Hídricos e Amazônia. Legal & World Bank, Brasília.

- Smith, N.J.H., Williams, J.T., Plucknett, D.L. and Talbot, J.P. 1992. Tropical forests and their crops. Cornell University Press, Ithaca.
- Sombroek, W.G. 1966. Amazon soils. Center for Agricultural Publications, Wageningen.
- Tosi, Jr., J.A. and Vélez-Rodriguez, L.L. 1983. Provisional ecological map of the Republic of Brazil. Institute of Tropical Forestry, San Juan, Puerto Rico.
- van Leeuwen, J., Menezes, J.M.T., Moreira Gomes, J.B., Iriarte-Martel, J.H. and Clement, C.R. 1997. Sistemas agroflorestais para a Amazônia: importância e pesquisas realizadas [Agroforestry systems for Amazonia: importance and research done]. In: Noda, H., Souza, L.A.G. and Fonseca, O.J.M. (eds.) Duas décadas de contribuições do INPA à pesquisa agronômica no trópico úmido [Two decades of contributions by INPA to agronomic research in the humid tropics]. 131-146. Instituto Nacional de Pesquisas da Amazônia, Manaus.
- van Leeuwen, J., Pereira, M.M., Costa, F.C.T. and Catique, F.A. 1994. Transforming shifting cultivation fields into productive forests. In: Anais do 1º Congresso Brasileiro sobre Sistemas Agroflorestais. Embrapa Florestas, Colombo, PR. Vol. 2: 431-438.
- Wood, A., Stedman-Edwards, P. and Mang, J. (eds.) 2000. The root causes of biodiversity loss. Earthscan, London.

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Chapter 10

Bacuri (*Platonia Insignis* Martius), the Amazonian fruit that has become gold

Gabriel Medina¹ and Socorro Ferreira²



(*Platonia insignis*)

Common name	Part of the product used	Dominant handling format	Level of transformation	Commercial scale	Geographic distribution
Bacuri	Fruit	Handled	Low	National	Broad

SUMMARY

This article portrays the experience of two communities of family farmers in the microregion of Bragantina in north-eastern Pará, Brazil, on handling and sales of the fruit species *bacuri* (*Platonia insignis* Mart. Clusiaceae). In these communities, the *bacuri* is part of the cycle of itinerant cultivation of annual crops and performs a fundamental role in regenerating the vegetation of areas left fallow. In order to allow a few *bacuri* plants to produce fruit, farmers set aside 'islands' of *capoeira* (secondary vegetation in cleared lands) and handle them in a way that promotes this growth. The *bacuri* is traditionally used in the local population's nutrition, consumed in the form of fresh fruit or used in making jams, juices, ice cream, and yogurt. Its consumption has been increasing significantly in the local market, and *bacuri* is now being shipped to other Brazilian states. The growth of the market has stimulated farming families of north-eastern Pará to set aside larger areas for production of the fruit. The *bacuri* is a species that has conflicting uses for the production and harvesting of fruit on the one hand and for extraction of wood on the other. In forest areas located on the frontiers of expansion of the lumber activity, the population is dropping rapidly.

INTRODUCTION

The extraordinary diversity and potential of the fruit of the Amazon, combined with the attention currently given to tropical fruit, create significant sales prospects *in natura* or in industrial uses (Teixeira 2000). The north-east of the Amazon is the centre of dispersion for a fruit-bearing species with growing importance on the market and in the production systems of farming communities: the *bacuri* (*Platonia insignis* Mart. Clusiaceae).

The fruit of the *bacurizeiro* (*bacuri* tree) has traditionally been consumed and sold in Pará and the other states of the Amazon region, like Maranhão and Piauí. This species has a special place in the culture of Pará and displays potential for increasing its market, even though the better part of production is still from extraction from plants of indigenous populations. In recent years, the *bacuri* has seen significant trade increase. The local and regional markets still have space for growth, thus being able to generate more formal and informal employment. Because of the growing demand, many farmers, such as the ones from the microregion of Bragantina, have begun to realise that the *bacuri*, previously used mainly for home consumption, can now be included as a source of income for their families. In these areas, the handling of the *bacurizeiros* has come to represent an excellent alternative for diversifying the production system of family farmers, which currently is practically monopolised by annual crops, in particular manioc (*Manihot esculenta*).

THE PRODUCTION-AND-CONSUMPTION SYSTEM

The resource

The *bacurizeiro*, a typical tropical fruit tree, belongs to the family Clusiaceae. It is a perennial, heliophyte, and selectively hygrophyte species characteristic

of the open transition vegetation, in particular of open field areas. The species occurs in low densities in dense primary forest, with 0.5 to 1.5 trees per hectare (FAO 1986). Higher densities of between 50 and 100 trees per hectare are normally the outcome of handling practices carried out by Native American Indians or *caboclos* (of mixed Indian and European descent) (Clement *et al.* 1999). Cavalcante (1991) considers that medium-size and large trees, when fully mature, measure between 15 m and 25 m in height and have trunks with up to 1 m in diameter at breast height (DBH). In the observation undertaken in the study area, trees were found with up to 1.7 m DBH. Fruit production is seasonal and fruit drop occurs, for the most part, between January and March. The word *bacuri* comes from the Tupi (native American Indian language), in which 'ba' means to fall and 'curi', soon, that is, that which falls as soon as it is ripe (Teixeira 2000). In the study area, the trees handled begin to produce, on average, at 10 years of age, but cases of production at six years old were found.

The fruit of the *bacurizeiro* measure between 7 cm and 15 cm in diameter and weigh, on average, 400 g, but there is large variation in terms of size, shape, and taste. The fruit has white pulp, enveloping the seeds, protected by green-yellowish rind (Photo 1). The pulp is usually consumed fresh or used in making juices, ice creams, jams, and sweets. The sweeter fruit, with more pulp, are preferred.

Photo 1. Fruit of the *bacuri* (Photo: G. Medina)



The fruit originate in an ovary with five multi-ovulated carpelums. A few of these develop without forming seeds and, in the ripe fruit, receive the popular name of 'children' (Cavalcante 1991). According to Shanley &

Medina (2005), the average production per tree on firm land along the Capim River is 400 fruit per year. But this production is not constant from year to year, because the trees usually 'rest' between one fructification and the next (Shanley and Medina 2003). A few farmers interviewed confirmed this phenomenon, while others observe three distinctive production periods: after a high-production year the trees would produce little in the following year and a larger quantity in the one thereafter, until a new high-production year, that is, there would be a two-year interval between two large harvests.

Because of the significant variation in the annual number of nonproductive individuals in populations, there is an extremely large variation in the volume of fruit produced. In studies in the municipality of Ipixuna, in Pará, in a 16-tree sample, Shanley (2000) found an annual average of 55% of productive individuals, as opposed to 45% of nonproductive ones.

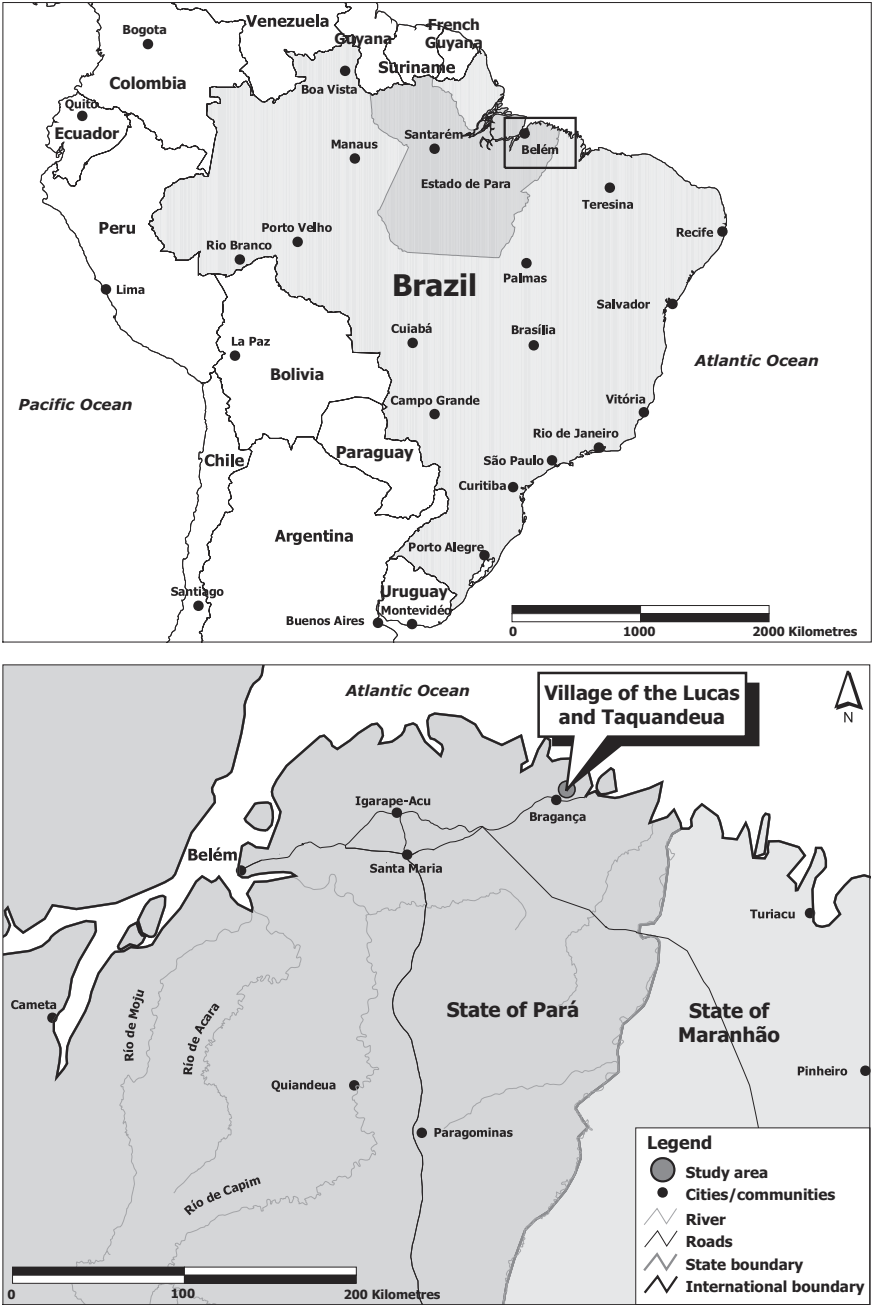
The reproduction of the *bacurizeiro* by way of seeds takes a very long time. Carvalho *et al.* (1998) and Carvalho *et al.* (1999) presented studies showing the difficulty in forming seedlings from seeds. The *bacuri* features a special type of dormancy that prevents the emergence of the epicotyl until the primary root reaches a certain length. In addition to reproduction by seeds, the *bacurizeiro* can be propagated using asexual processes, such as burgeoning from roots (which occurred frequently in the area studied), and by grafting. Each of these methods has its constraints, however, which, for the time being, make them unfeasible for commercial scale production of *bacuri* seedlings.

Throughout the Amazon, the area with the highest concentration of *bacurizeiro* is the estuary of the Grande Rio, with more marked occurrence in the region of the Salgado and the island of Marajó. However, it is also found abundantly in the microregion of Bragantina (Cavalcante 1991). According to Cavalcante (1991), the origin of this species is Pará, from where it dispersed throughout the Northeast from Maranhão all the way to Piauí, and south down to Goiás and Mato Grosso, reaching all the way to Paraguay. Northwards, the dispersion reached the state of Amapá and the Guianas, and its sparseness in the state of Amazonas indicates the expansion took place towards the west. The species occurs naturally in the open transition vegetation, in open field areas, and sometimes in the high forest; it is indifferent to soil types (Cavalcante 1991). In these altered environments, the *bacurizeiro* proliferates with extreme ease, in particular through burgeoning from roots, often completely dominating the landscape.

The study area and the social economic context of farmers

The microregion of Bragantina, located in north-eastern Pará (Figure 1), was the first region of the Brazilian Amazon to be intensely settled under direction. Before occupation the better part of this area was covered in exuberant humid tropical rainforest, but currently there is little of this type of vegetation. Settlement took place by way of the land being cleared by grubbing, which consists of felling and burning trees, and later planting rice, maize, beans, and manioc (Baena *et al.* 1998).

Figure 1. Location of the study area



Source: ESRI Data and Maps 2002.

Since a few decades ago, the farming practice used by most of the communities in the microregion consists of the following: secondary vegetation resulting from a fallow period of usually three to four years is dropped for planting crops. The woody vegetation that remains after the fire is used as firewood in manufacturing manioc flour or the production of charcoal. The planted area usually produces for one year and is again left to lie fallow.³

This study was undertaken in the two neighbouring communities of Vila dos Lucas and Taquandeua, located 7 km from the main city in the municipality of Bragança. The two communities combined have about 400 families, with an average of six persons per family, distributed across an area of 27 square kilometres. In these areas, the *bacuri* can be found in two forms: preserved by farmers as part of the itinerant cropping system in newly cleared land areas (initial stages of regeneration of vegetation) and as fruit bearing trees. In the itinerant cropping cycle, the regeneration of the *bacuri* plays an important role in the production of biomass. Owing to its regenerative vigour, which stems from the intense root burgeoning process, the *bacuri* grows very quickly after the burning⁴ and, one year later, the entire cleared area is already covered by trees over one meter in height.

The production of fruit occurs in areas with more than 10 years of handling, preserved for the regeneration of the *bacuri*. A field survey estimated the concentration of this species in these areas at around 1,800 trees per hectare. In areas over 150 years old, tree densities of up to 100 trees per hectare with DBH superior to 30 cm are common. Since the extent of cleared land areas preserved for longer periods is minute, the concentration of *bacuri* estimated for the entire area of the communities drops to about 1.6 trees per hectare with DBH of over 30 cm.

It is common to find groups of *bacurizeiros* probably formed by genetically identical trees, since this species displays very strong regeneration by way of root burgeoning. Within the production system studied, the large majority of farmers maintain at least one 'island' of forest, that is, an isolated area with high concentration of *bacuri*, with an average of 30 to 80 trees. Since the *bacurizeiro* is a crossed fertilisation plant⁵, pollinated by psittacidae birds (parrots) (Maués and Venturieri 1996), it is generally supposed that this reproduction has been occurring from crossing of individuals from different groupings or 'islands'.

The *bacurizeiro* is a tough plant requiring little cultivation care. In most areas in the communities studied handling was applied only after the trees began producing and consisted merely of clearing the land once a year to facilitate picking the fruit. More recently, with the increased importance of the fruit and its derived products on the market, a few farmers have started to handle the area earlier, from the onset. Since the *bacuri* has a high capacity for regeneration in areas left fallow, at about one and a half year of age the plants that have already reached heights of close to 2 m begin to be selected. The more vigorous ones that are at a distance of between 4 m and 8 m from each other are kept, the others taken down. After this, the land is cleared every two or three years preserving the plants selected until they reach the reproduction period, when the land begins to be cleared every year to facilitate fruit collection⁶. This trend for maintenance of the areas of

cleared land has respected the following criteria: when the *bacuri* springs in 'islands', the stands are preserved; when the trees come back in isolation in cultivated areas, they are eliminated.

The main product collected from *bacuri* trees is the fruit. Only in exceptional cases, one or two trees are felled in order to provide the community with building material. Collection of the fruit occurs immediately after they drop naturally, and the impact of handling and collection on the ecosystem is positive compared to the alternative of using the soil for agriculture.

Farmers have in manioc for the production of flour their main crop and main source of financial income. About 10% of the families in the communities have in fishing another important activity. Another important source of income for these families is the retirement benefit paid by the federal government to elderly farmers and to those considered incapable of working or disabled.

In addition to the activities targeting economic remuneration, the diversity of production systems comprises some livestock (mainly chicken) and other subsistence crops meant for family use (such as maize, *cupuaçu*, and coconut). Annual crops predominate, with perennial ones being the exception. The older cleared areas present in most lots also make a major contribution to family consumption and, in some cases, income. From these lots comes the extraction of *bacuri*, *açaí* (*Euterpe oleraceae*), *uxi* (*Endopleura uchi*), *piquiá* (*Caryocar villosum*), *bacaba* (*Oenocarpus bacaba*), and *buriti* (*Mauritia flexuosa*). These areas are also important sources of firewood and straw, as well as a habitat for hunting.

In the study areas, among the products of the cleared areas, *bacuri* is the one with the highest contribution to feeding the family and income. Families that have surplus production (in general with more than 10 trees producing a year) sell it, earning from this activity a significant contribution to their financial income. The field survey showed that 70% of the community have *bacuri*, but only 11% produce sellable surplus. The total income (monetary and nonmonetary) of families is around US\$2,470 per year. Out of this figure, only 14.5% (US\$358/year) comes from the family's integration with the market (income obtained from the sales of surplus). Of the total income, on average, 2% comes from consumption and/or sale of *bacuri*. For families with better access to the market and more than 10 trees producing, *bacuri* represents on average 8% of the total income. Having less access to the market and fewer trees producing, however, most of the community uses *bacuri* only for home consumption.

The small amount of daily work employed in collecting the fruit is essential in not compromising the pursuit of the activities that families consider priorities, in particular the manioc plantation and flour production-related activities). Two crops are planted every year and the *bacuri* collection period coincides with moments of intensive use of the family workforce in manufacturing flour. The workload demand from *bacuri* is low, however, and carried out mostly by children, older adults, and women, which does not compromise the main activity of flour making.

The work invested in collecting *bacuri* during the harvest period of January through March is usually 3 hours/ha/day. Considering that in three

hours of work a collector manages to collect on average 90 fruit, at a value of US\$0.04 each, the family work remuneration (Basso 1993) is around US\$1.2 per hour⁷. If workers should collect fruit all day, their earnings would be US\$9.6. According to Medina (2001) the family work remuneration for flour lies around US\$2.5 per day. These data show that diversification of the production system can ensure farmers better remuneration for their workforce.

It is worth highlighting the importance of the division of work by gender and age. In families in which men work in fishing, the men's work in farm activities is limited to cutting and burning. The remainder of the activities are carried out by women, children, and older adults. In families in which fishing is uncommon, work by women, children, and older adults, in spite of being important in agriculture, is deployed mainly in housework activities and collection of the fruit. In collecting the *bacuri*, if considering adults between 16 and 45 years old, 90% of the work is done by women. Among children and older adults, there is no clear distinction between genders in the division of the work. Of the overall total work employed in collection, 70% is done by children (<15 years old), 2% by adult men, 18% by adult women, and 10% by older adults (>45 years old).

Industrial processing, trade, and market

Bacuri is sold throughout the entire state of Pará. Belém, the capital, pools a large part of the production of several neighbouring farming communities and even from some more distant ones, like the microregion of Bragantina. In Belém, trade of the *in natura* fruit is quite significant, followed by ice creams, juices, and smoothies. In a market survey of the fruit trade in 1994, Shanley *et al.* (2002) found that the trade in *bacuri* fruit moved a total of US\$1,610,000 (7 million fruit at a price of US\$0.23 each). In the last nine years, the volume of this market may have grown at least threefold (Shanley and Medina 2003). *Bacuri* can be found both in the most outlying markets and in large supermarkets. Most ice cream parlours and a few snack bars also serve ice creams, juices, and smoothies containing this fruit.

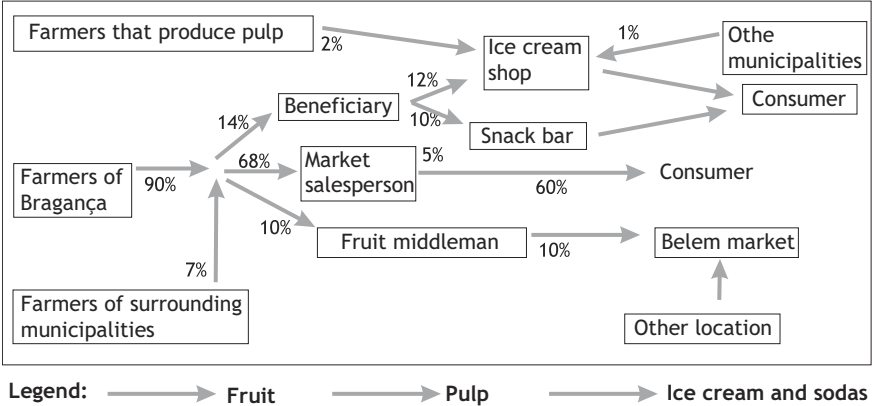
This study identified, starting from the main city in the municipality of Bragança, the main trade routes for the *bacuri* fruit and its derived products. In this way, we were able to sketch the way in which the product follows the trade routes from producer to consumers. The stages of processing were followed, the costs and gains of each intermediate agent and the way in which value is added all the way to the final product recorded. The Bragança market (Photo 2), which is the most important in the microregion of Bragantina, usually has about 20 *bacuri* middlemen during the harvest period, negotiating, on average, 4,000 fruit a day. A schematic diagram of the trade circuit of the *bacuri* from the microregion is shown in Figure 2.

Farmers from Bragança contribute 90% of the fruit sold in the seat of the municipality, with farmers from neighbouring municipalities making up the remainder. A few farmers sell the product already processed into pulp, representing 2% of the total of this product coming to market. Other municipalities contribute 1% by bringing in pulp to sell to ice cream parlours.

Photo 2. Market seller with *bacuri* (Bragança street fair, 2001) (Photo: Gabriel Medina)



Figure 2. Trade circuits for *bacuri* and products derived starting from the municipality of Bragança, 2001



Of the product coming to market, 97% is sold *in natura* and 3% in the form of pulp. Of the fruit *in natura*, 68% are sold at street markets directly to the final consumer; 14% are sold to pulp processing concerns, which then sell the pulp to snack bars and ice cream parlours; 5% go directly from farmers to

snack bars and ice cream parlours (generally on a lower scale and ones that remove the pulp from the fruit themselves); and 10% are taken by middlemen to outside markets, in particular in Belém. Farmers who work with sale of *in natura* fruit receive on average US\$0.05 per fruit from the person who is going to sell at the market. At the market, the fruit is sold to the final consumer at an average price of US\$0.07, with a gain of US\$0.02 per fruit. (A market stall that negotiates 200 fruit a day receives US\$4 as remuneration for the work. This income is derived solely from *bacuri*, not considering the range of products sold.) As already stated, there is huge variation in prices, influenced mainly by the size and shape of the fruit, in addition to the seasonality of the prices during the harvest period.

When negotiating with pulp processing ventures, farmers normally receive around US\$0.045 per fruit. Processors sell 1 kg of the pulp (equivalent to 20 fruit) for US\$2.5 and have a cost of US\$0.9 per kilo produced for a gain of US\$1.6. From processing, the pulp goes to snack bars, where it is sold at US\$5.00/kg, with a net gain of US\$1.5 per kilo, or to ice cream parlours, where the pulp is made into ice cream and sold at US\$13.3, with a net gain of US\$4.3 per kilo of pulp. When the fruit is taken to the market in Belém, the final sale price is on the order of US\$0.15 each, with a gross gain for the middleman of US\$0.08 and the stall owner of US\$0.05. Farmers who sell the processed pulp deliver it at about US\$2.25/kg.

Environmental policies

Brazilian legislation determines that extractive activities for any forest product should occur under a sustainable handling plan approved by Instituto Brasileiro do Meio Ambiente (IBAMA, Brazilian Institute of the Environment)⁸. By legislation, rural properties were mandated to maintain a legal reserve area⁹ corresponding to 50% of the total area. Provisional bill (*Medida Provisória*) no. 1956-50/00 modified this article, increasing the percentage to 80% whenever the property exceeds 100 ha (Lopes 2000). The idea behind this legislation is to stimulate the production of forest goods and services in a sustainable manner. In practice, despite seeking advances to increase its capacity, in few cases has IBAMA been effective in inspecting compliance with the law.

In the areas studied, the law applies in a differentiated manner since it rules on forest areas, while in the microregion of Bragantina rotation cropping of cleared areas has been the predominant land use for over a century. Forests are few in the area and, in any case, they are secondary forests. For those cases where legal reserves are smaller in area than what the law establishes, the legislation contains three measures, which can be adopted in isolation, all together, or in any combination: a) *reconstitution* by way of planting native species under IBAMA guidance; b) execution of *regeneration* by way of silviculture-based treatments that allow the natural regeneration of the legal reserve; and c) environmental *compensation* using other areas (Lopes 2000).

In 2000, the federal government published decree no. 3,420, creating the national forests program Programa Nacional de Floresta (PNF). Insets II,

III, and IV of article 2 attest to plans for fostering reforestation activities, notably on small rural properties, for recovery of permanent preservation forests, legal reserves, and altered areas, and for support of social and economic initiatives by the populations who live in forests. Effects of the legislation should still take some time to be felt, however.

In so far as concerns trade and processing of *bacuri* and related products, there is in practice no specific legislation or intervention by the state. The few small companies that process *bacuri* neither receive support nor are they subject to impediment. In this study, the only case of interference found, and an indirect one at that, was of a brick factory operating with funding from the Constitutional Fund for the North (*Fundo Constitucional do Norte*) that bought firewood from *bacuri* trees for its kilns.

TRENDS

Change dynamics

In the communities studied, up to the recent past, products generated in cleared land areas had (and in most cases still have) little commercial value, being used primarily for family nutrition. From information gathered from farmers it became clear that annual crops with guaranteed sales always had the preference for soil use, even at low prices because of the long middleman process. A large portion of the families did not hesitate to transform their old cleared land areas into plantations. With the increase in the population, fallow times became shorter, leading to a progressive depletion of the soil. In the last few years, with the growth, even if still restrained, of commercial products like the *bacuri* (in addition to *buriti*, *uxi*, *piquiá*, and others of less importance), this trend began to revert. The market for *bacuri*, for example, started to gain force in the last five or six years. Up to then, there was little demand, and farmers used the fruit merely for home consumption.

In the communities studied, the farmers' regret at having cut down the older *bacuri* cleared land fields is already nearly universal. They say that had those been kept, they could be making good income from the extraction of the fruit. Many farmers have begun to set aside small areas, up to now used for itinerant cropping, for the regeneration of cleared fields. According to them, they will be making more and working a lot less when these areas begin to produce.

In addition to the conversion of the older cleared fields into areas for agriculture, another risk pushed away by the recent gain in monetary value of the *bacuri* is that of cutting down trees for firewood or building materials. Around Manaus, where the density of *bacurizeiros* is low, the tree is more often used for its wood rather than the extraction of fruit (Clement *et al.* 1999). In the study areas the demand for wood is high, but farmers are increasingly less willing to sell. Cases of felling of *bacurizeiros* by the community have become rare.

The consequences of this new attitude by the community can already be perceived. In the lots that were organised first—and here we should highlight all the efforts by the families in looking to diversify their production systems—

the improvement in quality of life conditions, and in particular of the family's nutrition, has already become perceptible through the income obtained from selling the fruit. Today, owners of these lots and their families no longer depend only on manioc flour, but have increased their activities for use of the cleared land areas by planting a few perennial crops (in general still only for home consumption) and by resuming the hunting activity. Advances like these, even if small and having a slow development process, have already served as examples for other families.

Finally, it is worth highlighting that these changes have been undertaken by the farmers without any institutional support, governmental or nongovernmental. The learning inventory of these communities has been built based on trial-and-error experiments.

KEY ISSUES AND PROBLEMS

There are few botanical and ecological papers about the *bacurizeiro*, and research targeting perception of the species and other non-timber forestry products (NTFP) as part of the production system of farmers in the Amazon are practically nonexistent. Fieldwork seeking to retrieve knowledge from farmers who have been using forestry products and the importance they attribute to these products is absolutely mandatory. Only in this way will it be possible to understand the role NTFP play, or could play, in the production systems of farmers of the Amazon. In order to better understand the importance of forest products in rural and urban zones, it is important to address issues such as: the following.

- What is the importance of NTFP for the subsistence of families (home consumption)?
- What is their importance for the monetary income of farmers?
- What is their ecological importance for the sustainability of the production system?
- What differences in valuing NTFP can be felt in relation to the closeness of markets and abundance of natural resources?
- What is the importance attributed to NTFP by people who are exploiting them and what factors interfere in this valuation?

LESSONS IN PRESERVATION AND DEVELOPMENT

Lessons

The growth of the *bacuri* market has led to some changes throughout the entire chain from production to consumption. The changes having occurred up to the period of this research are testimony that the fruit and its derivate products have been gaining in importance in the local population's consumption habits. This change has caused demand to rise significantly. According to the field survey, up to a few years ago, the market in Bragança was self-sufficient and sold practically nothing of its production to other municipalities. Surplus production held no commercial value and the market was limited to sales of the fruit in street markets and to the direct and occasional contact with

snack bars and ice cream parlours (who attributed minimal importance to the *bacuri*).

Today, the trade chain has become diversified. Bragança is already buying *bacuri* from other municipalities and exporting part of its production, in particular to Belém. The rise in demand has caused an increase in prices, and all the points along the chain are making enough income to foster the broadening of the market. Agents specialising in transforming the fruit into pulp and selling it to snack bars and ice cream parlours, which earlier did not even exist, are now gaining space; ice cream parlours and snack bars have begun to realise much higher turnovers of the product; stall owners in markets have managed to increase the scope of their activities and now sell the product daily during the harvest period. All of this activity has filtered back to the farmers, which have begun to value their areas of cleared land and revert areas currently used in itinerant cropping to regeneration of the cleared land. Considering the current state of depletion of the soil in the region, the advantages of this approach are quite high. In addition to given the fallow lands enough time to recover, these can also become sources of family income. Nonetheless, it is worth highlighting that a large part of the demand has been generated by the local market. No significant increases in shipping of *bacuri* to other states have been recorded and there is no news of it being exported to other countries. From a strategic standpoint, investing in the local market seems much more interesting since it implies much lower risks and still offers a large potential for growth.

There is no way to forecast how this growth in demand will behave in coming years. According to Homma (1996), national and international trade, extraction and planting of extraction products in the Amazon have been characterised by four phases. In the first phase of exploitation, there is significant growth in extraction activities. The second phase, stabilisation, should represent a balance between offer and demand until the point of limit of the capacity for extraction is reached. This is the point when prices begin to rise. In the decline phase, the extraction costs rise, leading to a gradual decrease in the volumes extracted. The cultivation phase (fourth phase) begins during the stabilisation phase as a form of meeting demand. This would be the 'boom-bust' model of major growth and rapid collapse in the extraction of the products.

Shanley (2000) defends the idea that, within local markets, products need not necessarily follow this model. According to the author, extraction products locally consumed and traded rarely display extreme behaviours like fast growth and collapse. The generalised acceptance of the 'boom-bust' model would be, in part, due to the fact that local consumption and subsistence figures are nearly always unavailable, which means that it is impossible to measure the participation of a product in the livelihood of an extracting family; that is, this model would represent the product only on external markets, barely taking into account its local role.

The *bacuri* is a rather particular case, because it grows easily in degraded areas and achieves high densities with the simplest handling techniques, in addition to having a unique flavour appreciated by people of all classes everywhere in Amazonia. The possibility of overexploitation of the raw

material is difficult to imagine, at least in the short term. A few lessons that can be learned from the *bacuri* case study follow.

- Changes may occur in the public perception of a forestry species formerly seen as second-class produce and appreciated only by the poorer people. Today, the *bacuri* is appreciated by the uppermost layers of society and the fruit has reached the most sophisticated restaurants.
- Government institutions can develop new products and influence demand. Embrapa Amazônia Oriental and the Federal University of Pará, working in partnership with a few small companies, have developed new and sophisticated existing products, such as chocolate with *bacuri* filling, creating a new market niche.
- The zero intervention theory is applicable. Traditional knowledge, initiative, and experimentation by small farmers have developed a handling possibility for an extremely efficient, practical, and low-cost species without intervention from any institution outside the community.
- Conflict exists in the use of wood and nonwood products. Especially in firm land areas, along the expansion front of the lumber industry, the conflict in usage between the traditional collection of fruit and the felling of species like the *bacurizeiro* for extraction of wood becomes increasingly more difficult. In terms of genetic erosion losses are irreparable, since *bacurizeiros* handled in degraded areas are usually clones from root burgeoning, with a much lower level of genetic variation. The fruit display extremely variable features from one tree to the next and this variation could be exploited, for example, to obtain fruit with fewer seeds, less rind, and more pulp. For *caboclo* populations living in and depending on forest areas, remuneration from the sale of wood is usually negligible while the loss of nonwood products is irreparable (Medina and Shanley, 2004).
- The local populations' knowledge of and attention to signs of change in demand by the market have shown themselves to be quite operative in the case of *bacuri*, as they responded with changes in the production system, with a view to addressing and meeting the new demand.
- Farmer-to-farmer transmission, locally called radio-vine, of news in handling or about the market has also shown itself to be quite active in the case of the *bacuri*.

NOTES

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3. Cleared lands make up a large and growing portion of the forest cover in the humid tropics and are an important potential source for environmental production and preservation on local, national, and global scales. Given this

importance, the level of knowledge and experience about areas of cleared land is inadequate (CIFOR/GTZ/LNE 2000).

4. One of the *bacuri*'s important features is its resistance to fire. Because of their thick bark, *bacurizeiros* recover remarkably well in recently burned areas (Shanley 2000).

5. The species has hermaphrodite, self-incompatible flowers (Maués and Venturieri 1996), requiring cross-pollination for the formation of fruit.

6. Outside the communities studied, experiences with handling of *bacuri* are extremely rare. There are experiences with grafted plants, in consortium with other crops (e.g., *cupuaçu* and coffee), and directioning of the canopy, but unhandled populations still represent over 90% of the total production.

7. In addition to price seasonality during the harvest period, there is large variation in prices dependent mainly on fruit size and shape, .

8. Decree no. 2,788, of 28 September 1998, altering Decree no. 1,282 of 19 October 1994.

9. 'Area located inside a rural property or possession, excepting those for permanent preservation, necessary for the sustainable use of resources, for the preservation and rehabilitation of ecologic processes, for the preservation of biodiversity and shelter and protection of local indigenous fauna and flora' (Provisional Bill no. 1956-50/00).

REFERENCES

- Baena, A.R.C., Falesi, I.C. and Dutra, S. 1998. Características físico-químicas do solo em diferentes agroecossistemas na região bragantina do nordeste paraense. Embrapa-CPATU, Belém.
- Basso, D. 1993. Produção familiar e desenvolvimento agrário. Unijuí/ Departamento de Economia e contabilidade, Ijuí. 44p.
- Carvalho, J.E.U., Muller, C.H. and Leão, N.V.M. 1998. Cronologia dos eventos morfológicos associados à germinação e sensibilidade ao dessecamento em sementes de bacuri (*Platonia insignis* Mart.-*Clusiaceae*). Revista Brasileira de Sementes 20(2).
- Carvalho, J.E.U., Nascimento, W.M.O. do and Muller, C.H. 1999. Sistemas alternativos para a formação de mudas de bacurizeiro (*Platonia Insignis* Mart.). Embrapa Amazônia Oriental, Belém. 5 p.
- Cavalcante, P.B. 1991. Frutas comestíveis da Amazônia. CEJUP, Belém.
- CIFOR/GTZ/LNE 2000. Towards sustainable management and development of tropical secondary forest in Asia: The samarinda proposal for action. CIFOR, Jakarta.
- Clement, C., Clay, J. and Sampaio, P. (eds.) 1999. Biodiversidade Amazônica: exemplos e estratégias de utilização. Programa de Desenvolvimento Empresarial e Tecnológico, SEBRAE/AM, Manaus.
- FAO 1986. Food and fruit bearing species 3: examples from Latin America. FAO Forestry Paper 44/3. FAO, Rome, Italy.
- Lopes, S.R.M. 2000. Procedimentos legais da exploração florestal na Amazônia. E.F.S., Belém. 124p.

- Homma, A.K.O. 1996. Modernization and technological dualism in the extractive economy in Amazonia. In: Péres, M.R. and Arnold, J.E.M. (eds.) Current issues in non-timber forest products research, 59-81. CIFOR, Bogor.
- Maués, M.M. and Venturieri, G.C. 1996. Ecologia da polinização do bacurizeiro (*Platonia insignis* Mart.) Clusiaceae. Embrapa-CPATU, Belém. 24p.
- Medina, G. 2001. Comercialização da mandioca e seus sub-produtos pela agricultura familiar de área de assentamento, no nordeste paraense. Universidade Federal do Pará (Centro Agropecuário/NEAF), Belém.
- Medina, G. & Shanley, P. 2004. Big trees, small favors: loggers and communities in Amazonia. *Bois et Forêts des Tropiques*. 282 (4) 19-25.
- Shanley, P. 2000. As forests falls: the changing use, ecology and value of non-timber forest resources for caboclo communities in eastern Amazonia. Ph.D. Thesis, The University of Kent, U.K.
- Shanley, P., Luz, L. and Swingland, I. 2002. The faint promise of a distant market: a survey of Belém's trade in non-timber forest products. *Biodiversity and Conservation* 11: 615-636.
- Shanley, P. and Medina, G. (eds). 2005. Frutíferas e plantas úteis na vida amazônica. Imazon/CIFOR, Belém. 300p.
- Teixeira, G.H.A. 2000. Frutos do bacurizeiro (*Platonia insignis* Mart.): caracterização, qualidade e conservação. Jaboticabal.

EXPRESSION OF THANKS

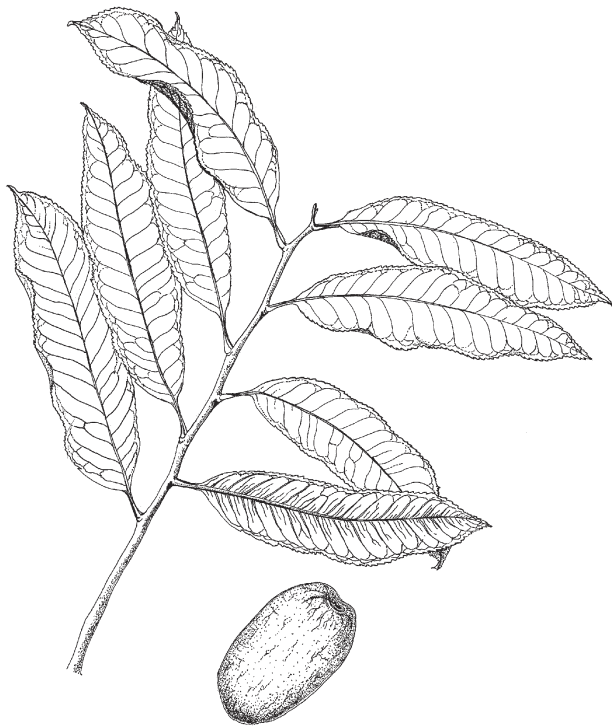
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Chapter 11

Poor Man’s Fruit Turns Profitable:
Endopleura uchi in managed groves
near Belém, Brazil

Patricia Shanley¹ and Gloria Gaia²



(*Endopleura uchi*)

Common name	Product part used	Dominant form of management	Degree of transformation	Commercial scale	Geographic distribution
Uxi	Fruit	Wild/managed	Low	National	Wide

ABSTRACT

In isolated forest communities and urban cities of Amazonia, the nutritious pulp of *Endopleura uchi* (Cuatrec.) [Humiracea] is eaten raw, in juices and ice creams. Rural families maintain that consumption of uxi, which is nutritious in vitamins, minerals, and oils, keeps sickness at bay during the four-month fruiting season. In addition to providing food for people, uxi supports a wide variety of wildlife. A native forest tree occurring in low densities in unmanaged forests, *E. uchi* has been described as an economically unviable species nonconductive to domestication or management. As sources of fruit from mature, unmanaged forests have declined in the wake of deforestation, however, the response of some farmers around Belém, Brazil, has been to intensively manage fruit trees in home groves (*sítios*) near the city. These management systems in peri-urban areas may help conserve a monotypic species vulnerable to land use change as well as help sustain thousands of rural families. Within easy transport distance of Belem, some smallholders are generating an estimated 16% of their income from the fruit. The case highlights the subsistence and cultural value of locally used and traded species, calling into question widespread development assumptions favouring heavily traded and export commodities.

INTRODUCTION

During the rainy season of February through April, among the colorful native forest fruits of the Amazon market lies a motley, brown-and-green-colored egg-shaped one. Bit into, teeth strike hard endocarp, its fleshy layer being a mere 4 mm thick. This thin layer of gritty, oily flesh must be peeled off with one's teeth. Distasteful to most northern hemisphere palates, the tiny bit of pulp on each fruit competes surprisingly well with the 50 other fruit flavours used in the popsicle, juice, and ice cream industries.

Occurring throughout the Amazon basin from Peru to the central and eastern states of Pará and Amazonas in Brazil, *Endopleura uchi* (locally called uxi) has received scant study. A species of *terra firme* (upland dry), high canopy forest, the straight, gray-barked trees attain 25-30 m in height, with diameters reaching 1 m. The tree's fruit is appreciated by both human and animal populations throughout Amazonia, making uxi a favoured tree for hunters to place traps, thus boosting the protein intake of families. Its bark is sold as a medicinal remedy for arthritis, cholesterol, and diabetes. In addition to these many non-timber uses, its dense wood is prized for carpentry and in eastern Amazonia uxi is heavily extracted by the timber industry. One of a score of locally valued species uxi presents a conflict of use for its excellent timber or for its fruit, medicinal and game-attracting value.

The nondescript appearance of the fruit belies its cultural and economic importance in urban centres throughout the region. Two decades ago it was called *fruta da pobre* (fruit of the poor) due to its cheap prices and accessibility to the poor, but prices have steadily risen over the last decade reflecting the greater demand and increasing value placed on uxi. Today in Belém, an estimated US\$3 million worth of uxi are sold during its three-to-four-month fruiting season.

Farmers near the city who benefit from the management techniques favouring uxi employed by their fathers and grandfathers appreciate profits from the fruits. Largely undocumented, these management systems are especially important in light of the low densities of uxi in upland *terra firme* forests, given land use change and habitat loss. Bearing durable, heavy wood (0.93 g/cm^3), uxi is extracted by the timber industry and used in cabinet making, and for posts and beams. In frontier regions, logging roads, a plethora of sawmills and lack of ready markets to sell fruit combine to favour short-term economic gains of timber extraction. Fire often follows repeated episodes of selective logging (Uhl and Kaufmann 1990; Gerwing 2002). In logged-over areas throughout the region, synergistic effects of fire and ranching further contribute to the decline of *Endopleura uchi*.

RESEARCH QUESTIONS

This study uses uxi as a lens to evaluate different responses to land use change in two sites. In the frontier site, uxi is valued for subsistence use, as markets are far away and transportation infrastructure is lacking. In the peri-urban site, however, proximity to a burgeoning market, rapid transport, and intensive management of the species allow high-volume marketing of the fruit during the four-month fruiting season. These contrasting scenarios give rise to a number of research questions with relevance to local livelihoods and forest fruits. First, how do people and species respond differently under different land use regimes and socioeconomic conditions? Why does fruit generate relatively high income for rural households in one site, while in the logging frontier, fruit trees are extracted by the timber industry? As logging, ranching, and fire rapidly alter species composition throughout Amazonia, the resilience and vulnerability of species to land use change and their capacity for management play a key role in determining whether they will be present or absent from future flora, and hence, whether their roles in nutrition and health care are maintained or destroyed.

This article first describes the resource base—the geographic setting, species ecology, and management of uxi in both the logging frontier and peri-urban sites. A description follows of the production to consumption system in the peri-urban site where fruit are sold—the harvesters and their socioeconomic context, trade, marketing, the processing industry, and the policy environment affecting the species. We next address trends and issues in conservation and development, which the case study illuminates. We conclude by recommending where research attention is most needed to help ensure that rural and urban people maintain access to species of greatest value for their nutrition and health care.

METHODS

The main focus of the study is on a peri-urban site and the market of Belém, where fruit is sold. Because of the exceptional resource and infrastructural advantages of this site, some data will also be presented from a more remote setting, to offer a more balanced perspective and to demonstrate the varied

Figure 1. Location of the study area



Source: ESRI Data and Maps 2002.

responses of people and particular species to different socioeconomic and geographic conditions. The second research site is located in *terra firme* forest, in a logging frontier 200 km from Belém and 120 km from Paragominas, characterised by predatory logging, ranching, and fire. Sites demonstrate marked differences in land use regimes, species use, trade, and management (Figure 1).

Uxi was selected by communities in both the frontier, logging site and the peri-urban site as one of the species considered of highest local value. These sites present striking differences, however, in management, use, and economic and environmental prospects for the future. Because no prior research was available on uxi in either site, forest inventories, ecological studies of production and yield, and market studies were conducted. These activities formed part of broader, longer-term study initiated in response to a request for information from the Rural Workers Union of Paragominas, and carried out with community members and researchers from the Woods Hole Research Center.

To account for the highly variable annual fruit production, data were collected over a period of six years in the frontier site (3,000 ha, 24 individuals) and for four years in the peri-urban area (1 ha, 11 individuals). Concurrently, during a period of four years in Belém, market data were collected from wholesalers, open-air markets, and ice cream shops. In addition, daily diaries of fruit collection and consumption, participatory appraisal methods, and semistructured interviews were used to assess the role of uxi for local livelihoods and forest conservation.

THE RESOURCE BASE

Geographic setting

The principal study area, the small community of Boa Vista in the municipality of Acara, is located in the eastern state of the Brazilian Amazon, Pará, less than an hour's boat ride from the major port city of Belém founded in 1621. Seventy miles inland from the sea, the city lies on a piece of land formed at the 20-mile wide junction of the Guamá and Pará rivers, and Paraenses proudly call the vast inland fresh water source 'the Mediterranean of South America'. The case study area is one of hundreds of island communities along this massive inland waterway.

Located 1°28' south of the equator, the peri-urban case study area and the vast Amazon estuary in which it lies bear exceptional phytogeographic advantages for non-timber forest product management and trade. The locale includes both *varzea* and *terra firme* forests, thus broadening the species composition and production choices for farmers living within the region. In the peri-urban site, uxi is grown in home groves, forests composed exclusively of fruit trees and palms. Located less than 10 km by water from Belém, the case study site benefits from inexpensive and frequent boat transportation to major ports. These ports are hubs for burgeoning outdoor markets supplying fruit, vegetables, and fish to Belém's 1.7 million inhabitants.

The frontier study site is located on the western bank of the Capim River, municipality of Ipixuna, slightly over 200 km from Belém. Through an informal but locally recognised land titling system, three small communities composed of 50 families have occupied the 3,000 ha for close to a century. The land consists of selectively logged forest, agricultural fields, secondary forests, and settlements. Families practice swidden agriculture, their principal market commodity being *farinha* (manioc flour). Residents hunt and gather fruit and fiber for subsistence use. During the last 20 years there have been over 10 episodes of selective logging in the 3,000 ha forest.

Species ecology

An Amazonian native of the Humiraceae family and a monotypic genus, the status of *E. uchi* has implications for biodiversity conservation. While an in-depth study of its distribution has not been conducted, literature reveals that it occurs throughout the Brazilian Amazon from the eastern Amazonian state of Pará to Amazonas (Cavalcante 1991). In eastern Amazonia, where the study sites are located, it is commonly found in the Amazon estuary, in the Zona Bragantina, and along the Guamá and Capim rivers (Lorenzi 2000).

Of the fruiting tree species found in the case study region, *uxi* is distinct in that it has been described as an economically unviable species nonconductive to domestication or management in agroforestry systems because of its slow germination and delayed reproduction (Cavalcante 1991). Reproduction is by seed, commonly taking 9–10 months to germinate. Seedlings grow slowly and trees often do not fruit until they attain 15 years. This view is supported by small producers outside of the study region, who relate that both germination and growth are sluggish, stating that it is not unusual to wait more than 15 years for fruit. Experiences of farmers in the case study area stand in marked contrast. There, farmers relate that they effectively plant and transplant trees, thereby increasing population density of *uxi*. Their planted trees sometimes begin reproducing at nine years of age. Lorenzi (2000) affirms the empirical findings of farmers and relates that, while *uxi* naturally occurs in the primary forest, it tolerates cultivation in semi-open areas.

Density: comparing peri-urban and mature forest sites

The forest ecosystem within which the peri-urban case study area lies is largely anthropogenic, crafted by generations of households who have selected particular fruit species for home use and trade. In the managed landscape of the case study area, biodiversity is deliberately altered to favour roughly a dozen fruiting species, a combination of which are common to most home groves. The composition of the forest has been deliberately simplified to meet the consumption preferences of Belém's mushrooming urban population. Producers near the case study site close to Belém have ingeniously devised means to intensively manage native Amazonian palm fruit, particularly *Euterpe oleraceae* (açai) (Anderson and Jardim 1989). By contrast, in mature forest where *uxi* occurs naturally and which has undergone little management in recent history, there are close to 200 species per hectare (Shanley and

Table 1. Recorded densities of *E. uchi* in two locations of Pará

Study site	Density		Management status
	Plot A	Plot B	
Logging frontier (prior to logging) Distance to market: 122 km to Paragominas Population density: 1 person/km ²	1.2	0.36	Little to none
Peri-urban Distance to market: 10 km to Belém Population density: 200 persons/km ²	5	34	Intensive

Rosa 2004) with less than one *E. uchi* tree per hectare (0.4-1.2). Differences in density of *E. uchi* in the two sites are likely linked to differences in human population density and distance to markets (Table 1). In remote areas such as the frontier site, with a population density of less than 1 person/km², expansive forests produce sufficient fruit to meet subsistence needs, and transportation infrastructure to reach the nearby market is limited. In peri-urban areas, however, such as the case study site with 200 persons/km², economic incentives are strong to intensively manage income-producing species for trade.

Production

Although fundamental to an understanding of rural livelihoods and forest conservation, fruit production rates have rarely been quantified for upper canopy tropical tree species (Peters 1989) such as uxi. Challenges include low density and highly variable production, the former necessitating a large area for an adequate sample size and the latter a lengthy time frame to obtain sufficient data.

Fruit production of 24 individuals in a 500 ha area demonstrated marked annual variation; a period of five years verified oscillating production, one year of high production followed by a year of *descansa* (rest) with half the earlier production or less. During the 3-to-4-month fruiting season, production varied between 300 and 4,000 fruit per tree, and average annual production was roughly 850 fruit per tree. Findings demonstrate that of Amazonian forest fruit trees, uxi offers an advantage that some 'wild' forest fruit trees lack in that individual trees generally produce fruit once every year (Lorenzi 2000; Shanley, Luz *et al.* 2002). Unlike other native *terra firme* fruit species, such as *Caryocar villosum* (piquiá) and *Platonia insignis* (bacuri), of which only 20% to 55% of individuals may produce fruit in any given year, the five-year average annual percentage of fruit producing uxi trees was 80% (Shanley and Medina 2005).

Changing levels of production of fruit in the forest are mirrored by supply in the marketplace. In 2001, harvesters, wholesalers, and retailers maintained that supply was insufficient to meet demand, indicating that more fruit could have been sold, particularly to meet year-round demand by ice cream shops and vendors who extract and freeze the pulp. This analysis was echoed in the

Photo 1. Harvest of *E. uchi* (Photo: P. Shanley)



forest, where community members considered the poor harvest season to be a year of fruit tree 'rest'. Based on knowledge of the phenology of forest fruit trees, indicating that a low-harvest year is followed by one of average or high production, harvesters and vendors predicted a season of high returns in 2002. As anticipated, forest fruit production increased throughout the region in 2002, meeting consumer demand with positive economic results for both collectors and vendors.

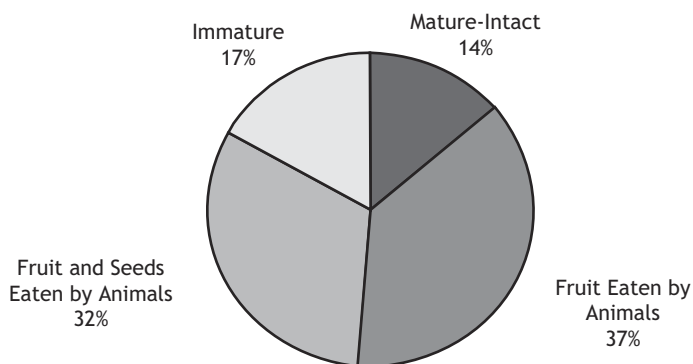
In addition to the regular fruiting season that occurs from January to April, some harvesters are fortunate to benefit from a profitable bonus production midway through the year. In both Manaus and Belém, uxi sometimes offers a second harvest season in mid-summer (July/August). One producer explained that trees that 'rested' during the rainy season produce fruit at this time. Others relate that individual trees may produce fruit twice yearly and that 'managed *uxizeiros*' are most likely to offer a second harvest. Increased consumer demand, deforestation in areas of natural uxi populations, and higher prices during the off-season suggest that research is needed to document the geographical extent of this phenomenon and to identify conditions favouring a second fruiting season.

Regeneration and dispersal in mature forests

Uxi is shade tolerant, regenerating in the mature forest. In the peri-urban case study site, farmers encourage regeneration by manipulating the population structure and actively managing seedlings, saplings, and adults. Farmers plant uxi in canopy clearings, where other trees have died or where one is removed for lack of productivity. In the frontier site prior to logging, the naturally occurring uxi trees were sufficient to provide fruit for subsistence purposes, thus community members harvested, but did not directly manage uxi trees to increase their productivity.

In peri-urban areas wildlife is not abundant and fruit is rarely damaged by mammals. But in mature forests, uxi attracts a variety of frugivores during its season, becoming a staple food of armadillo, bats, deer, paca, peccary, squirrels, and toucans. In forests distant from cities, where uxi is used for subsistence, children, hunters, and women gather fruit as they hunt and walk to their swidden fields; some children go on expeditions to collect fruit from distant trees. In these regions a small portion of fruit production is consumed by families, while the majority is eaten by wildlife. Sustaining wildlife populations indirectly supports human populations as hunters place traps beneath uxi, thereby securing a source of protein. During one year, in *terra firme* forests of the Capim River logging frontier region, combined predation of 24 uxi trees reached 69% (Figure 2). In addition to the 69% of the production eaten by wildlife, 17% of the production was immature, leaving only 14% available for human consumption or sale (Shanley 2000).

Figure 2. Fruit crop fate of *Endopleura uchi*, $n = 24$



Management by smallholders in peri-urban areas

Experienced fruit vendors recall that, several decades ago, much of the fruit sold in Belém arrived by boatload from mature, high canopy forests that still surrounded the city. Within the last few decades many of these forests have been cleared. Today uxi marketed in the city is also supplied to the market from intensively managed family forest groves close to the city. In the peri-urban site, a successful collector and wholesaler of fruit

stated that the forest fruits uxi and piquiá were marketed in Belém a century ago and that 'my grandfather already managed uxi'. During his grandfather's time, the forest was composed of large-diameter timber trees, which were selectively extracted and substituted with fruiting species. This smallholder revealed that 30 years ago there were six large uxi trees on his property of 50 hectares. Because of management, today there are over 100, roughly 60 productive and 40 immature; 34 uxi trees are present in one intensively managed hectare.

Techniques to increase density and improve fruit production of uxi include enrichment planting, transplanting of seedlings, selection of preferred germ plasm, thinning of competing vegetation, fire to control ant populations on the branches and trunk, biannual clearing of vegetation and ground debris beneath trees, and scattering of damaged fruit and their seeds onto the forest floor. To allow the seeds to germinate more rapidly, some smallholders experiment by placing endocarps from the prior year whose pulp has decomposed in a humid place on the forest floor. In humid conditions the seeds can germinate more quickly and, as seedlings, are transplanted to forest or garden. Other smallholders contend that allowing nature to do the

Photo 2. *E. uchi* transplanted (Photo: P. Shanley)



work works best. One of the successful producers allows seedlings to become established naturally within the forest, then transplants them to areas in the forest where they will get filtered sunlight to allow them to grow. Some of the management practices increase fruit quality through selection of better germ plasm, while other management practices serve to foster overall tree growth, with no selection.

Some producers deliberately leave damaged fruit on the forest floor, particularly from trees with high production and good-quality fruit. The next year, when these fruits have decomposed, they represent a greater percentage of the seedlings collected for transplanting. These management practices favour preferred germ plasm and have helped to guarantee a relatively high production of marketable fruit on small plots of land. Over the years, the principal tool to tend uxi, a machete, has not changed; few other tools are needed. Well-managed groves resemble parks; they are cleaned of vegetative debris and occupied exclusively by edible palms such as bacaba (*Oenocarpus bacaba*), buriti (*Mauritia flexuosa*), pupunha (*Bactris gasipaes*), and acai (*Euterpe oleraceae*), nuts such as Brazil nut (*Bertholletia excelsa*), and fruits like cupuaçu (*Theobroma grandiflorum*), piquiá (*Caryocar villosum*), and bacuri (*Platonia insignis*). Clearing the grounds serves not only to allow better visibility of the egg-sized uxi that fall from the tree into the litter, but also facilitates unencumbered walking and collection of other fruit species within the grove. Trees showing signs of senescence may be extracted and used for their timber; the home of one long-time harvesting household is constructed completely of uxi.

THE PRODUCTION-TO-CONSUMPTION SYSTEM

Harvesters and socioeconomic context in peri-urban site

The mixing of Europeans, African slaves and indigenous people resulted in what is known as a *caboclo* population (Parker 1989). The 200 households in the 6 km² case study area of the peri-urban site are each composed of four to eight persons, many families having lived in the area for three or four generations. Land tenure is relatively secure; although not all families possess legal documentation of tenure, decades of living in the area have established clear patterns of land rights and usage. Traditional regulations regarding property rights are generally adhered to, although theft of fruit is reported occasionally.

The stable value and long-held tradition of managing uxi has resulted in the majority of community households basing their livelihoods on management and sale of this and a dozen other fruiting species. The relative contribution of uxi or any particular species to the income of individual harvesters varies depending on density of trees, annual production and labor intensity.

In addition to managing groves of fruit trees and palms, some households have small swidden fields a short distance from their homes where they grow banana, cassava, corn or various other crops for subsistence use and occasional sale. The portfolio of traded products in the case study area is highly diversified throughout the year, offering strategic choices to minimise

risk. The wide range of agricultural and forest products allows incomes to reach roughly US\$3,000 per year, three times higher than that of communities 200 km distance away, with less access to market and little to no forest management. Some smallholders maintain that, during a good harvest season, profits from sales of uxi fruit can provide close to 20% of their annual income.

Trade in eastern Amazonia

Uxi is sold throughout eastern and central Amazonia, major sales venues being Manaus and Belém. Native fruits marketed locally and regionally have the advantage of relatively stable trade as opposed to internationally traded commodities characterised by boom-bust cycles (Homma 1992). Additionally, profits from regionally consumed fruits is captured locally and not appropriated by outsiders or elites (Dove 1993). On the contrary, disenfranchised people, such as women and the rural poor, figure prominently in the harvesting and processing of fruit and the appreciable retail trade in locally consumed forest products (Padoch 1988).

During the last decade, vendors report that domestic demand has fueled increased sales. Although each year more and more temperate fruit arrive from the south of Brazil (i.e., apples, grapes, melons), Amazonians continue to fancy uxi. Vendors and rural farmers who sell uxi relate that three decades ago the sale of uxi was considered to be restricted to lower socioeconomic strata (Shanley and Gaia 2004). Native forest fruits such as Brazil nut (*Bertholletia excelsa*), piquiá, and the small fruit of the palms, tucumã (*Astrocaryum vulgare*) and inajá (*Maximiliana maripa*), were considered 'fruit of the poor'. Today traders state that 'everyone buys uxi. Uxi is now a fruit eaten by society.' The growing volume of regional trade in 'wild gathered' forest fruits, such as bacuri (*Platonia insignis*), inajá, piquiá, tucumã, and uxi, during the four-month harvest season is significant. Wholesalers and retailers in Belém report that they have substantially more cash in their pockets during the season of native fruit than during any other time of the year (Shanley, Luz *et al.* 2002).

Because they are not marketed nationally or internationally, however, no governmental statistics are available regarding traded volumes of any of the native fruit listed above. Critical to rural livelihoods both for subsistence and for income generated by local trade, the majority of Amazonian non-timber forest products remain invisible to governmental agencies and academia, with notable exceptions (Padoch 1988; Anderson and Jardim 1989; Vasquez and Gentry 1989; Phillips 1990, 1993; Clay *et al.* 1999). A tendency in ecological and economic research to focus on high volume and export commodities can directly impede understanding of the species that are most critical for the livelihoods of rural and urban people.

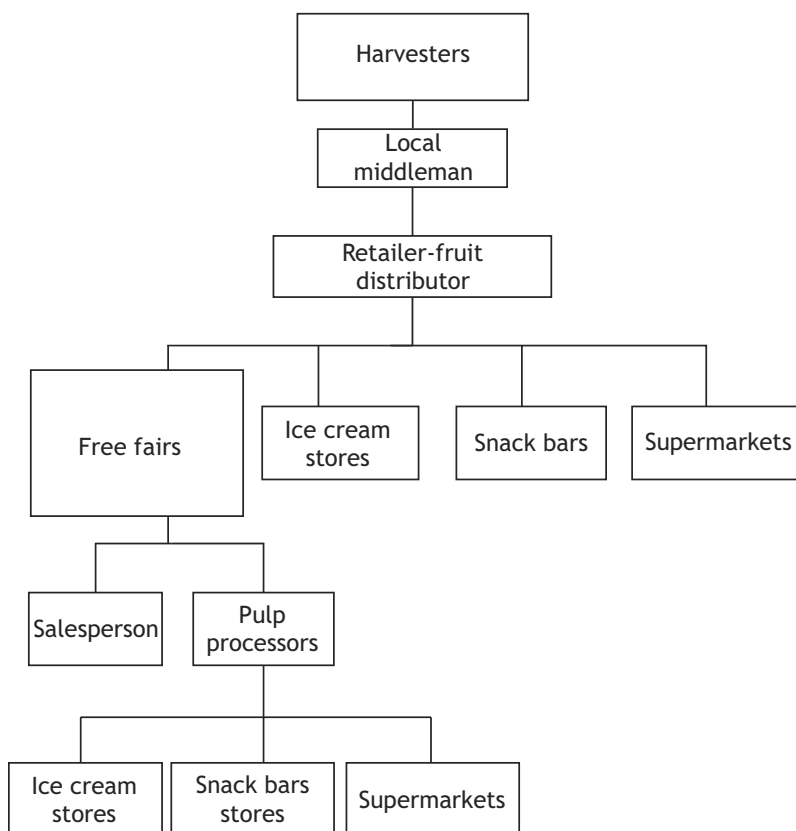
Marketing in the peri-urban site

During the regular harvest season, thousands of households throughout Amazonia collect uxi from the forest floor after its natural ripening. In the

case study area, men, and occasionally women, cruise the fruit grove to collect fruit once or twice a day. The fruit is sorted by quality (large, small, and those with unfavourable markings on the skin), placed in sacks or roughly hewn baskets, and sold to one of 10 middlemen in the village. Perishable after four to five days, uxi must be transported frequently to market. At dusk three to four days a week, the baskets are heaped atop wooden wheelbarrows and transported $\frac{1}{4}$ km to 2 km to the river's edge. At three o'clock in the morning, boats depart for *porto da palha*, one of several ports in the city, which serves as a collection hub for fruit and occasionally game, fiber, and medicinal oil and bark. In the predawn darkness, 20 to 30 wholesalers arrive; collectors and buyers negotiate prices, collectors as a general rule receiving half or less of retail prices. Deals close quickly; by six or seven o'clock, fruit are on their way to one of Belém's numerous (> 25) open-air marketplaces and to ice cream outlets, supermarkets, and luncheonettes.

In the case study area, collectors are paid the equivalent of R\$0.02 per fruit for 100 fruits by one of the ten middlemen, who are also producers, from within the community. (R\$1 equalled US\$0.41 at the time of study.) During

Figure 3. Commercial chain, *Endopleura uchi*



the last five years, the number of village intermediaries from households has risen from three to ten, signifying rising trade. Intermediaries are friends, relatives, and neighbours who also harvest a variety of fruiting species, but who are willing to make three trips a week in the middle of the night to the port and to negotiate sales. The intermediaries sell 100 uxi fruit for R\$0.03, after which the reseller receives R\$0.05-0.06 per fruit for 100 fruits. Collectors receive approximately US\$0.13 per kilogramme, while the retail price varies from 3 to 16 times as much. Households from the study area may sell between 5,000 and 10,000 fruit per week.

Retail prices vary considerably by outlet and neighborhood: prices of fruit in supermarkets are often three- to fivefold higher than in open-air markets. Prices also vary during the season, tending to be highest at the beginning and end of the season, when fewer fruit are available for sale. Depending on the site of sale and the fruit size and quality, a consumer may pay US\$0.66 to US\$2.00 per kilogramme of uxi. In 2001 retail vendors began dividing fruit into classes, selling 12 small fruit, 8 medium fruit, or 6 large fruit for R\$1. The number of fruit within a R\$1 sack has gradually diminished each year, from 12 in 1998 to half that in 2002. The average inflation rate during this period was 6.2% per year, thus, accounting for inflation, the real price has risen by approximately 75%.

'*Fruta da pobre*' currently offers a profitable return for many harvesters, rising in price at many outdoor markets from US\$0.02-0.03 per fruit in 1994 to US\$ 0.07-0.09 per fruit in 2002. In some communities surrounding Belém, the four-month fruiting season generates the bulk of household cash income. Yearly purchases of school materials, clothes, shoes, and other manufactured goods coincide with fruit fall. Uxi serves not only to boost income but to provide 'natural insurance', mitigating agricultural and other risks (Pattanayak and Sills 2001).

Processing industry

Uxi often falls still green and unripe; a number of days must pass to soften the hard pulp before it is ready to be eaten. In the past, to enhance ripening, villagers in these forested regions dug ditches, lined them with leaves, placed dozens of uxi fruit in the ground, and covered them with leaves and dirt. In one to two days the cache of uxi was unearthed, ripe for eating (Shanley and Rosa 2004).

Fruits weigh 50 g to 70 g and possess a large endocarp, surrounded by a thin layer of oily, orange-yellow mesocarp. The fruit is generally eaten in its fresh form, by chewing the thin layer of gritty flesh off of the raw fruit. The pulp of uxi is high in calories, containing 46.7% water, 20.2% lipids, 19.8% carbohydrates, 10.8% fiber, 1.3% ash, and 1.2% protein (Villachia 1996). Both the pulp and small seeds (2-3 cm) contain oil. Chemically and physically the oil is similar to olive oil, used in remote communities to fry fish, against sinusitis in children (by passing warm oil on the nose), and as a remedy against gas (by massaging warm oil onto the stomach). Today, few rural persons recall such treatments or know how to extract the oil, signaling an erosion of traditional knowledge (Shanley and Rosa 2004).

The majority of the fruit is marketed and consumed raw, but a portion of the production is used for juice and ice cream. To make juice, the flesh is scraped off with an implement, and stirred into water. Throughout Belém pulp is extracted manually; no mechanisation exists. While harvest and wholesale of much of the fruit trade in Belém is dominated by men, urban women figure prominently in the processing of fruit and the expanding retail trade. Scores of women in ice cream parlors, in the *Ver-o-Peso* market, and in home cottage industries extract the fruit pulp by hand. Approximately 60 uxi fruits are needed to produce 1 kg of pulp, which costs the consumer US\$1.37 to US\$2.60. One ice cream shop in Belém purchases 200 kg of uxi per month from three or four suppliers and employs three to four women during the harvest season to remove the pulp. One kilogramme of uxi is adequate to make five litres of ice cream. Pulp is frozen to maintain sufficient supply for the year, uxi being a favourite popsicle flavour.

The owner of the city's largest ice cream chain noted a change in consumer preferences 15 years ago, coinciding with the arrival of McDonald's in Belém. He commented that the introduction of ice cream featuring fruits grown in the south of Brazil and artificially flavoured ice cream sold in supermarkets and luncheonettes reduced the relative sales of traditional flavours. In spite of the introduction of a wider range of flavours, ice cream vendors throughout Belém relate that imported flavours, such as strawberry, continue to take second place to native tropical fruits such as *Euterpe oleracea* (açai) and *Theobroma grandiflorum* (cupuaçu).

In addition to the economic value of the fruit, medical claims made on television in 2001 as to the efficacy of the bark of uxi for treatment of diabetes, elevated cholesterol, and rheumatism have created a market for its bark. The rapid growth in sales based on modern media coverage is particularly notable because until this report aired not one of the scores of vendors and 100 smallholders interviewed as part of this study reported use of uxi bark for medicinal purposes. New uses of uxi also grew from dissemination of species-specific information through booklets. Information gleaned from a booklet on the use of Amazonian species catalysed some jewellery makers to resurrect the old-time use of uxi's endocarp as an amulet, using it whole or cutting it in slivers to make necklaces, belts, and earrings. Residue or broken pieces of uxi's endocarp may be burned, the smoke being purported to repel both insects and bad spirits. Beginning in 2002, seeds of *Maximiliana maripa* (inaja), *Astrocaryum vulgare* (tucuma), and uxi are found for sale in the *Ver-o-Peso* market for prices close to that of the actual fruit (Shanley and Medina 2005). Seeds are used in the growing natural-jewellery trade. Appealing to 'green' consumers, sellers dub strings of recycled seeds 'bio-joias' (bio-jewels).

Policy environment

Brazilian federal legislation requires permits and forest management plans to extract and sell forest products. Federal legislation also dictates that no more than a certain percentage of forest cover may be removed (20% in the case of humid, tropical forests in Amazonia, 65% in the cerrado, and 80% in

forests of other regions). Implementing such laws in the expansive forests of Amazonia is extremely difficult, however, where smallholders, ranchers, and loggers are scattered across millions of hectares. In the Amazon estuary, near the case study site, such legislation does impact high-profile industries, such as heart-of-palm harvesting and processing companies dealing in tons of product annually. For the majority of *caboclo* harvesters, however, who individually collect and trade in small volumes of fibers, fruits, and medicinal barks, roots, and herbs, legislation has little to no bearing on their daily collection and trade. This lack of implementation of forestry laws can be favourable to small producers; marginalised already, they cannot afford to bear additional costs imposed by permits. For the often nonliterate *caboclo* having little formal documentation of land tenure, costly and time-consuming requirements such as management plans could create inappropriate and ineffectual burdens.

In the region of Belém, without the intervention of government, thousands of traders and collectors give and receive market signals, efficiently producing and trading forest goods. Tons of terrestrial and aquatic species are funneled from a wide geographic area to reach close to two million consumers.³ For the farmers from the case study community who supply fruit to the market, lack of external interference and support may be one of the reasons for their successful, independent operations. Development assistance often involves new and unfamiliar administrative procedures, frequently created with insufficient knowledge of locally important species, labor supply, market conditions, prices and/or sustainable management practices. In the case study area, farmers successfully maximise their time to manage trees, not paper.

More important to the status of *uxi* than national forestry laws has been extrasectoral policies enacted during the last 40 years. Geopolitical decisions to colonise Amazonia have promoted cattle ranching (Hecht and Cockburn 1990) and timber extraction (Uhl *et al.* 1991), which are part of a synergistic series of events that eventually lead to forest conversion (Nepstad *et al.* 1999; Cochran and Laurance 2002). These land use changes are key factors in determining future species composition and the maintenance or loss of forest resources valuable to rural communities.

TRENDS AND ISSUES: CONSERVATION AND DEVELOPMENT LESSONS

Conservation

'I found Pará greatly changed, the noble forest trees had been cut down . . . only a few acres of the glorious forest now remained in their natural state. A naturalist will henceforward have to go farther from the city to find the forest scenery which lay so near in 1848, and to work much more laboriously than was formerly needed to make the large collections', observed Henry Walter Bates in 1863. Although close to one-and-one-half century have passed since Bates made this statement about a plot of land not far from the case study site, Pará, covering 1.25 million square kilometres, still remains largely (82%)

forested (Veríssimo *et al.* 1997). Domestic and international demand for the region's timber will likely increase, as international demand for wood products is forecast to rise sharply over the coming decades, particularly as Asian timber stocks decline (Skole and Tucker 1993). In addition, land use change as a consequence of logging and ranching greatly increases susceptibility of landscapes to fire (Cochrane and Laurance 2002; Gerwing 2002).

In the logging frontier site, uxi became part of the suite of species extracted by the timber industry in 1997. Because of its thin bark, low resistance to fire, excellent timber properties, and naturally low densities, uxi appears to be among a suite of species vulnerable to recent land use change. A long-term study of the ecology and fruit production of uxi conducted in the frontier site demonstrated the species' vulnerability to logging and fire. Within only six years 50% of 24 uxi trees in three frontier communities had died as the result of direct and indirect effects of logging, fire, and swidden cultivation (Shanley and Medina 2005).

Would disappearance of uxi matter from a conservation perspective? Without protection, populations of uxi may decline along the advancing arc of deforestation. One of Amazonia's premier botanists, Paulo Cavalcante (1991), highlights uxi as a prime example of a noncultivated forest species under increasing threat from deforestation. A leading authority on fruit trees in Amazonia, Urano Carvalho, a scientist at Embrapa, the National Agricultural Research Centre of Brazil in Belém, predicts that habitat loss and characteristics that render the tree vulnerable to land use changes may lead to the disappearance of *E. uchi* from the regional landscape in the coming decades. Decline in fruits and seeds may lead to decreasing potential for regeneration and certain genetic erosion. In addition, its substantial role as wildlife food implies that it possesses a wider role in maintaining the forest ecosystem. Extinction of *E. uchi* would imply an irretrievable loss of a monotypic genus distinct to Amazonia.

Livelihoods

Would disappearance of uxi matter from a livelihoods perspective? Since 1997, rural populations in the logging frontier region have shown sharp decreases in consumption of uxi fruit and the numerous game animals the species attracts (Shanley, Cymerys *et al.* 2002). Whereas individual households consumed thousands of uxi during the four-month harvest season in 1994, six years later, after three successive logging events and fire, consumption for many families had dipped to zero. Because a limited number of wild fruits comprise the majority of fruit intake for many rural families, declining access may have particularly damaging nutritional consequences.

Uxi is one example of hundreds of locally consumed and traded forest goods that will remain unknown to outsiders. The oily, gritty pulp of uxi is not likely to make its way to northern ice cream parlors and frozen food bins. But in rural areas, where calories are lacking and kilogrammes celebrated, women proclaim the virtues of the nutrient-rich pulp, proudly reporting weight gain and health benefits. Locally preferred animal and plant species such as uxi, whose taste, smell, or caloric value may be undesirable to outsiders,

frequently remain peripheral—casualties of a research and development spotlight focused on high volume and internationally traded commodities. Underlying assumptions regarding the value of species must be scrutinised to ensure that forest products that serve the needs of the rural and urban people are not overlooked.

A decade of enthusiasm for market-based approaches to conservation and less attention to locally traded species has overshadowed not only subsistence goods but also another critically important aspect of forests for communities—their cultural value (Posey 1999). Failure to address nonmarket benefits of forests can confound research aimed at alleviating poverty and conserving forests by infusing bias as to species selection criteria, creating a blind spot as to local perceptions of the value of biodiversity and missing potentially threatened forest species with high importance for rural livelihoods. From an environmental perspective, families managing uxi in peri-urban areas may play a role in conserving a monotypic genus that is poorly understood by scientists. If natural habitat of uxi declines, enclaves where the species is intensively managed may serve as a repository of genetic stock for future restoration efforts. Clearly, in this case, the value of trade has provided incentives for conservation, demonstrating resiliency in a changing landscape for both human and plant populations.

From an economic perspective, although uxi is declining in the wild, popularity of its fruit is increasing. In spite of the introduction of temperate fruit flavours in the ice cream industry, native fruits such as *Euterpe oleracea* (açai), *Theobroma grandiflorum* (cupuaçu), *Platonia insignis* (bacuri), and uxi continue to appeal to the Paraense palate. Although it may be unpalatable in its raw form, its distinctive flavour and texture in ice cream could encourage sales to expand to other regions. Both açai and cupuaçu now have national markets and incipient international markets. In addition, bacuri is slowly gaining popularity in Maranhão, Piauí, and Ceará—it is only a question of time before it reaches a national market. The popularity of formerly 'wild' forest fruits in the cities can, in part, be explained by the rural-to-urban migration exodus occurring in Amazonia (Browder and Godfrey 1997). Many urban citizens hail from rural zones, where they grew up consuming forest fruits.

As globalisation proceeds and chain foodstuffs become available, younger generations may no longer appreciate the distinct and only slightly sweet flavour of uxi. The popularity of the fruit may also wane for certain consumers in the midst of an imported weight loss fad. In this future scenario, the poor people's fruit may return to the domain of the rural people, who lack financial capability and have less market access to modernise their palates to desire processed, sweet foods. If this happens and market demand declines, uxi could decrease in importance in managed forests surrounding Belém. On the other hand, Brazilians are consuming more sweet processed foods than they ever have. If purchasing power remains stable and Amazonian fruits stylish, growing market demand may foster the expansion of incipient home groves throughout the peri-urban area.

Currently, farmers' peri-urban resiliency improves income while conserving a potentially vulnerable species. Farmers in the estuary of Belém

are privileged to have fertile land, home fruit groves, secure tenure, a family heritage of management skills, and a large, hungry population a short boat ride away who retain a strong hankering for native forest fruits. Uxi, together with a couple of dozen other native fruits serve as an economic and nutritional foundation for the sustenance of tens of thousands of rural people in eastern Amazonia. In this exceptional case scenario, a suite of forest fruits play a central role, not only in sustaining families, but in boosting their overall quality of life.

NOTES

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3. While much of this trade is legal, there also exists black market trade in birds and mammals that is contrary to the Convention on the International Trade in Endangered Species of Flora and Fauna.

REFERENCES

- Anderson, A. and Jardim, M. 1989. Costs and benefits of floodplain forest management by rural inhabitants in the Amazon estuary: a case study of acai palm production. *In*: Browder, J. (ed.) *Fragile lands in Latin America: the search for sustainable uses*. Westview Press, Boulder, Colorado.
- Bates, H.W. 1988. *A naturalist on the River Amazonas*. Penguin Books, New York.
- Browder, J.O. and Godfrey, B.J. 1997. *Rainforest Cities*. Columbia University Press, New York.
- Cavalcante, P.B. 1991. Frutas comestíveis da Amazônia. Museu Paraense Emilio Goeldi, Edições CEJUP, CNPq, Belém.
- Clay, J.W., Sampaio, P.T.B. and Clement, C.R. (eds.) 1999. Biodiversidade Amazônica: exemplos e estratégias de utilização {Amazonian biodiversity: examples and strategies for use}. Sebrae-AM, Prog. Desenvolvimento Empresarial e Tecnológico, Manaus. 409p.
- Cochrane M.A. and Laurance, W.F. 2002. Fire as a large-scale edge effect in Amazonian forests. *Journal of Tropical Ecology* 18: 311-325.
- Dove, M.R. 1993. A revisionist view of tropical deforestation and development. *Environmental Conservation* 20: 17-24.
- Gerwing, J.J. 2002. Degradation of forests through logging and fire in the eastern Brazilian Amazon. *Forest Ecology and Management* 157: 131-141.
- Hecht, S.B. and Cockburn, A. 1990. *The fate of the forest: developers, destroyers and defenders of the Amazon*. Harper Collins, New York.
- Homma, A.K.O. 1992. The dynamics of extraction in Amazonia: a historical perspective. *In*: Nepstad, D.C. and Schwartzman, S. (eds) *Non-timber products from tropical forests: evaluation of a conservation and development strategy*, 23-31. *Advances in Economic Botany* 9. The New York Botanical Garden, Bronx, New York.

- Lorenzi, H. 2000. Árvores Brasileiras: manual de identificação e cultivo de plantas arbóreas do Brasil vol. 2. Instituto Plantarum de Estudos da Flora Ltd., São Paulo, Brazil.
- Nepstad, D.C. et al. 1999. Large-scale impoverishment of Amazonian forests by logging and fire. *Nature* 398: 505-508.
- Padoch, C. 1988. Aguaje (*Mauritia flexuosa* L.f.) in the economy of Iquitos, Peru. In: Balick, M. (ed.) The palm-tree of life: biology, utilization and conservation. *Advances in Economic Botany* 66: 214-224. New York Botanical Garden, New York.
- Parker, E.P. 1989. A neglected human resource in Amazonia: the Amazon caboclo. *Advances in Economic Botany* 7.
- Pattanayak, S.K. and Sills, E.O. 2001. Do tropical forests provide natural insurance? The microeconomics of non-timber forest product collection in the Brazilian Amazon. *Land Economics* 77(4): 595-612.
- Peters, C.M. 1989. Reproduction, growth and the population dynamics of *Brosimum Alicastrum* Sw. in a moist tropical forest of central Veracruz, Mexico. Ph.D. Thesis, Yale University, New Haven, Connecticut.
- Phillips, O.L.B. 1990. *Ficus insipida* (Moraceae): ethnobotany and ecology of an Amazonian anthelmintic. *Economic Botany* 44(4).
- Phillips, O.L.B. 1993. The potential for harvesting fruits in tropical rainforests: new data from Amazonia Peru. *Biodiversity and Conservation* 2: 18-38.
- Posey, D.A. 1999. The cultural and spiritual values of biodiversity. UNEP, Intermediate Technology Publications, London, UK.
- Shanley, P. 2000.
- Shanley, P., Cymerys, M. and Luz, L. 2002. The interface of timber and non-timber resources: declining resources for subsistence livelihoods (Brazil). In: Shanley, P., Pierce, A., Laird, S. and Guillen, A. (eds.) Tapping the green market: certification and management of non-timber forest products. Earthscan, London.
- Shanley, P. and Gaia, G. 2004. Uxi: 'poor man's fruit' a rich taste from Amazonia. In: Lopez, C. and Shanley, P. (eds.) Riches of the forest: fruits, remedies and handicrafts in Latin America. CIFOR, Bogor, Indonesia.
- Shanley, P., Luz, L. and Swingland, I. 2002. The faint promise of a distant market: a survey of Belém's trade in non-timber forest products. *Biodiversity and Conservation* 11: 615-636.
- Shanley, P. and Medina, G. (eds.). 2005. Frutíferas e plantas uteis na vida Amazônica. CIFOR/IMAZON, Editora Supercores, Belém, Brazil.
- Shanley, P. and Rosa, N.A. 2004. Eroding knowledge: an ethnobotanical inventory of *terra firme* forest in eastern Amazonia's logging frontier. *Economic Botany* 58(2) 136-160.
- Skole, D. and Tucker, C.J. 1993. Tropical deforestation and habitat fragmentation in the Amazon: satellite data from 1978 to 1988. *Science* 260: 1905-1910.
- Uhl, C. and Kauffman, J.B. 1990. Deforestation effects on fire susceptibility and the potential response of tree species to fire in the rainforest of the eastern Amazon. *Ecology* 71: 437-449.
- Uhl, C., Verissimo, A., Mattos, M., Brandino, Z. and Viera, I. 1991. Social, economic and ecological consequences of selective logging in an Amazon

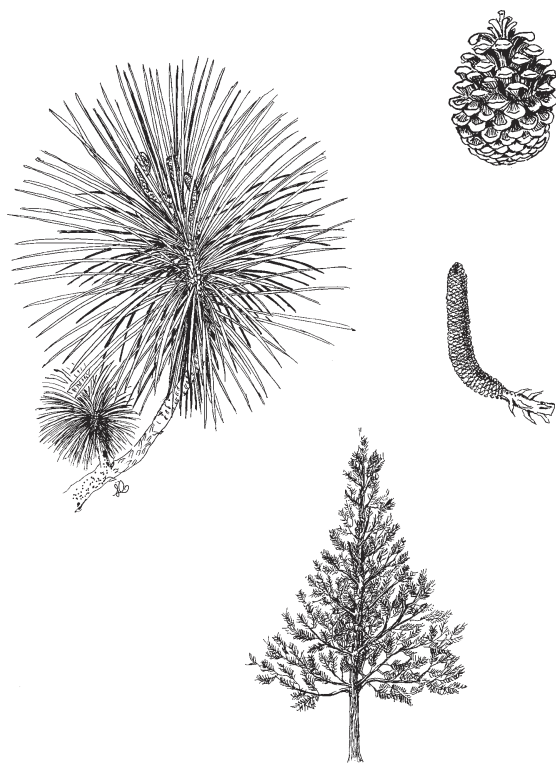
- frontier: the case of Tailandia. *Forest Ecology and Management* 46: 243-273.
- Vasquez, R. and Gentry, A.H. 1989. Use and misuse of forest-harvested fruits in the Iquitos area. *Conservation Biology* 3: 1-12.
- Verissimo, A., Souza, Jr., C., Stone, S. and Uhl, C. 1997. Zoneamento e atividade madeireiro na Amazônia. *Seria Amazonia* 8. IMAZON, Belém, Brasil.
- Villachia, H. 1996. Frutales y hortalizas promisorios de la Amazonia. *Tratado de Cooperación Amazónica*, Lima, Peru.

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Chapter 12

Use of resin from *Pinus caribaea* morelet var. *caribaea* Barrett and Golfari

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(*Pinus caribaea*)

Common name	Product part used	Dominant form of management	Degree of transformation	Commercial scale	Geographic distribution
Pino macho	Exudate (resin)	Managed/ cultivated	High	International	Restricted

SUMMARY

Humans have used pine resin since long before modern times. The geographic distribution of the pine tree, present at all latitudes, has allowed resin extraction to become relatively well-established in the economic sector, and resin is one of the most important non-timber forest products (NTFP). The People's Republic of China, Germany, India, Mexico, Portugal, Russia, Spain, and the United States reached their maximum production levels in the second half of the last century. Other countries like Brazil, Cuba, Guatemala, Honduras, and Vietnam have developed this resource while obtaining less significant yields. The various uses of resin and its derivatives (colophony and oil of turpentine) cover a wide sector of the chemical industry, especially paints, varnishes, and dyes as well as paper adhesives, soaps, detergents, cosmetics, disinfectants, and to a lesser extent medicines.

In Cuba, research into pine resin started in 1975 in the Department of Forestry Engineering at the University of Pinar del Rio. Commercial production began in 1985 in the forestry companies, and the number of extractors, collectors, and other related workers now exceeds 600, approximately 33% being women and 28% being younger than 35 years old.

This new source of work has benefited hundreds of families and has helped create a culture specific to the activity. New communities of extractors or resin collectors differ from other forestry workers because the characteristics of the work have produced a specific culture with its own skills and abilities. Small, self-funded processing plants have been set up, and in 1994 an industrial plant was built with the capacity to process 800 tons a year, giving greater value to the resin derivatives.

The present study focuses on an area of approximately 3,000 hectares of plantations of *Pinus caribaea* Morelet var. *caribaea*, in the community of San Andres de Caiguanabo in the municipality of La Palma, province of Pinar del Rio.

INTRODUCTION

Brief history of the use and commercialisation of pine resin

Resin is an important chemical compound found in plants. Pine resin in particular has various important properties with the potential to satisfy a wide range of market demands.

In the 1950s, the United States produced half of the global production; in the year 2000 the People's Republic of China (PRC) accounted for 600,000 tons, or approximately 40% of world production. During the last century pine resin production began in France, Germany, Poland, Portugal, Russia, and Spain in Europe, in China, India, and Vietnam in Asia, and in Brazil, Cuba, Guatemala, Honduras, and Mexico in Latin America.

World production in 1999 was 1,100,000 tons of resin, of which the PRC produced 400,000 tons, or 36.4%. Other Asian countries such as Indonesia, India, and Vietnam produced 53,000 tons, 26,000 tons, and 2,000 tons, respectively, while the United States produced 288,000 tons, or 26% of world

production. Other countries and regions with significant levels of production were Russia with 90,000 tons, Scandinavia with 75,000 tons, Brazil with 40,000 tons, and Mexico with 27,000 tons (De Souza 1999). Countries with lower levels of production include Portugal, Spain, Guatemala, Honduras and Cuba.

The main consumers of resin and its derivatives in 1999 were Western Europe with 276,000 tons, United States with 242,000 tons, PRC with 190,000 tons, Eastern Europe with 142,000 tons, Japan with 88,000 tons, Latin America with 90,000 tons, Canada with 15,000 tons, and Austria with 12,000 tons (De Souza 1999).

Importance of *Pinus caribaea* in Pinar del Rio province

The pine groves of Pinar del Rio province are of great economic importance, not only because they produce timber for a number of uses but also because plantations occupy land that is generally not used for intensive agriculture. The level of production is well below its potential, however, because of a number of factors that prevailed until 1959. These factors include uncontrolled exploitation, absence of forestry management, fires, uncontrolled grazing, and other deleterious practices (Samek and Del Risco 1989).

Pinus caribaea Morelet var. *caribaea*, known as 'male pine', and *Pinus tropicalis* Morelet, or 'female pine', form the most important pine groves in the western region of Cuba. In the eastern region of the country, *Pinus cubensis* Griseb and *Pinus maestrensis* Bisse are endemic (Varona 1982).

From an economic standpoint, pine is one of the most versatile species in terms of utilisation of biomass. It provides significant quantities of sawed timber and round logs for rural construction, is often used for making plywood boards, particles and fibre, and is the main raw material in the production of pulp for paper (Matos 1963).

The importance of pine resin in Cuba

Production of pine resin and its derivatives as raw materials for various industrial sectors is important in Cuba. Demand has increased in the last few years as a result of the industrial development of the country, in particular of chemical industries dealing with first and second levels of transformation. A variety of products can be obtained from resin in a sustainable manner, and can be used instead of other hydrocarbon derivatives that are currently imported. Bustamante (1999) emphasises that the adhesives and dyes sectors consume 46% of resin and its derivatives, followed by glues for paper at 21%, and modified resins at 11%.

Although pine wood is still of great economic importance for construction, resin extraction is increasing. Achieving this extraction before the trees are cut down is important in increasing the value of the forest biomass. Since 2000, resin production in Pinar del Rio province has exceeded 1,200 tons.

Impact of pine resin on the quality of life of the extractors

We must emphasise the social and cultural importance of the resin sector. Workers and communities associated with this industry form a group with well-defined characteristics within the forestry sector. They identify closely with their work, enjoy an increase in living standards, have the highest income within the forestry workforce, and an improved level of technical training. Working in groups or brigades has developed a collective and individual sense of responsibility towards production levels. In addition, it has served to strengthen ties between individual workers and groups, and to develop a greater sense of stewardship towards the conservation of natural resources like pine forests.

Purpose of the study

The present study focuses on the results obtained in an area of plantations of 30-year-old *Pinus caribaea* Morelet, var. *caribaea*, a pine species of great economic importance and the largest in Pinar del Rio province. Located in the mountain range of Guaniguanico, near the community of San Andres de Caiguanabo in the municipality of La Palma, these plantations occupy an area of 30 km².

The research on which this study is based began in 1985 under production conditions; the objective was to improve technology and organisation of resin production in the forest industry. La Palma was selected as a reference point for the objectives established in the study. These results have been generalised to four other resin producing companies in the province.

PRODUCTION SYSTEM

Background information, ecology, abundance, and distribution

Members of the family *Pinaceae* are one of the oldest and most widely distributed trees in temperate regions. They are also present in other geographic regions—although not as the most important or typical forest formations—in particular in tropical and subtropical climates where some species have adapted to the point of becoming endemic. Three of the four species of pine present in Cuba are endemic: *Pinus cubensis* Griseb, *Pinus maestrensis* Bisse, and *Pinus tropicalis* Morelet, while the fourth, *Pinus caribaea* Morelet, is also found in Central America and other Caribbean islands. However the *P. caribaea* Morelet variety can be considered indigenous as established by Barre and Golfari (Varona 1982).

Pinus caribaea is divided into three varieties, *caribaea* Morelet, naturalised in Pinar del Rio, Cuba, *caribaea hundurensis* Barrett and Golfari, present in Central America, and *caribaea bahamensis* Barrett and Golfari, which is found in the Bahamas. They are monoecious, with male amentiform inflorescences, terminal, from 20 mm to 32 mm long. The female cones are 8 cm to 12 cm long, the leaves are in fascicles of two to five, with two fibro-vascular bundles. Flowering takes place from February to March and

the cones mature from June to July of the following year, opening to release the seeds after 15 days. Each cone contains 60 to 70 viable seeds and 1 kg contains about 60,000 seeds.

The pine has a natural distribution in Pinar del Rio province, where it forms the largest seed producing mass in the world on about 10,000 ha. In total the province has more than 100,000 ha of *Pinus caribaea* in differently aged groups, allowing sustainable production of resin over a minimum of 40 years. One of the most important NTFPs obtained from pine is resin, produced in a specialised system of resinous vessels in the wood.

A number of substances can be obtained from the foliage and bark that contain active compounds used in medicine, cosmetics, and other chemical industries, as well as in the production of nutritional supplements from sawdust and foliage.

Photo 1. Resin tapping (Photo: Y.B. Figueras)



Technology used

The technology used in this study is known as the German System or Technology for Tapping Resin, used throughout the province and country for collecting pine resin. According to Betancourt (1980) the main features of this technology are as follows.

- The trees to be tapped are identified according to the breast high diameter (BHD). Cuba has established a minimum BHD of 20 cm.
- Tapping starts at a height on the trunk of 1.6 m.
- The circumference is measured to mark what is known as the 'life route', a band equal to one third of the circumference, which will be left intact

to allow the tree to develop. When the life route is reduced further, the practice is known as ‘tapping to death’, which is not the case in this study.

- In the marked area (two thirds of the circumference) known as the ‘tapping surface’, the bark is removed using a de-barker, an instrument specifically designed for this purpose. A minimum of 2 mm of bark must be left intact. The vertical length of the tapping surface depends on how often the cuts, or *picas*, are made. In our case a 65 cm long tapping surface is prepared, to be used for a year’s supply of resin, equal to between 40 and 44 weeks of extraction (40 *picas*).
- Once the bark has been removed in the centre of the tapping surface and at a height of 1.6 m from the ground, the central canal is made to allow movement of resin from the cut to the collection cup or container. The length of the central canal is the same as that of the tapping surface. A metal tube is placed at the end of the canal, where the collection cup is hung. The central canal is cut with a special knife, and the cuts are made with an instrument called the ‘tapping knife of descending cuts’. This instrument can be adjusted to vary the depth and width of the cuts in the wood. In this study, the depth of the cut is 5 mm and the width 10 mm.
- The direction of the cut in the tree trunk can be ascending or descending. In this case it was descending.
- The time interval between one cut and the next may vary depending on the intensity of tapping. In this study cuts were made every seven days, considered a standard interval that allows stable recovery of the resin exuded by the system of resin canals.
- The angle formed between the cut and the central canal is normally between 40 degrees and 60 degrees. In this study it was 40 degrees.
- With this technology it is possible to tap for resin for two to four years before felling the tree.

Geographic location of the study

The forest exploitation company of La Palma is situated in the north of Pinar del Rio province between 22°54’50” and 22°34’54” latitude north and 83°21’34” and 83°39’30” longitude west. The company has 27,004 ha of forest, with 6,351,2 ha of *Pinus caribaea* and *Pinus tropicalis* plantations (Vazquez 2000).

The study area consisted of 3,000 ha of *Pinus caribaea* plantations, which are cut every 30 years, and 200 ha of natural forest of the same species. The maximum elevation is 350 m above sea level, and the predominant soils are ferrous. The areas selected for this study were representative of the province as a whole, which contains 130,000 hectares of this species.

The study plantations were between 25 and 30 years old, and are included in the felling programme. Although felling normally targets trees between 36 and 40 years old, these have already reached maximum growth due to irregularities in forestry procedures. The reproductive age of this species is 18 years and the biological age is 60 years.

The producers of raw material and their socio-economic context

From an economic perspective, the use of resin has added a new production sector to the Cuban forestry economy, as well as new job sources to the population associated with forest areas. In accordance with Cuba's socio-economic policies, resin extractors are workers that have a direct connection with the state forestry company where they work and live. In our study, the extractors that began production in 1985 came from the same forestry sector and had a specific culture related to the forest as a natural environment. It was necessary to train them for only a short period of three months in resin tapping technology as determined by Betancourt (1980).

Today, the average age of extractors is between 40 and 45 years, and their level of education is above sixth grade. Some extractors have finished 12th grade (baccalaureate), which implies they may be capable of becoming fully trained in minimal time. They are generally younger (under 30 years old), and are a potential source of continuity to guarantee the stability needed for this sector.

The average distance between the work areas and the communities is under 15 km. Resin extractors and collectors, who are mainly women, travel to work on company transport such as a truck or tractor with a trailer for collective transport of the brigade, or their own bicycle or horse. As a result, work attendance exceeds 85%.

Figure 1. Study area



Source: ESRI (Environmental Systems Research Institute, Inc.) 2002. Data and maps.

The resin extractors, or tappers, may choose their own resin collectors, a practice that reduces problems related to the work itself and to payment distribution. If extractors wish to collect their own resin, they may do so.

Resin is a highly valuable raw material in terms of earning currency for the forestry sector in this area. Because 65% of the resin extracted is exported and the remainder is processed within the same province, extractors earn salaries that are 1.5 times greater than those of other forestry workers. Approximately 70% of the extractors also own small holdings, where they grow a variety of crops for their own use, particularly rice and beans.

In the social context, health services and education are free, services such as electricity, water, and domestic fuel are subsidised by the government, and a significant amount of food is subsidised as well. Consequently, the workers adopt an institutional and moral obligation and sense of participation in their work activity.

Twenty-four of the more than 200 extractors that work in Pinar del Rio province participated in the present study. Apart from the producers, brigades are composed of 10 or 12 extractors, three or four collectors, a driver that transports them to the work site, a cook, and a brigade leader. The latter is a mid- or higher-level expert responsible for evaluating and distributing the areas among extractors, systematic quality control of the work, problem solving, monthly meetings with the brigade to review the fulfilment of the production plan, and acting as liaison between the producers-extractors and the company. The rights and responsibilities of the extractors are also considered and defended by the union, which at the brigade level consists of a union section. The production system framework has made it possible to identify the role of the producer or extractor, the link with the area, the development of a sense of belonging to the production system and of responsibility in the conservation and protection of the pine forests.

Processing industry, transport and additional value

In addition to the results obtained in resin production in Pinar del Rio province, the study also included the industrial transformation of pine resin into its main components: colophony and oil of turpentine. For this purpose a pilot distillation plant was designed and built on the grounds of the University of Pinar del Rio with a capacity of 100 kg per work day (8 hours). The results obtained were used to characterise the quality of resin obtained based on the products derived. Table 1 shows the quality indicators for resin from *Pinus caribaea*, var. *caribaea* Morelet determined by Bustamante (1999).

Table 1. Quality indicators for unprocessed resin

Acidity index	Saponification index	Unsaponifiable material	Humidity (%)	Impurities (%)
140-145	144-148	37	2.1-3.4	0.2-12

The quality indicators for colophony and turpentine oil obtained for *Pinus caribaea*, var. *caribaea* Morelet (Bustamante 1999) can be seen in Tables 2 and 3.

Table 2. Quality indicators for colophony

Acidity index	Saponification index	Unsaponifiable material	Colour	Softening temperature (°C)	Humidity (%)
165-168	168-170	4-4.6	X-WW	77-79	0.01-0.03

Table 3. Quality indicators for turpentine oil

Acidity index	Sterification index	Refraction index	Soluble solids (%)	Density g/mL
0.36	0.27	1,468	71-73	0.865

Photo 2. Pilot plant, industrial plant, colophony (Y.B. Figueras)



From the economic viewpoint these products have added to the value of pine resin. In the last few years, the price of a ton of unprocessed resin has fluctuated between US\$350 and US\$400, and the price of colophony and of turpentine oil have remained at US\$1,200 and US1,100, respectively.

Commercialisation and market

The first link in the chain is the company, not the producers-extractors who, as state employees, cannot participate in commercialisation. However, they

receive up-to-date information about the market and prices. MADECA, a company created by the Ministry of Agriculture, sets down the conditions for commercialisation of resin, nationally and for export. Over the study period approximately 35% of the resin was processed in an industrial plant in Pinar del Rio province, the remainder exported to India, Mexico, and Spain.

Certification of product or quality control is done by the state producer company and the state marketing company, and this determination is used to establish the value of a ton of resin. Over the study period, the value per ton ranged from US\$350 to US\$400.

Depending on the characteristics of the production area and the sale price of the ton of resin, the extractor receives 0.36-0.50 Cuban pesos per kilogramme of resin harvested. Extractors average between 1.0 tons and 1.5 tons of resin production per month, although some 10% of the total tappers may average 2 tons of resin production per month. According to the extraction norms (minimum production of 800 kg per month) the extractor receives a cash incentive that may be equal to, or higher than, the monthly salary.

TRENDS AND RESULTS

The results of this study have helped create an atmosphere of increased interest in the resin sector on the part of the Cuban government and national institutions responsible for forestry development, as can be detected in the level of attention and of guarantees offered despite this being an emerging industry. In addition, the degree of participation of the extractor-collectors as principal actors in the process establishes a basis for continuity with excellent perspectives.

During the 13 years of the study under production conditions, research focused on improving resin technology (German-American System), organising production, increasing resin yield by means of incentives (per tree, per extractor, and per hectare), cost reduction, and determining the effect of tapping on tree growth. Research also included evaluating the impact of the production process on the economic, social, and cultural development of families connected to it, as well as the chemical characteristics of resin, distillation process, and obtaining of new products. Tasks related to commercialisation were not a major area of research because there is only one state company in charge of commercialisation.

The trends seen in this raw material indicate that the existing potential in Pinar del Rio province would allow annual production of 5,000 tons by 2005, allowing the country to become self-sufficient in terms of resin derivatives. By then, the current 150 extractors will have increased to 450, with an annual production of 12 tons of resin per producer. Based on this outlook one can conclude that with the existing areas of pine, and if the availability of workers and economically viable production system are met, the prevailing conditions would make the trend viable.

Cuba has a high demand for both products, as annual consumption is around 2,500 tons of colophony and 2,000 tons of turpentine. To meet this demand it is necessary to increase national production, presently between 1,200 and 4,000 tons, so that the perspectives of this sector of forestry show

a trend towards development. Based on the above, the following can be stated.

- The dynamic changes noted favour increases in production.
- The ecological indicators studied show a favourable tendency towards sustainable production without affecting the ecosystem.
- The ecological effects are a result of eliminating part of the understory to allow easier access of extractors to the area.
- There are no changes to the forest infrastructure; workers use the same paths originally made for plantation use and maintenance.
- The extractors' income is higher than the average income of the rest of the forestry workers.
- The extractors' productivity is directly related to making good use of the workday, about 65%-70%. Although the location of work areas is far away from the communities and because they use various types of collective transport, they manage to work 5 to 6 hours daily.
- The production cost per ton of resin is US\$180, similar to international values. However, it is high for Cuba, and alternatives must be found such as national production of work tools and other imported materials.
- Some extractors still prefer to carry out the extraction and collection work themselves, and this affects productivity. It is necessary to ensure that extractors carry out only extraction, while other workers, preferably women, collect the resin from the cups on each tree and deposit it in the tanks.
- Women's participation in the resin sector is still low, at about 33%. Of this about 20% work as extractors making *picas*, while the rest work as collectors or prepare trunks for tapping by removing bark.

CONSERVATION AND DEVELOPMENT

Pine resin is highly significant for the Pinar del Rio province and country as a whole for the following reasons.

- The pine is a native species of Pinar del Rio.
- The species has the greatest production potential of all forest ecosystems in the country.
- Currently, the greatest production of sawn wood comes from *Pinus caribaea* var. Morelet.
- This species is used in reforestation of the main areas in Pinar del Rio and in the rest of the country.
- It has a high aesthetic value, because of its shape and intense green colour to improve important tourist areas.
- Reproduction is achieved naturally and mainly in nurseries where trees stay for a maximum of six months.
- The State Forestry Service, which legislates and controls, issues directives establishing areas of reforestation and logging to achieve the ecological equilibrium of the species.
- Tapping for resin is carried out only in areas that are going to be logged, so that the negative impact on growth (about 25% reduction) is not a factor.

- Resin is an important raw material and contributes to an increase in jobs in the forestry sector.
- Products can be made from resin instead of other raw materials that are currently imported, thus contributing markedly towards improving the country's economy.
- Areas used for resin production have shown a decrease in forest fires as the extractors become participants in protecting the environment.

CONCLUSIONS

The results obtained from this research allowed the authors to evaluate the technology used. This technology was later applied to the rest of the forestry sector companies in the country. Using statistical analysis of paired observations and analysis of variance, the value of resin yield per tree, per hectare, and per extractor were established, as well as yearly trends. This allowed the development of an adequate organization of the work and response to the resin program.

Work organization reached a higher level where collective work in brigades replaced individual or personal work. This has contributed towards creating a work culture of greater interest in improving productivity.

The yields obtained per tree (at least 4 kg per year), per extractor (at least 12 tons per year), and per hectare (2.18 tons per year) exceed those obtained in other countries.

The use of monthly inspections and checks of program targets has created a sense of belonging, and an interest in the technical and cultural development of extractors and collectors. As a way of increasing resin yields, the application of organic stimulants based on beer yeast (*Saccharomyces cerevisiae*) was started. This has managed to reduce the production costs, a major problem of the forestry activity.

The economic benefits for workers are evident in that the increased monthly income of the families resulted in an increased standard of living. Many of the extractors used their spare time to grow rice, beans, and other food crops; since the salary increase many now spend that time on extraction work and use the extra income to buy food staples.

With the opening of this sector, new job opportunities have been created directly contributing to an improvement in the communities' standard of living. The results of the study have been applied to other forestry companies, and every six months there are technical workshops organised in coordination with the companies to select the best extractors and give them prizes in the form of different incentives.

All of the above means that in the community workers connected to the resin industry are favourably differentiated and that there is new motivation for people to join the sector, increasing human resources, especially for young people who have an educational level of tenth or twelfth grade.

The research developed as the basis for this study was derived in considering this area as an experimental or pilot project to apply results from new investigations and then generalise them to the other companies.

NOTES

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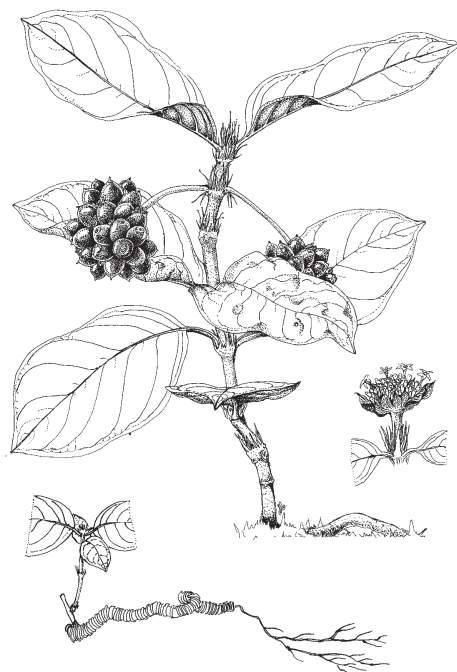
REFERENCES

- Betancourt, Y. 1980. Investigaciones básicas para la determinación de la tecnología de la resina de los pinos cubanos. Doctoral thesis, Technical University of Dresden, Germany.
- Bustamante, J.F. 1999. Procesamiento de la resina de *Pinus caribaea*, var. *Caribaea*, y sus componentes para la obtención de productos resinosos. Doctoral thesis, Universidad de Pinar del Río, Cuba.
- De Souza, O. 1999. Boletín ARTIGO Técnico. Embrapa, Brazil.
- Matos, E. 1963. Las coníferas en Cuba. Departamento Forestal y Frutal. INRA, La Habana, Cuba. 22 pp.
- Samek, V. and Del Risco, E. 1989. Los pinares de la provincia de Pinar del Río, Cuba. Estudio Sinológico. Editorial Academia, La Habana, Cuba.
- Varona, J.C. 1982. Fomento de plantaciones de pino. Editorial Pueblo y Educación.
- Vazquez, G. 2000. Dinámica forestal. Proyecto de ordenación. Empresa Forestal La Palma.

Chapter 13

Ipecac [*Psychotria ipecacuanha* (Brotero) Stokes] root: A non-timber forest product cultivated within the Huetar Norte forest, Costa Rica

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(*Psychotria ipecacuanha*)

Common name	Product part used	Dominant form of management	Degree of transformation	Commercial scale	Geographic distribution
Raicilla, Ipecacuana, Ipecac	Root	Cultivated	Average/half/middle	International	Wide

ABSTRACT

Ipecac, a native herb, is the only medicinal plant cultivated within the humid tropical forests of Costa Rica. Currently cultivated in the Huetar Norte region bordering Nicaragua, the dried ipecac root has been marketed in Costa Rica as raw material for the international pharmaceutical industry since the early twentieth century. Ipecac root is exported as raw material without aggregate value, together with coffee and banana, Costa Rica's two principal export crops. The structure of the ipecac root trade is little developed, with only two major and two minor exporting companies buying directly from the producers. In the 1990s, ipecac root producers were organised in a cooperative that disintegrated some years later. According to official statistics, annual ipecac root exports from Costa Rica in the last 20 years averaged 64 tons. Overproduction of raw material and stagnation of the international market recently brought prices down to less than US\$6 per kilogramme for the producer. These problems are linked to false expectations created by overestimations of official figures on exports, which, in their turn, had been motivated by speculation and abuse of a national subsidy program for the sector.

INTRODUCTION

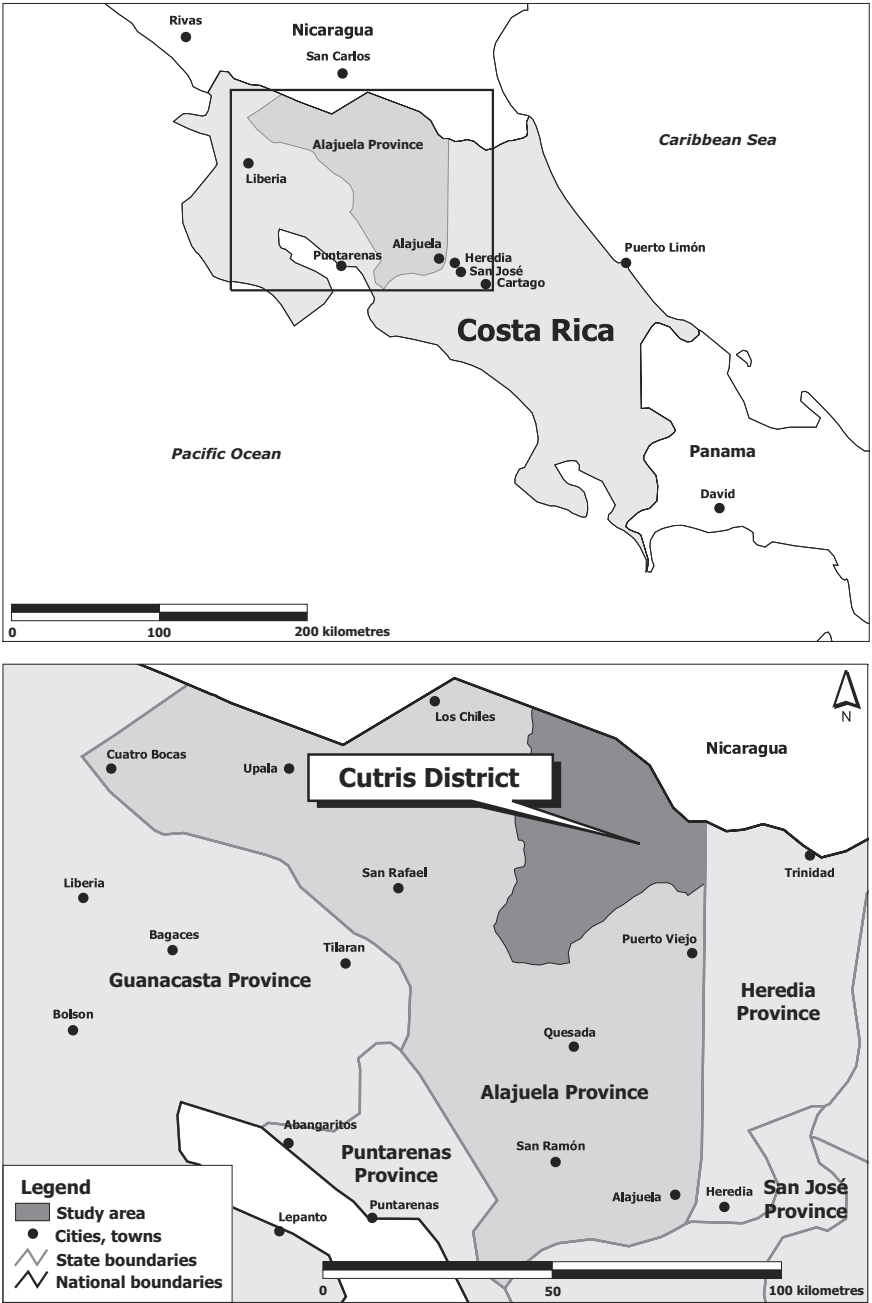
Ipecac is known as *raicilla* in Costa Rica and Nicaragua and as *ipecacuanha* in the international market. Its scientific name is *Psychotria ipecacuanha* (Brotero) Stokes (Rubiaceae family). It constitutes the first medicinal plant from the tropical rainforest to be rationally exploited in Costa Rica and Nicaragua. Extract from the roots is used to make amoebicides, emetics, and expectorants. Its principal components are isoquinolinic alkaloids, of which emetine is the most important for the pharmaceutical industry (Trease and Evans 1988). Ipecac has been used as a medicinal plant in Europe since 1762. During the 1940s, it became a major drug for the pharmaceutical industry in the United States of America and Europe (Sievers and Higbee 1948).

For about 300 years, ipecac root was extracted from wild populations in the forests of tropical America. In mid-twentieth century, plantings were started under arboreal cover in rainforests, first in Nicaragua and later in Costa Rica, with the goal of producing quality roots exclusively for the international market. The contrary situation occurred with root supplies from Brazil, which still came from wild populations in the state of Mato Grosso and were more variable in terms of secondary metabolite contents.

Introduced into Asia in the nineteenth century, ipecac is also cultivated in India (Atal and Kapur 1982), which produced about 10 tons of roots in 1982 (ITC 1982). It is mostly used locally to produce alkaloids (Atal and Kapur 1982). The crop growing in the Old World is of poorer quality because of its low alkaloids content, a deficiency that might be remedied by applying advanced technology. Nicaragua and Costa Rica, respectively, provide 32% and 20% of the global market, with the rest of the world's production coming from various countries, including Colombia and Brazil (ITC 1982). World demand for ipecac root in 1982 was estimated at about 100 tons (ITC 1982).

Assuming an average production of 2810 kg of root per hectare in Costa

Figure 1. Study area



Source: ESRI (Environmental Systems Research Institute, Inc.) 2002. Data and maps.

Rica, then 35.5 ha have been established to cultivate ipecac. This figure suggests a total forest area of 58 ha, assuming 63% of total to be useful area.

In Costa Rica, the original distribution of ipecac was limited to about 10,000 km² in the Huetar Norte region bordering Nicaragua (Figure 1A). In 1850, entrepreneurs initiated commercial exploitation of wild populations of ipecac in Huetar Norte, using the knowledge and skills of the Malekus, the indigenous population. Intense working days and abusive conditions led to the Malekus suffering severe health problems that decimated their populations (Sáenz 1970). One century later, and motivated by the pharmaceutical industry's demand for quality raw material, the cultivation of ipecac was encouraged in the region, involving mainly farmers of Nicaraguan origin, a situation that continues today.

Since becoming a commodity, ipecac root has constituted an important export line for Costa Rica. Between 1961 and 1985, annual exports fluctuated between 11.5 tons and 30 tons, with an average of 20 tons per year. Since then, ipecac root exports have undergone greater fluctuations. For example, in 1988, 1993, and 1996, exports totalled between 100 tons and 200 tons annually, the fluctuations being linked to irregularities detected in payments of incentives for nontraditional crops for the export market. Prices have also been subject to large fluctuations. In 1976, for example, FOB prices for export ranged from US\$4.6 to US\$38 per kilogramme (Ocampo 2000) and in 1980 prices reached US\$66 per kilogramme. The principal markets are Germany (39%), England (28%), France (7%), USA (7%), Malaysia (5%), Netherlands (5%), and Spain (5%) (Palma 2000).

Currently, Costa Rican producers face problems that create uncertainty in this activity such as lack of markets, low prices for the raw material, and lack of attention from the state. In addition, other factors are determining the future international market, including competition from synthetic production, crop production in India, and reduced demand by the pharmaceutical industry because of the problem of toxic emetic products.

CASE STUDY

During the ipecac root boom, several production centres were formed in the Huetar Norte region. For our study, we selected Cutris District in San Carlos Canton, Alajuela Province (Figure 1B), with a population of 9104, covering 870 km² and maintaining the largest concentration of ipecac crops. We estimate 48 families produce ipecac in this area, with 43 having had answered a survey in 2001. Small ipecac crops are also grown in the cantons of Upala, Los Chiles, and Guatuso.

PRODUCTION-TO-CONSUMPTION SYSTEM

The resource base: ipecac root

Ipecac is a herbaceous plant with a thin, twisted, and semiwoody stem. It grows to 30 cm tall. Its hermaphrodite flowers are small, growing in a terminal

inflorescence. The fruit is a small fleshy berry. The rhizome is tuberous, grows 15 cm to 17 cm long, and possesses a rough bark that is 0.5 cm to 1.0 cm thick (Burger 1993). Once harvested, the rhizome loses its thickness and weight, but not its characteristic rings and twists. Abundant seeds are produced, dispersed by birds, and the herb readily reproduces vegetatively. Ipecac is a shade-loving plant, unable to resist high light intensity, thus making it, *a priori* on a physiological basis, a sciophyte (Lamprecht 1990; Ocampo 2000). To grow it requires warm temperatures, high relative humidity, and adequate concentrations of organic matter. Such biological characteristics present advantages for management under forest conditions.

Distribution and abundance

The distribution of this plant ranges from the eastern plains of Nicaragua, south through Central America (Costa Rica and Panama) and northern South America, to Brazil (Torres 1976; Camargo and Giuletti 1999). Yet, only in Costa Rica and Nicaragua is ipecac managed under forest cover, thus yielding a raw material with high contents of alkaloids and therefore of better quality than that from South American wild populations.

In the wild, ipecac presents various patterns of distribution and abundance (Thielbot 1980). Root collectors, or *raicilleros*, refer to scattered distribution of individuals as well as to patches or groupings of individuals in the forest. León (1968) confirms the presence of numerous colonies, with clumps of up to 1 m in diameter. In addition, Camargo and Giuletti (1999) indicate that populations in the Brazilian Atlantic forest are discontinuous and formed by few individuals. Not many data exist on the species' density or natural abundance.

Chemistry and taxonomy

The principal components of ipecac root are isoquinolinic alkaloids such as emetine, cephaeline, psychotrine, methyl ether of psychotrine, and emetamine (Trease and Evans 1988). During the twentieth century, various researchers (León 1968; Trease and Evans 1988) refer to the exploitation of *Cephaelis ipecacuanha* (Brot.) A. Rich. ('Rio' or 'Brazilian ipecacuanha') and *C. acuminata* Karsten ('ipecacuanha of Cartagena'). Although both species are currently considered to be synonyms of *P. ipecacuanha*, the literature indicates that various varieties of ipecac contain different proportions of the principal alkaloids.

Despite its broad distribution in the forest understorey of the subtropics and tropics, both in the Amazon region and Central America, little is known about the variations of isoquinolinic alkaloid contents in roots of wild populations. Through research on alkaloid contents of roots from wild ipecac plants and tissue culture in Brazil, Castro (2000) identified the genetic potential and tissue type of the plant, environmental factors, and harvesting period as factors determining secondary metabolite contents. Research carried out in Costa Rica by Palma and Hidalgo (1994) confirms the high genetic variability related to alkaloid contents, finding, in addition, differences stemming from

Photo 1. Adult ipecac plant (Photo: R.O. Sánchez)



morphological variations and age of the plant. Such genetic variability in its region of origin represents an important element for domesticating the species within agro-ecological systems.

Forest management for growing ipecac

Cropping experiences in other similar tropical areas show that the environmental conditions found in their area of origin are fundamental for obtaining quality raw material from ipecac in terms of alkaloid concentrations. These environmental conditions and ipecac's (especially its leaves') intolerance of bright light require the crop to be grown under arboreal cover or other material that provides the necessary shade. Ipecac cultivation was encouraged primarily by increased demand for the raw material, especially during World War II, following natural reduction in the forest. The *raicilleros* were forced to invest too much time in collecting roots, thus confronting excessively low economic recovery.

In our study, 86% of the *raicilleros* cultivate the root on their own land, the other 14% on rented land. The farmer begins by preparing the land, cutting down some trees and leaving others, according to the ipecac's spatial distribution in the area being cultivated and to the leaf size of each

tree. These two factors mean that only those trees with large leaves are cut, leaving the shade of trees with fine or small leaves, which would reduce the impact of rain running off the leaves and spattering the soil. Next, the understorey is manually cut down, leaving an open area for planting. This action transports plant biomass to the ground, where it accumulates around the remaining trees, as it is not normally used by the *raicilleros*.

Now with space and no obstructions, the *raicilleros* build planting beds in the form of mounds, measuring 1.5 m wide, 30 cm high, and as long as the land permits. The beds are separated from each other at intervals of about 40 cm. Planting material comprises stakes, 6 cm to 8 cm long, taken from recently cut material. Planting is done at a density of 200 plants per square metre. The planting is maintained by manual weeding or 'cleaning' every four or six months.

To obtain a quality product with adequate alkaloid concentrations, harvest takes place three to four years after planting during the rainy season, when the land is softer for extracting roots and when conditions are better for propagating the apical stakes obtained during harvest. Only 2.4% of respondents to our surveys refer to harvesting during the dry season.

The *raicilleros* cultivate ipecac only once in the same site. Hence, ipecac cultivation is itinerant, depending on virgin areas for its establishment. It is important to emphasise that, where a forest area is exhausted, ipecac is planted again in areas that had been left fallow for no less than five or six years. This situation is compatible with the indigenous system of soil management, whereby the forest is permitted to regenerate and recover in marginal soil areas (Vargas 1990).

In recent decades, the production area in our study has been subject to degradation of forests and natural resources in general. The boom of livestock and agricultural production, together with forest exploitation, has reduced forest cover. *Raicilleros* are therefore obliged to use limited and isolated areas of highly disturbed forest.

Forest degradation leads to producers searching for alternative areas to grow ipecac. For example, *raicilleros* commonly use secondary forests and stands of pure forests such as those of pioneering trees like the balsa [*Ochroma pyramidale* (Cav. ex Lam.) Urb.] to plant ipecac. The shade of cacao (*Theobroma cacao* L.) plantations, representing a more agro-ecological system, is also commonly taken advantage of. Producers have even resorted to installing artificial bowers made of palm leaves to provide shade for the plantings. According to the 2001 survey, the study area had a commercial production of 73,903 kg growing on about 26 ha.

The *raicilleros* and their socio-economic context

The Huetar Norte region is an area with little primary forest. An inventory determined that, already by 1994, only about 23% of the region had some type of forest cover, whether primary, disturbed or secondary, or plantation (COSEFORMA 1994). This same study also noted an increase in the migration of Nicaraguans in search of agricultural work. According to our data, only 0.72% of the region's population grows ipecac (Table 1).

Table 1. Total populations and numbers and percentages of ipecac root producers in the study area, 1998

Canton	District	Total population	Producers	
			Number	Percentage of total population (%)
San Carlos	Cutris	9,104	29	0.32
	Pital	9,160	2	0.02
Upala	Upala	9,822	4	0.04
Los Chiles	Caño Negro	1,726	3	0.17
Guatuso	Buena Vista	2,990	5	0.17
	Total	32,802	43	0.72

About 29% of the *raicilleros* are Nicaraguan farmers, who have lived in Costa Rica for an average of 21 years, ranging from 3 years to 64 years. The remaining *raicilleros* are Costa Rican farmers. There are no indigenous *raicilleros*. The *raicilleros* in our study fluctuated in age from 23 to 87, with a median age of 46 years. Such a range indicates a transmission of knowledge over time. Our survey also found that about 70% of the *raicillero* had received primary-school education and a further 9% high-school education, while the remaining 21% are illiterate.

Assuming an average production of 2.8 t/ha, and depending on prices, *raicilleros* can, hypothetically, receive an income of US\$17,000 (at US\$6/kg) or more per hectare. The instability and uncertainty of the market for ipecac root has obliged farmers to diversify income sources. Only 5% of *raicilleros* dedicate themselves entirely to ipecac root production. Most (79%) also grow maize (*Zea mays* L.), beans (*Phaseolus vulgaris* L.), cassava (*Manihot esculenta* Crantz), and cocoyams [*Xanthosoma sagittifolium* (L.) Schott and Endl. or *tiquisque*, and *Colocasia esculenta* (L.) Schott or *malanga*]. Other complementary activities, of smaller importance, include livestock, citrus, and timber. Although ipecac is cultivated within the forest, extraction of other non-timber forest products (NTFPs) does not occur. Only 6 of the 43 *raicilleros* interviewed obtained NTFPs such as seeds of timber trees and firewood.

Processing ipecac root

Once the root is harvested, it is dried, usually in the sun, close to the *raicilleros'* homes by the women and other members of their families. Optimal drying point is identified when the roots break easily on bending. The dried roots are then kept stored in sacks, ready for transport to collection centres operated by intermediaries. Our survey revealed that only 7% of the *raicilleros* transport the root over distances of less than 20 km from their houses. The rest must transport it for more than 40 km.

At the centres, the dried roots are then broken into small pieces and packed for export. The material is not processed locally, or even ground, because of potential problems of adulterating the raw material. After industrial processing, the root's chemical components are incorporated into

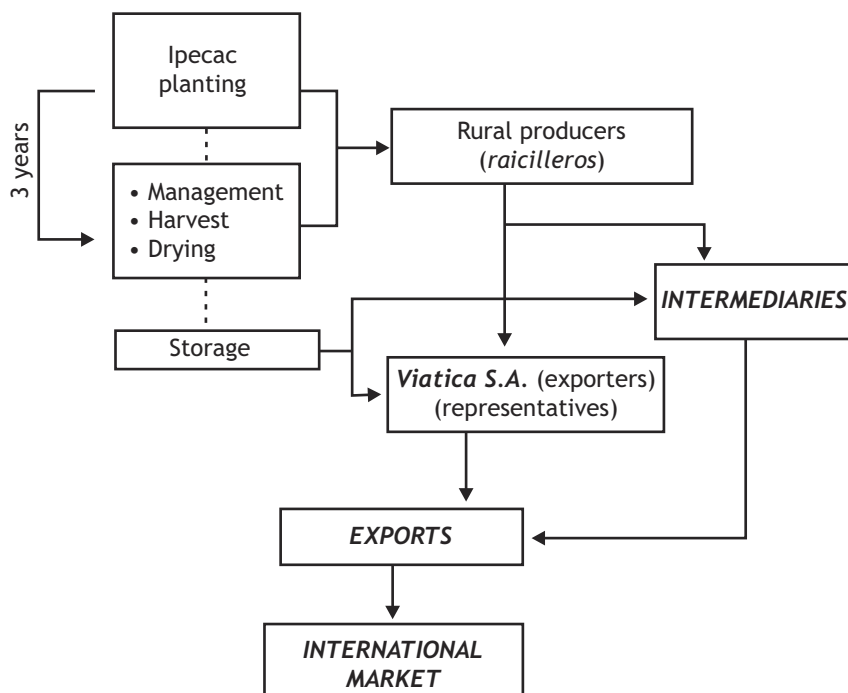
preparations in either liquid or syrup form and used as expectorants and emetics and for treating amoebic dysentery.

Marketing ipecac root

No national market currently exists for ipecac root, even though Costa Rica, including its state health entities, imports drugs that incorporate ipecac root as an ingredient. The only market existing is international and is relatively limited—almost 90 tons in 1992, for example. Exports that year were to USA, Mexico, Germany, France, UK, Malaysia, and Thailand at a total value of US\$4.3 million.

The marketing chain for ipecac root is simple (Figure 2), because of the low level of processing conducted in Costa Rica and the existence of only one limited market (international). Hence, intermediaries and exporters are few. The only two centres for collecting ipecac root existing in the region also buy sarsaparrilla (*Smilax chiriquensis* C.V. Morton), another medicinal plant from the forest, but one with a national market (Ocampo 1997b). Similarly, only two major national exporters export ipecac root, of which Viatica S.A. is the more important. Both are located in the national capital, where they also engage in other commercial activities unrelated to medicinal plants. Such market conditions give *raicilleros* and intermediaries few options for selling.

Figure 2. Production and marketing chain for ipecac root in Costa Rica



Policies and institutional factors in ipecac root production

In environmental law, Costa Rica is in the vanguard. Although no law specifies the concept of NTFPs, effort is clearly made to protect and conserve the country's biodiversity. Despite their theoretical scope, such initiatives have not had evident impact on the *raicilleros*, partly because the institutions responsible for applying the legislation and invigorating production systems such as that of ipecac root in the Huetar Norte region do not have the direction, capacity, or necessary tools.

In one case at least, legislative interventions made by the government had a counterproductive and direct effect on the ipecac sector. In 1984, in its zeal to promote the development of nontraditional crops, the government of Costa Rica promulgated Law 6955 by which ipecac root exports were encouraged through bonuses and subsidies to exporters. It was precisely this internal factor that induced interest in establishing ipecac plantings throughout the country, promoting efforts in the public and private sectors. Although the intervention led to an increase of almost 600% in the official export figures, some years later several exporting companies were discovered to have distorted the figures, thus leading to a clampdown on the sector and creating doubt as to the validity of the official figures on ipecac root exports.

The expectations for the production and marketing of ipecac root at the end of the 1980s generated the formation of a cooperative (COOPEIPECA) in 1988, demonstrating, at the time, a certain degree of organisation in ipecac root production. Through this cooperative, producers could offer the root at stable prices and from one collection centre. The later collapse of the

Photo 2. Planting material for the ipecac crop (Photo: R.O. Sánchez)



cooperative during the sector's crisis was the result of abuse by unscrupulous merchants of a governmental initiative developed in good faith and with a view to encouraging nontraditional crops. Usually, for various reasons, private enterprise characteristically lacks interest in industrialising raw materials from native species. The reasons include reticence to invest in businesses of a certain level of risk and the timidity of research institutions to accompany initiatives of applied research towards developing our natural resources. Nevertheless, at the current rate of globalisation, this traditional model of trading with developed countries should incorporate an element of industrialising our resources so as to face globalisation with positive results.

TRENDS AND KEY THEMES

Transforming the production systems for ipecac

We can only suppose that NTFPs were the first forest products to be exploited by primitive man (Ocampo 1997a). After the conquest of America in the fifteenth century, the extraction of natural resources from the forest accelerated. Extractive activities were characteristic of the colonial economy (1492-1810) until the beginning of the republican era (nineteenth century) (Sáenz 1970; Galvis 1994). From the nineteenth century onwards, as the pharmaceutical industry began to develop, the extraction of medicinal plants increased.

Up until mid-twentieth century, the production of ipecac root depended on wild populations. Attempts at domestication in Costa Rica, Panama, and Nicaragua began in the 1940s, motivated by USA's strategic interest, during World War II, in having close by a guaranteed, inexpensive supply of raw material of good quality (Sievers and Higbee 1948; Higbee and Kelly 1950; Gattoni 1959). Although England had previously attempted, during the nineteenth century, to cultivate and domesticate ipecac in India from Brazilian genetic material (Fischer 1973), these efforts did not succeed in surpassing the quality obtained in its biogeographical region of origin (Ocampo 2000), mainly because the alkaloid yields in the roots were too low (Atal and Kapur 1982).

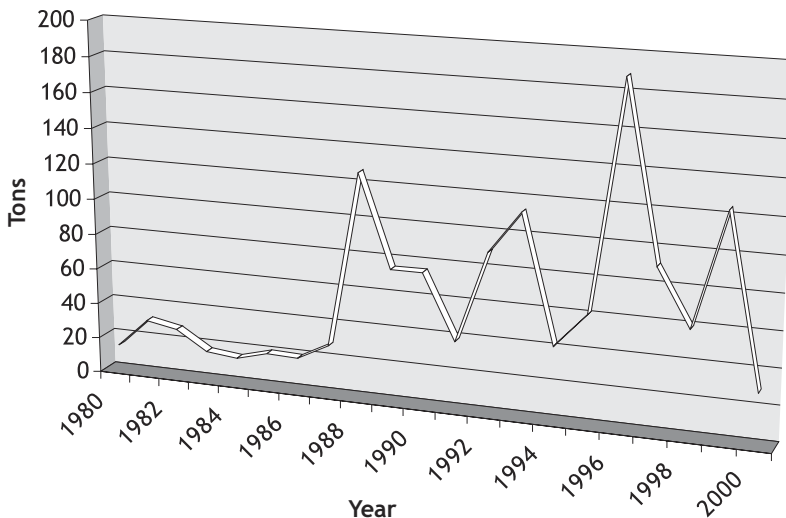
Obviously, when referring to the exploitation of NTFPs, one assumes that behind the activity are individuals dedicated to exploiting wild populations. Indeed, the reality of Latin America can frequently be summed up in terms of truly extractive actions (Ruiz and Arnold 1996; Ocampo 1998). Although the term *raicillero* originally referred to a person who extracts ipecac root from the forest, at present, the *raicillero*—at least in Costa Rica—has the profile of a farmer who handles ipecac populations in forest environments. Hence, the situation of *raicilleros* in Costa Rica is incorporated within the general transformation of extractive activities towards domestication. For example, for cacao, the forest disappears to give way to agricultural systems based on a plant that originated in the forest (Homma 1990). A contrasting situation occurs with the management of natural populations of *Quassia amara* L., whose wood is used in the pharmaceutical industry, and whose management can promote the conservation of both forest and species (Ocampo 2000).

Ipecac represents a unique case, where classic agricultural activities (e.g., planting distances and weeding) are mixed with keeping the forest cover.

Producing ipecac root

Marketing information on ipecac root in industrialised countries is scattered and difficult to access, partly because statistics frequently group different species and products (Lange and Schippmann 1997). Taking this factor into account, available statistics on demand for ipecac root in Costa Rica can reflect the importance of the resource to the international market. During the period of greatest stability in ipecac root production, between 1961 and 1985, Costa Rica produced an annual average of 20 tons, which corresponded to 20% of world production. Later, as a result of the governmental interventions mentioned above, efforts by governmental and private sectors promoted ipecac plantings in the country. In 1989 and 1996, according to official statistics, national production reached 115 tons and 180 tons, respectively (MRN & DGF 1990; Figure 3). Unfortunately, during the 1990s, exporting companies were discovered to be distorting the export figures for ipecac root, inducing a clampdown on the sector and creating doubt as to the validity of the official statistics. By 2000, exports were a little less than 30 tons (Palma 2000) and, in 2002, only 7 tons were exported (Viatica S.A. personal communication).

Figure 3. Export volumes of ipecac root, Costa Rica, 1980-2000

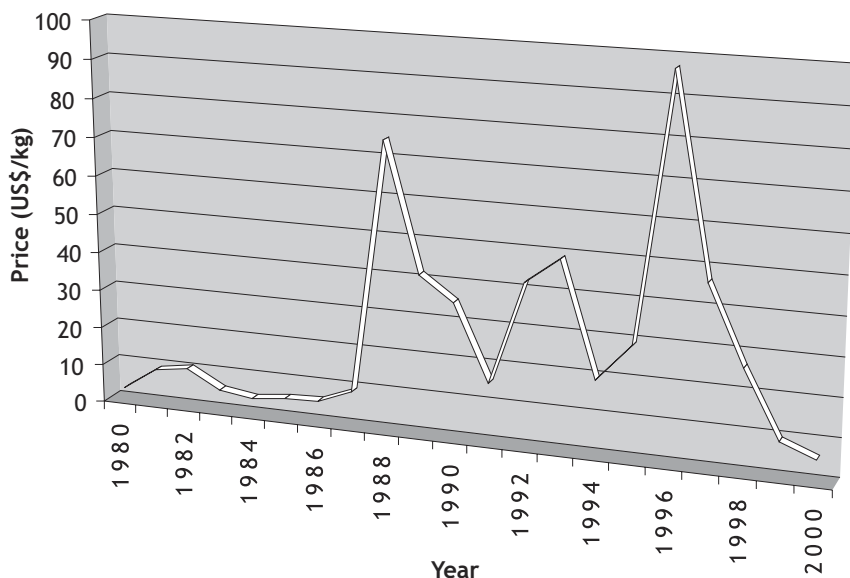


Source: MRN & DGF 1990.

The prices, both national and international, of raw material have fluctuated with production. While in the late 1980s the price per kilogramme

was US\$72, it reached US\$99 during the mid-1990s and dropped to US\$7 a couple of years later (Figure 4). In 1990 and 1991, with the advent of COOPEIPECA and other ipecac implementation projects, prices received by producers averaged US\$19 per kilogramme of roots.

Figure 4. Export prices (FOB) for ipecac root, Costa Rica, 1980-2000



Source: MRN & DGF 1990.

IMPLICATIONS FOR CONSERVATION AND DEVELOPMENT

During the period of classic extractive activity, the acquisition of raw ipecac material had low impact on forest structure, as harvesting did not alter the structure of the understorey. In that period, however, the natural populations of ipecac were subject to pressure from harvesting, which reduced, to a yet undetermined degree, its abundance in the forest. Furthermore, by selecting plants with roots of a greater size and according to certain morphological characteristics such as length, form, and leaf colouring, this extractive activity may have induced a level of genetic erosion. We therefore recommend that any attempt to domesticate this plant should incorporate elements of conserving the species *in situ*.

The later production of ipecac under conditions of incipient domestication had the effect of temporarily degrading the forest, precisely by cultivation, which includes eliminating the understorey. However, the itinerant manner of cultivating ipecac and the agro-ecological conditions it requires, particularly shade, constitute important elements for conservation of the arboreal layer.

No direct evidence documents the disappearance of ipecac from its natural environment in Costa Rica. It is surprising that, despite its broad exploitation, no studies exist on the species' abundance in the wild to determine its vulnerability. In Brazil, production continues to be from wild materials, which demonstrates that wild populations are still being exploited. If we consider the extensive area of the Amazon forest, obviously there must be regions where the wild material has disappeared as a consequence of arboreal cover having disappeared. This setting does not compare with the study area, which presents small forest areas, and, consequently, different strategies have developed to continue supplying the world market.

In addition, the ipecac crop has a strong impact on the rural dwellers of the study area. High prices and market demand in certain years made ipecac root an intensive model of an NTFP resembling an agricultural crop, with the great difference of an arboreal cover being necessary for its adequate cultivation. Historically, the concentration of *raicilleros* occurred close to the border with Nicaragua, from where the activity was introduced to Costa Rica, mainly through the cantons of Los Chiles and Upala. It is noteworthy that, at the time, forest area was not a constraint. As natural resources in the country, and specifically in the Huetar Norte region, degraded, however, the existence of remaining forests came to determine the concentration of *raicilleros*. Hence, the greatest concentration of *raicilleros* (29 of 43, or 67%) is currently found in Cutris District, where some highly disturbed primary and secondary forests remain. This same scarcity of forest for production has led to using other systems, such as cacao plantations, where it has greater social impact by diversifying farm production.

To supply the demand of the current market, large extents of land are not required; barely 0.72% of the population in the Huetar Norte region is dedicated to this activity, occupying about 45 ha for the ipecac crop. The *raicilleros* can potentially produce almost 127 tons annually with current plantings. The contribution of the ipecac crop to farmers has therefore been both positive and negative. The expectations created by high prices, which were first induced by rises in the market and then by fraud with the incentives granted by the government, led to an increase in production area, which resulted in overproduction and a drop to the current low prices. Nevertheless, our survey indicated that, despite the existing market problems, 60% of the *raicilleros* would continue.

NOTE

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REFERENCES

- Atal, C.K. and Kapur, B.M. (eds.) 1982. Cultivation and utilization of medicinal plants. Regional Research Laboratory, Jammu-Tawi, India.
- Burger, W. 1993. Rubiaceae in flora costaricensis fiel. Publications, Botany Series No. 33. Museum of Natural History.

- Camargo, M. and Giulietti, A. 1999. Diferenciación morfológica e anatomica en poblaciones de 'ipecacuanha'-*Psychotria ipecacuanha* (Brot.) Stokes (Rubiaceae). *Rev. Brasil.* (São Paulo) 22(2): 205-216.
- Castro, S. 2000. Abordagens biotecnológicas para a obtenção de substâncias ativas. *In: de Oliveira Simões, C. et al.* (eds.) *Farmacognosia: da planta ao medicamento: organizado*, 2nd rev. ed. Universidade UFRGS and Ed. da UFSR, Porto Alegre, RS, Brazil.
- COSEFORMA (Cooperación en los Sectores Forestal y Maderero) 1994. Inventario forestal de la Región Huetar Norte. GTZ, Costa Rica.
- Fischer, H. 1973. Origin and uses of ipecac. *Economic Botany* 27(2): 231-234.
- Galvis, G. 1994. Economía extractiva y desarrollo sostenible. *Rev. Acad. Cienc.* 19(73): 229-304.
- Gattoni, L.A. 1959. La raicilla o ipecacuana. Servicio Interamericano de Cooperación Agrícola, Panama.
- Higbee, E.C. and Kelly, J.W. 1950. Possibilities of improving Nicaragua ipecac root by selection. *Amer. J. Pharmacol.* 122: 184-188.
- Homma, A.K.O. 1990. Extractivismo vegetal e a solução para a Amazônia? Paper presented at the symposium on 'Ecologia e Agricultura Sustentable em Biomas Brasileiros', held at the Academia Brasileira de Ciencias, Rio de Janeiro, Brazil.
- ITC (International Trade Centre) 1982. Market for selected medicinal plants and their derivatives. UNCTAC & GATT, Genova, Italy.
- Lamprecht, H. 1990. Silvicultura en los trópicos: los ecosistemas forestales en los bosques tropicales y sus especies arbóreas—posibilidades y métodos para un aprovechamiento sostenido. GTZ, Germany.
- Lange, D. and Schippmann, U. 1997. Trade survey of medicinal plants in Germany. Bundesamt für Naturschutz, Bonn, Germany.
- León, J. 1968. Fundamentos botánicos de los cultivos tropicales. IICA, San José, Costa Rica.
- MRN & DGF (Ministerio de Recursos Naturales and Dirección General Forestal) 1990. Estadísticas de exportación de raicilla de Costa Rica. Dep. Des. Ind., San José, Costa Rica.
- Ocampo, R. 1997a. Aprovechamiento de productos no maderables del bosque tropical; tradición y perspectivas hacia una silvicultura con fines de producción diversificada. *In: Sabogal, C., Camacho, M. and Guariguata, M.* (eds.) *Experiencias prácticas y prioridades de investigación en silvicultura de bosques naturales en América tropical*. CIFOR, CATIE, and INIA, Costa Rica.
- Ocampo, R. 1997b. Estado de avance en la agroindustria de plantas medicinales en Costa Rica. *Agronomía Costarricense* 21(1): 103, 109.
- Ocampo, R. 1998. Extractivismo y domesticación de plantas medicinales. Paper presented at the Primera Jornada Catarinense de Plantas Medicinai, held at Santa Catarina, Brazil.
- Ocampo, R. 2000. Agrotecnología para el cultivo de ipecacuana o raicilla. *In: Fundamentos de agrotecnología de cultivo de plantas medicinales iberoamericanas*. Convenio Andrés Bello and CYTED, Santa Fe de Bogotá, DC, Colombia.

- Palma, T. 2000. Cultivo de la raicilla. Instituto Tecnológico de Costa Rica, San Carlos.
- Palma, T. and Hidalgo, N. 1994. Biotecnología: elemento importante en la domesticación de plantas medicinales. *In*: Domesticación de plantas medicinales en Centroamérica, 17. Serie Técnica, Informe Técnico No. 245. CATIE, Turrialba, Costa Rica.
- Ruiz, P.M. and Arnold, J.E.M. (eds.). 1996. Current issues in non-timber forest products research. CIFOR, Bogor, Indonesia.
- Sáenz, M.A. 1970. Historia agrícola de Costa Rica. Universidad de Costa Rica, San José.
- Sievers, A.F. and Higbee, E.C. 1948. Plantas medicinales de regiones tropicales y subtropicales. Unión Panamericana, Washington, DC.
- Thielbot, M. 1980. A mata da poaia e os poaieiros do Mato Grosso. Escola de Folclore/Livramento, São Paulo.
- Torres, C.L. 1976. Contribución al conocimiento de la *Cephaelis ipecacuanha* (Brot.) A. Rich. con especial referencia a Colombia. *In*: Simposio Internacional sobre plantas de interés económico de la flora amazónica, 123-136. Informe No. 93. IICA, Turrialba, Costa Rica.
- Trease, G.E. and Evans, W.C. 1988. Tratado de farmacognosia, 12th ed. Nueva Editorial Interamericana, Mexico, DF.
- Vargas, J. 1990. Prácticas agrícolas indígenas sostenibles en áreas de bosque tropical húmedo en Costa Rica. Revista Egoísmo 1(1-2).

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Chapter 14

Camu-camu [*Myrciaria dubia* (HBK) McVaugh] From the river plains of the Peruvian Amazon

Mario Pinedo Panduro¹ and Wil de Jong²



(*Myrciaria dubia*)

Common name	Product part used	Dominant form of management	Degree of transformation	Commercial scale	Geographic distribution
Camu-camu	Fruit	Wild	Average/half/middle	International	Average/half/middle

ABSTRACT

The fruits of camu-camu [*Myrciaria dubia* (HBK) McVaugh] contain high levels of vitamin C, an attribute that has attracted considerable interest in their use as a natural source of the vitamin. International demand has been growing since 1995. Natural populations of this fruit tree are found on the banks and shores of black-water rivers and lakes of the Amazon Basin. This species regenerates easily, producing numerous fruits, and is easy to access. The flooding of river banks and shores favours plant nutrition and controls pests, diseases, and weeds. Our study focussed on the middle catchment of the Putumayo River, in north-eastern Peru, bordering Colombia, populated by 4,000 mestizos and members of four other ethnic groups. The organisation of harvesters, processors, and other actors in the production chain is still incipient and weak. Between 1997 and 1999, the Peruvian government promoted camu-camu production on levees known as *restingas*. Compared with other reforestation experiments, the level of success was relatively high (20%), and it provided an emerging and innovative option with notable attributes for sustainability. In marketing terms, it still lacks consolidation and continuity of both supply and demand. Consumption of the fruit and its products needs to be promoted at both domestic and international levels to help stabilise this important agro-industry.

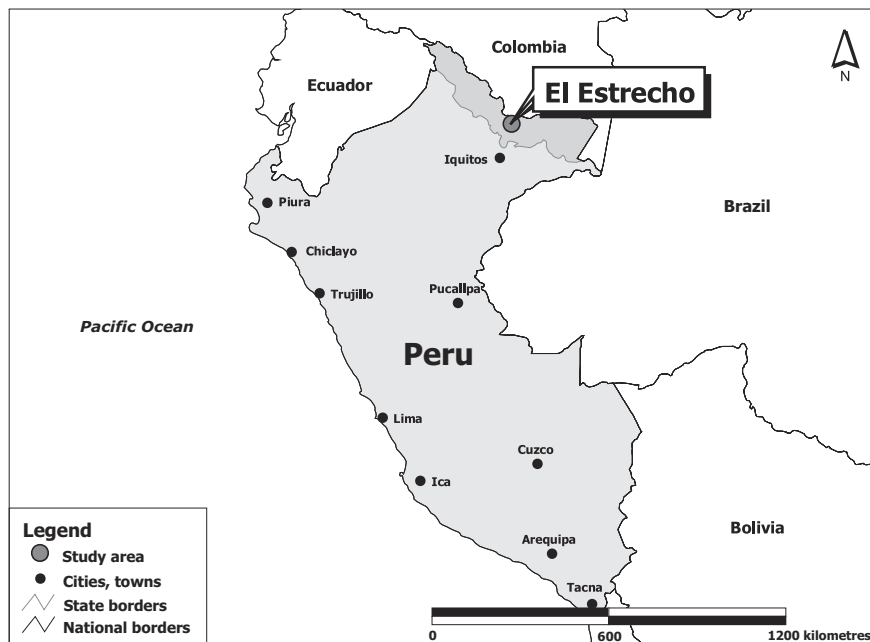
INTRODUCTION

The fruits of camu-camu [*Myrciaria dubia* (HBK) McVaugh, Myrtaceae] contain 3,017 mg of vitamin C per 100 g of edible pulp—the highest contents in any fruit known (Pinedo Panduro 2002). Natural populations concentrate in north-eastern Peru and are the genetic and commercial source of today's incipient camu-camu agro-industry. Ten years ago, the fruit was consumed only by the local population and was unknown in most of the Peruvian cities outside the region.

In the early 1990s, several research efforts and business initiatives created interest in camu-camu, leading to increased consumption inside and outside Peru. Currently, in several countries, the fruit is used to make refreshing beverages rich in vitamin C. The demand for natural vitamin C seems to offer a promising future for camu-camu. A series of products was introduced into the Brazilian market, such as hair treatments (e.g., shampoos, balsams, and capillary creams) and different foodstuffs enriched with camu-camu (e.g., yoghurts, ice creams, lollipops, and nectars) (Pinedo Panduro *et al.* 2001).

Our specific case study focuses on the area around the town of El Estrecho (Figure 1), located in the middle catchment of the Putumayo River, with a population of 4,202. The area is about 320 km², spread over 27 communities, from the hamlet of Santa Mercedes, upstream of El Estrecho, to that of Remanso, which is downstream (Águila and Souza 2003; López 2003). Camu-camu exists in abundance under natural conditions along the tributaries of the Putumayo River. Hence, this region is considered highly significant for managing natural camu-camu populations, given the relatively large area of exploitation.

Figure 1. Location of the study area



Source: ESRI Data and Maps 2002.

Our study area lies within the floodplains of the Peruvian Amazon, occupying north-eastern Peru. The Amazon River and a multitude of tributaries cross the region as they flow north-east. The larger rivers with origin in the Andes region carry heavy loads of sediments and are called white-water rivers. Rivers that originate from swamp forest areas have dark coloured water and are therefore called black-water rivers. The climate is hot and humid with fluctuating rainfall, but without a true dry season. From late in the year until the early months of the next year, most of the floodplains of the white-water rivers inundate. Both sediments and water levels greatly influence the flora and fauna of the flooded areas. Because the region is so flat, the rivers and their tributaries often change courses, leaving behind numerous oxbow lakes, known as *cochas*, many of which are permanent.

This chapter presents general information on the camu-camu production chain, describing the species ecology; the management, production, and supply of raw material; and its processing, trade, and marketing. The chapter also discusses trends of the camu-camu industry, and its contributions to rural development and reduced pressure on the forest.

The main information for this study was obtained by interviewing families involved in exploiting the species' natural populations. The interviews were based on a list of thematic categories for consultation and were applied either as dialogue or direct questions to the mother, father, and children

of each family. Fifty families were interviewed, representing 15% of all inhabitants participating in activities with camu-camu in El Estrecho. Some information was obtained through consultation of publications of the Ministry of Agriculture, institutions for research or statistics, and other sources of secondary information.

THE CAMU-CAMU PRODUCTION CHAIN

Habitat

Camu-camu is found naturally in different watersheds in Brazil, Colombia, Peru, and Venezuela. In Peru, natural camu-camu populations concentrate in the Department of Loreto around the rivers Putumayo, Curaray, Tigre, Napo, and Ucayali, and other smaller ones. The 2 m to 3 m tall shrub grows in pure stands on the banks of black-water rivers (Mendoza *et al.* 1989) or oxbow lakes. As a result of changes in the water levels of these rivers and lakes (up to 10 m between low and high), camu-camu populations remain submerged and can survive in water for five months. The coincidence of rising water levels with fruit maturation can negatively affect harvest. The Ministry of Agriculture at Iquitos has calculated the area of almost all populations existing in Peru (MINAG 2000b). Private enterprises exploiting the fruit have also made evaluations in watersheds such as that of the Putumayo and in secondary watersheds such as those of the rivers Mazán and Curaray (Italo Cardama, Empresa CAMPFOR, personal communication). Using these sources, we estimate that in the 380,000 km² of the Peruvian Amazon, about 15 km² have natural camu-camu stands (Table 1).

Table 1. Estimates of natural camu-camu populations in the Department of Loreto, Peru, 1999

Province	Number of oxbow lakes	Area under camu-camu (ha) ^a	Productivity (tons of fruit)
Maynas	85	1,023	5,115
Requena	10	195	975
Loreto	14	88	440
Ramón Castilla	18	35	175
Ucayali	10	6	30
Alto Amazonas	2	5	25
Total	139	1,352^b	6,760^c

- Source: Regional Agrarian Office-Loreto of the Ministry of Agriculture. Preliminary inventory of natural camu-camu populations. It was updated with information from the River Putumayo, adding 58 *cochas*.
- The inventory is still incomplete as watersheds such as that of the Yavari River (bordering Brazil) and other areas have not yet been examined. In the Putumayo watershed in the Province of Maynas, supply from Colombia can increase the total offer by 30%.
- This estimate is obtained by multiplying the number of hectares by 5 tons, a conservative factor based on an average of 10 t/ha.

Fruit yield

A high-yielding adult camu-camu plant produces up to 11,000 fruits of about 2 cm in diameter that have a purplish-red skin and yellow pulp. We estimate, on a conservative basis, an average production of 5 tons per hectare, which means a total production of 6,760 tons of fresh fruit per year. Assuming a commercial yield of 50% of pulp, we therefore calculate a potential production of 3,380 tons of pulp from all natural populations. At a price of US\$3.5 per kilogramme of frozen pulp, this would amount to a gross income of US\$11.8 million per year. Currently, the levels of exploitation of natural populations are much lower (Morten 2001), mainly because of the loss of mature fruits through floods, problems of access, and limitations in extraction capacities. Where access is easy, natural stands are frequently harvested in manners that damage plants.

Harvesting and fluctuating water levels

Harvest within a specific watershed is concentrated over two months per year. For example, waters in the camu-camu production region of Sahuá and Supay lakes at the Ucayali River, about 350 km south of El Estrecho, start rising in November. The leaves of camu-camu plants are affected, as shown by their copper colouring. In June, water levels drop and the leaves lost during or immediately after the flood are renewed. Flowering occurs in August and September, and harvesting starts in December, continuing until February, while the plants are largely submerged. Differences in terrain, however, lead to differences in reproductive phenology. Plants located on higher elevation (i.e., with a topographical difference of about 1 m in height) have been observed to fruit earlier than those located on lower elevation.

If we consider the flooding and related harvesting regimes in different areas, harvesting camu-camu in Peru may extend from December to April. The flooding of natural stands of camu-camu begins in the Ucayali watershed near Sahuá and Supay lakes in November and finishes in the Putumayo watershed in July to August (SINCHI 1999). Flooding usually causes the loss of most of the fruit production, meaning that harvesting has to be completed before the flooding is at its peak.

About 98% of the fruit in the production area of El Estrecho is harvested from natural populations. The harvest is manual, carried out mainly from canoes, and the fruits are collected in containers of domestic use such as buckets and trays with a capacity of about 10 kg. In some cases, companies that buy camu-camu provide special crates that have a 25 kg to 30 kg capacity. The state of maturity of the harvested fruit is critical as it determines the content of vitamin C and the resulting pulp colour. The state of maturity recommended and often required by buyers is half-ripe to mature, that is, when the fruit presents a reddish colour over at least 50% of its surface. The ideal time between harvest and processing is two days, although it can be prolonged to a maximum of four days.

Impact of harvesting on camu-camu populations

Harvesting the fruit implies a direct, although low, impact on the plant. In some areas, however, camu-camu populations were significantly reduced as a result of harvest pressure. Between 1975 and 1999, the area of natural populations of camu-camu around the Sahuá and Supay lakes was reduced from 124 ha to 50 ha (Inga and Pinedo Panduro 2002). Recent evaluations suggest that loss of these populations is the result of increasing flooding of sediment-rich waters. Floods from the Ucayali River, which carried high levels of sediments, made incursions into the black waters of the Sahuá and Supay lakes, the typical habitats of camu-camu populations, and caused significant plant mortality (Inga and Pinedo Panduro 2002). Indeed, the area with dead plants was observed to correspond to lower-level areas, where the impact of the sediment waters was greater. In general, we can assume that the direct negative impact of harvests on genetic diversity is minimal, as it does not destroy the populations' reproductive capacity.

The volume of fruit reaped from camu-camu plantations has remained stable over the last 10 years, providing only 2% of annual production. In coming years the production of cultivated populations is expected to increase, when plantations established in 1997 are harvested for the first time. Between 1997 and 1999, more than 5,000 ha of camu-camu were planted in the departments of Loreto and Ucayali (MINAG 2000a), only 300 ha of which are in a good state. Most of these plantations are found on farms with seasonal crops, where farmers can care for the fruit trees simultaneously with other crops such as maize, plantain, cassava, and beans (Pinedo Panduro 1998).

Camu-camu harvesters and their socio-economic context

The Department of Loreto, which has most of the area's natural camu-camu, has a rural population of about 128,000. This population grew at an annual rate of 2.64% between 1981 to 1993 (INEI 2000). About 3,000 rural families in the Peruvian Amazon engage in camu-camu related activities, including harvesters, merchants, and people who provide freezing and transport services. As with river-dwelling communities of other areas of the Amazon region, the inhabitants of El Estrecho are descended from indigenous groups, such as Ocaynas, Quechas, Witotos, and Yaguas (TCA 1997), or are emigrants from other parts of the Peruvian (Padoch and de Jong 1989) or Colombian Amazon. The average family size in El Estrecho is six people. In all, about 300 families in El Estrecho directly harvest camu-camu.

According to our 2001 survey of 50 families of El Estrecho, the average total family income is US\$1,164³ per year, slightly lower than the national average for 1998 (INEI 2000). Cash income averages US\$265 per year in El Estrecho, or only 23% of total income. Sales of plantain, cassava, and maize are the principal source of income for half of the surveyed families. Table 2 shows the importance of different types of agricultural use in the region.

Women extract almost 50% of the camu-camu raw material. Under favourable conditions harvesters reach the harvesting sites in canoes or small motorised boats. If water levels are low, then the camu-camu stands may remain isolated and harvesters have to walk several kilometres through very

Table 2. Land use systems around El Estrecho, Peruvian Amazon

Land use system	Percent of total (%)
Forestry	40.1
Exploitation of flora and fauna	34.5
Agroforestry	11.8
Seasonal agriculture (intensive)	4.8
Silvo-livestock	4.5
Areas for the conservation of biodiversity	2.3
Perennial agriculture	1.7
Silvo-livestock or forestry	0.2
Fishing	0.1
Total	100.0

Source: Instituto Nacional de Desarrollo, Peru.

Photo 1. Harvesting camu-camu in flood-prone areas, Peruvian Amazon (Photo: Mario Pinedo Panduro)

difficult terrain. The time needed to travel from the area of extraction to the market, usually in motorised boats, averages two days, and boats are hired expressly for this purpose.

Stress factors and regenerating natural populations

The location of natural camu-camu populations in extremely low, flood-prone areas results in natural control of pests and weeds. As a result

camu-camu stands persist over long times as long as no anthropogenic or ecological destructive events occur. Judging by the state of undisturbed natural populations, camu-camu's location in a semiterrestrial semiaquatic habitat appears to adequately control adverse factors (pests, diseases, and weeds), and provide needed nutrients. Local communities remember natural populations to have persisted for more than 100 years, and there is evidence of a 40-year-old plantation in a flood-prone area.

A natural population regenerates through seed germination⁴ from fruits that fall into the riverbed or are dispersed by fish such as *Colossoma macropomum* (Goulding 1983) or *Brycon erythropterum* (Canepa 1982). Camu-camu is potentially autogamous (geitogamous)⁵, although it is functionally allogamous, with pollination mainly through insects, particularly *Melipona fuscopilara* and *Trigona portica* bees (Peters and Vásquez 1987).

Asexual reproduction occurs when secondary branches grow, droop to the ground, root, and produce abundant shootings of tertiary branches (Peters and Vásquez 1987). This mechanism permits the renewal and expansion of populations along river margins. The flooding regime strongly reduces competition from other plant species within camu-camu stands. This aspect also favours commercial production of camu-camu in this habitat, as it reduces the need for weed control.

Processing camu-camu

In El Estrecho, a pulping and freezing plant was established, with a capacity for 80 tons of pulp. The town thus became in 1997-1999 the principal centre for exploiting camu-camu in Peru. Three local companies and one from the coastal region (Amazon Import) purchased fruit from the surrounding villages, both in Peru and Colombia, and pulped and froze the raw material. In 1999 some 400 tons of fruit were processed. A few small companies located in Iquitos also pulp camu-camu, buying fruits that are offered for sale in the city. Empresa Backus, the largest beer producer in Peru, has a floating processing plant that can move to more distant production areas. The camu-camu can be processed in this plant and the pulp stored in an on-board freezer. The floating processing plant permits a more efficient exploitation of remote natural populations, because once harvested the fruits quickly lose quality in terms of cleanliness and nutritional value (García and Paredes 1995).

Camu-camu sold outside Peru undergoes pulping, refinement, and standardisation treatment in the country. Outside the country, the pulp is treated for colour and flavour, standardised, and further processed for specific products. There is no evidence of adulteration of pulp in Peru to increase profits.

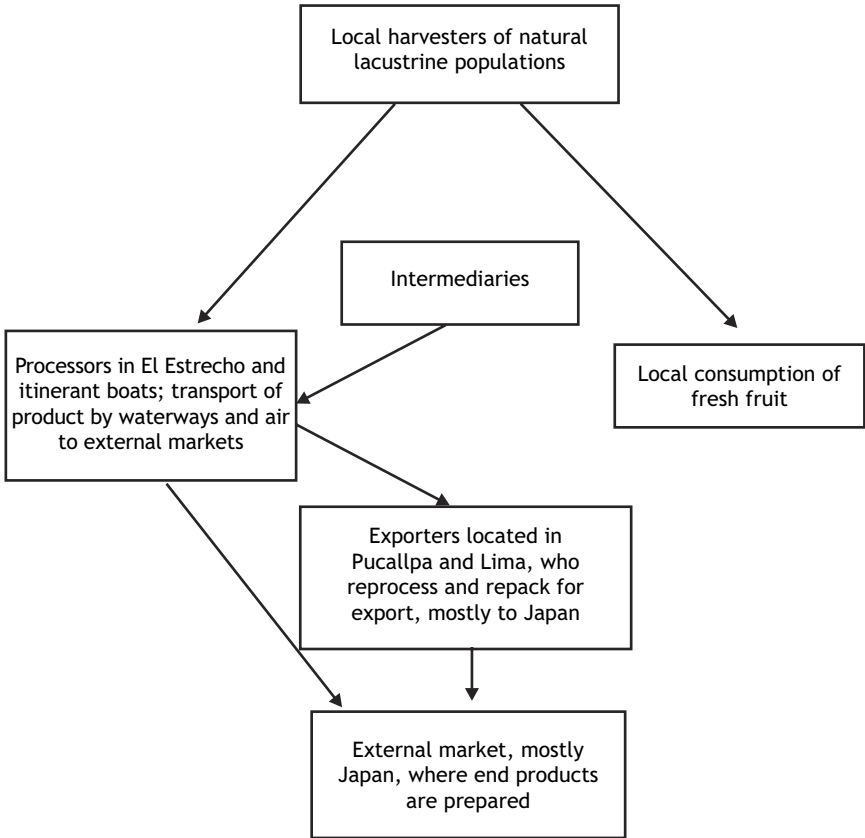
Trade and marketing

The total value of camu-camu products marketed inside Peru is estimated at US\$100,000 per year. Between 1995 and 1999, about 340 tons of frozen pulp were exported (MINAG 2000b), corresponding to about 800 tons of harvested fruit. In 1999, 167.7 tons of raw material and semiprocessed product were

Photo 2. Camu-camu products (Photo: Mario Pinedo Panduro)



Figure 2. Marketing chain for camu-camu [*Myrciaria dubia* (HBK) McVaugh], Peruvian Amazon



exported at a value of US\$586,950 (FOB prices at US\$3.5 per kilogramme of frozen pulp) (MINAG 2000a). Families are known to earn about US\$60 per day harvesting and selling camu-camu from the lakes where most of the natural populations are found. This amount represents an important income for a small rural economy. However, significant volumes of end products are not exported. The expansion of exports of products from camu-camu seems particularly limited by the unstable and irregular supplies of raw material, which often is of poor quality.

The area of exploitation of natural populations being in the Department of Loreto in north-eastern Peru (Figure 1), the principal centre for trade in camu-camu in Peru is the city of Iquitos. Travel from Iquitos to the places where natural populations of camu-camu grow can only be by river, which connects the extensive area of tropical rainforest that characterises the region. The Department of Loreto has only about 150 km of passable road, none of which permit access to the extraction centres for the species.

The principal product, fruit pulp, has been marketed on the international market since 1995, initially with an upward trend (Weiss 1998). The Japanese market had appeared promising at that time as it purchased the frozen pulp and concentrated it for manufacturing beverages with high levels of vitamin C, dehydrated products presented as tablets or capsules, or cream bleaches for the skin. Since 2000 to date, however, neither Japan nor any other country has purchased camu-camu. Pulp is now sold in Peru for preparing ice creams and beverages for national consumption (Figure 2).

Role of intermediaries

When residents of relatively nearby hamlets come together at El Estrecho to directly sell their fruit they are considered local harvesters (Figure 2). More distant harvesters mostly opt to negotiate *in situ* with intermediaries, of which there are 10 in the area. The relationship is more or less stable, resulting in relatively stable marketing chain. Buyers in El Estrecho number six people and companies, one of whom is an exporter who buys products from the other five. (Note that this chain operated during a period when the Japanese market had a monopoly.) Most of the harvest, about 70%, was marketed through intermediaries. Local consumption of fresh fruit is less than 1% of the volume harvested, while the Japanese market absorbed the rest of the harvest. Table 3 presents average prices according to stages in the production chain.

Quality as expressed by pulp colour can vary prices for end products by as much as 15%. Probably because of the incipient nature of marketing of camu-camu on a global level, so far no rigid requirements have been demanded with respect to levels of vitamin C. Although the species has shown potential for values of over 3,000 mg of vitamin C per 100 g of pulp (Pinedo Panduro *et al.* 2001), the minimum level required for foreign trade in frozen pulp is 1,800 to 2,000 mg. In the medium term, when the business becomes more competitive, requirements will likely become higher and more rigid.

Table 3. Prices received by the different actors in the camu-camu production chain, Peru

Actor	Unit	US\$/kg
Harvester	Fresh fruit	0.20
Intermediary	Fresh fruit	0.28
Processor	Frozen pulp	1.50
Exporter	Frozen pulp	3.00 ^a
	Concentrated pulp	15.00

a. Because of competition, the price recently dropped to US\$2.50.

POLITICAL AND INSTITUTIONAL ASPECTS

Plantation policies

State entities became interested in camu-camu in 1970, when species domestication trials started. In recent decades, guidelines have been developed for the management of plantations (Mendoza and Pinedo Panduro 1992). The degree of intervention from the government has also been increasing, especially to promote plantations. Since 1997, the government, through the Instituto de Investigaciones de la Amazonía Peruana (IIAP), the Ministry of Agriculture, and other institutions, has been promoting the planting of this fruit tree with the direct participation of communities (MINAG 2000a).

Of the 5,274 ha planted to camu-camu in the departments of Loreto and Ucayali, about 1,100 were surviving in 2002, with an average age of five years. This poor result can be attributed to the lack of support to producers of plantation maintenance. As a result, producers with limited economic and credit capacity neglected the crop, causing weed invasion. Despite this apparent failure a 21% survival rate after five years is noteworthy, compared with previous reforestation experiences in the Peruvian Amazon. Concrete cases can be shown of producers that, through sales of camu-camu, significantly increased their income and investment in capital goods.

Ownership policies

Until recently there were no standards or clear and effective laws to control extraction from natural camu-camu populations. Since then, the Peruvian government has established the right to exploitation in flood-prone areas through renewable 10-year concession contracts.⁶ These legal dispositions are yet to be applied broadly, however, and the current situation is that no clear mechanism exists to establish ownership rights of camu-camu stands.

In response to such inertia over ownership, people in some places, such as El Estrecho, started to define their own ownership rules. For example, some communities have divided stands within the community's jurisdiction into lots for exclusive use, thereby preventing outsiders from entering to harvest.

Agro-industrial development

In addition to promoting camu-camu plantations the government has made some investment to support camu-camu product development. As a result, some technologies have been developed for preparing products such as pulp for making ice creams, beverages, marmalades, and vitamin C tablets. So far no standards, laws, or regulations direct the processing of raw material. There exist tax exemption opportunities to promote agro-industrial development in the Peruvian Amazon.⁷ Table 4 summarises the support government agencies have provided to the camu-camu industry.

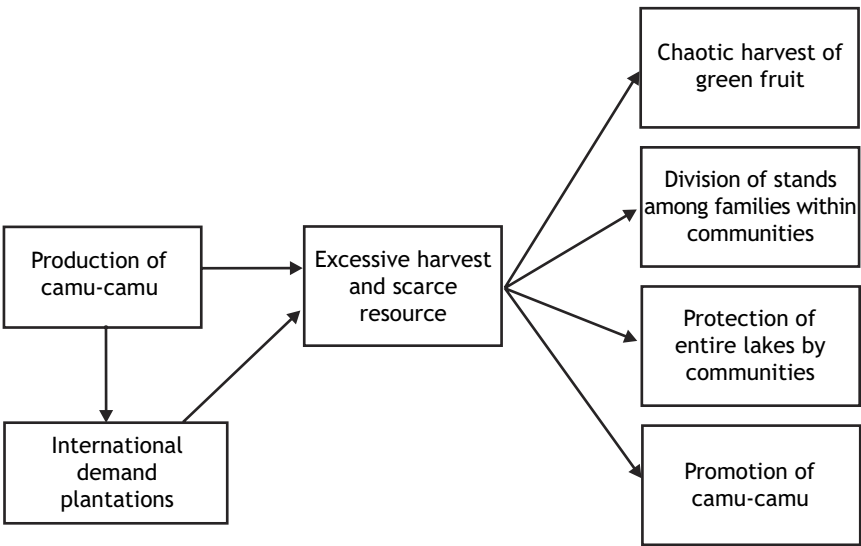
In specific cases, state agencies have been ambiguous in encouraging the development of an agro-industry based on camu-camu. In El Estrecho, for example, the government provided direct investments for processing

Table 4. Key policies that influence the study area around El Estrecho on the Putumayo River, Peruvian Amazon

Policy type	Entities	Beginning in year:	Current status
Research	INIA, IIAP, UNAP	1970	Continuous, active
Crop promotion	MINAG, IIAP	1997	Continuous, little activity
Industrial promotion	COFIDE	1998	Discontinuous
Decrees, laws	MINAG, Congress	1999	Unimplemented

COFIDE: Corporación Financiera de Desarrollo
IIAP: Instituto de Investigaciones de la Amazonía Peruana
INIA: Instituto Nacional de Investigación Agraria
MINAG: Ministry of Agriculture
UNAP: Universidad Nacional de la Amazonía Peruana

Figure 3. Responses to situations of scarcity of camu-camu in a demand scenario with international markets



camu-camu, but only large entrepreneurs could access these loans. If adequate natural stand management criteria for management are not applied, exploitation may cause genetic erosion in the complex and diverse water ecosystems that supply fish, timber, and other products together with camu-camu. In other regions where camu-camu is harvested, such as in the Sahuá and Supay lakes, the incipient organisational conditions and absence of standards and guidelines for management of natural stands led to weak control, reducing fish populations and timber trees. A series of responses of various degrees of impact on natural stands has been developed in case the fruit should become scarce or pressure of exploitation high through increase in demand, especially for export (Figure 3).

TRENDS IN KEY THEMES

International markets

Development of the camu-camu market between 1995 and 2002 showed two defined stages. Between 1995 and 1999, export was growing notably, but only to the Japanese market. Since 2000, this single export market disappeared, causing a drastic decline in income for harvesters, processors, exporters, and other actors in the production chain. The reasons why this market abruptly disappeared is still unclear, but possible explanations are that (1) consumption of camu-camu products was not adequately promoted; (2) changes in the Peruvian government in 2000 affected commercial relationships with Japan; (3) problems of pulp quality and requirements arose; (4) confusion and instability in the Peruvian tariff policy led to a significant cost increase for the Japanese importer; and (5) strong competition from azarole, the price of which is lower, displaced camu-camu.

Within three years of export to Japan, farmers started to adopt the new crop for flood-prone environments. These changes resulted from the promotion of the camu-camu crop by national agencies and revolutionised sustainable production models for flood-prone areas of the Peruvian Amazon. The new crop generated new incomes for camu-camu growers, substantially increasing their overall income. Marketing of camu-camu and its products domestically has good potential, and increased opportunity to be influenced. Therefore it can become an alternative to the fluctuating and highly competitive foreign market.

Organic status and sustainability

An essential feature making the sustainability of camu-camu viable is the possibility of maintaining its category of organic product, as its production can be confined exclusively to flood-prone areas without the need for use of agricultural chemicals.⁸ This nonuse is possible because of the buffer effect of the periodic floods, which, on the one hand, help considerably in keeping down the economic impact of pests, diseases, and weeds and, on the other hand, minimise the requirement for nutritional inputs thanks to the contribution of sediments that they transport and deposit. The Backus

Company, located in Pucallpa, has experimented for 20 years with producing camu-camu on uplands, on very poor Oxisols. As a sustainable option for the Peruvian Amazon, results have not been promising. The possible use of camu-camu in orthomolecular medicine⁹, making use of megadoses of natural vitamin C, gives the species priority over other Amazon species.

Current constraints to higher production include loss of mature fruits in flooding, difficult access to some natural populations when river levels are low, and lack of operating capacity for harvesting or processing, including labour, canoes, boats, motors, and containers. The proposal to produce in locations in river beds at elevations of about 2.5 m higher than natural populations does not entirely eliminate these risks.

The possibility for sustainably exploiting camu-camu is possible because only the fruits are harvested which does not affect the regenerative capacity of natural populations. No other damaging activities, like cutting branches or removing leaves, should be undertaken, a practice that is quite common among communities managing natural populations.

Ownership

Much remains to be done regarding ownership of areas of exploitation, community organisation, and linkages with state entities for managing camu-camu ecosystems. During the early years of the camu-camu boom green fruits were commonly harvested in areas of exploitation where property was not defined. Recently, a greater sense of conservation among harvesters has been noted, together with increased response to ownership and organisation. These include the assignment of stands for the exclusive use of individual families, as was done in El Estrecho, and protection of entire lakes by the communities, as was done for Sahuá and Supay lakes.

The weak promotion of alternative production, processing, and marketing schemes and the limited progress in organising groups of producers are constraints for progress in the sustainable exploitation of the species. Under these conditions, achieving a stable supply of high-quality fruits and pulp is difficult. Strengthening the promotion of alternative plantations on relatively higher but also flood-prone terrain constitutes an important strategy for consideration, one that had been initiated in 1997 but without the vigour and continuity needed to make a lasting impact.

The industry's future

Although camu-camu production in flood-prone alluvial areas appears promising, it is still in too early a stage as to ensure a stable supply of raw material for the industry. It is also unclear how much demand will grow, where the production centre will be, and who will benefit from the trade.

What may significantly influence the camu-camu industry's future development is the initiative of small investors and support from state entities, both factors that, today, are still limited in Peru because of the country's precarious economic situation. When the industry started in 1995, not only did camu-camu exports become possible, but regional and national

business groups also showed increased interest in investing in the business. Despite the good signs, however, capacity to invest is almost nonexistent because of the prevailing economic depression in Peru and the lack of access to credit that is the reality of the Amazon region. The requirements and guarantees of the traditional Peruvian trading system are impractical for companies wanting to invest in the harvest or production of camu-camu. In addition to these limitations, state policies have not been sufficiently robust or clearly favourable for this industry's development.

CONCLUSIONS

The production and processing of camu-camu in the lowland forests of Peru have meant, in the last five years, a serious option for the agricultural and industrial development of the Peruvian Amazon. The phenomenon of camu-camu in El Estrecho on the Putumayo River has become a tangible alternative to coca production, carried out mainly on the Colombian side with Peruvian labour. If camu-camu production and processing progress to occupy an important place in the regional economy, we envisage two probable trends with regard to their impact on the rural population:

- a. Camu-camu production in flood-prone areas could be adopted by thousands of small producers in the region, thus significantly increasing earnings. Such activity would favour the genetic conservation of natural populations, as pressure from horticultural options of flood-prone areas would be reduced. However, this relief would depend on factors such as patterns of demand and reactivation of plantations. With respect to the conservation of natural populations, current legal standards need to be enforced and community organisations strengthened for the integrated management of these ecosystems.
- b. Less optimistic projections envisage camu-camu production as being adopted by numerous producers, inside and outside Peru, thus eroding prices and taking the market away from the producers of El Estrecho. There also exists the risk that economically and politically stronger investors take over the production of camu-camu and deprive current producers of potential economic benefits.

The contribution to tropical rainforest conservation of the adoption of camu-camu production can be expected to be positive. Probably, the increase of camu-camu production areas on river levees would either replace or complement other crops, reducing pressure on the tropical forest.

NOTES

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3. This figure includes income from all sources, that is, monetary income from the sale of products and services, as well as equivalent income for

subsistence foods and others.

4. Germination occurs between 23 and 63 days after planting (Pinedo Panduro 1984). The earliest maturing plants begin production three years after germination (Pinedo Panduro *et al.* 2001).

5. Geitonogamy is a type of autogamy whereby a flower does not self-pollinate but is pollinated by another flower on the same plant.

6. Supreme Decree No. 046-99, promulgated on 24 September 1999, declares camu-camu to be of national interest and authorises the granting of renewable 10-year concessions for plantations of the species in courses, on banks and shores, and in marginal zones of rivers, streams, lakes, and lagoons.

7. Law No. 27037, promulgated on 30 December 1998, promotes investment in the Peruvian Amazon and exempts from income tax those taxpayers that develop activities with camu-camu.

8. The Peruvian Amazon is estimated to have a total of 6 million floodable hectares that could be considered for this end (Rodríguez *et al.* 2001).

9. Orthomolecular medicine has as its fundamental objective the re-establishment of the body's chemical balance. It aims to combat free radicals with substances or natural elements, whether they be vitamins, minerals, or amino acids.

REFERENCES

- Águila, M.A. Del and Souza, N.M.A. 2003. Diagnóstico socio económico y de potencialidades agropecuarias. Trip report 18-03 to 08-04-03. Proyecto Especial Binacional de Desarrollo Integral de la Cuenca del Río Putumayo. Instituto Nacional de Desarrollo.
- Canepa, C.R. la 1982. Estudio bio-ecológico del sábalo 'cola roja' *Brycon erythropterum* en el sistema de lagunas Supay y aledaños, Jenaro Herrera, Requena. B.Sc. Thesis, ____, Lima, Peru.
- García, R.J. and Paredes, Z.E. 1995. Estudio técnico de la extracción liofilizada de la pulpa refinada del fruto del camu-camu (*Myrciaria dubia*) conteniendo ácido ascórbico (vitamina C). B.Sc. Thesis, Universidad Nacional de la Amazonía Peruana, Iquitos, Peru.
- Goulding, M. 1983. The role of fishes in seed dispersal and plant distribution in Amazonian floodplain ecosystems. Sonderbd. Naturwiss. Ver. Hamburg 7: 271-283.
- INEI (Instituto Nacional de Estadística e Informática) 2000. Condiciones de vida y pobreza en el Perú 1997-1998. INEI, Lima, Peru.
- Inga, S.H. and Pinedo Panduro, M. 2002. Investigación para el manejo de rodales naturales de camu-camu (*Myrciaria dubia*) en las cochas Sahuá-Supay, Jenaro Herrera, Loreto. Instituto de Investigaciones de la Amazonía Peruana, Iquitos, Peru.
- López, V.R. 2003. Evaluación de la intervención del estado en la cuenca del Río Putumayo. Trip report 13-24 May 2003. Proyecto Especial Binacional de Desarrollo Integral de la Cuenca del Río Putumayo. Instituto Nacional de Desarrollo.
- Mendoza, R.O., Picón, B.C., Gonzales, T.J., Cárdenas, M.R., Padilla, T.C.,

- MediaVilla, G.M., Lleras, E. and Delgado, F.F. 1989. Informe de la expedición de recolección de germoplasma de camu-camu (*Myrciaria dubia*) en la Amazonía Peruana. Instituto Nacional de Investigación Agraria y Agroindustrial, Lima, Peru.
- Mendoza, R.O. and Pinedo Panduro, M. 1992. Veinte años de investigación agrícola: avances y perspectivas. Estación Experimental Agropecuaria 'San Roque'. Instituto Nacional de Investigación Agraria y Agroindustrial (INIAA), Peru.
- MINAG (Ministerio de Agricultura) 2000a. Estudio de mercado para camu-camu. Instituto Latino Alemán de la Tecnología del Aprendizaje, Peru.
- MINAG (Ministerio de Agricultura) 2000b. Programa nacional de camu-camu 2000-2020. Unidad de Desarrollo de la Amazonía, Instituto Nacional de Recursos Naturales, MINAG, Peru.
- Morten, B.H. 2001. The natural extraction of the native fruit from *Myrciaria dubia* (camu-camu) and its potential for cultivation in the Peruvian Amazon. The Royal Veterinary and Agricultural University, Copenhagen, Denmark.
- Padoch, C. and de Jong, W. 1989. Santa Rosa: the impact of forest products trade on an Amazonian village. *Advances in Economic Botany* 8: 151-158.
- Peters, Ch.M. and Vásquez, M.A. 1987. Estudios ecológicos de camu-camu (*Myrciaria dubia*): producción de frutos en poblaciones naturales. *Acta Amazónica* 16/17: 161-173.
- Pinedo Panduro, M. 1984. Investigación en frutales nativos en la Estación Experimental de 'San Roque'. In: Serie de Ponencias, Resultados y Recomendaciones de Eventos Técnicos N°. 350, pp. 36-42. Instituto Nacional de Investigación Agraria (INIA), Iquitos, Peru.
- Pinedo Panduro, M. 1998. Informe de supervisión; departamento de Loreto. Programa de Agro exportación del Camu-camu, Instituto de Investigaciones de la Amazonia Peruana, Iquitos, Peru.
- Pinedo Panduro, M. 2002. Variación del contenido de vitamina C de camu-camu silvestre en Loreto, Perú. Programa de Ecosistemas Terrestres, Instituto de Investigaciones de la Amazonía Peruana, Iquitos, Peru.
- Pinedo Panduro, M. *et al.* 2001. Sistema de producción de camu-camu en restinga. Instituto de Investigaciones de la Amazonía Peruana, Iquitos, Peru.
- Rodríguez, A.F., Peka, S.N., Tello, M.S., Mejía, C.K., Limachi, H.L. and Maco, G.J. (eds.) 2001. ERABI: Ecoregión del Río Amazonas y Bosques Inundables en el Perú. Instituto de Investigaciones de la Amazonía Peruana and Office for the Peruvian Program, World Wide Fund for Nature.
- SINCHI (Instituto Amazónico de Investigaciones Científicas) 1999. Zonificación ambiental de la cuenca del Río Putumayo. Oficina de Desarrollo Sostenible y Medio Ambiente, Organización de los Estados Americanos, Bogotá, Colombia.
- TCA (Tratado de Cooperación Amazónica) 1997. Amazonía: biodiversidad comunidades y desarrollo. Lima, Peru.
- Weiss, D.K. 1998. Un estudio del mercado mundial para el camu-camu. Winrock International. Proyecto de Desarrollo Alternativo, USAID/CONTRADROGAS, Convenio USAID-INADE.

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Chapter 15

Potentials and Perspective of Cat's Claw [*Uncaria tomentosa* (Willd. Ex Roem. & Schult) DC.]

Walter Nalvarte Armas¹ and Wil de Jong²



(*Uncaria tomentosa*)

Common name	Product part used	Dominant form of management	Degree of transformation	Commercial scale	Geographic distribution
Uña de gato, Cat's claw	Bark	Wild	High	International	Wide

ABSTRACT

Cat's claw is the common name of two species of *Uncaria* used traditionally in several South American countries. These vines have generated interest in the pharmacological world since the 1960s, when analyses verified that they have important and promising active components. In 1995 a boom in cat's claw sales took place, when it was exported from Peru to more than 30 countries. This boom was followed by a drastic reduction in exports in later years. Even so, cat's claw still holds significant interest for the pharmaceutical sector, which continues to develop new products for national and international markets. Peruvian state agencies have defined a series of norms for regulating the exploitation of the two species, but these measures appear to have resulted in overregulation, discouraging the production and marketing of cat's claw. In better years, the marketing of these plants represented an opportunity for rural populations to improve their income. The disturbance of forests as a result of exploiting the two species was minimal.

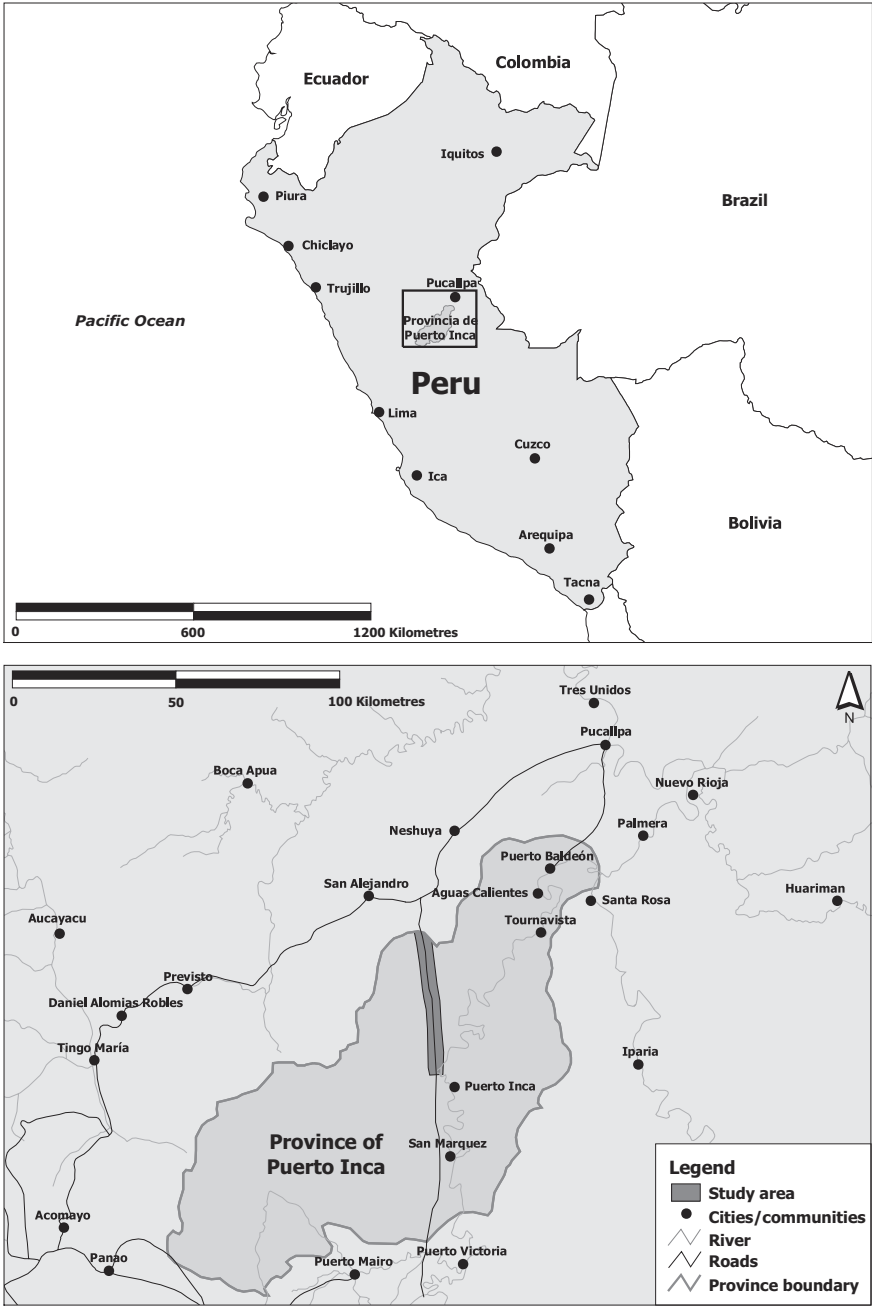
INTRODUCTION

Cat's claw in Peru is the name of several medicinal plant species, including *Uncaria tomentosa* and *U. guianensis* (Rubiaceae). These lianas or vines owe their vernacular name to the thorns that resemble cat claws. Both species are considered to have curative properties. Especially *U. tomentosa* is considered to have anti-inflammatory and immunological qualities, and may possibly be anticarcinogenic. Active ingredients in these plants have been researched by well-known research laboratories such as the Institute of Pharmaceutical Biology of the University of Munich, Germany; the universities of Graz and Innsbruck, Austria; the universities of Naples, Salerno Paiva, and Milan, Italy; and important U.S. laboratories (Hemingway and Phillipson 1974; Montenegro de Matta *et al.* 1976; Wagner *et al.* 1985; Aquino *et al.* 1989, 1991; Yépez *et al.* 1991; Rizzi *et al.* 1992).

The two species native to Central and South America have been used as medicinal plants in the various countries where they occur (Balée 1994), but their local use has been described mostly for Peru. Although the species were already known locally for their curative properties for generations, they only recently acquired wider acceptance in national and international popular medicine.

In the early 1990s, the plants—especially *U. tomentosa*—came to be widely known outside Peru and their collection and marketing intensified (de Jong *et al.* 1998; Nalvarte *et al.* 2000). The ensuing boom followed the typical boom-and-bust trend of other Amazon products. Sales of mainly the bark accelerated abroad, resulting in a strong increase in the extraction of the plants. When the markets became saturated, warehouses in the principal centres of collection became oversupplied because international demand declined significantly. For some years, activities derived from exploiting this resource generated profits for the collectors in the forests and for the traders in Iquitos, Pucallpa, and Lima. Parallel with this process, cat's claw attracted the attention of conservationists and some politicians.

Figure 1. Location of the study area



Source: ESRI Data and Maps 2002.

The interest in these plants is the result of phytochemical and ethnopharmacological studies that demonstrated high contents of chemical compounds related to certain pharmacological properties. The principal compounds found in both species are alkaloids, which have properties such as immuno-stimulating (oxindoles), anti-inflammatory (quinovic acid), antimutagenic (alkaloids and polyphenols), and anti-oxidant (alkaloids and other compounds). The cat's claw compounds can also inhibit cellular mitosis, increase the formation of granulocytes and macrophages, suppress the implantation of tumorigenic cells, inhibit cellular proliferation, and increase phagocytosis by macrophages (Hemingway and Phillipson 1974; Montenegro de Matta *et al.* 1976; Wagner *et al.* 1985; Aquino *et al.* 1989, 1991; Yépez *et al.* 1991; Rizzi *et al.* 1992).

The discoveries of cat's claw's attributes were not on a par with the great expectations for its use in the early 1990s, however. Although some chemical components have been identified in cat's claw and their use verified for treating a variety of symptoms, Peru still finds itself far from being able to produce medicines that reach international markets. Neither has it successfully established a market for the so-called complementary dietary inputs. The demand for raw material has declined significantly, while new legislation restrains the commercial exploitation of natural stocks.

This chapter describes the cat's claw boom of the 1990s and the responses of markets and various actors during that time. We also evaluate the impact of this boom on the well-being of the rural population and on the species in areas where they are harvested, indicating current trends. Our point of reference is the 'Alexander von Humboldt' forest settlement, located between Kilometres 4 and 60 of the Carretera Marginal de la Selva (Figure 1). In 1980, a settlement programme assigned 400 ha of forest lots to settlers who could take advantage of forest resources. By the end of the 1990s the population of this area was about 1500. The political and social instability that characterised most of Peru became the principal obstacle to implementation of effective forest management. Today the area attracts many new migrant farmers, even though the area has been designated for forest exploitation.

THE CAT'S CLAW PRODUCTION CHAIN

The resource base

Populations of *Uncaria tomentosa* and *U. guianensis* have been reported from Central America and the western countries of South America, from northern Belize to southern Paraguay (Quevedo Guevara 1995; Zavala Carillo and Zevallos Pollito 1996). The most easterly recorded stand was in the State of Maranhão in north-eastern Brazil (Balée 1994). In Peru, both species are found in the departments of Ayacucho, Cusco, Huánuco, Loreto, Junín, Madre de Dios, Pasco, San Martín, and Ucayali.

Uncaria tomentosa is found at higher altitudes than *U. guianensis*. Reports disagree, however, on their altitudinal distribution. Zavala Carillo and Zevallos Pollito (1996) suggest that *U. tomentosa* occurs between 100

and 995 m above sea level (masl), whereas *U. guianensis* occurs between 100 and 800 masl. Quevedo Guevara (1995) indicates that *U. guianensis* is found only between 100 and 500 masl. In Peru, the two types of *Uncaria* prefer Orthic Acrisols, Dystric Cambisols, and Fluvisols. *U. tomentosa*, particularly, is found in high and mountainous land with well-drained soils and high organic matter content. In the departments of Loreto and Ucayali, this species can also occur in the shoals and flood-prone fluvial plains of the principal rivers of the Peruvian Amazon. In contrast, *U. guianensis* is found more frequently on flat or slightly undulated lands with poorly drained soils (Zavala Carillo and Zevallos Pollito 1996).

The area of the Carretera Marginal, where data for this chapter were obtained, is ecologically classified as tropical humid forest that predominates in the Peruvian Amazon. Its location close to the Andean piedmont favours *U. tomentosa* over *U. guianensis*. The physiography is mostly hilly, consisting of an undulating landscape, with slopes fluctuating between 8% and 18%. The most common soil is Typic Eutropept (Inceptisol) or Eutric Cambisol, moderately deep to deep, fine textured, with acid in surface layers, and possessing moderate to good drainage. These are classified for forestry exploitation (ONERN 1983). Intense timber extraction has altered the structure of the natural primary forests and swidden agriculture has resulted in areas of secondary forests.

In the primary forest, the dominant species are *Matisia cordata* Humboldt & Bonpl., *Pseudolmedia laevis* (Ruiz & Pav.) J.F. Macbr., *Hura crepitans* L., *Clarisia racemosa* Ruiz & Pav., and various species of the family Myristicaceae. The trees surpass 120 cm diameter at breast height and are more than 50 m tall. *U. tomentosa* has a density of two to eight mature individuals per hectare. This low density is probably a result of the limited opportunities for plantlets to grow under shade (Quevedo Guevara 1995). The Peruvian nongovernmental organisation Pro-Naturaleza, however, found 17 individuals per hectare in inventories carried out with indigenous Yanesha of Loma Linda in the Palcazú Valley (Arce 1996).

The two *Uncaria* species differ slightly in size and their reproduction. Mature *U. tomentosa* individuals have a basal diameter of 5 cm to 40 cm. Its thorns enable it to climb to a potential height of 20 m or 30 m (Quevedo Guevara 1995; Photo 1). In contrast, mature individuals of *U. guianensis* reach lengths between 4 m and 10 m, and have basal diameters between 4 cm and 15 cm. Compared with *U. tomentosa*, this species resembles a creeping plant more than a climbing one, because its thorns curve inwards.

The two species have different light requirements. Both species are heliophytes but *U. tomentosa* is found in mature or disturbed residual forests, whereas *U. guianensis* is found mostly in secondary forests (Quevedo Guevara 1995; Zavala Carillo and Zevallos Pollito 1996). This species also grows along large and small rivers (Balée 1994). In this context, Duke (1992) questions the restriction of *U. tomentosa* to a more closed vegetation, suggesting that only this *Uncaria* species occurs in the lowlands of Panama, Costa Rica, Honduras, Guatemala, and Belize, where it is a pest in plantain plantations (Standley and Williams 1975).

Photo 1. Leaves and flowers of cat's claw *Uncaria tomentosa* (courtesy, Instituto de Investigaciones de la Amazonía Peruana)



Producers of the raw material and their economic context

The inhabitants of the Carretera Marginal are mainly migrants from the Andean and sub-

Andean regions of Peru. In the 1960s, a wave of migration began from the country's highlands to the tropical lowlands around Pucallpa, triggered by the construction of the road between Peru's coast and its interior. The new population adapted rapidly and succeeded in taking advantage of the opportunities that arose with the cat's claw boom.

In 1980, the Pichis-Palcazú Special Project started to develop the central region of the Peruvian Amazon. In the same year and as part of the same project, the construction of the San Alejandro-Puerto Bermúdez sector of the Carretera Marginal de la Selva started. The land occupation policy gave each family 400 ha of forest as a forest concession to be exploited under a management plan. The strategy was implemented in 1984 with support from Belgian and Canadian development assistance.

In the early 1990s, migration towards the forest region accelerated. The previous situation, linked to the country's armed conflicts, especially in the area of the Carretera Marginal, had weakened the planned settlement. Instead, a spontaneous and unorganised occupation occurred, especially

along the road, rivers, and streams, and the forest was converted into lands for agricultural and livestock activities.

The people of the Peruvian Amazon where cat's claw is collected are a mixture of indigenous populations, who have maintained their own languages and indigenous social structures, and descendants of indigenous populations and immigrants. Most of these people live in settlements along rivers, as these are the principal transportation routes. The people who collect cat's claw usually live from agriculture, fishing, hunting, and collection. Most of the production is destined for household consumption, while some market-oriented production is also common. Income is usually low, coming from sales of agricultural and forest products, or in kind for household consumption. Household income varies greatly, but is generally about US\$200 per month (Smith *et al.* 1999; de Jong *et al.* 2001). This level of income is higher than the national average for Peru, but it conceals great variability.

Extraction and processing

Collection of the raw material constitutes the first phase of the cat's claw production chain. Bark is the part of the *Uncaria* species commonly used. A plant yields on average 30 kg of dried bark (Domínguez 1997). Extraction consists of cutting the stem or trunk at 30 cm from the base, then pulling on the rest of the plant, thus taking advantage of its entire length. Almost 100% of the national extraction of bark comes from primary forests. The bark is either sold wholesale in 20 kg polyethylene sacks or retailed in 1000 g, 500 g, and 100 g bags. The bark is processed in different ways to be sold as ground bark; micropulverised in capsules of 150 mg and 400 mg; cat's claw extract in capsules of 90 mg and 100 mg; candies in 500 g jars; or extracts in 1100 ml,

Photo 2. The stems of both species of cat's claw are used for furniture making (courtesy, Instituto de Investigaciones de la Amazonía Peruana)



550 ml, and 310 ml bottles. In addition, a relative small number of cat's claw stems are used for furniture making (Photo 2).

Trade and marketing

The city of Lima is the most important Peruvian centre of processing and marketing of medicinal plants, with numerous companies, laboratories, pharmacies, and natural product shops that engage in processing, export, distribution, and sales. During the 1990s companies that produced cat's claw products made tablets of the extract through lyophilisation, atomisation, or dehydration; capsules; small bags of micropulverised cat's claw; hydro-alcoholic extract; and packaged and cleaned unprocessed bark.

Statistics of production and marketing in Peru, carried out by the National Natural Resources Institute (Instituto Nacional de Recursos Naturales, INRENA) show that cat's claw began acquiring commercial value in both national and international markets in 1992 (Figure 2). The simplest chain is that of the collector who sells his product directly to merchants and markets in places such as Iquitos and Pucallpa. A further link of this chain is the sale of bark to more distant buyers in Lima (Nalvarte *et al.* 2000). Collectors from the Carretera Marginal work individually or as a group, and sell bark to intermediaries in regional cities like Pucallpa. These intermediaries impose prices paid to collectors and offer the product to different buyers in Lima. The latter process the raw material into the kinds of products mentioned above (de Jong *et al.* 1998).

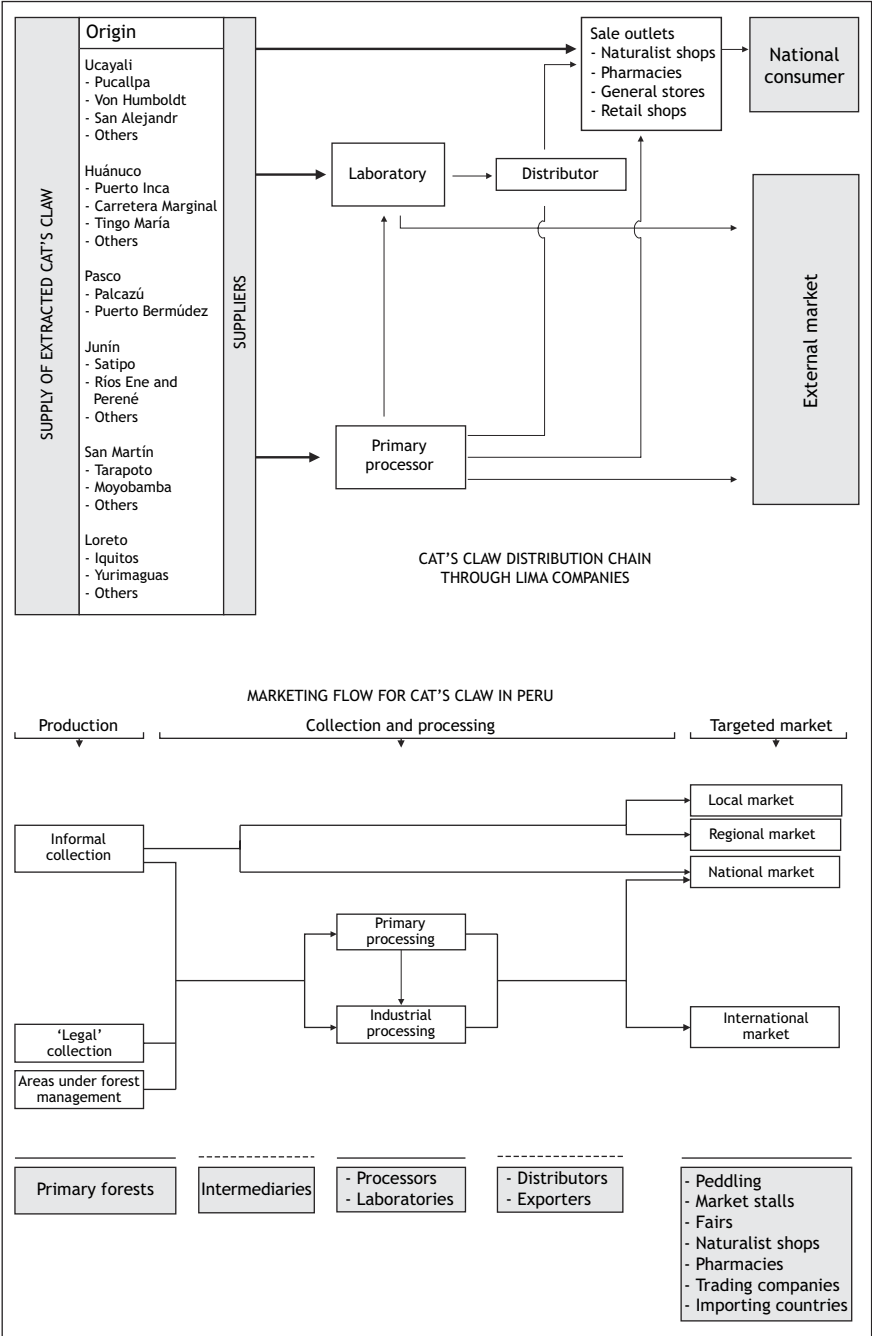
Several companies sell bark to foreign buyers. These companies obtain the raw material directly from collectors or through intermediaries, or in a dehydrated form from other companies. Exports of the bark, whether processed, ground, or micropulverised, require authorisation from INRENA. In 1995, INRENA granted 400 authorisations for the export of cat's claw. One hundred companies obtained permission to export whole, ground, and micropulverised bark; and 12 companies to sell cat's claw as pills, or as micropulverised, ground, or unprocessed bark. Table 1 presents marketing data of the various processed forms of cat's claw.

Table 1. International trade in cat's claw (*Uncaria* spp.) bark

Year	Volume (kg)	Unprocessed bark (%)	Processed bark				Countries importing
			Ground (%)	Micro-pulverised (%)	In jars (%)	Extracts (%)	
1993	200	100	0	0	0	0	1
1994	20,743	84.9	0	13.6	1.5	0	8
1995	726,684	89.6	4.6	5.3	0.5	0	24
1996 ^a	346,903	80.3	15.2	3.5	0.8	0.1	26
Price (s/) ^b	-	3.4/kg	5.86/kg	20.31/kg	1.8/100 g	-	-

a. Fractions until October 1996; volumes for other years are for entire years.
b. 1995 prices; source: INRENA 1997. The 1995 exchange rate was about s/2.25 to US\$1.

Figure 2. Two examples of marketing chains for cat’s claw (*Uncaria* spp.) in Peru



The manufacture of products from cat's claw has been registered since the 1970s, even though production occurred on a small scale. Recently, it has constituted almost 98% of the FOB value of exports of medicinal plants from the Amazon, the greatest volumes of production being registered in 1995 (Figures 3 and 4). This unusual boom resulted mainly from the intense publication of its supposed anticarcinogenic properties.

Figure 3. Exports of cat's claw (*Uncaria* spp.) and other medicinal plants from the Peruvian Amazon

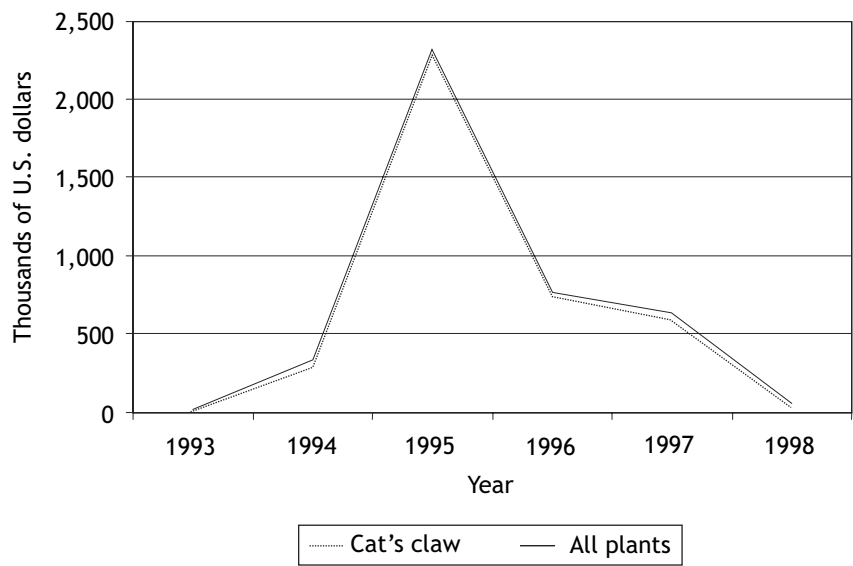
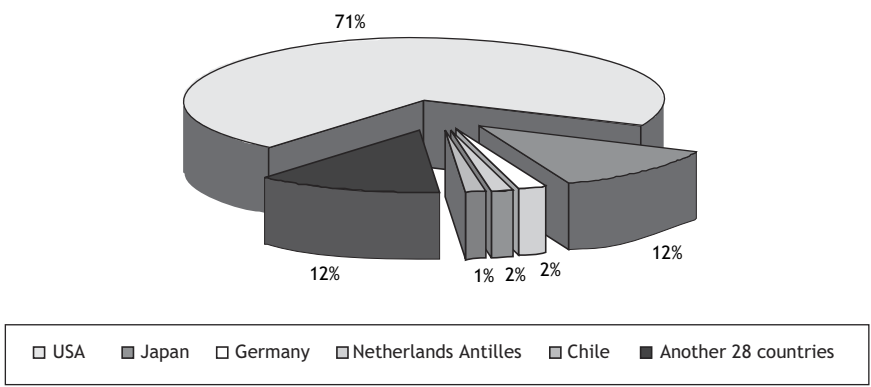


Figure 4. Importing countries for medicinal plants from the Amazon region



The number of countries to which unprocessed cat's claw is exported has changed over the years, increasing from one (USA) in 1993 to 26 in 1996. The countries that imported more than 5 tons of cat's claw in 1995 were, in descending order of volume USA, Chile, Mexico, Austria, Brazil, Japan, Spain, and Italy (INRENA 1997). Although the total 1996 export represented only 48% of the volume exported in 1995, it reached a larger number of countries. The reduction in exported volume resulted largely from USA importing 93% (679 tons) of the total in 1995 and only 46% (161 tons) in the following year.

The 1995 exports had an FOB value of US\$3.3 million (INRENA 1997), with the volume originating from 11 departments of Peru. Of these departments, only five handled quantities of more than 10 tons: Ucayali (280 tons), Huánuco (230 tons), Pasco (113 tons), Junín (44 tons), and San Martín (40 tons).

Since the early 1990s, Europe has become the most important consumer of exotic or imported natural products, constituting one of the markets with the greatest demand for cat's claw. USA remains the largest importer, however, re-exporting to other markets and thus increasing aggregate value. About 50 U.S. brands of this product are sold, which suggests its great potential for marketing. USA has 12 laboratories dedicated to the production of capsules and other products obtained from cat's claw. These are able to produce 3 million capsules daily, obtaining their raw material either directly from Peru or through intermediaries (de Jong *et al.* 1998). The laboratories supply about 39 distributors, which sell the products to health food stores across USA.

In addition to being sold in the form of capsules, cat's claw bark is also sold simply as bark cleaned for consumption in infusions. The average price of this end product is US\$6.6 per kilogramme. Distributors sell 60 tablets of 500 mg each at prices that fluctuate between US\$5 and US\$12. Retailers then offer the 60 tablets to consumers at prices ranging between US\$9 and US\$20. The price of producing 24 infusion-type bags is about US\$4.6, which are then sold in stores at US\$7. Capsules and tablets are produced in different concentrations (e.g., 250 mg and 500 mg), and may contain either micropulverised bark or bark extract (de Jong *et al.* 1998).

Political-institutional aspects

The cat's claw boom received active, although not always effective, responses from different government bodies (de Jong *et al.* 2000). In the boom's early years, a series of projects were proposed, organised, and implemented around cat's claw raw material production and to promote its commerce. From the mid-1990s, the government of Peru and some conservationist organisations began an intense promotion of cat's claw. For example, in Pucallpa the Reforestation Committee organised events to publicise the qualities and marketing of cat's claw to encourage its planting. The reforestation committees in Iquitos and Pucallpa organised the planting of cat's claw as part of their activities and declared 1997 the year of reforestation in Peru. During this year, 10,000 ha of land were targeted for planting with cat's claw (de Jong *et al.* 1998). Several research agencies such as the Peruvian Amazon Research Institute (IIAP) and the National Institute for Agricultural

Research (INIA) have promoted the production of cat's claw in plantations or agroforestry systems (Flores Bendeزú 1995).

In parallel, some private enterprises attempted to develop effective *in vitro* reproduction, with the intention of obtaining high-quality genetic material. Although certain alternative methods of production and reproduction have been created, these have had, until now, limited impact as demand for raw material is easily supplied by bark extracted from natural forests.

Several norms regulate the exploitation of cat's claw in Peru, including the following:

1. Law No. 27300 on the Sustainable Exploitation of Medicinal Plants, promulgated in July 2000, aims to regulate and promote the sustainable exploitation of medicinal plants.
2. Law No. 27308 on Forests and Wild Fauna, also promulgated in July 2000, aims to govern, regulate, and supervise the sustainable use and conservation of forest resources and wild fauna. It covers modalities of exploitation and management of primary natural forests, designates forest concessions for non-timber purposes to be granted by the responsible authority, depending on the location and specific characteristics of the resource. Published in April 2001, this law mentions, among other points, that exploitation may take place only through management plans previously approved by INRENA and through concessions, authorisations, and permissions.
3. The Terms of Reference for Preparing Forest Management Plans for Cat's Claw Species (*Uncaria tomentosa* and *Uncaria guianensis*) were approved through Resolution No. 045-99-INRENA of April 1999.

Trends and key themes

Before undertaking any action or intervention in the current cat's claw industry, the following principles should be taken into account:

1. The resource should be exploited sustainably, that is, the species should not be threatened with extinction, and its exploitation should not negatively affect any other species depending on it to carry out its biological cycle.
2. Cat's claw should continue to benefit local collectors, that is, the income obtained through its exploitation should increase, so that a larger number of low-income people may benefit from the collection and production of this plant.
3. The cat's claw industry in Peru should maintain or increase the volume of current sales and employment opportunities. The industry should also contribute to the country's economy through national sales and exports.

These three principles are not easily reconciled. To increase the earnings of local collectors means that merchants and manufacturers of derivatives will require larger volumes of raw material, thus increasing collection and pressure on wild populations of cat's claw. We have yet to verify if increasing collectors' income is compatible with expanding industrial involvement with cat's claw production, manufacturing, and trade. Possibly, larger companies will assume control of the collection, including the manufacturing of products

obtained from cat's claw, thus tending to eliminate opportunities for small collectors and producers. Private companies would be interested in assuming the control of collection or production if by doing so they can improve the quality of raw material towards having higher contents of active components. The quality of raw material is of utmost importance to producers, as it is directly related to demand.

Is cat's claw threatened?

The impact of exploitation of a renewable natural resource depends on two principal factors: (1) the quantity of resource harvested with regard to its population size, and (2) the species' capacity for recovery under a regime of specific exploitation. In the case of cat's claw, the first question is difficult to answer, mainly because we do not know how much of it exists. The quantity exported in the last three years is known, however, and it is estimated to constitute 95% of the collected total. We can then estimate the area of forest from which cat's claw has been extracted. This last datum indeed lets us appraise the level of impact of the current harvest.

An individual cat's claw that has a stem diameter of 8 cm generates, on the average, 0.55 kg of dried bark per metre of stem. The harvestable length varies according to diameter, but an individual plant with an 8 cm diameter is estimated to have an exploitable length of 19.71 m (Carrasco Arce 1996), whereas a stem with a 10 cm diameter has a usable length of 27.9 m (Domínguez 1997). Between 13.26 kg (Carrasco Arce 1996) and 15.34 kg (Domínguez 1997) of dried bark has been estimated as being obtained from each plant. If an area has two individuals per hectare, total production would be between 26.52 kg/ha and 30.64 kg/ha. If we use these calculations, then the 726 tons of cat's claw exported in 1995 (the year with the highest export volumes to date) would have come from between 27,400 ha and 23,700 ha of forest, which means that, with these values of density, the total volumes indicated in Table 1, corresponding to three years, would have been harvested from 41,272 ha of forest.

The total area of tropical humid forests in Peru is almost 70 million ha. Of this total, almost 44 million are lowland rainforests in interfluvial areas, with altitudes as high as 800 masl. We do not know how much of this forest contains cat's claw, but if we assume that the species is found distributed throughout this area at a density of two mature individuals per hectare and the annual harvest is 726 tons, we would need 1722 years to exploit the entire area. Although we do not know how much of this resource the area really contains, these estimates suggest that no short-term danger exists of the two cat's claw species disappearing from the Peruvian forests.

These conclusions need to be confirmed by appropriate research, as they are based on assumptions and insufficient data. They indicate, however, that the current exploitation rate represents a low risk of extinction for both species. These conclusions also suggest that, at present, it is unjustified to take specific measures to limit exploitation of this resource.

Future of the cat's claw industry

Considering that the current levels of exploitation do not seem to put cat's claw in danger of extinction, and that several manufacturers of derivatives from this resource plan to produce their own raw material, we see the future of the Peruvian cat's claw and its products industry as depending largely on market evolution and competition from other producing countries. Until now, the way in which the market has developed seems positive for cat's claw products. As long as quality is maintained, sales will probably remain stable or increase, and the development of improved raw materials will consolidate existing markets.

Most exports of cat's claw included both processed and unprocessed bark. Current trends indicate that, in the future, more extracts will be sold to the biggest buyer, USA. What is unclear is the extent to which Peruvian companies will be able to increase their participation in the production of derivatives that are currently manufactured and sold outside the country. While shipping costs of products made in Peru would be higher, production in this country would be cheaper than in, for example, USA. Comparing the advantages and disadvantages would be useful because, if lower manufacturing costs in Peru compensate for increased shipping costs, then this scenario would favour Prompex, the State Agency for the Promotion of Exports, or other agencies interested in introducing derivatives manufactured in Peru to international markets. Also useful to know in more detail is the difference between sales of unprocessed and semiprocessed bark, or between extracts and manufactured products, and what sales would present the most advantages for Peru.

Capturing benefits for small farmers

How small farmers will benefit will be strongly influenced by the way in which the industry develops. No accurate figures are available on the number of small farmers who collect cat's claw, but, again, data on total production allow us to estimate. If the 726 tons of dried bark produced in 1995 were obtained from 1,200 tons of fresh bark, and if we calculate that a collector can harvest 50 kg of fresh bark per day, then about 24,000 working days have been invested in acquiring this amount. If each collector receives a net profit of US\$0.09/kg, then he would earn US\$4.5 per day of collection, which was the minimum wage in Peru in early 1997. If we assume that postharvest handling requires an investment of 50% of the labour used for collection, then total labour would be 36,000 working days. Finally, if full-time employment is 250 working days per year, then this workload would correspond to a permanent occupation for nearly 144 people (de Jong *et al.* 1998).

These values depend on demand and the amount of raw material that can be extracted from plantings and/or areas managed by the farmers themselves. No data exist on the labour invested to produce cat's claw in slash-and-burn agriculture or other types of management. However, considering the low intensity at which cat's claw can be produced, it is unlikely that the investment in work is much greater than that of collecting in the distant forest. Producing cat's claw in slash-and-burn agriculture may give small

farmers greater control over the resource, and, if prices for the raw material remain stable, their profits would increase.

IMPLICATIONS FOR CONSERVATION AND DEVELOPMENT

With regard to potential for conservation and development, and to non-timber forest products in general, the lessons that can be derived from this case are few, mainly because the cat's claw boom is very recent. As already mentioned, exports grew considerably in 1995 and 1996, and then declined sharply. In the best years, cat's claw generated income for many rural inhabitants of the regions where it grows. Because of reduced demand, however, such income generation was short term, which means that the exploitation of this resource did not have much impact on long-term incomes or on the well-being of rural populations in the Peruvian tropical rainforests.

Almost all the extractors obtained their product from remote areas of primary forest, where the pressure on the resource would not usually be high. In some cases, with apparently positive results, community management of forests was initiated, prompted either by the communities themselves or by the influence of external advisers (de Jong *et al.* 1998). If demand for bark from wild populations is maintained, then these production systems may have a positive impact on the conservation of small areas of primary forests. The exploitation of cat's claw may represent an alternative to using the land for agricultural activities, although we cannot tell at what rate the forest is being transformed into croplands, as no effective restrictions exist for determining the extent to which lands may be destined for agriculture, quite apart from the fact that extensive cropping demands considerable labour. Where primary forest cover is already severely reduced, however, the exploitation of wild populations may contribute to the conservation of such forest.

As seen in the case of camu-camu (Chapter 14), the cat's claw situation seems encouraging with respect to the consolidation of pharmaceutical and health foods industries and their possible contributions to the national economy. In Peru, many companies are interested in this forest product, but the critical fulcrum continues to be the manufacture of medicines, dietary inputs, and other products in demand abroad, and the participation of Peruvian pharmaceutical companies. Such participation depends, among other things, on their competitiveness, but also requires a favourable political environment. The creation of laws that prohibit the export of raw material would contribute little to the above-mentioned problem (de Jong *et al.* 1998, 2000; Nalvarte *et al.* 2000). At present, the trend of companies producing their own raw material endangers small collectors and local producers. As in the case of camu-camu, the benefits of a successful national cat's claw industry to the well-being of the poorest collectors remains to be seen.

NOTES

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3. Recent publications on cat's claw are based on various sources of information. See summaries by de Jong *et al.* 1998, de Jong *et al.* 2000, and Nalvarte *et al.* 2000.

REFERENCES

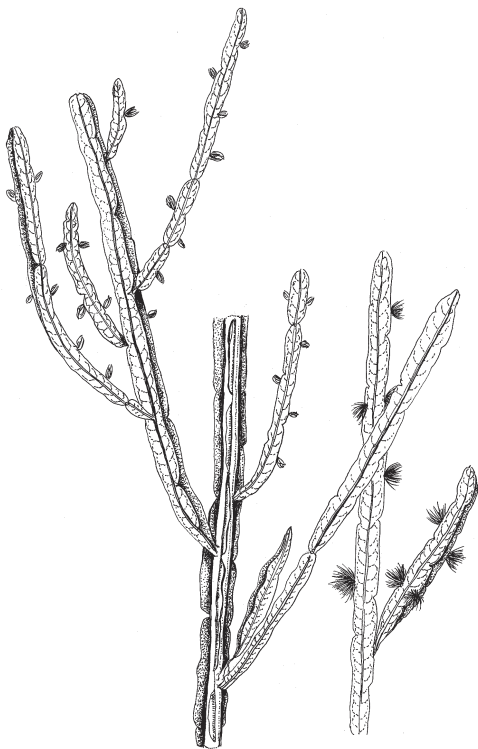
- Aquino, R., Conti, C. and Stein, M.L. 1989. Plant metabolites: structure and *in vitro* antiviral activity of quinovic acid glycosides from *Uncaria tomentosa* and *Guettarda platypoda*. *Journal of Natural Products* 52(4): 679-685.
- Aquino, R., Defeo, V., Desimone, F., Pizza, C. and Cirino, G. 1991. Plant metabolites: new compounds and anti-inflammatory activity of *Uncaria tomentosa*. *Journal of Natural Products* 54(2): 453-459.
- Arce, J. 1996. Manejo de bosques para producción sostenible de uña de gato: la experiencia del valle del Palcazú. Paper presented during the course 'Identificación, Producción, Propagación y Manejo de Uña de Gato' held at the Universidad Nacional Agraria 'La Molina' on 13-15 November 1996, Lima, Peru.
- Balée, W. 1994. Footprints of the forest: Ka'apor ethnobotany, the historical ecology of plant utilization by an Amazonian people. Columbia University Press, New York.
- Carrasco Arce, L.E. 1996. Análisis de la estructura de costos de extracción de corteza de uña de gato, *Uncaria tomentosa*, en la provincia de Puerto Inca (Huánuco). B.Sc. Thesis, Universidad Nacional Agraria 'La Molina', Lima, Peru.
- de Jong, W., Melnyk, M., Alfaro, L., Rosales, M. and García, M. 1998. Uña de gato: fate and future of a Peruvian forest resource. Occasional Paper, 18. CIFOR, Bogor, Indonesia.
- de Jong, W., Melnyk, M., Alfaro, L., Rosales, M. and García, M. 2000. A concerted approach to uña de gato development in Peru. *International Tree Crop Journal* 10(4): 321-337.
- de Jong, W., Freitas, L., Baluarte, J., van de Kop, P., Salazar, A., Inga, E., Meléndez, W. and Germaná, C. 2001. Secondary forests dynamics in the Amazon floodplain in Peru. *Forest Ecology and Management* 150: 135-146.
- Domínguez, G. 1997. Uña de gato: mercado y producción sostenible. Universidad Nacional Agraria 'La Molina', Lima, Peru.
- Flores Bendezú, Y. 1995. Propagación por semilla de la uña de gato (*Uncaria tomentosa*). Proyecto Suelos Tropicales, Instituto Nacional de Investigación Agraria, Lima, Peru.
- Hemingway, S. and Phillipson, R. 1974. Alkaloids from South American species of *Uncaria* (Rubiaceae). *Journal of Pharmacology* 26: 113.
- INRENA (Instituto Nacional de Recursos Naturales) 1997. Anuario estadístico de exportaciones de flora y fauna silvestres, año 1996. Ministerio de Agricultura, Lima, Peru.

- Montenegro de Matta, S., Delle Monache, F., Ferrari, F. and Marini-Bettolo, G.B. 1976. Alkaloids and procyanidins of an *Uncaria* sp. from Peru. *Il Farmaco* 31: 527-535.
- Nalvarte, W., de Jong, W. and Domínguez, G. 2000. Plantas amazónicas nativas de uso medicinal: diagnóstico de un sector económico con un potencial de realización. CIFOR, Lima, Peru.
- ONERN (Oficina Nacional de Evaluación de Recursos Naturales) 1983. Inventario y evaluación semidetallada de los recursos naturales de la zona del río Pachitea. Lima, Peru.
- Quevedo Guevara, A. 1995. Silvicultura de la uña de gato: alternativa para su conservación. Instituto de Investigaciones de la Amazonía Peruana, Iquitos, Peru.
- Rizzi, R., Re, F., Bianchi, A., Defeo, V., Desimone, F., Bianchi, L., and Stivala, L.A. 1992. Mutagenic and antimutagenic activities of *Uncaria tomentosa* and its extracts. *Journal of Ethnopharmacology* 38: 63-77.
- Smith, J., van de Kop, P., Reátegui, K., Lombardi, I., Sabogal, C. and Díaz, A. 1999. Dynamics of secondary forests in slash-and-burn farming: interactions among land use types in the Peruvian Amazon. *Agriculture, Ecosystems and Environment* 76: 85-98.
- Standley, P.C. and Williams, L.O. 1975. Flora of Guatemala. Fieldiana: Botany, Volume 24.
- Wagner, H., Kreutzkamp, B. and Jurcic, K. 1985. Die Alkaloide van *Uncaria tomentosa* und ihre Phagozytose-steigernde Wirkung. *Planta Médica* 51: 419-423.
- Yépez, A.M. et al. 1991. Quinovic acid glycosides from *Uncaria guianensis*. *Phytochemistry* 30(5): 1635.
- Zavala Carillo, C.A. and Zevallos Pollito, P. 1996. Taxonomía, distribución geográfica y status del género *Uncaria* en el Perú: uña de gato. Facultad de Ciencias Forestales, Universidad Nacional Agraria 'La Molina', Lima, Peru.

Chapter 16

In search of sustainable management of carqueja (*Baccharis trimera* Lers) in the central region of Paraná, southern Brazil

Walter Steenbock¹



(*Baccharis trimera*)

Common name	Product part used	Dominant form of management	Degree of transformation	Commercial scale	Geographic distribution
Carqueja		Managed	Average/middle/half	National	Wide

ABSTRACT

Carqueja (*Baccharis trimera* Lers), a shrub widely used for its therapeutic properties, occurs naturally in various regions of Brazil. In recent years the demand for the species in the national market has grown rapidly, putting the conservation of its natural populations at risk. In the central region of Paraná, the Medicinal Forests Project (*Projeto Florestas Medicinais*), coordinated by the Rureco Foundation² (*Fundação Rureco*), aims, among other objectives, at promoting the production of native medicinal species by family farmers, coupled with *in situ* conservation. In 2000, 87 small scale farm families in 17 communities in the central region of Paraná were involved in this project. *Carqueja* is one of the main managed species, and the community of Banhado Grande, one of the largest producers of this species. In this community, participatory experiments are being developed that aim at determining criteria for the management of *carqueja*. The plant is collected, cut, and dried in the community. From there it is sent to a central association of family farmers, where it is processed into packages of tea. The sale of the tea produced by this association has been growing rapidly. The whole process is certified as 'organic'. The involvement of female farmers, the community organisation, the self management of the production chain, and the search for adequate management of the species have been important elements in the production of *carqueja* for the community of Banhado Grande.

INTRODUCTION

Carqueja (*Baccharis trimera* Lers) is a medicinal species, traditionally utilized in the treatment of indigestion and diabetes and to assist in the treatment of obesity (Teske and Trentini 1995). Because of its therapeutic properties, *carqueja* is one of the most commercialised naturally occurring medicinal species in Brazil, with the vast majority of the product obtained through gathering. *Carqueja* is an erect and branching subshrub that measures up to 80 cm in height. It possesses a woody stem with winged expansions (cladodes) (Pio Correa 1984). It is believed to have originated in Brazil, where it occurs throughout the country and is especially prevalent in the southern region. It is found growing in fields and natural pastures, where it acts as a pioneer species of more advanced stages of succession.

The present case study was developed in the central region of the state of Paraná, southern Brazil, where *carqueja* occurs at high frequency. This region contains the largest remnants of mixed araucaria forest (*Araucaria angustifolia* (Bert) O. Ktze) in the country (SPVS 1996), an ecosystem related to the Atlantic Forest. This ecosystem possesses a high degree of biodiversity and is currently in a critical state for conservation (Biodiversity Support Program 1995). In the environment in which these forests dominate, there is also a pronounced cultural richness represented by the miscegenation of local culture, which is of indigenous origin, with immigrant culture, which is mainly European. The environmental and cultural richness is reflected in the substantial use of medicinal plants, among them *carqueja*. Marquesini (1995), in an ethnobotanical survey, cites the wide use of *Baccharis trimera* by the indigenous peoples of southern Brazil—Ava-Guarani, Caingang, Cayuá,

Guarani, Kraô, and Xokleng—for the treatment of upset stomach, vomiting, and bladder problems.

Since the 1980s groups of female farmers connected to rural workers associations of the central region of Paraná have met to exchange ideas, seedlings, recipes, and knowledge concerning medicinal plants in order to use them as alternative medicine. Gradually these women started to see that medicinal plants, in addition to being alternative medicine, could also represent an option for additional income in the context of family farming.

Since then *carqueja* has become one of the most valued species, because of elevated demand and its abundant natural occurrence. The Rureco Foundation—a nongovernmental organisation that acts to assist family farmers and their organisations—started to follow the work of these groups in 1996. This resulted in the Medicinal Forests Project, a multi-institutional initiative with financial support from the federal government and from the World Bank through a line of funding entitled Agricultural Technologies Development Project for Brazil (*Projeto de Desenvolvimento de Tecnologias Agropecuárias para o Brasil*—Prodetab) (Steenbock 2000). The institutions involved in this project include the Rureco Foundation, the Bernardo Hakvoort Agroforestry Institute, the State University of Mid-West Paraná (Unicentro), the Brazilian Agricultural Research Company-Forest Research Center (Embrapa-Florestas), the Regional Center for Commercialization of Mid-West Paraná (Cercoppa), the Catholic Church Pastoral Health Commission, and local family farmers associations.

The Medicinal Forests Project has four lines of action:

1. encourage the production of medicinal plants by family farmers;
2. conduct ethnobotanical surveys and disseminate the knowledge of medicinal plants accumulated by the rural population;
3. research sustainable management and agroforestry involving native medicinal species; and
4. implement phytotherapy as complementary alternative treatment in the public health system.

Among the project's actions, the support for production of medicinal plants by family farmers, especially through the work of female farmers, is one of the most prominent. The production of organically grown plants that are acclimated to local conditions, and the collection of native medicinal species, has been stimulated. Some of the activities of the project are conducted in the form of participatory research, aimed at determining criteria for the sustainable management of medicinal plants.

In reality, this management is often one of the few economic alternatives that remain for a large number of small farmers of the region. A large part of their properties have, in general, serious environmental and/or edaphic limitations, which make the cultivation of the majority of commercial crops difficult. The farmers, together with technicians involved in the project, have been developing studies of autecology and the capacity for resprouting and regeneration of native commercialized species in order to validate management plans for these species.

Currently there are 87 families producing medicinal plants in the area

Figure 1. Location of the study area



Source: ESRI Data and Maps 2002.

covered by the Medicinal Forests Project, distributed over seventeen rural communities. These families, in general, produce various medicinal species, an activity that has been generating an increase in income in the order of 30% to 40% (Steenbock 2000). In this case study, one of the communities involved in the project—Banhado Grande—was selected since it is one of the largest producers of *carqueja* in the region. *Carqueja* is not the only medicinal species produced in this community, however. The community of Banhado Grande covers an area of approximately 32 km², in which 95 small scale farmer families live (Figure 1).

THE SYSTEM FROM PRODUCTION TO CONSUMPTION

Characteristics of the resource

Carqueja (*Baccharis trimera*) is a profusely branching small shrub. Its winged stem expansions (cladodes) constitute the part of the plant that is of interest for harvest (Photo 1). The leaves are significantly reduced and oval. The capitulum inflorescence is yellow; the fruits are glabrous achenes, with wings adapted for wind dispersal. It is a dioecious species, pollinated by insects—especially coleopterans—a fact that has great importance in the interaction with fauna and contributes to the formation of secondary interactions (Reis *et al.* 1999).

Carqueja produces a large quantity of flowers and fruits. Apparently, the germination of its seeds, in natural conditions, occurs at a high rate,

Photo 1. *Carqueja* plant (*Baccharis trimera*). The parts collected for medicinal use are the winged stem expansions (cladodes) (Photo: W. Steenbock)



allowing for substantial natural regeneration. Recent studies (Schneider and Guerra 2001) have demonstrated that *carqueja*, along with other species of the same genus, plays a fundamental role in the viability of the initial growth of *Araucaria angustifolia* (Brazilian pine). *Araucaria angustifolia* is one of the native forest species of highest commercial value in the region and a key element in the interrelation between various animal and plant species and, consequently, in the conservation of the forest environment. Even though it is a pioneer species, *A. angustifolia* has difficulty establishing in clearings along with grasses, but not when the clearing is initially occupied by species in the genus *Baccharis*, among them *carqueja*.

In the community of Banhado Grande, the density of *carqueja*, in certain areas, reaches 1000 individuals per hectare. Although the spatial distribution of individuals is relatively uniform within a natural population of *carqueja*, the geographic distribution of populations is clustered. The development of studies analyzing the genetic diversity within and between these populations would be of significant importance, especially in relation to strategies for sustainable management of the species.

Its capacity to resprout is also significant. During extraction the farmer collects the whole aerial part, leaving only 5 cm of stem above the soil, but even this intense intervention allows for an increase in biomass after five or six months equal to the quantity removed. *Carqueja* flowers twice per year. Collection occurs before each flowering and, consequently, before the production of seeds. As the pressure on this species increases, this collection practice begins to represent a threat to the conservation of *carqueja*. Participatory experiments aimed at avoiding this problem have been conducted in the community of Banhado Grande since 1999, with the goal of evaluating the natural regeneration of *carqueja* seedlings after different collections by maintaining different quantities of individuals per unit area without collection.

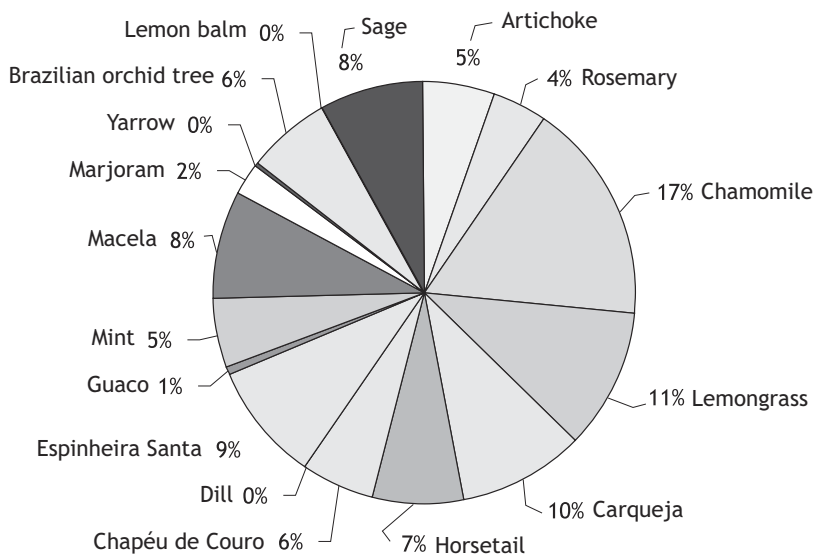
The producers in the socio-economic context

In the year this research was conducted families that participated in the Medicinal Forests Project sold 17 medicinal species. All of these families originally had low income (lower than one minimum salary per month³), owned small properties (<40 ha), and worked in a family economy regime, i.e., with labour coming only from family members (Steenbock 2000). Forty percent of the total volume of plants produced is represented by native plants, among which *carqueja* is the principal representative. When all medicinal species are considered, *carqueja* ranks third (Cercoppa 2000) (Figure 2).

In the context of the project, there are eight communities of farmers that are producing *carqueja*. The community of Banhado Grande produces the largest quantity. This community has a total area of approximately 32 km², mostly composed of natural fields and *várzeas* (flooded forests) with acidic soils of low natural fertility from the physical, chemical, and biological point of view.

Ninety-five families live in Banhado Grande. They are all *caboclos* (descendants of Europeans and native Brazilians) (Guarapuava 1999) and have

Figure 2. Medicinal species commercialized by groups of family farmers in the central region of Paraná, Brazil



strong cultural roots. The community shows serious social problems. The rates of infant mortality (especially up to one year of age), of undernourishment, of parasitosis, and of diseases typical of very poor regions—such as Hansen's disease and tuberculosis—are high (Paraná 1999). At the same time annual household income, at US\$918, is low (Guarapuava 1999).

Traditionally, the gathering of *yerba mate* (*Ilex paraguariensis* St. Hill.) is the community's principal activity, which, associated with the ethnic origin of the population, has allowed the community to maintain a close relationship with the natural environment and which has limited cultivation. Perhaps this fact, in part, explains why the area in which the community is located is relatively well conserved. In this sense, the management of *carqueja* represents a culturally appropriate activity, while at the same time representing an interesting economic alternative. With the harvest of *carqueja* there has been an increase in household income in the order of 20%.

Eight families in Banhado Grande participate in the project. *Carqueja* is the principal product for these families. Motivated by their example, more families from the community have gradually come to participate in the activities supported by the project. The participation of female farmers in the activities of the project in the community has been fundamental. In the region, women are traditionally responsible for the domestic realm, for example, caring for health, feeding, education, clothing, and reproduction. In this way, the knowledge and utilization of medicinal plants are, in general, the responsibility of women.

With the increasing involvement of women in the production and commercialization of a good that was formerly utilized only for the maintenance of the family has come an increase in the degree of participation

and autonomy of women in the domestic management of financial resources. In general, this responsibility is attributed to men. In this way the production of *carqueja* in Banhado Grande has been contributing to the increasing role of women in the responsibilities associated with the management of household income and decision making.

Processing industry

Initially, the areas of natural occurrence of *carqueja* that were available for collection in the community of Banhado Grande were identified and delineated, in collaboration with the community. In these areas *carqueja* is collected manually, with knives or sickles. As described previously, the entire aerial part of the plant is collected, leaving only 5 cm of stem above the soil. The collection is made two times per year, prior to flowering. Farmers harvest on their own property; the cutting and drying, however, are done communally. Thus the community collectively plans the harvest calendar.

After collection, the processing begins (Photo 2). The stalks are ripped into pieces of approximately 2 cm with the help of a manual fodder ripper. Once ripped, the *carqueja* is dried in a community dryer, a small wooden

Photo 2. Processing of *carqueja* (*Baccharis trimera*) (Photo: W. Steenbock)



house into which drying screens are placed. The covering of the house is designed to take advantage of solar energy for the heating of its interior. When solar energy is insufficient, an electric heater is used to maintain the drying temperature at around 35°C.

After being dried, *carqueja* is packed and sold to a central association of family farmers, Cercropa (*Central Regional de Comercialização do Centro-Oeste do Paraná*), of which the group of producers from Banhado Grande is a member. The group is able to receive a much better price through Cercropa than would conventionally be paid in the wholesale market. A kilogramme of *carqueja* is sold at approximately US\$0.40 in the conventional market, while Cercropa pays US\$1.20 per kilogramme.

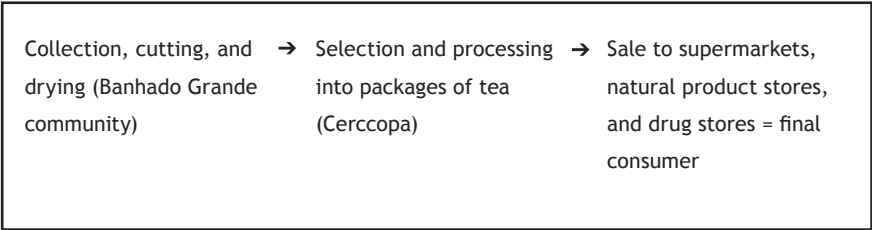
Quality control is also a collective activity. Gradually the farmers of Banhado Grande have come to recognize the requirement for quality standards in the market, leading to group inspection of the *carqueja* to be sold. The farmers involved in the production of *carqueja* are part of a community association, composed of 37 families. The necessity of organisation demanded by the production of *carqueja* has served as a reference for the process of organizing the association and, at the same time, has been attracting more members to the association.

Marketing

In addition to Banhado Grande, 16 other communities of family farmers produce medicinal plants as a way to add value to production. These communities are regionally organised within Cercropa and, through periodic meetings of the associates, decide on markets to explore, marketing policies, the price to be paid for each species, and the criteria for quality standards, among other topics. Cercropa receives and buys from the communities medicinal plants produced in a similar way as the process described for Banhado Grande.

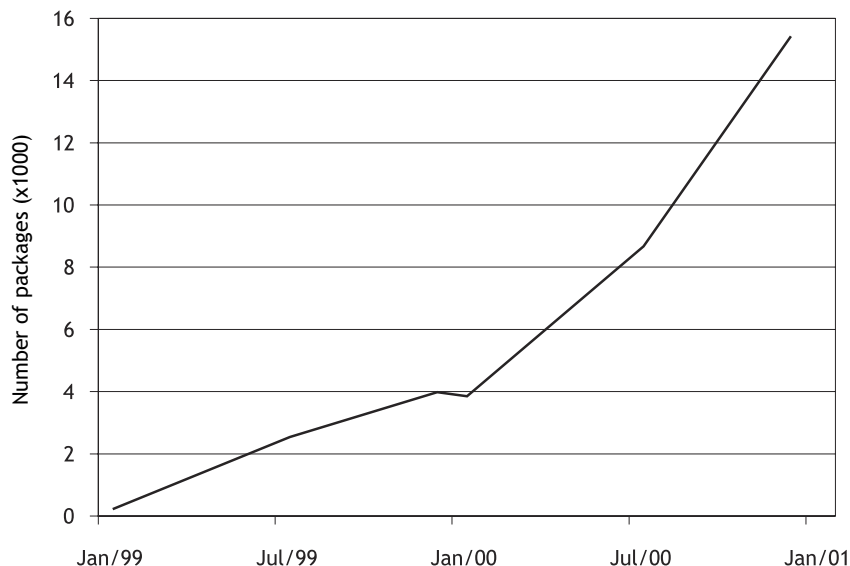
Inside the Cercropa buildings, there is adequate space for the processing of the plants, which are selected and packed into packages of tea, currently totalling 15 products. The teas are then sold with the brand name *Produtos da Roça* (Country Products) in natural product stores, drug stores, supermarket chains, the local market as well as in other parts of the state and the country. The production process is certified as ‘organic’ by an officially credentialed certifier in Brazil. The system, from production to consumption, of *carqueja* in this case study is shown in Figure 3.

Figure 3. Production system of *carqueja* (*Baccharis trimera*) in the community of Banhado Grande, in the central region of Paraná, Brazil



The sale of teas began, in an organized form, at the beginning of 1999. Since the Medicinal Forests Project was implemented, the growth in sales has been exponential, as illustrated in Figure 4 (Cercopa 2000).

Figure 4. Progress of the monthly sale of *Produtos da Roça* teas



At the beginning of 1999, approximately 200 packages of tea were sold per month. Sales increased to 15,000 packages by the end of 2000. The success of the activity makes possible the involvement of an increasing number of families in the process of producing medicinal plants.

Political environment

Aiming at guaranteeing the sustainability of the extraction of native medicinal plants in Brazil, a number of regulatory requirements have been proposed. Perhaps the most prominent one was Decree number 122/85 (Brasil 1985), which proposed the requirement to replant extracted species in accordance with the part and quantity gathered. This decree was not put into practice, however, due principally to the lack of technical-scientific criteria in support of its proposed requirements and the lack of capacity for inspection by the government required for its implementation.

Currently, therefore, a legal instrument that can guide the development of specific management plans for each species explored has become extremely necessary, in accordance with criteria developed from studies related to the autecology of these species. In this sense the production process of *carqueja* adopted in Banhado Grande, which is being developed in parallel with participatory research experiments, will also be able to serve as a model for the management of this species in other regions, as well as contribute to the generation of a pertinent legal instrument.

Current legislation results in a significant limiting factor in sales of the product—the high tax rate. Seventeen percent of the value of the tea packages corresponds to taxes. This fact results in a significant increase in the final price of the product, causing a reduction in the potential for sales.

Another limiting factor is the way in which the teas may be marketed to the consumer. In accordance with the legislation in effect (Brasil 2000), the teas of *Produtos da Roça* are considered food, not phytotherapeutic products. For the production of food it is necessary to meet a series of standards, many of them inappropriate for this product, which results in elevated costs. Moreover, once the teas are considered food, it is impossible to inform the consumer of the therapeutic effects of each product or the side effects in the case of overdose. On a national level, various organisations have been pressuring the government to be flexible in the legislation referring to the production of phytotherapeutics in order to allow, with certainty, a more ethical commercialization process and one that is committed to the health of the consumer.

PERSPECTIVES

Dynamics of the process

The present case study is related to a production process that did not have an origin directly related to a local cultural matter. Although *carqueja* is a plant that was already widely utilized domestically by the families of Banhado Grande, its commercial production did not exist until the beginning of 1999, when the Medicinal Forests Project was created in the community. In this sense the project started to stimulate the exploration of a non-timber forest product, aiming at sustainability. Such stimulus is justified, given that a large part of the area of the community of Banhado Grande presents serious limitations for the cultivation of most commercialized species; at the same time cultivation is not a traditional practice in the community. The sustainable management of *carqueja* could contribute to the domestic income of family farmers, preventing the rural exodus, and making possible better conditions of health and of life. Simultaneously such management should provide for the conservation of the species and of the natural environment in which it occurs.

Some of the predictions of the project are being realized. The production and sale of *carqueja* has allowed the initial development of conservation criteria for the management of its natural populations, and this process has been generating an increase in income in the order of 20% for the families of farmers involved. At the same time, the involvement of farmers in questions related to the market for products like the teas *Produtos da Roça* has allowed them an increased capacity in this area. Similarly, the growth in the sale of the teas has provided a stimulus for the participation of an increasing number of farmers.

An efficient community organisation becomes necessary in order to make the production viable. This organisation has been growing gradually, as much in its own community as in relation to its regional involvement. At

the same time the increased participation of women in the management of the production process has been contributing to their larger involvement in family decisions, guaranteeing them more respect and autonomy.

KEY ELEMENTS

As the involvement of family farmers in the production process of *carqueja* increases, the demand for the collection of the product in the natural environment also increases. As a result the community organisation that is being built must guarantee the application of the criteria for sustainability that are being generated. Moreover this organization must be sufficiently strong and well connected regionally, in order to guarantee its effectiveness in the market. In this way the local and regional community organisation is an essential factor in making the continuation of the activity possible.

Currently there is external support for the production of *carqueja* in Banhado Grande, promoted by the actions of the Medicinal Forests Project. This support is a result of the participation of several institutions, which are in frequent contact with the community, in the stimulation of production. The end of official activities of the project will take place in 2002. In light of the network that has been created and the involvement of the farmers of Banhado Grande in the development of a sustainable production system for *carqueja*, it is believed that the farmers should be able to continue the project with autonomy. However, successfully continuing the program will still be a challenge.

CONSERVATION AND DEVELOPMENT LESSONS

Carqueja is a relatively abundant species in the community of Banhado Grande, and it has a large capacity for regeneration and resprouting. These factors facilitate the sustainability of its management. The experiments conducted in 1999 and 2000 suggest that by leaving untouched 'islands' of *carqueja* as seed sources in the areas of collection, regeneration will not be different from that found in natural conditions without human intervention. These studies need to be expanded, however, to include evaluation of the conservation of the genetic diversity under managed conditions.

Nevertheless, the autonomy of the farmers in the process of organising the sales allows a significant aggregation of value, which puts less pressure on the natural resource and allows for more attention to the quality of the product. In this case study, there are no *atravessadores* (profiteers) in the processing and sales of the product. From the production of raw material until the final consumption, the production chain is administered by the farmers themselves.

The quality of the product and the certification of the production process as 'organic' are determining factors in the growth and maintenance of the market. The quality of the product is guaranteed, among other reasons, because of the familial management of the resource: the collection is manual, the cutting and drying are artesian processes. This arrangement allows for a

high level of care for the quality, which is, in a large part, the responsibility of the female farmers.

Thus, in a certain way, the community management of the production process and sales, associated with the production on a small scale, are factors that control the quality of the product and, consequently, create market opportunities; the assurance of the continuity and growth of the market opportunities, however, is associated with the sustainability of the production process. The big challenge is to guarantee the community management of the production and sale, the sustainable management, and the conservation consciousness of new farmers that enter into the process, as the market quickly grows.

The management of *carqueja* in the community of Banhado Grande has made possible a significant aggregation of value to the family economy. At the same time it constitutes an activity compatible with sustainability. In both respects, the participation of female farmers, the consciousness of the necessity for conservation of natural resources for the community, and the self-management of the production process and the market have been—and need to continue to be—essential factors.

ENDNOTES

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2. Nongovernmental organisation that assists family farmers in the area of agroecology.
3. Translator's note: The 'minimum salary' was R\$280, or approximately US\$108, per month as of February 2005.

REFERENCES

- Biodiversity Support Program, Conservation International, The Nature Conservancy, Wildlife Conservation Society, World Resources Institute, and World Wildlife Fund. 1995. A regional analysis of geographic priorities for biodiversity conservation in Latin America and the Caribbean. Biodiversity Support Program, Washington, D.C.
- Brasil. 1985. Decree number 122-P, of March 19, 1985. In: Lex: coletânea de legislação e jurisprudência. São Paulo, v. 49, 597-609, Jan.-Mar. 1985.
- Brasil. 2000. Ministério da Saúde. Agência Nacional de Vigilância Sanitária. RDC nº 17. Diário Oficial da União, 24/02/2000.
- Cerccopa (Central Regional de Comercialização do Centro-Oeste do Paraná). 2000. Relatório de vendas de chás. CERCCOPA, Guarapuava.
- Guarapuava - Prefeitura Municipal. 1999. Plano de ação para o desenvolvimento da comunidade do Banhado Grande. Guarapuava.
- Marquesini, N. R. 1995. Plantas usadas como medicinais pelos índios do Paraná e Santa Catarina, sul do Brasil. Dissertation, Universidade Federal do Paraná, Curitiba.

- Paraná, Secretaria Estadual de Saúde - V Regional de Saúde. 1999. Dados de patologias por faixa etária ocorridos no ano de 1999, no município de Guarapuava e nos 22 municípios da V Regional. Relatório anual. Guarapuava.
- Pio Corrêa, M. 1984. Dicionário das plantas úteis do Brasil. Ministério da Agricultura, IBDF, Distrito Federal.
- Reis, A., Zambonim, R.M. and Nakazono, E.M. 1999. Recuperação de áreas florestais degradadas utilizando a sucessão e as interações planta-animal. Conselho Nacional da Reserva da Biosfera da Mata Atlântica, São Paulo.
- Steenbock, W. 2000. Medicinal plants: popular knowledge survey, alternative therapeutics, option of income and environmental conservation in the centre of Paraná State, Brazil. Revista da Sociedade de Olericultura do Brasil 13, Suplemento: 137-140.
- SPVS. 1996. Nossas árvores: manual para recuperação da reserva florestal legal. SPVS, Curitiba.
- Teske, M. and Trentini, A.M.M. 1995. Compêndio de fitoterapia. Herbarium Laboratório Botânico, Curitiba.

Chapter 17

Espinheira-santa (*Maytenus ilicifolia* Mart. ex Reiss) production in the metropolitan region of Curitiba, Paraná, Brazil

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(*Maytenus ilicifolia*)

Common name	Product part used	Dominant form of management	Degree of transformation	Commercial scale	Geographic distribution
Espinheira-santa	Leaves	Wild	Average/middle/half	National and international	Average/middle/half

ABSTRACT

Espinheira-santa (*Maytenus ilicifolia* Mart. ex Reiss-Celastraceae) is a small tree that occurs in mixed araucaria forests. Its leaves have been used for centuries for medicinal purposes by the indigenous and nonindigenous peoples of southern Brazil, Argentina, Paraguay, and Uruguay. To date, the consumption of its leaves has expanded throughout all of Brazil as well as abroad. The confirmation of its antigastritis and antiulcer effects has resulted in an increase in its extraction, subjecting the species to genetic erosion and to the risk of disappearing from certain areas. It is estimated that 95% of the *espinheira-santa* consumed is still obtained by extraction. The metropolitan region of Curitiba, Paraná, Brazil, is within the area of natural occurrence of this species. Because of the proximity to a large commercial and consumption centre, the effects of extraction of *espinheira-santa* are very noticeable. Collectors do not have a fixed area in which they harvest; they are always canvassing for new areas. Extraction is illegal and collectors have had difficulties in their attempts to legalize it. Part of the product that reaches the consumer does not meet the demands of sanitary laws. Cultivation of *espinheira-santa* has been researched and encouraged in order to guarantee a supply of raw material and to assure the preservation of the species. Even though the cultivation of *espinheira-santa* is environmentally and economically positive, it has the negative effect of displacing traditional collectors, who typically are landless and rely on the collection of medicinal plants as their main or only source of income.

INTRODUCTION

Espinheira-santa (*Maytenus ilicifolia* Mart. ex Reiss-Celastraceae) is a small tree. The ethnobotanical literature registers the use of its leaves for medicinal purposes by the indigenous peoples who live in southern Brazil, Argentina, Paraguay, and Uruguay (Toursarkissian 1980; Gonzalez *et al.* 1982; Marquesini 1995), and also by nonindigenous people (Ratera and Ratera 1980; Priore *et al.* 1986; Simões *et al.* 1988). According to notes from Dr. Aloísio França, a physician from Paraná,

[F]rom the therapeutic point of view, I fit the properties of *Espinheira Santa* into four great actions,—analgesic, antiseptic, tonic and curative. It alleviates stomach pain quickly. It has such an evident action on pain, comparable to opium and cocaine. However, it does not alleviate the pain because it numbs the sensitivity of the organ, but rather because it stimulates or corrects the malfunctioning. . . . Two more adjuvant properties must be added to the ones already mentioned,—it is slightly laxative and it is diuretic. (Araújo and Lucas 1930; Cruz 1985)

In the first half of the twentieth century large pharmaceutical laboratories in their fluid extract catalogues listed *mayteno* extract, made from *Maytenus ilicifolia* leaves (Araújo and Lucas 1930; Stellfeld 1934). Contraceptive (Toursarkissian 1980; Gonzalez *et al.* 1982) and abortive (Martinez-Crovetto 1981; Marquesini 1995) properties are also attributed to this species, but

these claims are challenged by other authors (Simões *et al.* 1988). Other species of the family Celastraceae are also used for medicinal purposes in the Americas and Africa.

In 1983, the Medicine Centre started the Medicinal Plants Research Program (*Programa de Pesquisa de Plantas Medicinais*) with the objective of systematically and scientifically evaluating the plants most utilized by the population for medicinal purposes, including *espinheira-santa*. In 1988, research results were published that confirmed the therapeutic properties of *espinheira-santa* leaves in the prevention and treatment of gastric ulcers (Carlini *et al.* 1988). Based on these results, complementary research is being conducted for the industrial production of a medicine. The therapeutic potential of *espinheira-santa* did not escape notice abroad, and there are currently several patents and patent requests in Japan and in the United States for extracted products from this species to act, among others, as an adjuvant in cancer treatment (Vieira 1999). *Espinheira-santa* is also offered for sale on the Internet (www.rain-tree.co.uk).

Leaves of *espinheira-santa* used to be mixed with leaves of *yerba mate* (*Ilex paraguariensis*), in the proportion of 10% to 15%, and were commercialized in this way for the preparation of *mate*, or '*chimarrão*' (Bernardi and Wasicki 1959). Hoehne (1939) describes *chimarrão* as

an infusion used to substitute for the 'Indian Tea' or 'Coffee'. The infusion is most commonly served in little gourds or wood bowls, where the ground leaves are placed and boiling water is added to them. With a little metal pipe, or suction tube, composed of a spout on one side and a little strain on the other to avoid the passing of fragments, one sucks the delicious beverage throughout southern and rural Brazil in the same way the Guaraní used to do before the arrival of Europeans.

Espinheira-santa is added to *mate* to combat the heartburn and stomach pain that some people experience while consuming this drink. Currently, this mixture is not commercialized on a large scale, but many people still mix leaves of *espinheira-santa* into the *chimarrão* at home, and there are businesses that have resumed the sale of the mixture on an industrial scale.

These facts, together with the growing interest in phytotherapeutics, have stimulated the extraction of *espinheira-santa*. Currently, the plant is consumed as much by the population who lives in its area of occurrence as by those outside this area. In general, it is consumed in the form of a tea made from scraped leaves or in the *chimarrão*. It is also consumed in the form of capsules, tinctures, and other preparations.

In spite of the scarcity of available information, Grünwald (1997) has estimated the retail sales of medicinal plant products at around US\$14,500 million per year. Of these, US\$7,000 million is generated in Europe, US\$2,000 million in the United States, US\$1,000 million in Latin America, and the remaining US\$4,000 million in Asia and Africa. It is estimated that there will be a threefold increase in sales over the next 10 years. The largest growth is expected in the United States, followed by Latin America and Europe. In Brazil, it is estimated that retail sales of phytotherapy products are currently

Figure 1. Location of the study area



Source: ESRI Data and Maps 2002.

between US\$550 million and US\$800 million (Biancarelli 2001). There are no official data on the market volume per species. Based on wholesale information, it is estimated that the volume of commercialized plants sold, such as *espinheira-santa*, is 60 metric tons per year.

The metropolitan region of Curitiba (Figure 1), where the case study is located, comprises an area of 1,183,375 ha containing 22 cities, and is within the area of natural occurrence of *espinheira-santa*, within the mixed araucaria forest (*Floresta Ombrófila Mista*). Because of the proximity to a large market for the sale and consumption of this species, the effects of the intensive exploitation of *espinheira-santa* are felt more intensely in the study area than elsewhere. According to reports from collectors, it is necessary to search ever farther to find the product. The geographic study area included natural pastures and forests in the city of Campo Largo, Paraná, since these are the areas explored by collectors without a permanent exploitation area. Collectors are constantly canvassing a large part of the city in search of new areas with high concentration of *espinheira-santa* trees in order to gather their leaves. They ask for permission from the landowners, who usually agree because they do not have interest in the activity or do not know the economic value of the species.

THE SYSTEM FROM PRODUCTION TO CONSUMPTION

Espinheira-santa (*Maytenus ilicifolia*) and its ecology

Espinheira-santa (*Maytenus ilicifolia*) is a shrub or tree, branched from the base, usually 5 m in height (Carvalho-Okano 1992), but able to reach 15 m (Cervi *et al.* 1989). In Brazil, *espinheira-santa* occurs mainly in the mixed araucaria and semideciduous seasonal forests, in small islands of forest and river margins of the steppe region in the states of Paraná, Santa Catarina, and Rio Grande do Sul, but being also found in São Paulo and Mato Grosso do Sul. *Espinheira-santa* is found in the understorey of late secondary succession or old-growth forests, especially in areas of fluvial influence (Scheffer 2001).

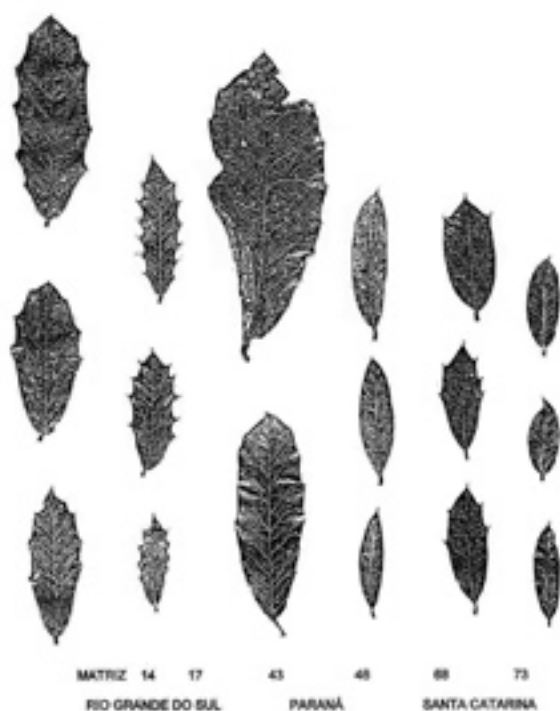
Espinheira-santa shows a predominantly subtropical distribution (Carvalho-Okano 1992). Its occurrence was reported in regions with a mean temperature of 22°C during the warmest month, a mean temperature higher than 10°C during the coldest month, and a mean annual precipitation of 1442 mm. It occurs in dystrophic red-yellow podzolic soils (Carvalho 1980), dystrophic epieutrophic gleyic cambisol (Inceptisol), deep alic cambisol (Inceptisol) and litholic soils (Radomski 1998).

Because it branches from the base, *espinheira-santa* is rarely mentioned in phytosociological surveys, since these usually include trees with diameters greater than 10 cm, a size *espinheira-santa* stems rarely reach. The literature suggests an index of value of importance for this species of between 0.99 (Tabarelli *et al.* 1993) and 1.82 (Kuniyoshi and Roderjan 1989), which is low when compared to values found for other forest species. This species occurs in small groups of uneven distribution.

The genus *Maytenus* Mol. is composed of 225 species and is represented in Brazil by 77 species and 14 varieties. It includes trees, shrubs, and subshrubs.

The leaves are coriaceous and glabrous. The species of the section *Oxyphylla*, which includes *M. ilicifolia*, are characterized by the presence of thorns on the leaf margin, but the number and distribution of thorns vary. Leaves of *espinheira-santa* are extremely variable in length and width (Figure 2).

Figure 2. Variation in leaf morphology of espinheira-santa (*Maytenus ilicifolia*)



The inflorescences of *espinheira-santa* are multifloral fascicles. The flowers are greenish-white and small, from 3 mm to 5 mm in length. The fruit is an orbicular bivalve capsule; the epicarp is red-orange and its size varies from 7 mm to 10 mm (Photo 1). The seed number varies from one to four per fruit, being most commonly two or three. The testa is brown or black and usually hard, smooth, and shiny. The aril is succulent, white, and covers the whole seed. In general, the arils are attractive to birds and are associated with seed dispersal (Carvalho-Okano 1992).

Maytenus ilicifolia is easily distinguishable from the other species of the same section by its tetra- or multi-carinated, angled branches and orbicular, red-orange fruits. However, it is frequently confused with *M. aquifolium*, the type species of the section, with which it shares the common name *espinheira-santa*. The confusion is even greater because the geographic distribution of *M. aquifolium* as well as its chemical properties and uses are

Photo 1. *Espinheira-santa* fruits in several stages of maturation (Photo: Waldir da Silva)



similar to *M. ilicifolia* (Carlini *et al.* 1988). In addition to the two *Maytenus* species, *Sorocea bomplandii* (Baill.) (Burger, Lanj. and W. Bôer) (Moraceae) and *Zollernia ilicifolia* Vog. (Caesalpinaceae) are also commonly used as adulterants. Even though preliminary research indicates possible medicinal properties of these latter two species (Gonzalez *et al.* 2001), they are sold as adulterants of *M. ilicifolia* because there are no products in the market that officially contain *Sorocea* or *Zollernia*. It is estimated that 30% of the plants sold as *M. ilicifolia* are, in fact, other species.

Reproductive biology and phenology

Even though the flowers of *espinheira-santa* are complete, the species is allogamous. Under cultivation, flowering occurs three or four years after sowing. In Paraná, the flowering period extends from the end of winter until mid-spring, the majority occurring in August and September. The outcrossing rate is 99.6% (Scheffer 2001). Analysis of four populations showed that the genetic diversity within the populations was larger than among them (Scheffer 2001). However, the reduction in the number of populations and the increase in distance between them can lead to endogamy, i.e., cross-fertilization among related individuals, which could reduce the vigour of future descendents. In

relation to fruiting, Scheffer and Araújo (1998) observed: (a) presence of fruits only on trees that receive direct sunlight for at least part of the day; (b) even under direct sunlight, not all individuals of the population fruit in the same year; (c) fruiting occurs over a relatively long period, starting in the state of Rio Grande do Sul, then Santa Catarina, and finally Paraná, and is concentrated, respectively, in the months of November, December/January, and January/February; (d) the fruits, which are dehiscent capsules, are more abundant on branches from the previous year; and (e) there is a high variation in seed size and weight.

Silvicultural aspects

Traditional collectors have empirical notions concerning the management of species in their natural environment, for example, the appropriate time of year for collection, the frequency of collection the species can support, the environments in which the species occur and the care required during collection so that the plants can resprout. Collectors teach that *espinheira-santa* should be collected by breaking the branches rather than cutting them. Some collectors say that this practice is necessary for the plant to have medicinal properties; others say that, if the branches are cut, the tree does not resprout. The fact is that branches that are broken off are thinner than those that could be collected if a cutting instrument were used, and this difference certainly influences the regeneration of individuals. Another piece of information from traditional collectors is that the leaves of a particular tree should be collected in two-year intervals. They say that this is the time required for the tree to 'recover'. In cultivation it is observed that regeneration occurs in one year. However, since the fruits are formed on branches from the previous year, the collectors' recommendation can be linked to the management of the species, guaranteeing the minimum time necessary for reproduction. With the same objective, the producers decline to collect leaves from some trees so that the trees can produce seeds, guaranteeing natural regeneration and, of importance more recently, a source of seeds for planting. The collectors are familiar with *espinheira-santa*'s distribution and cover large distances to locate collection areas where there is a significant number of trees. They usually collect in a particular area in intervals of one or more years or collect leaves from only one side of the plant and in the following year from the other side.

There are also the *curiosos* ('curious')—people lacking traditional background in plant collection who, because of financial need are hired by traditional collectors or plant buyers to collect *espinheira-santa* and other medicinal species that occur in the proximity of their residence.

Espinheira-santa producers in the socio-economic context

The population of the metropolitan region of Curitiba is composed of descendants of Europeans who migrated to the area in several waves during the nineteenth century. They are principally descendants of Germans, Italians, Poles, Ukrainians, and others. The vast majority of the immigrants

made their living through agricultural activities. They also incorporated the gathering practices of the '*caboclos*', descendants of Portuguese colonizers and local Indians. In the city of Campo Largo, there are 1,469 rural properties of which 1,164 are involved in activities related to agriculture and silviculture. According to the Brazilian Geography and Statistics Institute 2000 Census, the rural population was 15,580 (IPARDES 2001), with approximately 50 people involved in the production, processing and sale of *espinheira-santa*.

There are several kinds of producers of raw material. They include

- (a) traditional collectors whose only economic activity is the collection of medicinal plants, including *espinheira-santa*;
- (b) collectors of medicinal plants who also grow food species. In this case, the collection of medicinal plants aims to complement their income;
- (c) farmers who cultivate and gather medicinal plants; and
- (d) farmers who only grow, but do not gather, medicinal plants.

The extraction and/or cultivation of *espinheira-santa* is part of a strategy to obtain diversified income and, on average, the return does not exceed 17% of the family income. Collectors generally receive R\$0.4²/kg for fresh plants (leaves and thin branches). After being dried, the plants are sold for R\$2.5-3.5/kg. The price paid for dried leaves from cultivated plants can reach R\$8-12/kg.

Processing of *espinheira-santa*

After being harvested, the branches are taken to the collector's property where the leaves are either selected and dried or directly offered to the buyer. The drying can be done in the shade or in a drier with a continuous flow of warm air. Producers who do not have their own drier may dry their leaves in a neighbour's drier, who receives part of the yield as payment. Several drier models are in use. The fuel may be firewood, natural gas, or sawdust. Some driers have temperature controls.

Depending on buyer specifications, the dried leaves may be removed from the branches and scraped. The product is then packed in a bag made of jute or polypropylene mesh, sometimes with a paper lining. After that, it is either stored or sent directly to the market for sale.

Sales may be made to wholesalers, phytotherapy laboratories, or the food industry. The material may be submitted to another selection according to the quality control program of the company. It is usually checked for microbial and macroscopic contamination. In addition, phytotherapy laboratories also analyze its chemical constituents.

In the food industries, the scraped leaves are fragmented and are inserted into 10-30 g containers or teabags, which are packed in cardboard boxes and sold similarly to other teas. Upon reaching the consumer, the price varies between R\$30/kg and R\$50/kg for 0.5-1 kg packages, and between R\$80/kg and R\$100/kg for 10-30 g packages.

Phytotherapy laboratories sell *espinheira-santa* (a) in bags or in bulk, mixed with other herbs in a predefined composition for digestive problems; (b) in gelatinous capsules, containing 350-400 mg of ground leaves; (c) as a tincture of *espinheira-santa*, which is extracted from the leaves through

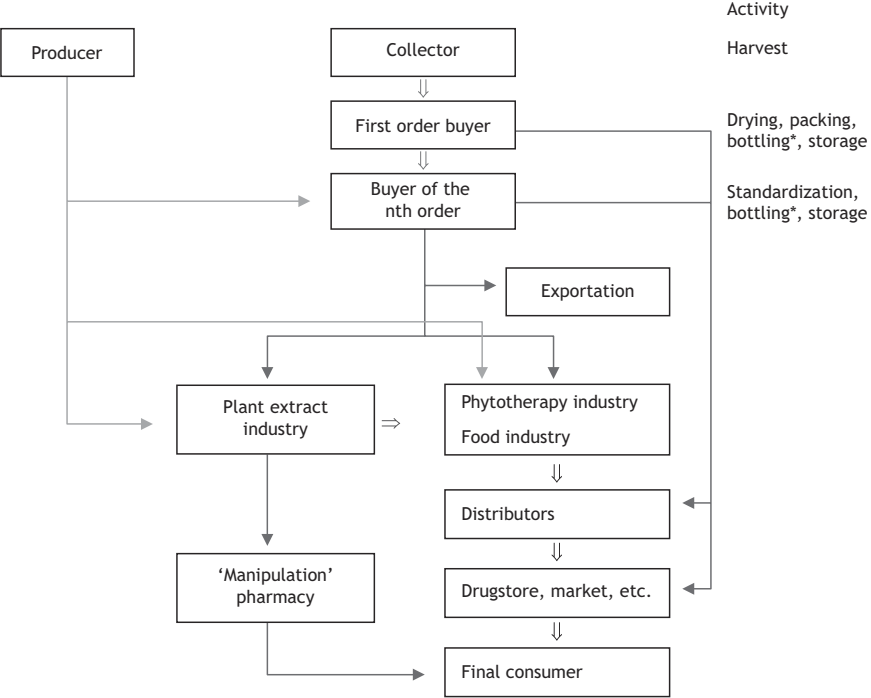
water/alcohol extraction; and (d) in pills, in which a dry leaf extract is used.

Trade and marketing

Generally, the owner of the dryer sells the product in large quantities to intermediates, phytotherapy laboratories, or the food industry (Figure 3). Some producers, in order to add value, make packages of small quantities (10-30 g) which they sell in fairs and markets as food products. This type of sale is made by producers that have easy access to a significant consumer market such as supermarkets, pharmacies, or fairs. Sanitary legislation, however, imposes numerous requirements for direct sale to the final consumer.

Wholesalers, the majority of which are located in the state of São Paulo, acquire the product in Paraná and distribute it to other regions of Brazil and also abroad. Commonly, companies in Paraná acquire *espinheira-santa* leaves originally harvested in Paraná from wholesalers in São Paulo. This reflects the lack of organisation of the producers that have still not been able to develop the region as a production centre for medicinal plants.

Figure 3. Flux diagram of the production and sale of *espinheira-santa* (*Maytenus ilicifolia*)



* Some buyers also bottle and sell their product directly to distributors and retailers.

The food industry, after packing the product, resells it to supermarkets. The phytotherapy laboratories, after manufacturing the product as a medicine, normally sell it to pharmaceutical product distributors or directly to large pharmacy chains that distribute it internally.

Politics related to exploitation and commercialization

The production and sale of *espinheira-santa* is subject to environmental legislation and sanitary monitoring. The first establishes guidelines for the registration of people or businesses that consume, explore, or sell raw material from the forest, including non-timber forest products (Brasil 1985, 1995, 2000). Collectors know that they must register as collectors and sellers of native plants with state and federal environmental enforcement agencies—Instituto Ambiental do Paraná (IAP) and Instituto Brasileiro de Meio Ambiente (IBAMA), respectively. The legislation presumes that collectors and producers, when collecting a plant, will have an authorisation that was issued based on a management plan. The plan must state the techniques and strategies that will be adopted in order to guarantee the sustainability of the exploitation.

Only two medicinal plant collectors are registered with the IBAMA office in the state of Paraná. However, they do not regularly request authorisation for collection accompanied by a respective management plan. In the period in which this research was conducted, IAP had still not defined the guidelines to be followed by those interested in obtaining authorisation to collect plants. One of the reasons is that all of the technical information necessary for the development of a plan is still not available. Although research and extension agencies and universities have been conducting studies with the objective of establishing technical criteria, as of 2002 there was not a single management plan successfully implemented. Another problem is the lack of integration in the actions of federal, state, and city regulatory agencies, which makes the regulation by these agencies complex and expensive for producers to comply with.

In order for producers to be able to sell their product in the retail market, they must follow the requirements of sanitary legislation, which exceed the economic capacity of the majority of the collectors and farmers. The product must be within established limits for contamination by microorganisms. When the product is packaged as a phytotherapeutic, the requirements are even more stringent and involve registration with proof of the chemical constituents and the pharmacological activity, along with standardisation of the product. Even laboratories have difficulty in following the requirements of the current legislation. Nevertheless, the product arrives in the market in various forms: as potted plants, in sachets, in capsules, as an extract, mixed with herbs for stomach problems, among others.

TRENDS AND ISSUES

Dynamic changes

Response of collectors to the decline in populations

The reduction in the number of *espinheira-santa* trees has been worrying collectors. According to one of the traditional collectors, with 45 years of experience, a reduction of 30% has occurred in the last 10 years in the yield of the areas in which he collects, due to the expansion of urbanised areas and excessive exploitation of the species. Stimulated by the regular and increasing demand, and with the guidance of technicians from the Agricultural Extension Service (Correa Júnior *et al.* 1991), some collectors are already planting (Photo 2).

For the production of seedlings, fruits need to be collected when the capsules open, exposing the white aril. At this point, the seeds are dark brown and shiny. Extraction of seeds is made by manually removing the aril. When dry, seeds have about 6% water content. *Espinheira-santa* has orthodox seeds (Eira *et al.* 1993) and, when stored outside of a cold chamber, they lose viability rapidly (Scheffer *et al.* 1994). Seeds of good quality have germination rates between 70% and 100%.

For the propagation of *espinheira-santa*, various techniques have been studied: micropropagation (Pereira 1993), transplanting seedlings obtained in native forests (Magalhães *et al.* 1991), and production of seedlings from seeds (Santos 1999), which is currently the most common form of propagation.

Photo 2. General view of a *espinheira-santa* plantation (Photo: Waldir da Silva)



Radomski (1998) verified that there is a high positive correlation between the amount of light received and characteristics such as specific leaf weight and total phenolic content, nontannin phenolics, and tannins.

Farmers that are growing *espinheira-santa* still on a small scale have been empirically testing the spacing and ways to cultivate under full sun or in the forest on their properties. According to the farmers, the cultivation of *espinheira-santa* has been providing satisfactory results in economic terms. It has been observed that cultivated trees present different phytosanitary problems than those in the natural environment. In the natural environment, the largest problem is the high level of microorganisms due to the fungi that form on the leaves. This fungus growth occurs mainly because *espinheira-santa* is part of the forest understorey. It has already been observed in the plantings, for example, that some plants have resistance to scales insects, both with and without carapace, while other plants have been shown to be highly susceptible. The tendency in the study region is to increase the areas under cultivation as a result of the drastic reduction in the natural populations and the requirement for a product of higher quality as demanded by the buyers, especially by honest companies.

Espinheira-santa has been cultivated under full sun. The plantings are established with spacings of 3.0 m × 1.0 m, intercropped with shrubs or annual plants. They are also densely planted (1.0 m × 0.5 m), in rows. The number of rows depends on the topography of the land and which other species will be cultivated. In the central region of Paraná, the shorter *espinheira-santa* is intercropped with the taller *yerba-mate*. In regions with less environmental pressure, studies to establish sustainable management techniques for *espinheira-santa* in natural forests are being conducted, including the use of forest enrichment.

The intensity in which leaves are collected, using pruning sheers, varies with the type of planting. In plantings with larger spacing between trees, one-third of the leaf mass is collected. In more crowded plantings, an annual low pruning is made (as in tea), and almost the entire aerial part of the plant is collected.

Each planting system requires trees with a specific type of architecture. It has already been observed that there are individuals that branch from the base, forming several stems. These plants would be more appropriate for dense plantings. Other individuals form a single trunk and branch 60 cm or more above the soil. This type of architecture is more appropriate for intercroppings. Research to develop a seed production program is being conducted. This program is fundamental for the successful cultivation of *espinheira-santa* since the plant is allogamous and the reduced size of the natural populations and the distances between them would favour crossing between related individuals.

The ideal temperature to dry leaves has not yet been determined through research. In practice, some farmers dry the leaves in dryers between 38°C and 40°C, while others dry them at about 60°C. After being dried, the leaves are cleaned again, and the product is packaged and stored.

Marketing trends

The Pharmaceutical Products Industry Syndicate (*Sindicato da Indústria de Produtos Farmacêuticos*), in the state of São Paulo, developed a list of the 102 most important species for the industry. *Espinheira-santa*, included as both *M. ilicifolia* and *M. aquifolium*, is considered the 14th most important. The list was developed in order to guide the priorities of a bibliographical survey and also was used in a proposal to the Permanent Commission for the Review of the Brazilian Pharmacopoeia (*Comissão Permanente de Revisão da Farmacopéia Brasileira*) as a suggestion for the elaboration of monographs of raw materials that are not listed in previous editions, but that are frequently present in the phytotherapy market (Moretto *et al.* 1995).

After an initial boom at the end of the 1980s, which resulted from the publication of results that showed the therapeutic properties of *espinheira-santa*, demand for the product stabilised in the 1990s. Currently, the demand has increased again as a function of the development of new medicines containing *espinheira-santa*. This increase, together with the reduction in the native populations, has encouraged cultivation of the species in order to guarantee quantity and quality of the supply of raw material to the industries.

Consequences for the collectors, intermediaries and consumers

With the attention *espinheira-santa* has drawn, environmental inspectors intensified the protection of this species. However, environmental laws aimed at protecting the species and its environment are developed and applied without simultaneous education or an incentive for the cultivation or management of the species. This state of affairs confuses both collectors and farmers, and discourages regularisation, thus causing the majority of producers to work unlawfully. This illegality harms the producers and forces them to sell the product at low prices to profiteers. In addition, the goal of protecting the environment and the species is not achieved because of the inefficiency of the regulatory mechanisms.

Moreover, those collectors that are not landowners lose their participation in the market, and also part of their income, because of the decrease in the natural populations of *espinheira-santa*. The trend is that they will gradually be replaced by farmers. These collectors find it increasingly difficult to find an activity of the same nature to substitute for collection of *espinheira-santa*.

The enforcement of environmental legislation has forced honest intermediaries to buy the product preferentially from farmers, as there are only two officially permitted collectors. Currently, the trend in the honest industries is to refuse products obtained without the necessary environmental license. An increase in inspection to confirm that the raw material was obtained in accordance with environmental laws has occurred on the heels of an increase in sanitary monitoring for the registration and trade of products originating from native plants. Nonetheless, there are several companies that sell the species with no concern for its origin, and inspection continues to be insufficient. For these reasons, *espinheira-santa* continues to be sold in large quantities, even though it has been adulterated with, for example, *Sorocea bomplandii*.

Several aspects need to be considered in relation to consumers. As mentioned before, *espinheira-santa* is traditionally consumed by the population throughout southern Brazil in the form of medicinal tea or mixed with *yerba-mate* leaves in the *chimarrão*. After the confirmation of its medicinal properties, *espinheira-santa* started to be treated as a medicine by sanitary legislation, impeding its registration as a food (tea) and restricting its sales to drugstores. Because the plant is a tree, it is not found in most domestic gardens. The restrictions on the sales of leaves can deprive the population from a plant that has traditionally been utilized. On one hand, consumers are offered an industrial product within the legal requirements and, on the other hand, an illegal product, with no guarantees of quality and one that is frequently adulterated.

Interventions aiming for development

Both governmental and nongovernmental organisations have committed their agencies to rural extension work in order to take available information to the producers so they can cultivate and/or manage the species. A study of the production chain of medicinal plants (including *espinheira-santa*) is being developed by the state public administration. The study aims at obtaining information and the participation of all stakeholders in order to collectively make an assessment and suggest solutions for the detected problems, especially those that should be resolved by the government.

KEY PROBLEMS

Traditionally, leaves of *espinheira-santa* were collected in the forests. With the reduction of forests because of urbanization, agriculture, ranching, and other anthropogenic actions, however, the number of trees has been decreasing drastically. In addition, the increase in demand, caused by the confirmation of its therapeutic properties, is exposing this species to strong genetic erosion. The systematic cutting of new branches reduces seed production because fruit production is concentrated on the previous year's branches. There is a risk that this species may disappear from certain areas, as was already observed in Paraná (Paraná 1995). Universities and research organisations are developing studies to encourage its cultivation. However, it is estimated that 95% of the *espinheira-santa* consumed is still obtained from extraction. There are few official data related to extraction because the collectors have been acting illegally.

In spite of the attention that *espinheira-santa* has been drawing from universities, research organisations, and extension and inspection services, the practical results have been insufficient to guarantee its preservation. There has probably been strong genetic erosion in the germplasm of this species, at least in the study area, due to intense exploitation. Lack of integration in the actions of the various organizations involved (research, inspection, extension) and lack of organisation of the producers contribute to this condition.

CONSERVATION AND DEVELOPMENT LESSONS

The discontinuity of actions and the absence of cooperation among the various agencies responsible for carrying out political guidelines to develop, in a rational way, the use of medicinal plants for medicine production have made medicinal plants an easy target for all kinds of abuse from opportunistic national and foreign companies. *Espinheira-santa* is a typical example of this development.

The confirmation of the medicinal properties of *espinheira-santa* has drawn attention to this species and to the problems related to the exploitation of native plants for medicinal purposes. The species used traditionally by indigenous and nonindigenous peoples were the subject of research developed by governmental organisations. The positive results caused an explosion in consumption and have drawn the interest of national and foreign companies. Consequently, several patent requests have been approved or are being analysed. On one hand, this has stimulated necessary research for the extraction to become sustainable; on the other hand, it has stimulated consumption. The development of research, however, has not happened at the same pace as the increase in consumption. Extraction under the traditional form of sustainable management is compromised, especially close to large urban areas, as is the case of Campo Largo.

Under these conditions and in order to guarantee the supply of raw material to intermediaries, food industries, and phytotherapy laboratories, cultivation of the species has been encouraged. This activity, however, has been displacing some of the traditional producers. Even though cultivation is environmentally and economically positive, it has the negative effect of displacing traditional collectors, which typically are landless and rely on the collection of medicinal plants as their main or only source of income.

ENDNOTES

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2. In December 2000, US\$1.00 equalled R\$1.97 according to the Departamento de Economia Rural, SEAB, Paraná.

REFERENCES

- Araújo, J.E. da S. and Lucas, V. 1930. Catálogo de extractos fluidos dos Laboratórios Silva Araújo. Silva Araújo & Cia Ltda, Rio de Janeiro. 185p.
- Bernardi, H.H. and Wasicky, M. 1959. Algumas pesquisas sobre a 'Espinheira Santa' ou 'Cancerosa' *Maytenus ilicifolia*, Martius, usada como remédio popular no Rio Grande do Sul. Universidade Federal do Rio Grande do Sul, Santa Maria. 46p.
- Biancarelli, A. 2000. Brasil começa a investir em sua 'horta'. Folha de São Paulo, 29 de abril, p. C1.
- Brasil. 1985. Decree nº 122-P, March 19, 1985. In: Lex: coletânea de legislação e jurisprudência. São Paulo, v. 49, 597-609, Jan.-Mar., 1985.
- Brasil. 1995. Decree nº 6 [SNVS], January 31, 1995. Diário Oficial [da] República Federativa do Brasil 133(26): 1523-1524, 6 fev. 1995. Sec. I.

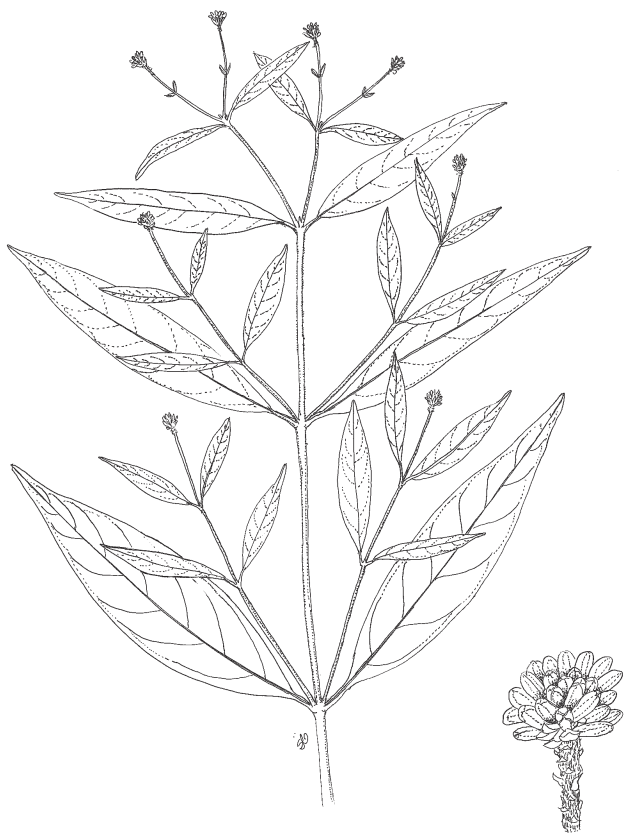
- Brasil. 2000. Resolution-RDC N° 17 [ANVS], February 24, 2000. Diário Oficial [da] República Federativa do Brasil 138, February 25, 2000. Seção I.
- Carlini, E.A. (coord.). 1988. Estudo da ação antiúlcera gástrica de plantas brasileiras: *Maytenus ilicifolia* (Espinheira-santa) e outras. Central de Medicamentos /CEME/AFIP, Brasília. 87p.
- Carvalho, P.E.R. 1980. Levantamento florístico da região de Irati-PR. (1ª aproximação) Empresa Brasileira de Pesquisa Agropecuária/Centro Nacional de Pesquisas Florestais—EMBRAPA/CNPQ, Curitiba. 44p. (Circular Técnica N° 03).
- Carvalho-Okano, R.M. 1992. Estudos taxonômicos do gênero *Maytenus* Mol emend. Mol. (Celastraceae) do Brasil extra-amazônico. Ph.D. Thesis, Universidade Estadual de Campinas, Brasil. 253p.
- Cervi, A.C., Paciornik, E.F., Vieira, R.F. and Marques, L.C. 1989. Espécies vegetais de um remanescente de floresta de araucária (Curitiba, Brasil): estudo preliminar I. Acta Biológica Paranaense 18(¼): 73-114.
- Correa Júnior, C., Ming, L.C. and Scheffer, M.C. 1991. Cultivo de plantas medicinais, condimentares e aromáticas. Empresa Paranaense de Assistência Técnica e Extensão Rural, Curitiba. 151p.
- Cruz, G.L. 1985. Espinheira-santa. In: Cruz, G.L. (ed). Dicionário de plantas úteis do Brasil, 335-336. Civilização Brasileira, Rio de Janeiro. 599p.
- Eira, M.T.S., Dias, T.M.C. and Mello, C.M.C. 1995. Comportamento fisiológico de sementes de espinheira-santa (*Maytenus ilicifolia*) no armazenamento. Horticultura Brasileira 13(1): 32-34.
- Gonzalez, F.G., Portela, T.Y., Stipp, E.J. and Di Stasi, L.C. 2001. Antiulcerogenic and analgesic effects of *Maytenus aquifolium*, *Sorocea bomplandii* and *Zollernia ilicifolia*. Journal of Ethnopharmacology 77(1): 41-47.
- Gonzalez Gonzalez, J., Delle Monache, G., Delle Monache, F. and Marini Bettolo, G.B. 1982. Chuchuhuasha: a drug used in folk medicine in the Amazon and Andean areas, a chemical study of *Maytenus laevis*. Journal of Ethnopharmacology 5: 73-77.
- Grünwald, J. 1997. The market situation and marketing of herbal medicinal products (HMP) in Europe. In: II World Congress on Medicinal and Aromatic Plants for Human Welfare, 33. ICMAP/ISHS/SAIPA, Buenos Aires.
- Hoehne, F.C. 1939. Aquifoliáceas e afins. In: Hoehne, F.C. (ed.) Plantas e substâncias vegetais tóxicas e medicinais, 180-182. Graphisars, São Paulo. 355p.
- IPARDES. 2001. Caderno estatístico do município de Campo Largo. IPARDES, Curitiba. 29p.
- Kuniyoshi, Y.S. and Roderjan, C.V. 1989. Levantamento fitossociológico das principais associações arbóreas da Floresta Nacional de Irati, PR. Floresta 19(1/2): 30-49.
- Magalhães, P.M., Figueira, G.M., Archangelo Jr., U. and Montanari Jr., I. 1991. Aspectos agronômicos do cultivo em larga escala de *Maytenus ilicifolia* Mart. ex Reiss. (espinheira-santa). Horticultura Brasileira 9(1): 44.
- Marquesini, N.R. 1995. Plantas usadas como medicinais, pelos índios do Paraná e Santa Catarina, Sul do Brasil. Guarani, Kaingang, Xokleng, Ava-Guarani, Kraô e Cayuá. Dissertação de Mestrado, Universidade Federal do Paraná, Brasil. 290p.

- Martinez-Crovetto, R. 1963. Esquema fitogeográfico de la Provincia de Misiones (Republica Argentina). *Bonplandia, Corrientes* 3(1): 171-215.
- Moretto, L.D., Zeringota, H.F.C. and Marques, L.C. 1996. Contribuição do sub-grupo de fitoterápicos do SINDUSFARM-SP à estruturação da fitoterapia no Brasil. Sindicato da Indústria de Produtos Farmacêuticos no Estado de São Paulo, São Paulo. 8p.
- Paraná, Secretaria de Estado do Meio Ambiente. 1995. Lista vermelha de plantas ameaçadas de extinção no estado do Paraná. SEMA/GTZ, Curitiba. 139p.
- Pereira, A.M.S. 1993. Técnicas de micropropagação de *Maytenus aquifolium* Mart. e *Maytenus ilicifolia* Mart. (espinheira-santa). Dissertação de Mestrado, UNESP, Jaboticabal, Brasil. 67p.
- Priore, H., Carpiuc, L., Alonso, E. and Bassagoda, M.J. 1986. Guia taxonômico de plantas que se comercializam como medicinales en Uruguay: primera contribución. *Acta Farmaceutica Bonaerense* 8(3): 187-198.
- Radomski, M.I. 1998. Caracterização ecológica e fitoquímica de *Maytenus ilicifolia* Mart., em populações nativas, no município da Lapa, Paraná. Dissertação de Mestrado, Universidade Federal do Paraná, Brasil. 98p.
- Ratera, E.L. and Ratera, M.O. 1980. Plantas de la flora argentina empleadas en medicina popular. Editorial Hemisferio Sur, Buenos Aires. 189p.
- Santos, E.P. dos. 1999. Influência de diferentes substratos e recipientes na produção de mudas de espinheira-santa. UFPR, Curitiba. 23p.
- Scheffer, M.C., Doni Filho, L. and Koehler, H.S. 1994. Influência do tipo de coleta, das condições e do tempo de armazenagem na viabilidade de sementes de *Maytenus ilicifolia*. In: 13o Simpósio de Plantas Medicinais do Brasil, 196. FINEP/CNPq, Fortaleza, Brasil.
- Scheffer, M.C. and Araujo, J.A. de. 1998. Observações sobre a frutificação de espinheira-santa (*Maytenus ilicifolia*) na região sul do Brasil. In: XV Simpósio de plantas medicinais do Brasil. UNIFESP, São Paulo.
- Scheffer, M.C. 2001. Sistema de cruzamento e variação genética entre populações e progênies de espinheira-santa. Ph.D. Thesis, Universidade Federal do Paraná, Brasil. 104p.
- Simões, C.M.O, Mentz, L.A, Irgang, B.E., Stehmann, J.R. 1988. Espinheira-santa. In: Simões, C.M.O, Mentz, L.A, Irgang, B.E. and Stehmann, J.R (eds.) Plantas da medicina popular do Rio Grande do Sul, 74-75. Ed. da universidade/UFRGS, Porto Alegre. 174p.
- Stellfeld, C. 1934. A espinheira-santa: contribuição ao estudo farmacognóstico. *Boletim da Associação Brasileira de Pharmacia* 15: 551-571.
- Tabarelli, M., Villani, J.P. e Mantovani, W. 1993. Estrutura, composição florística e dinamismo de uma floresta secundária na encosta atlântica-SP. In: I Congresso Florestal Panamericano, 340-343. Sociedade Brasileira de Silvicultura/Sociedade Brasileira de Engenheiros Florestais, Curitiba, Brasil.
- Toursarkissian, M. 1980. Plantas medicinales de la Argentina. Editorial Hemisferio Sur, Buenos Aires. 178p.
- Vieira, R.F. 1999. Conservation of medicinal and aromatic plants in Brazil. In: Janick, J. (ed.) Perspectives on new crops and new uses, 152-159. ASHS Press, Alexandria, VA.

Chapter 18

Fáfia [Pfaffia glomerata (Spreng.) Pedersen], the Brazilian ginseng

Cirino Corrêa Júnior¹ and Lin Chau Ming²



(Pfaffia glomerata)

Common names	Part used	Management	Degree of transformation	Scale of trade	Geographic range
Batata-do-mato, Fáfia, Brazilian ginseng	Root	Wild	Medium	International	Small (restricted)

ABSTRACT

Fáfia (*Pfaffia glomerata* (Spreng.) Pedersen - Amaranthaceae) has been utilised for centuries by native Brazilians for the cure and prevention of diseases, but had its medicinal properties scientifically confirmed only after research was conducted in Japan. Popularly known as Brazilian ginseng, *batata-do-mato*, *corango*, *corrente*, *sempre-viva*, and *paratudo*, *Pfaffia* is one of many genera that occur naturally in the riparian vegetation of the upper Paraná River, a region dominated by seasonal semideciduous forest, which occurs in tropical and subtropical climates with annual rainfall between 1,200 mm and 1,500 mm. *Fáfia* contains ecdysteroids, which are employed in cosmetic formulas. *Fáfia* is manually collected, mainly by small-scale farmers. Its commercialisation represents 55% of the annual income of these families. The buyers, fifteen in the region and three in the study area, pick up the product and apply the first steps of processing: to wash and crush the roots until a 'paste' is formed. After being dried in the sun, the material is ground. Intermediaries sell the powder to wholesalers and exporters at US\$5 per kilogramme. When exported, the price reaches US\$15 per kilogramme. One hundred percent of the product obtained in the study area is the result of predatory collection. The case of *fáfia* is an example of the harm that predatory exploitation can cause to a species of which the natural distribution is restricted to a fragile environment that is already subjected to other kinds of anthropogenic pressure. Research is being conducted to encourage the cultivation and management of *fáfia*. Some effective agrarian techniques have already been determined.

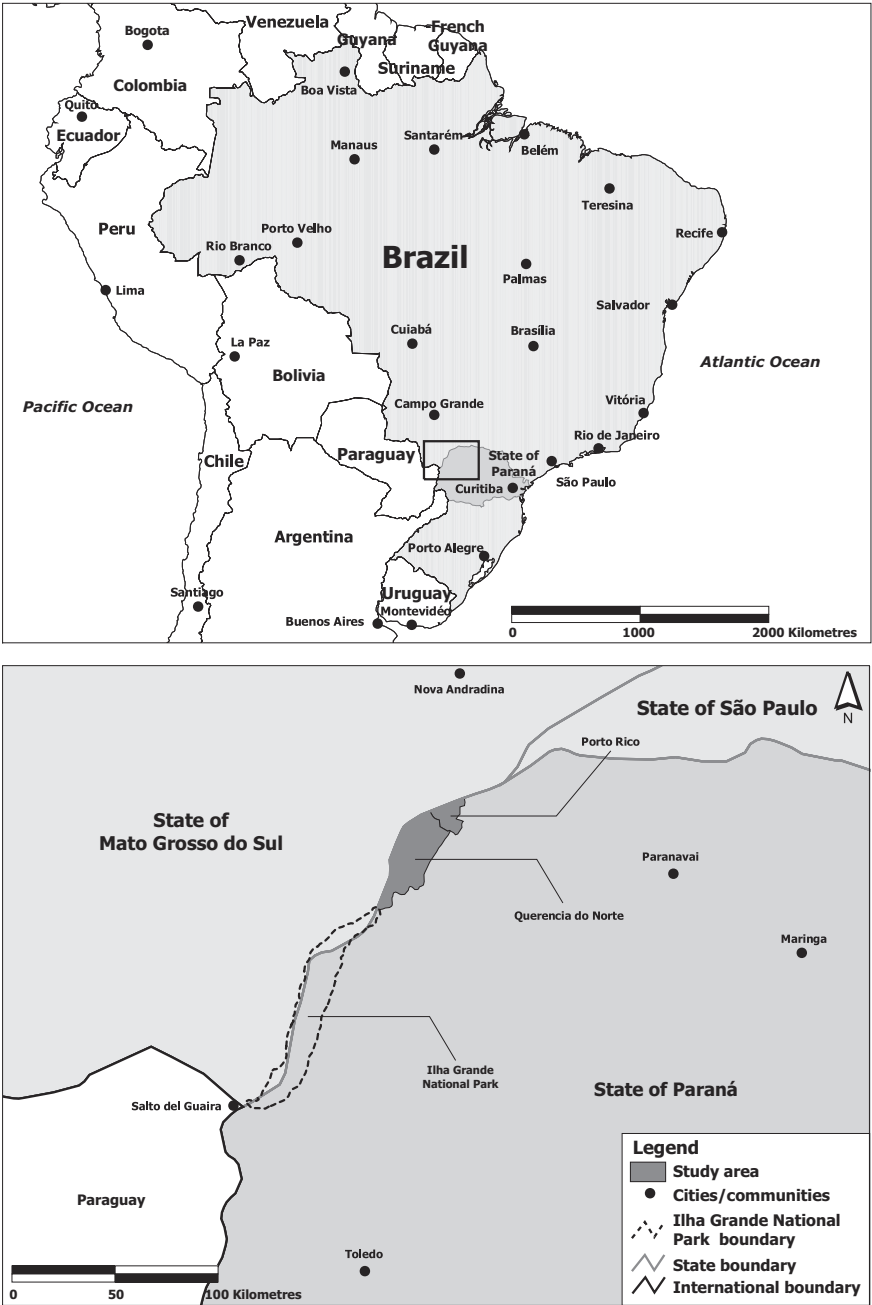
INTRODUCTION

Fáfia (*Pfaffia glomerata* (Spreng.) Pedersen - Amaranthaceae) has been utilised for centuries by native Brazilians for the cure and prevention of diseases. It had its medicinal properties scientifically confirmed only after it was taken to Japan and was subjected to analysis by the Rhoto Pharmaceutical Co. Ltd. laboratory. Recent studies have shown that native Brazilians were not mistaken: the plant's roots have components that act in cell regeneration, in blood purification, in the inhibition of the growth of cancer cells, in the regularisation of hormonal and sexual functioning, and as a bioenergetic (Nishimoto *et al.* 1984; Nishimoto *et al.* 1990).

Roots from species of the genus *Pfaffia* are used in popular medicine in Brazil, especially as tonics, antidiabetics, antidiarrheics, antihemorrhoidals (Mattos 1993), and aphrodisiacs. The use of these species, known popularly as Brazilian ginseng, has attracted the attention of the Japanese, who have been importing increasing quantities of roots, reaching an amount of approximately 120 metric tons in 1995. In only one month of 1999, 60 metric tons of roots were exported. More recently, the European Union and the United States of America showed interest in its importation. The increase in the consumption of this species is estimated at 10% per year.

Pfaffia collection is one of the activities that most employ rural workers in the study area, which is located in the cities of Querência do Norte and Porto Rico (Figure 1), north of Ilha Grande National Park in north-western Paraná, in the floodplain of the upper Paraná River, the main river of the Prata basin.

Figure 1. Location of the study area



Source: ESRI Data and Maps 2002.

This basin is the tenth largest in the world in terms of discharge and fourth in drainage area ($5.0 \times 10^8 \text{ m}^3/\text{year}$ and $2.8 \times 10^6 \text{ km}^2$, respectively), draining mid-central South America from the Andean slopes until the Serra do Mar in the vicinity of the Atlantic coast (Agostinho *et al.* 1995). From its source in the central plateau until its mouth in the Prata estuary, the Paraná River runs 4,695 km, crossing sedimentary and volcanic rocks of the sedimentary basin of Paraná and Chaco, whose boundaries are defined by the east slope of the Andes and the Precambrian rocks of the Brazilian Shield in the North and East (Agostinho and Zalewski 1996). The stretches ‘superior’ (Paranaíba River, 1,070 km), ‘upper’ (from the confluence of the rivers Paranaíba and Grande until the old Saltos de Sete Quedas, 619 km), and part of the ‘middle’ (from Sete Quedas until the mouth of the Iguaçu River, 190 km) are located in Brazilian territory, draining an area of 891,000 km², which corresponds to approximately 10.5% of the country’s area (Agostinho and Zalewski 1996). The geographic barrier that used to delimit the upper and middle stretches of the Paraná River, Saltos de Sete Quedas, is presently inundated by the Itaipu reservoir.

The name Brazilian ginseng is principally given to the species *Pfaffia glomerata* Pedersen, *P. paniculata* Kuritze, and *P. iresinoides* (H.B.K.) Sprengel, which have attracted a greater number of phytochemical studies. *Pfaffia glomerata* naturally occurs in the margins and islands of the Paraná River between the states of São Paulo, Mato Grosso do Sul, and Paraná, although its populations have been drastically reduced by intensive collection of its roots. This intense collection has forced several organisations to consider the domestication of this species as the best strategy to supply the national and international markets, provided that good rural practices are applied. These bodies include the Agency for Technical Assistance and Rural Extension of Paraná (EMATER-PR), the Brazilian Institute for the Environment and Renewable Natural Resources (IBAMA), the Environmental Institute of Paraná (IAP), universities, farmers, collectors, and national and foreign companies. This process must also involve phytochemical studies, studies on the interaction of the species with its environment, and studies aiming for sustainable management in the areas of the upper Paraná River, where the species grows naturally.

THE SYSTEM FROM PRODUCTION TO CONSUMPTION

Botanical aspects

The Amaranthaceae family has approximately 60 genera and 900 species, distributed in the tropical, subtropical, and temperate regions of the American and African continents. In Brazil, there are 12 genera with approximately 86 species (Barroso 1978). They are generally herbs, subshrubs, or shrubs, rarely vines or trees. They typically exhibit irregular secondary growth and vascular bundles in concentric circles. Frequently they accumulate free oxalates, potassium nitrate, and saponins (Cronquist 1981).

Fáfia is known by the common names Brazilian ginseng, *batata-do-mato*, *corango*, *corrente*, *sempre-viva*, and *paratudo*. It is one of the many genera

that occur naturally in the riparian vegetation of the upper Paraná River (Souza *et al.* 1997).

According to Vasconcelos (1986), *P. glomerata* is a perennial herb of up to 2 m in height. It has an erect, round, striated stem, frequently hollow in the upper part, with thickened nodes and with internodes up to 23 cm in length. Branching is predominantly dichotomous, especially in the younger branches and nodes, which can be either glabrous or pubescent. The petioles are short, up to 2 cm in length. Leaf blades vary in shape and size from linear-oblong to wide-ovate and range from 1 cm to 14 cm in length and 0.3 cm to 4.5 cm in width, the upper ones always being smaller.

The cymose inflorescences are yellowish-white, paleaceous, and the flowers, some of them smaller than 8 mm in diameter, are arranged in capitula. The capitula are spherical in general but spiciform in the lower flowers. The rachis is lanate. The simple dichotomous or trichotomous peduncles measure 3 cm to 20 cm and are pubescent. All flowers are complete. The fruit is an achene and contains cordiform seeds measuring approximately 1 mm in diameter and 1.5 mm in length. Seeds are light-green when immature and hazel when mature. The embryo is surrounded by an abundant farinaceous endosperm. The underground organs consist of a tuberous root that in the upper part contains a stem portion of variable size, the crown, where there are endogenous and exogenous buds, used as propagation material (Photo 1).

Photo 1. Root system of *fáfia* [*Pfaffia glomerata* (Spreng.) Pedersen] (Photo: Cirino Corrêa Júnior)



Ecological aspects

According to Maack (1968), the forest formation in the study area is called Pluvial Semideciduous Forest, while the Brazilian Institute for Geography and Statistics (IBGE 1992) uses the term Semideciduous Seasonal Forest. The area consists of native (*várzeas*) and artificial (pastures) herbaceous formations, as well as tree formations, with remnant forests in various stages of regeneration. The aquatic herbaceous species (in particular *Eichhornia azurea*, *E. crassipes*, *Polygonum acuminatum*, *P. stelligerum*, *Nymphaea* sp., *Sagittaria montevidensis*, *Pontederia cordata*, *Utricularia* sp., *Salvinia* sp., and *Pistia stratiotes*) cover parts of lagoons, swamps, and secondary channels. The dominant herbs found in natural fields are grasses (*Panicum prionitis*, *P. mertensii*, *P. maximum*, etc.), sedges (*Cyperus digitatus*, *C. difusus*), and fáfia (*Pfaffia glomerata*) (Romagnolo *et al.* 1994). The most common shrubs are *Senna pendula*, *Aeschynomene* sp., and *Sapium biglandulatum*, and the most common isolated trees are *Inga uruguensis* and *Croton urucurana*. In the riparian forest, considerably altered by human action and by catastrophic floods, the dominant species are *Cecropia pachystachya*, *Croton urucurana*, and *Lonchocarpus guilliminianus* (Souza *et al.* 1997).

It is estimated that 70% of the approximately 7,000 species of flowering plants in the state of Paraná are, currently, in environments that are so altered that their fauna and flora are at risk (SEMA/PR 1995). According to SEMA/PR (1995), there are several causes for the extinction risk of Brazilian plants, among them agriculture and pastures; floods because of the construction of dams; the extraction of timber, medicinal plants, ornamental plants, and plants for food; reforestation with exotic species; and urban expansion.

Fáfia (*P. glomerata*) is distributed in tropical to subtropical areas with annual rainfall between 1,200 mm and 1,500 mm. Very low temperatures paralyse its growth. It is a hydrophyte (plant that grows partially or completely under water or in waterlogged soil) and heliophyte (plant that grows better under full sunlight), occurring mainly at river margins and on the edges of riparian forests where it can receive abundant light (Smith and Downs 1972). It grows in altitudes up to 1,000 m. It occurs principally in sandy soils rich in organic matter, but grows well in clayey soils. In the latter, it produces more roots and is more difficult to harvest.

Pharmacological and chemical aspects

Since the discovery of a nortriterpenoid (pfaffic acid) in the roots of *P. paniculata* (Mattos 1993), interest in the species of *Pfaffia* has increased because of its antitumoural properties (Nishimoto *et al.* 1984). Nishimoto *et al.* (1990) report the occurrence of ecdysterone, rubrosterone, and beta-D-glucopyranosyl oleate in *P. glomerata*. This and other species of *Pfaffia*, also called Brazilian ginseng, are utilised in popular medicine as tonics, antidiabetics, antidiarrheals, and antihemorrhoidals (Mattos 1993).

According to Meybeck *et al.* (1994), the ecdysteroids are a group of 2, 3, 14-trihydroxy-D-7-6-cetosteroids represented by the compounds extracted from, among others, *P. glomerata*. The ecdysterone or b-ecdysone is the most important steroid employed in cosmetic formulas, extracted commercially

from various plants, especially from *fáfia*. Ecdysteroids have a hydrating function, which impedes the excessive loss of water from the epidermis. In cosmetics preparations, a mixture of ecdysteroids, b-ecdysone, its acetylated derivative, and plant extracts can all be utilised. The b-ecdysone acetylated derivative, due to its liposolubility, is widely employed in cosmetics preparation in the form of emulsions. There is also a patent request for analgesics containing ecdysone (Takemoto *et al.* 1988). Glomeric acid, pfameric acid, and rubrosterone were also isolated from *Pfaffia glomerata* (Shiobara *et al.* 1993).

Production and processing of *fáfia* in the study area

Fáfia collection is done mainly by landless workers, remnants of the landless farmers that, in 1985, invaded an 8,096 ha farm in the region. In 1988, negotiations were initiated in an attempt to legalize the occupation of the land, but the settlement was officially recognized only on 19 December 1995. Three hundred thirty-six families settled on this land on properties that average 24 ha each. However, the soil in the region has low fertility and agricultural yield is insufficient for subsistence. Frequently, the settlers are required to complement their income by selling their labour. *Fáfia* collection is one of the activities they work on. One hundred and fifty collectors work in the study area. All of them have lived in the area for more than 12 years and have been, on average, exclusively collecting *fáfia* for five years. The collection areas are located 2 km to 8 km from their residences. The majority of the collectors transport the *fáfia* they have collected to their houses using wagons or horses, although some use bicycles and boats, and others transport it by foot. Families have, on average, five members. Of these, three participate in the collection, and, of these, 25% are women. On average, one worker collects 84 kg of roots per workday. Families collect 16,440 kg in eight months of work, which results in an average annual income per family of US\$2,220³ from the collection of *fáfia*.

Root collection is done manually and is concentrated in the months of May through July. During these fall-winter months, the collection areas are not inundated and there are no other agricultural activities for the available labour. The collectors also believe that, during this time, the roots are 'riper'. According to the collectors' concept, this means that the colour of the shoot and of the roots becomes a deeper yellow and that the roots are heavier. The collectors identify three types of colouring of the roots: 'yellow', 'white', and 'darker'.

A strategy used by the collectors to facilitate the collection is to burn the fields because *fáfia* is one of the first plants to resprout, which facilitates its localisation and collection. The burn also cleans the area of other species and of poisonous animals. The collectors prefer to collect *fáfia* on river islands because the roots there are of better 'quality' and are heavier. We believe that this difference is related to the soil moisture and to the high amounts of organic matter. None of the collectors make use of the ability of *fáfia* stems to root in order to recolonise the collection area.

The roots are dug up with a hoe or shovel and packed into braided

polyethylene bags supplied by the buyer. The buyers, fifteen in the region and three in the study area, pick up the product with a truck at the collectors' houses or in the collection area. They are the ones who begin the processing of *fáfia*: to wash, cut, and crush the roots until a 'paste' is formed, which is then subjected to a predrying under the sun on a plastic tarp (Photo 2). The predried material is ground and again laid out in the sunlight for final drying, until it gets to around 10% to 12% moisture. After it is dried and ground, the powder is sold to intermediaries, wholesalers, or exporters, which are mainly located in the state of São Paulo (Ming and Corrêa Júnior 2001).

Photo 2. Whole and cut washed roots of *fáfia* (Photo: Cirino Corrêa Júnior)

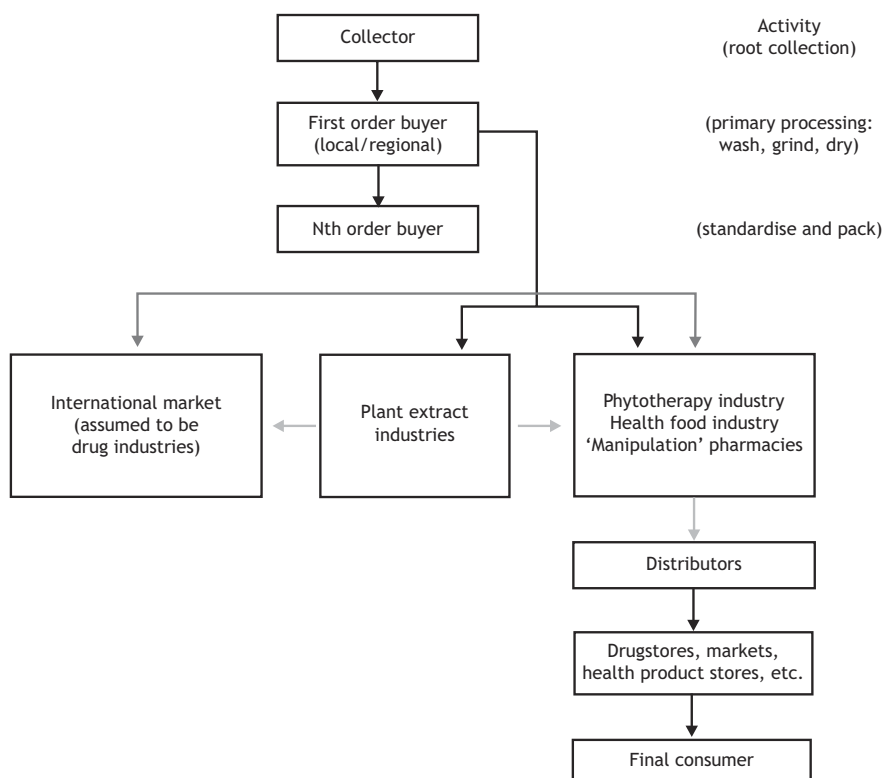


Socio-economic aspects

The World Health Organization estimates that 80% of the people in developing countries depend on traditional medicine for their basic health needs and approximately 85% of traditional medicine involves the use of plant extracts. This means that 3.5 billion to 4 billion people depend on plants as a source of drugs (Farnsworth *et al.* 1985).

Twenty-one of the 33 species of *Pfaffia* found in Central and South America occur in Brazil (Mattos 1993). Brazil is currently the most important collection centre of the species of this genus for medicinal and food purposes.

According to Rosa (1997), *fáfia* extraction is one of the activities that most employ temporary rural workers in the region of Porto Rico (study area), located in the floodplain of the upper Paraná River. Approximately

Figure 2. Flowchart of the production and commercialisation of *fáfia*

60 metric tons of roots per month are produced in the Paraná River basin alone. According to the same author, intermediaries hire temporary workers in riverine cities for the collection of this species. The temporary workers earn US\$0.10 to US\$0.13 per kilogramme of root. After being cut, dried, and ground, the product sells for US\$5 per kilogramme. When exported, the price reaches US\$15 per kilogramme (Ming and Corrêa Júnior 2001).

TRENDS

With the establishment of Ilha Grande National Park in 1977, extensive areas of natural occurrence of *fáfia* became protected by law, which deprived the collectors of part of their income because 100% of the product commercialised in the study area is obtained from collection. In addition, agriculture and ranching have impeded the natural regeneration of the species with intensive use of machines in soil preparation and by the grazing of cattle, which favor *fáfia*. In spite of *fáfia* being a source of income, the collectors presently have no interest in the preservation of this resource. When consulted, however, all showed willingness to cultivate it if they had the technical and economic capabilities, because they believe it would be a profitable activity that would

require less work and would allow good use of familial labour as it is a species adapted to the region and easy to collect (Ming and Corrêa Júnior 2001).

The Public Ministry of the Environment has made several attempts to stop *fáfia* collection because it is an activity that degrades the environment. As a result, *fáfia* intermediaries have moved to other regions. To encourage the systematic cultivation of the species and its management in preservation areas, research and extension organisations together with universities are developing techniques for cultivation and management. With this collaboration, they intend to educate and guide collectors without depriving them of their source of income. Some basic techniques for the cultivation of *fáfia* have already been determined.

Propagation

Propagation is done in three ways and under the following procedures:

- a) **via seeds:** *fáfia* has fertile seeds, with 50% to 77% viability (Magalhães 2000). Sowing is done in a seed bed with a thin layer of sand. After germination, the seedlings (3 cm to 4 cm in height) are transplanted to plastic bags or tubes. When the seedlings reach 25 cm to 30 cm, they are transplanted to the field.
- b) **via stem cuttings:** two thirds of the length of stems with two to three nodes are buried in plastic bags or in a seed bed. After rooting, they are taken to the field.
- c) **via crown cuttings:** the most vigorous and productive plants of a population are chosen. The crowns are divided into parts of 9 g to 12 g and put to root in plastic bags or placed directly into the cultivation area (Oliveira 1998). This option is considered the best because it is easy to prepare the seedlings and results in better root formation.

Soil preparation, spacing, and time for planting

One ploughing and one harrowing are enough in sandy soils. In clayey soils, the seedlings must be transplanted to the crest of the bed, aiming to facilitate the collection of roots, which, in this way, will be located close to the soil surface (Magalhães 2000). The beds can be made with a furrower or a plough.

The highest productivity in sandy or low-fertility soils was obtained with a spacing of 1 m between rows and 0.5 m within rows. For clayey or high-fertility soils, spacing of 1.5 m between rows and 0.5 m within rows or 1 m between rows and 1 m within rows is recommended.

Transplantation should be done at the end of winter or beginning of spring for the harvest to be done at the end of fall and in winter. Usually, it is at this time that the roots have higher amounts of active compounds because they have already been translocated to the storage organs.

Nutritional needs and fertilization

To date no studies have been published on the nutritional needs of *fáfia* and, consequently, no recommendation on fertilisation is available. In field

observations, high productivity was verified in soils rich in organic matter and high fertility (e.g., dark-red latosol). Based on these observations, 50 metric tons per hectare of aged cattle manure or 30 metric tons per hectare of aged chicken manure is recommended. The fertilizer should be applied as a side-dressing after weeding, 40% at planting, 30% in November or December, and the remaining 30% in January or February.

Cultural methods

In spite of the simplicity of *fáfia*'s culture, weeding is recommended in order to control invasive plants and reduce the need for irrigation during the driest periods.

Pests and diseases

Fáfia is susceptible to rust and nematode (*Meloydogine incognita*). Plants with stem borers were also found in the field. When the plant is cultivated in its natural environment (wet soils), however, no problems with pests or diseases were observed.

Harvest

Fáfia roots can be collected after one year, always at the end of fall and in winter. Collection is facilitated by a subsoiler or furrow maker, which should pass the base of the bed or planting row in such a way as to pull out the roots. Cutting and removing the aerial part of the plants is recommended to facilitate this operation (Magalhães 2000). It is also possible to use a grub hoe for the harvest. This allows for the collection and selection of material to be used for future plantings via vegetative propagation.

Product preparation and drying

After harvest, the roots must be taken for cleaning (washing), which can be done by placing the product over a wire mesh and using water jets or, for small quantities, manually with soft brushes. After the water drains, the roots may be ground until a 'paste' is formed. The paste will be predried in the sun before 10:00 AM and after 4:00 PM, and then brought to the drier. Another way to prepare the product is to cut the roots in slices or scrape them, place them in the drier, and then grind them until a powder is formed. Which method is used depends on the specifications of the buyer. A drying temperature of 55°C to 60°C is recommended.

Productivity

In experiments done both in the area of natural occurrence and by research organisations, a productivity of 1.9 metric tons of ground dry root per hectare was obtained at 12 months, 3.2 metric tons per hectare at 24 months, and 4.1 metric tons per hectare at 36 months. The amount of b-ecdysone did not vary

significantly as a function of harvest time at 12 months and 24 months, and was between 0.67% and 0.71% (Montanari Jr. *et al.* 1997; Magalhães 2000).

CONSERVATION AND MANAGEMENT LESSONS

Fáfia occurs in a fragile environment of sandy soils with low fertility and in preservation areas at river margins that are not easy to adapt for agriculture. There are few alternatives for income generation in the region. For some communities, *fáfia* collection represents up to 50% of household income. The rapid increase in demand for *fáfia* has stimulated uncontrolled collection of the species, which has caused a rapid decline in its natural populations. *Fáfia* demand continues to increase at a rate of 10% per year. Considering that *fáfia* is a species of relatively short cycle when compared to forest species, cultivation has been proposed to supply the demand for *fáfia* and to verify if, in certain circumstances, its management is possible.

The case of *fáfia* is a classic example of the damage that overexploitation can cause in a species whose natural distribution is limited to a fragile environment and which is also subjected to other types of anthropogenic pressure. The mere prohibitive action of inspection organisations did not have the desired effect; to the contrary, it has moved exploitation to other regions, increasing the area affected. Research currently being conducted with community participation, together with its practical implementation by the collectors, will allow the preservation of the species and of the source of income for members of the collectors communities.

ENDNOTES

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3. US\$1 equalled R\$1.86 at the time of the study.

REFERENCES

- Agostinho, A.A., Vazzoler, A.E.A.M. and Thomaz, S.M. 1995. The high river Paraná basin: limnological and ichthyological aspects. *In*: Tundisi, J.G., Bicudo, C.E.M. and Matsumura-Tundisi, T. (eds.) *Limnology in Brazil*, 59-103. ABC/SBL, Rio de Janeiro.
- Agostinho, A.A. and Zalewski, M.A. 1996. A Planície alagável do alto rio Paraná: importância e preservação. EDUEM, Maringá, PR. 100p.
- Barroso, G.M. 1978. *Sistemática de angiospermas do Brasil*. Editora da Universidade de São Paulo, São Paulo. 255p.
- Cronquist, A. 1981. *An integrated system of classification of flowering plants*. Columbia University Press, New York, USA. 1262p.
- Farnsworth, N.R., Akerele, O., Bingel, A.S., Soejarto, D.D. and Guo, Z. 1985.

- Medicinal plants in therapy. Bulletin of the World Health Organization 63: 965-81.
- IBGE (Fundação Instituto Brasileiro de Geografia e Estatística) 1992. Manual técnico da vegetação brasileira. Série Manuais Técnicos em Geociências, 1. IBGE, Rio de Janeiro. 92p.
- Maack, R. 1968. Geografia física do Estado do Paraná. UFPR/IBPT/Banco de Desenvolvimento do Paraná, Curitiba. 450p.
- Magalhães, P.M. 2000. Agrotecnologia para el cultivo de fáfia o ginseng brasileiro. In: Fundamentos de agrotecnologia de cultivo de plantas medicinales iberoamericanas, 323-32. CYTED, Bogotá.
- Mattos, J.K.A. 1993. Biologia da ferrugem (*Uromyces platensis* SPEG.) da *Pfaffia glomerata*. Master's Thesis, Universidade de Brasília-DF, Brazil. 54p.
- Meybeck, A., Bonte, F. and Redziniak, G. 1994. Use of an ecdysteroid in a cosmetic or dermatological composition or keratinocyte culture medium. Int. Cl. A6K7/48 Fr. n. PI 94/04132. 20 August 1993, 3 March 1994. Patent Application Paris, v. 92/10267. 28p.
- Ming, L.C. and Corrêa Júnior, C. 2001. Collection of fáfia (*Pfaffia glomerata* (Spreng.) Pedersen) in the northwest region of Paraná State, Brazil. World Conference on Medicinal and Aromatic Plants, 242. Budapest, Hungary.
- Montanari Jr., I., Magalhães, P.M. and Queiroga, C.L. 1997. Influences of plantation density and cultivation cycle in root productivity and tenors of b-ecdysone in *Pfaffia glomerata* (Spreng.) Pedersen. In: Proceedings of the II World Congress on Medicinal and Aromatic Plants for Human Welfare, 10-15. Org. ICMAP-ISHS-SAIPA, Mendoza, Argentina.
- Nishimoto, N., Nakai, S., Takagi, N., Hayashi, S., Takemoto, T., Odashima, S., Kizu, H. and Wada, Y. 1984. Pfaffosides and nortriterpenoid saponins from *Pfaffia paniculata*. Phytochemistry 23(1): 139-42.
- Nishimoto, N., Shiobara, Y., Inoue, S., Takemoto, T., Akisue, G., Oliveira, F., Akisue, M.K. and Hashimoto, G. 1990. Ecdisteroides de *Pfaffia glomerata*. In: XI Simpósio de Plantas Medicinais do Brasil. Universidade Federal da Paraíba, João Pessoa, Brazil.
- Oliveira, C.M.F. de 1998. Estudo sobre a reprodução da fáfia [*Pfaffia glomerata* (Spreng.) Pedersen]. Master's Thesis, Universidade Federal do Paraná, Curitiba, Brazil. 92p.
- Romagnolo, M.B., Souza-Stevaux, M.C. and Ferrucci, M.S. 1994. Sapindaceae da planície de inundação do trecho superior do rio Paraná. Revista Unimar Maringá 16(supl. 3): 61-81.
- Rosa, M.C. 1997. Processo de ocupação e situação atual. In: Vazzoler, A.E.A.M., Agostinho, A.A. and Hahn, N.S. (eds.) A planície de inundação do Alto do Paraná, 371-94. EDUEM, Maringá.
- SEMA-PR (Secretaria de Estado do Meio Ambiente, Paraná) 1995. Lista vermelha de plantas ameaçadas de extinção no estado do Paraná. SEMA/GTZ, Curitiba. 139 p.
- Shiobara, Y., Inoue, S.S., Keato, K., Nishiguchi, Y., Oishi, Y., Nishimoto, N., Oliveira, F., Akisue, G., Akisue, M.K. and Hashimoto, G. 1993. A nortriterpenoid, triterpenoids and ecdysteroids from *Pfaffia glomerata*. Phytochemistry 32(6): 1527-30.

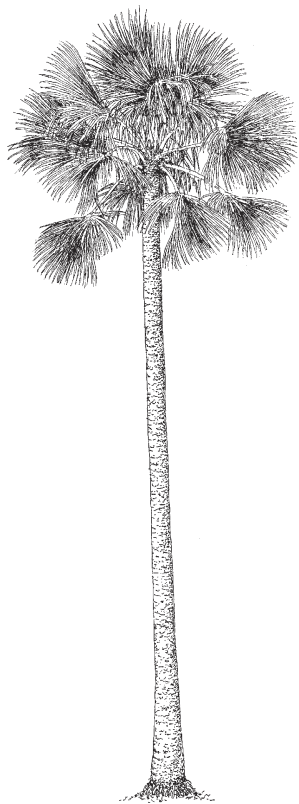
- Smith, L.B. and Downs, R.J. 1972. Amarantáceas. *In*: Flora ilustrada Catarinense, 35-50. Herbário Barbosa Rodrigues, Itajaí, Brazil.
- Souza, M.C., Cislinski, J. and Romagnolo, M.B. 1997. Levantamento florístico. *In*: Vazzoler, A.E.A. de M., Agostinho, A.A. and Hahn, N.S. (eds.) A planície de inundação do Alto rio Paraná: aspectos físicos, biológicos e socioeconômicos, 343-68. EDUEM, Maringá.
- Takemoto, T., Nishimoto, K., Shiobara, Y., Fujino, M. and Inoue, S. 1988. Analgesics containing 20-hydroxyecdysone and its extraction. Int. Cl A61K31/575//C07J 9/00. Jpn. n. PI 63002928 A. 20 June 1986, 7 January 1988. Patent Application. Kokai Tokkyo Koho v. 86/142959. 4p.
- Vasconcelos, J.M. de O. 1986. Amaranthaceae do Rio Grande do Sul-Brasil, V: gêneros *Pfaffia* Mart. e *Gomphrena* Mart. *Roesléria* 8(2): 75-127.

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Chapter 19

The Use of Guano Palm (*Sabal yapa* C. Wright ex Becc.) Leaf in the Quintana Roo Tourist Industry, Mexico

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(*Sabal yapa*)

Common name	Product part used	Dominant form of management	Degree of transformation	Commercial scale	Geographic distribution
Xaán Guano	Leaves	Wild	Low	National	Average/middle/half

ABSTRACT

Guano palm leaf (*Sabal* spp.) has been the principal roofing material for the Mayan Yucatecs. The use of *Sabal* palm, particularly *S. yapa*, in recent decades for the roofing of tourist installations on the Caribbean coast has created a potential market for this forest product. Ecological studies in the Xmaben Ejido, State of Quintana Roo, indicate that the resource is abundant and that the harvest is sustainable and compatible with the conservation of both species and forest. Even so, harvesting guano palm leaf has not significantly affected local socio-economic development. Recently, the small farmers involved decided not to sell any more leaf to ensure the resource's availability for domestic ends. In addition, the product's low price makes this economic activity unattractive to producers. Demand, itself limited, has declined drastically in the last two years as guano palm leaf became substituted by other materials. The case of the guano palm shows the fragility of markets for non-timber forest resources and that the persistence of conservative cultural attitudes can also limit the commercial exploitation of these resources.

INTRODUCTION

Guano palm (*Sabal* spp.) comprises an important multi-purpose plant resource that has significantly contributed to the subsistence of the Mayas of Yucatán for more than a thousand years (Caballero 1994). Over this time, this palm has provided complementary and emergency foods, forage, medicines, utensils, construction materials, raw material for handicrafts, and other various products for the household economy. Comparison of current ethnobiological information with available evidence from ethnohistory, archaeobotany, and ethnosemantics suggests that the use of guano palm goes back to the origins of the Mayan culture itself (Caballero 1991, 1992, 1993, 1994). Nevertheless, its role in the household economy, together with forms of its use and management, has changed over time as a result of complex interactions between sociocultural, demographic, and ecological factors (Table 1).

The use of mature guano palm leaf as roofing material for rural Mayan dwellings is an example of a pre-Hispanic use that has persisted to current times. Other traditional uses, however, have declined or disappeared. In contrast, new uses have arisen, particularly in the 20th century. For example, the use of immature leaves or shoots to make a wide variety of handicrafts. The disappearance of traditional uses of *Sabal* is associated with cultural change as Mayan Yucatecs become incorporated into the national society. The new uses, particularly that of shoots for handicrafts, are modifications of traditional forms of use that had been important on a local and family scale, and which had developed, in the last 4 decades, on a commercial scale, both regional and national. The growth of guano palm handicraft production has been associated with the growth of national and international tourism in Yucatán, the principal market of handicrafts.

Another traditional use of guano palm that was transformed or revitalized as a result of tourism is that of roofing. The tourist development of the Caribbean coast, which started in the 1970s in Cancún, included the

Table 1. Uses of species of *Sabal* palm in the Yucatán Peninsula, Mexico, and their current status

Use	Part used	Current status
Roofing	Mature leaf	Traditional; persistent
Handcrafts	Immature leaf	Modern; growing
Woven mats	Immature leaf	Traditional; disappeared
Hats	Immature leaf	Modern; declining
Brooms	Immature leaf	Modern?; declining
Fences	Petiole	Traditional?; declining
Construction posts	Trunk	Traditional?; declining
Seedbeds	Trunk	Traditional?; persistent
Fuel	Petiole	Traditional?; persistent
Food	Mature fruit	Traditional; declining
Food	Immature seed	Traditional; declining
Salt substitute	Mature leaf and trunk	Traditional?; declining
Amulet to accelerate delivery	Trunk	Traditional; disappeared
Antidote to snake bite	Trunk	Traditional; disappeared
Antidote to diarrhoea	Trunk and leaves	Traditional; disappeared
Remedy for ulcers	Trunk	Traditional; disappeared

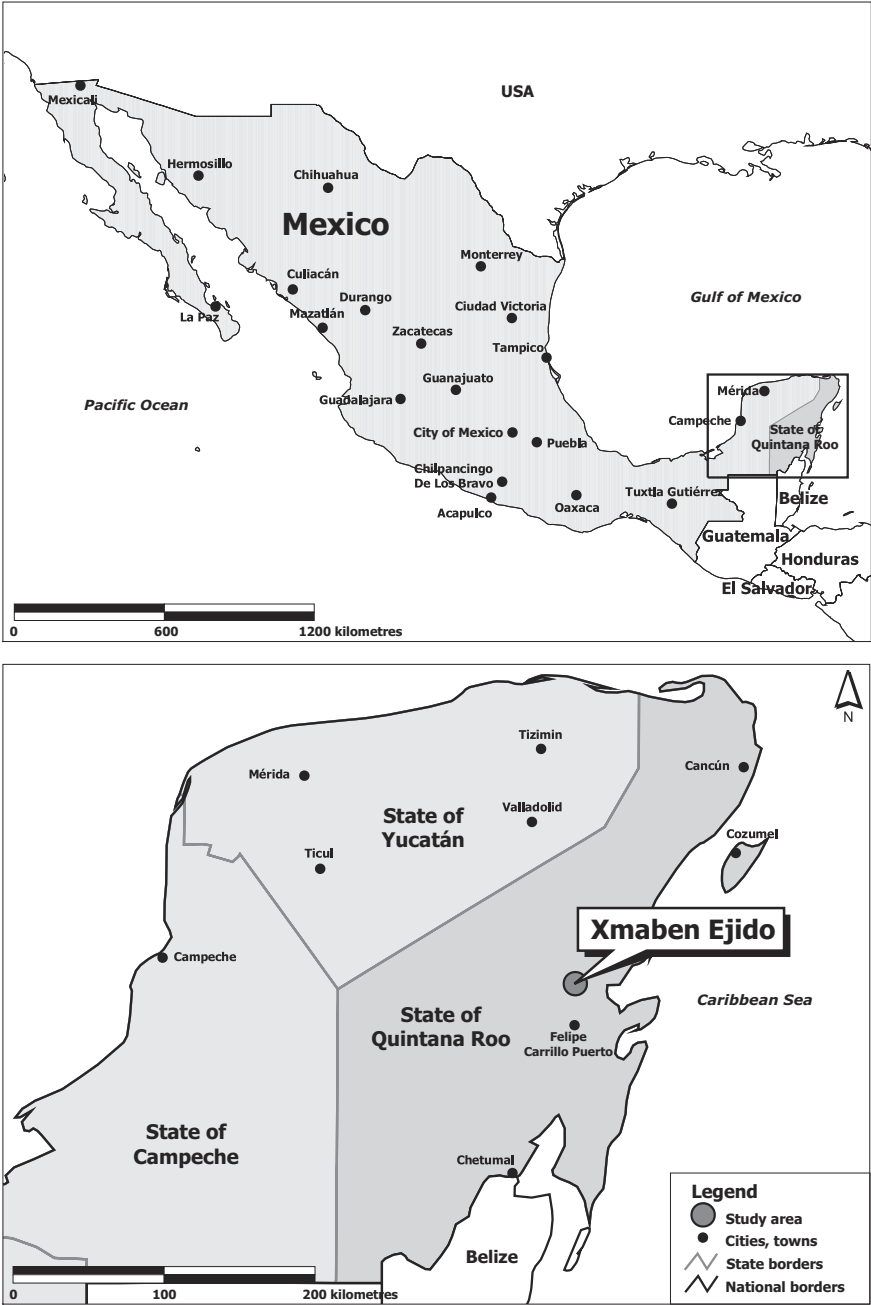
Source: Caballero (1994).

construction over 500 hotels and beach clubs in which the leaf was used as roofing, in a manner similar to traditional Mayan roofing, for different types of installations such as restaurants, bars, sunshades, and the local beach *palapas* (*lit.* thatched roofs)⁴. Thus, the tourist industry has become a potential market for a forest product that traditionally was used only for domestic consumption and which could represent a complementary source of income for Mayan farmers. The potential annual demand from the tourist industry for palm leaf cannot be estimated for lack of adequate censuses. Even so, the annual offer of palm leaf from major Mayan forest communities in central Quintana Roo is about 200,000 leaves, representing an income of about US\$16,000 for the Mayans.

In our case study on the extraction of guano palm leaf, we analyse its use in the tourist area of the Caribbean coast of Mexico. We describe the exploitation of guano palm leaf in the Xmaben Ejido, located in central Quintana Roo (state), Mexico, at 19°12'00" N and 88°6'00" W (Figure 1). The *ejido* or common land is a form of collective land tenure that arose in early 20th century in Mexico whereby the farmers are usufructuaries of the land, which remains the property of the nation. In areas with strong indigenous traditions, as in the case of the Mayans in central Quintana Roo, the *ejido* works as a *de facto* regime of community property, where the *ejido* assembly is the maximum authority who determines who shall access that land, and how (Challenger 1998).

The Xmaben Ejido was established in 1937 and was formed with Mayan populations from other localities of central Quintana Roo. The Ejido is

Figure 1. Study area of the guano palm industry, State of Quintana Roo, Yucatán Peninsula, Mexico



Source: ESRI Data and Maps 2002.

part of the Municipality of Felipe Carrillo Puerto. Paved roads enable easy communications with neighbouring towns and the principal cities of the Yucatán Peninsula. The Ejido has a total population of 2980, of which 2100 reside in the town of Señor (INEGI 2001). The other inhabitants live in Pino Suárez, Chanchén, and other small villages scattered throughout the Ejido. The estimated population growth rate is 3.08%, which is higher than the national average. However, this growth rate may decline through increasing emigration to the developing tourist areas along the Caribbean coast.

The Xmaben Ejido is located at 30 m above sea level and has a natural vegetation, formed mainly by rainy subtropical and subdeciduous forests. By being part of the karstic platform that comprises the Yucatán Peninsula, the area presents very stony soils (Lithosol) of low agricultural potential. The area has a subhumid warm climate with summer rains (García 1973). Annual precipitation is 1290 mm. The Ejido occupies 70,000 hectares. At present, only 33% of this area is covered by mature forest, most of which is severely disturbed by the intense extraction of fine timbers during the last 2 decades. The remaining 67% is occupied by a complex ecological mosaic of slash-and-burn agriculture, large areas of secondary forest, fallow land, and cropping land.

STUDY METHODS

This study is part of an ethnobiological research project on the sustainability of the traditional use and management of *Sabal* species in the Mayan area of the Yucatán Peninsula. From 1985 to 1994, ethnobotanic and historical studies were conducted on the cultural importance of this resource and the evolution of its forms of use and management (Caballero 1994). Since 1998, the Peninsula has been undergoing development (Martínez-Ballesté *et al.* 2001), and we are now conducting palm population studies to evaluate the ecological sustainability and technological efficiency of different traditional forms of guano palm management in the Mayan area of the Yucatán Peninsula. We are also obtaining information on the intensity of agrosilvicultural harvesting and management. We have therefore established study plots in family gardens, specifically in maize fields known as *milpas* and paddocks.

In the Xmaben Ejido, we recently initiated a study on the sustainability of managing *Sabal* spp. within the dynamics of slash-and-burn agriculture. We established 8 1-ha plots to conduct population studies. These plots include three in mature forests of more than 40 years old, three in secondary vegetation that was 5 to 15 years old, and two in *milpas*. These plots are representative of the ecological mosaic comprising the Xmaben Ejido and were selected according to Landsat satellite images, taken 9 February 2000 (Path 19, Row 46). In such plots, variables are being recorded such as production and harvest of leaves, survival, fecundity, and other parameters needed to estimate the growth rates of the targeted populations.

From a practical viewpoint, the studies on the guano palm are focused towards formulating a plan for sustainably managing this plant resource.

Information on the commercial use of the leaf was compiled between June 2000 and April 2001. We carried out interviews with 58 households

sampled at random through the method of probability proportional to size (Bernard 1994). Open interviews were conducted with buyers and the *ejido* authorities of the Xmaxben Ejido and three other *ejidos* in the region (Reforma, Santa Rosa, and Petkakab). We also interviewed leaders of nongovernmental organizations involved in the exploitation of the region's forest resources. Finally, we also travelled to Cancún and Cozumel to compile information on, and directly observe, the use of guano palm in the tourist industry.

THE PRODUCTION-TO-CONSUMPTION SYSTEM

The forest resource

Sabal is a genus of solitary hermaphrodite palms. They present collapsible aerial and occasionally underground trunks. Leaves are alternate, fan-shaped, and costapalmate. The genus is strictly Neotropical. It includes 15 species distributed in North America, Mexico, and the Antilles (Zona 1990). Four of these species are found in the Yucatán Peninsula. These are *S. yapa* C. Wright ex Becc.; *S. mexicana* Mart., *S. mauritiiformis* (Karsten) Grisebach & Wendl; and *S. gretheriae* Quero (Quero 1991, 1992). *Sabal yapa* is the most widely distributed species in the Yucatán Peninsula. It is found growing wild in evergreen and subdeciduous forests, and in the secondary vegetation derived from them. In general, all *Sabal* types are known as *xa'an* in Mayan, and as *palma de guano* in Spanish. Of the four species discussed, *S. yapa* is the only one found in the Xmaxben Ejido. Hence, our study refers exclusively to *S. yapa*.

The management of *Sabal* by the Mayan Yucatecs has evolved over time, not necessarily by substitution of one strategy for another, but through accumulation, coexistence, or integration over a broad range of situations that can be observed today in different parts of the Yucatán Peninsula. Central Quintana Roo is one of the few regions in the Yucatán Peninsula with significant areas—60% to 70%—under primary and secondary forests with low population densities, ranging from 4 to 6 inhab./km² (INEGI 2001). This means that, in places such as the Xmaxben Ejido, mature leaves of *S. yapa* are still collected from mature and secondary forests.

Elsewhere in the Mayan area, where forests have been almost totally eliminated, Mayan farmers manage guano palm in different ways: in the livestock region in northern Yucatán, *S. yapa* is promoted in paddocks. In several towns of northern Campeche and western Yucatán states, *S. mexicana* is cultivated in small plantations. In most of the Yucatecan Mayan area, including the Xmaxben Ejido, guano palm is tolerated and promoted in backyards and family gardens, or individual guano palms are left standing when a plot is established, or new individuals from palms of the same or neighbouring gardens are encouraged to establish and grow. Promotion practices consist mainly of an occasional sowing of seeds obtained from palms of the same garden, irrigation, and removal of dry leaves.

Changes occurring to guano palm management constitute adaptation to social, economic, and ecological factors, which operate differently in the various economic regions of the Yucatán Peninsula. This adaptation

has involved, especially where *Sabal mexicana* was introduced to western Yucatán (state), planting—an empirical process of technological innovation. This process responds to the diminishing availability of this resource, particularly in northern Yucatán Peninsula, as a result of population growth, rapid deforestation, and historical changes both in the regional economy and forms of land use (Caballero 1994).

Although *Sabal yapa* is a primary forest plant, it can develop in strongly disturbed environments. Mayan farmers take advantage of this characteristic by leaving individuals of *S. yapa* standing when opening up land to cropping. Although plantlets and small individuals may be eliminated, either deliberately or unintentionally, through agricultural practices, particularly burning or weeding, the juvenile and mature individuals respond positively to the conditions of increased sunlight of the disturbed sites, so that, in the long run, their populations can develop successfully (Zona 1990, Caballero 1994). Hence, the Xmaben farmers can harvest guano palm leaves from different patches of the fragmented landscape of the *ejido*, that is, not only from primary forest but also from *milpas* and secondary vegetation derived from slash-and-burn agriculture (Photo 1).

Photo 1. Harvesting a mature individual of guano palm (Photo: J. Caballero)



During harvest, the Mayan farmers take advantage of the population structure of *Sabal yapa*. Population studies conducted in various sites on the Yucatán Peninsula show that juvenile individuals are much more abundant than mature ones (Martínez-Ballesté *et al.* 2001). Mature individuals of 5 to 7 m tall are rarely harvested, as their thin trunks are too dangerous to climb. Moreover, a negative correlation appears to exist between the palm's age or height and the length of its leaves, and a positive correlation with leaf thickness. Thus, taller individuals have shorter and thicker leaves, which, although they last longer as roofing, are more difficult to manipulate and a larger quantity of them—at least one third more—is needed to cover one dwelling. Such leaf-quality criteria are applied as much for use in traditional housing as for tourist installations.

A mature palm may have between 7 and 12 leaves, whereas a young palm usually has 4 or 6. The Mayans always leave 1 to 3 leaves on the palm to ensure the plant's survival. Thus, Xmaben farmers usually harvest between 179 and 380 leaves of *S. yapa* per hectare every 6 months, depending on whether they are collected from the forest, secondary vegetation, or *milpa* (Table 2). Field studies indicate that a palm recovers its foliage within 6 to 9 months.

Table 2. Density of individuals of guano palm (*Sabal yapa*) and number of leaves harvested every 6 to 9 months per hectare according to three principal types of land use in the Xmaben Ejido. Estimates are based on three 1-ha plots of forest, three 1-ha plots of secondary vegetation, and two 1-ha maize fields (*milpas*)

Land use	Juvenile		Mature		Total	
	Individuals	Leaves	Individuals	Leaves	Individuals	Leaves
Forest	101	303	11	77	113	380
Second vegetation	86	258	10	70	96	328
Milpa	48	144	5	35	53	179

Sabal yapa grows slowly, and has a long life cycle. Individuals may live to 100 years or more. The time an individual takes to reach reproductive maturity in cultivated populations or family gardens is about 12 years. This period may be much longer in the forest and arboreal secondary vegetation, where shade conditions favour slow growth. Information compiled from Xmaben farmers and our field studies suggests that constant harvesting will drastically reduce the length of the aerial stem, thus significantly lengthening the period after which an individual can be harvested, whether for domestic use or commercial ends. Preliminary estimates indicate that harvesting may be conducted over 25 years or more.

If we take into account the distribution and structure of *Sabal yapa* populations and its rate of leaf production, the potential harvest of leaves in the Xmaben Ejido would be almost 23 million leaves each 6 to 9 months (Table 3). *Sabal yapa* can be harvested throughout the year. However, the Mayans

are accustomed to harvesting leaves for domestic use only in February to April, that is, in the dry season when agricultural tasks are fewer. This is also the period in which they prefer to cut leaves for commercial sale, although they may harvest leaves at other times of the year should a buyer request it.

Table 3. Potential leaf production from guano palm (*Sabal yapa*) every 6 to 9 months in the Xmaben Ejido, Yucatán Peninsula, Mexico. Areas not considered are those under irrigation agriculture or in family gardens in urban areas, where the abundance of the palm is insignificant.

Land use	Area		Harvestable individuals	Leaves
	km ²	%		
Forest	228.59	32.7	2,560,208	7,680,624
Secondary vegetation	449.77	64.4	4,317,792	14,752,456
Milpa (maize field)	20.05	2.9	106,265	358,895
Total	698.41	100.0	6,984,265	22,791,975

Although direct indicators are not yet available to measure current or potential impact of leaf harvesting on the wild populations of *Sabal yapa* in Xmaben, population studies conducted on other forms of management suggest that the exploitation of *S. yapa* in natural vegetation could be sustainable. With populations managed in gardens, paddocks, and *milpas* elsewhere in Yucatán, finite growth rates close to one (Table 4) were obtained. This indicates that the populations are stable and that management is efficient and environmentally sustainable under the current levels of demand for leaf. Based on the foregoing, and on the fact that the resource is readily available in Xmaben (Table 3), we can assume that neither the commercial exploitation nor household consumption currently represents an ecological impact on the resource.

Table 4. Rate of finite growth in four populations of guano palm (*Sabal yapa*), Yucatán Peninsula, Mexico

Locality ^a	Management	Density of harvestable individuals per hectare	Total density of individuals per hectare	λ (1998)	λ (1999)
Maxcanú (Y)	Garden 1	172	2446	1.010	0.9678
Maxcanú (Y)	Garden 2	310	2887	1.080	1.0800
Sucila (Y)	Paddock	103	2492	1.004	1.0400
Xkon Ha (QR)	Maize field	20	821	1.050	1.0400

^a Y refers to the State of Yucatán and QR to the State of Quintana Roo.

Source: Martínez-Ballesté *et al.* (2001).

Producers of *Sabal yapa* and their socio-economic context

The entire Xmaben population is indigenous, descending from the most traditional Mayans, who had, during the colonial period, escaped from Spanish

domination and sought refuge in the jungles of Quintana Roo (Villa Rojas 1945, 1962, 1978). In the 19th century, they rebelled against the government and the Yucatecan mestizo society, unleashing a movement that became known as the 'Caste War of the Yucatán'. The present Mayans of Xmaben are still culturally very conservative and manifest a certain rejection and mistrust of the national society. As with other Mayan populations of Quintana Roo, the inhabitants of Xmaben not only maintain their indigenous tongue but also some pre-Hispanic rites such as rainmaking ceremonies led by local shamans. They also maintain politico-religious cult institutions based on the Christian cross, and which are structured in such a way as to remind of their military organization during the Caste War.

The local economy is subsistence, being based on *milpa* cropping under the slash-and-burn system. Most of the *ejidatarios* (household heads with shared land rights in an *ejido*) cultivate 2 to 4 hectares per year, with an average of 3.67 ha per family (Table 5). As in other traditional Mayan populations (Terán & Rasmussen 1992), agriculture is combined with other activities such as the occasional extraction of timber and guano palm leaf from the forest, hunting, bee keeping, and temporary paid work outside the Ejido, mostly in the tourist area of the Caribbean coast.

Table 5. Area cultivated under maize fields (*milpas*) in a sample of 35 households in the Xmaben Ejido, Yucatán Peninsula, Mexico

Area per <i>milpa</i> (ha)	Number of families	% of total area
0.1-2	4	10.8
2.1-4	22	59.5
4.1-5.9	5	13.5
6-8	4	10.8
>8	2	5.4

The *milpa* is a polyculture of maize (*Zea mays* L.), beans (*Phaseolus* spp.), chilli (*Capsicum* spp.), sweet potato [*Ipomoea batatas* (L.) Poir], cassava (*Manihot esculenta* Crantz), and others crops (Pérez Toro 1942, Redfield & Villas Rojas 1962, Villas Rojas 1978, Arias Reyes 1980, Hernández Xolocotzi *et al.* 1990, Hernández Xolocotzi 1992, Colunga & May 1992, Ku 1992, Gutiérrez 1993). As has been discussed by several authors, *milpa* cropping is not only the basis of the domestic economy, but also the element that defines Mayan ethnic identity, so that 'to be Mayan is to be *milpero*' (Thompson 1974, Annis 1987, Re Cruz 1996). The subsistence and cash economy of the Mayan family are also complemented by a great diversity of fruits and other products obtained from family gardens.

For their type, the Mayan family gardens probably comprise one of the most complex and sophisticated agroforestral systems in the world (Vara 1980, Rico-Gray *et al.* 1990, Caballero 1992, Herrera *et al.* 1993, Herrera 1994). The guano palm, particularly *Sabal yapa*, is one of the characteristic elements of

these agroforestral systems throughout the Yucatecan Mayan area (Caballero 1992, 1993, 1994, Martínez-Ballesté *et al.* 2001).

The typical Mayan household is formed by the nuclear family, which, in the Xmaben Ejido, has an average of 7 members. Guano palm leaf is harvested exclusively by men, usually the father, with occasional help from the older children. Leaf harvesting for domestic purposes is often carried out on an individual basis. In contrast, harvest of leaves for sale is carried out by groups of volunteers.

No formal organization of Mayan farmers exists for leaf harvest and marketing. Usually, when a seller comes to the Ejido in search of leaf, the Ejido's commissary, who is the community's maximum authority, convenes an assembly to obtain agreement from the *ejidatarios*. At this assembly, the *ejidatarios* also volunteer to do the harvesting. They usually organize themselves into groups of 4 to 10. Less than 15% of the Xmaben *ejidatarios*, about 30 people, tend to participate in this type of work.

An *ejidatario* probably cuts an average of 200 leaves per day. Generally, each time a leaf sale is made, an *ejidatario* works for 7 days. During 2000, 15,000 leaves were cut for sale, which meant a total of 75 workdays. The investment of work was 2 days per person per hectare per year. During 2000 and early 2001, the price of one leaf was US\$0.08, so that an *ejidatario* could earn up to \$16 per day and thus \$112 for the 7 days. Although this profit can be important, given the low level of local income and relatively low cost of living in Señor (Table 6), it is also a highly sporadic income. Sometimes, a leaf sale is carried out only once a year. Thus, the impact of this activity on the standards of living of participants and local economy is virtually insignificant. Occasionally, a buyer will bring his own cutters and pay the community only for the right to cut, which is equivalent to 30% of the commercial value of the harvested leaves. When this money is distributed among community members, such income becomes very small. Hence, this money often goes to the budget of the *ejido* authorities or to a work for the common good.

Table 6. Distribution of family income in the Xmaben Ejido, based on a sample of 48 domestic units, Yucatán Peninsula, Mexico

Annual income (USD)	Number of families	%
<1000	23	48.9
1000-2000	13	27.1
2000-5000	8	16.6
>5000	3	6.25

Recently, the Ejido assembly decided not to continue selling leaf as members thought this would compete with the use of this resource for domestic ends. Given the very conservative nature of the Xmaben Mayans' culture, living in a house with a roof of guano palm leaf is not only considered desirable from a practical viewpoint, but it is also part and parcel of the

definition of Mayan identity. Thus, the availability of the resource for local use must be guaranteed over and above the monetary benefits that would be obtained from their commercial sale.

Processing

Sabal yapa leaves require minimal processing for sale to the end consumer. Farmers simply tie bundles of about 20 leaves each on the harvest site and then transport them, either on foot or tricycle, to different points along the road from where the bundle are collected by the buyer or carrier. During the dry season, the leaves can last for 5 months before being put on a roof. If, however, they are harvested during the rainy season they may last about 5 days and must be put out to dry in the sun before being placed on the roof. For traditional houses, the farmers do the roofing, either individually or in groups. For tourist installations, people known as *palaperos* do the thatching, either on a part-time or full-time basis. The Xmaben Ejido itself has no *palaperos*, although the region has several.

Tourist installations are roofed in the same way as for Mayan traditional housing. Green leaves can be placed immediately. If the leaves are already dry, they are customarily watered to soften them for easier handling. To roof a building, a leaf is inserted every three 'tins' or crosspiece of the roof's wooden structure. For this, the leaf is placed with the petiole pointing upwards. The leaf blade is separated in three parts with the hands, leaving the keel and a few adjacent segments in the centre. The leaf is then inserted between three adjacent tins passing the keel under the first one, over the second, and under the third. The lateral parts of the leaf are inserted in the opposite way. The leaves throughout a group of three parallel tins are placed side by side, pressing firmly against each other to prevent water infiltration. Again, to prevent water infiltration, each leaf row is superimposed on the previous one, starting from the lowest part of the roof. When the roof is finished, the ends of the leaves are cut to give a uniform appearance.

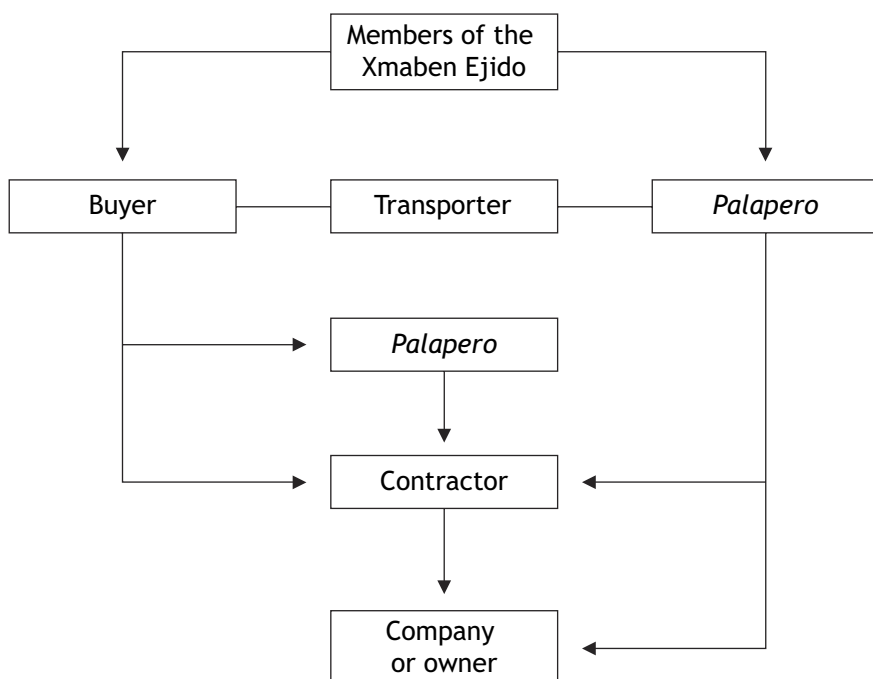
Trade and marketing

The market for guano palm leaf is little structured, with marketing chains existing in different ways. Some traders are dedicated to buying timber and guano palm leaf from the region's *ejidos*. One of these traders, living in Señor, is a member of the Xmaben Ejido. Such traders frequently contact builders and *palaperos* who are seeking leaf and timber or poles needed for a rustic installation. In others cases, the *palaperos* themselves go directly to the *ejidos* to purchase and sometimes cut leaves. All leaves sold in the region have as their final destinations Isla Mujeres, Playa del Carmen, Cancún, and other tourist sites on the Caribbean coast of Quintana Roo. Owners of small establishments such as beach clubs, restaurants, and stores often directly contract the *palaperos*. In contrast, large establishments, especially hotels and luxury restaurants, mostly the property of multinational companies, hire contractors to acquire materials and labour, and oversee the building. These contractors visit *ejidos* to buy leaf. An order is usually supplied by one *ejido*.

In addition to Xmaben, seven other *ejidos* exist in the region where leaf is commercially cut from guano palm forests. Three are affiliated with the Sociedad de Productores Forestales Ejidales de Quintana Roo [*Quintana Roo Society of Producers in Common Land Forests*], while Xmaben and four other *ejidos* are affiliated with the Unión Nacional de Organizaciones Regionales Campesinas Autónomas (UNORCA or *National Union of Autonomous Regional Farmers' Organizations*). Both are nongovernmental organizations that provide technical advisory services and coordinate the exploitation and marketing of timber forest resources. Recently, these organizations have begun participating in the sale of guano palm leaf, although the *ejidos* also carry out this activity independently.

The price of palm leaf increases significantly when it arrives at its destination. In Xmaben, a leaf costs US\$0.08, whereas at its end destination it may cost as much as \$0.25. This increase results from travel expenses and payments to federal authorities for permissions to exploit, with payments being made in the regional offices of the national government. Transport is normally by trucks capable of carrying between 8000 and 9000 leaves. A trip to Playa del Carmen or Cancún may cost about \$400. If the end destination is an island in the area, costs may increase by an extra \$280 for the use of the ferry.

Figure 2. Marketing chains for guano palm leaf (*Sabal yapa*) used as roofing for tourist installations, Yucatán Peninsula, Mexico



The volumes of leaf used in the tourist constructions depend on the type and size of the construction, and on the size and category of establishment (Table 7). On average, the establishments that most use leaves are the beach clubs, which offer access to the beach and provide services such as restaurants, bars, beach umbrellas, chairs, and lounge chairs. Usually, such establishments have all their roofing done in guano palm leaf. Although hotels are the most numerous establishments and usually provide all the facilities of

Table 7. Number of leaves used as roofing for different types of buildings in a sample of beach clubs and hotels in Cancún and Cozumel, State of Quintana Roo, Mexico.

Type of construction	Number of leaves used	
	Range	Leaves
Beach clubs	11,200-120,000	61,569
Hotels	6,000-56,100	26,650
Restaurants	3,000-20,600	8,475

Photo 2. Transporting guano palm leaf for commercial sale
(Photo: J. Cabellero)



beach clubs, they least use guano palm leaf. Altogether the volume of leaves used by different types of establishments can be very large. For a sample of 16 different types of establishments, the number of guano palm leaves recorded was 446,928, which represents about 1176 ha of forest or 1362 ha of secondary vegetation.

Political and institutional aspects

Legislation and the definition of environmental policies related to the exploitation of forest resources, particularly the non-timber type, are very recent in Mexico. In the last 6 years, official regulations have been prepared for the exploitation of some of these resources, including guano palm leaf. These regulations are still very general, partly because of a lack of sufficient technical information. Moreover, their application is sometimes hampered by the lack of a clear and adequate legal framework. For guano palm leaf, however, the development of the Mexican Official Regulation (NOM-006-RECNAT-1997), which establishes procedures, criteria, and specifications for exploiting, transporting, and storing guano palm leaves, has contributed positively to regulating the exploitation of this resource and preventing its over-exploitation.

After constitutional reform and as part of the process of orienting the Mexican countryside towards commercial agriculture (Challenger 1998), a process of converting *ejidos* to a small-property regime was begun in 1992. Such conversion implies the parcelling and granting of individual titles for land property. This opened up the possibility of land sales and, accordingly, the breakdown and disappearance of collective forms of decision and land use, which, according to some authors, would have serious environmental consequences (Carabias *et al.* 1994). In the indigenous areas, however, the process has been slow and, in the case of the Xmaben Ejido, openly opposed. Indeed, the Ejido assembly has retained the regime of common land property, which was foreseen by the new agrarian legislation. Hence, no short-term changes can be expected in the regime of land tenure and usufruct that would significantly alter the availability of guano palm leaf.

TRENDS AND PROSPECTS

After an initial growth in the 1980s and 1990s, the commercial exploitation of guano palm leaf has begun to diminish and will probably disappear soon in Quintana Roo. This is because of decisions made by the producers themselves and market changes. Despite the positive evaluations of the resource that were carried out by a forest technical advisory service to the Ejido, the assembly decided to stop commercial exploitation of the leaf in 2001. According to the Ejido, this decision was made to prevent exhaustion of the resource and guarantee its availability for local use. The *ejidatarios* see the resource as being very limited and presume that the volume of leaf sales is such that local supplies may be endangered. Moreover, they consider that the cash income from the trade does not justify the risk of having to replace guano palm leaf with other materials as roofing for traditional dwellings.

Xmaben farmers consider that the guano palm leaf roof provides a fresh and pleasant room. Moreover, such a roof is also regarded as an element of Mayan identity. Even so, our ecological studies suggest that cancelling leaf sales was an unnecessary measure, and that sufficient resources exist to fulfil both local and potential market demand. The total number of guano palm leaves used in the houses and other constructions currently existing in the Xmaben Ejido is almost 2 million leaves. Annually, these roofs must be replenished either partially or totally. We have estimated a replenishment rate of 129,000 leaves per year for the entire Ejido. This demand can be amply fulfilled with the resources available in the Ejido according to our estimates of the potential annual leaf production (Table 3).

Currently, no statistics are available to describe and evaluate the marketing patterns of the guano palm leaf. Even so, interviews with merchants and producers, and direct observations carried out in the Caribbean tourist area indicate that the guano palm leaf has lost most of its market, especially since 2000. Thus, the *ejidos* belonging to the Quintana Roo Society of Producers in Common Land Forests sold a total of 15,000 leaves by 2000, whereas, in previous years, annual sales had reached 70,000 leaves. The fall in the market is due mostly to the substitution of guano palm leaf by species of grass known locally as *zacate*⁵, particularly in the last 2 years. Although *zacate* is also obtained from natural vegetation in several sites in central Quintana Roo, Mayan farmers rarely use it as roofing for their traditional dwellings. When comparing the proportion of tourist establishments on the beaches of Cancún and Cozumel for materials used as roofing, *zacate* is currently more significant than guano palm leaf.

The trend of substituting guano palm leaf by *zacate* is related to the category of establishment, particularly in the case of hotels (Table 8). In our sample, none of the hotels in the highest category (six-star) and only a few of the five-star hotels used guano palm leaf, preferring *zacate*. In contrast, the analysis of adjusted residuals (Haberman 1973) indicated that four-star hotels used guano palm leaf significantly more than they did *zacate* (Table 8). The producers, merchants, and *palaperos* who were interviewed say that *zacate* does not last as long as guano palm leaf, is more expensive, and is more difficult to work with. Yet, architects, contractors, and owners of establishments—most of them being foreigners or mestizo Mexicans from

Table 8. Comparing the use of guano palm (*Sabal yapa*) leaf and *zacate* grass as roofing material in a sample of 25 beach hotels in Cancún and Cozumel, State of Quintana Roo, Mexico. The highest tourism category corresponds to six stars in this analysis.

Category (number of stars)	Hotels with guano		Hotels with <i>zacate</i>		Total
	Number	Adjusted residuals	Number	Adjusted residuals	
4	3	2.5	2	-2.5	5
5/6	2	-2.5	18	2.5	20
Total	5		20		25

the country's principal cities—increasingly prefer *zacate* to guano palm leaf on aesthetic grounds. The smoother and more uniform appearance of *zacate* roofs is more pleasing, especially to contractors, probably because it conforms better to the stereotyped image of 'tropical paradise' of the Mexican Caribbean that multinational tourist companies offer. The greater use of guano palm leaf by lower-category establishments is apparently due to the owners usually being small business nationals, many of whom originate in the Yucatán Peninsula and who make their own decisions for their establishments and directly deal with the workers and suppliers of materials, particularly sellers of guano palm leaf and *palaperos*.

Despite the trends described above, guano palm leaf still has commercial potential. A campaign promoting the resource, based on its long history of use by the Mayan culture, may be able to reverse the trend of substitution of this resource with *zacate*. This campaign could be developed by both governmental agencies linked to the tourist industry and nongovernmental organizations interested in developing plans for managing and marketing non-timber forest resources and which are active in central Quintana Roo. Currently, interest is growing in developing projects of this type in the Mayan forest communities of this region. Both local communities and nongovernmental organizations recognize the guano palm leaf as being a resource of potential value.

IMPLICATIONS FOR CONSERVATION AND DEVELOPMENT

As indicated by our ecological studies, the resource is abundant and harvest practices are sustainable and compatible with the conservation of both *Sabal yapa* and forest. Despite its commercial potential, the harvest of guano palm leaf has not had a significant impact on local socio-economic development. Although the cost of the leaf triples along the marketing chain, the product's final price is too low to represent an attractive economic activity for producers and merchants. Limited demand has also contributed to the marketing chain being little developed, aggravated by the progressive substitution of guano palm leaf by *zacate*. This grass is scarce and has no traditional use in Xmaben or other *ejidos* in the region.

The recent decline in the use of guano palm leaf in the Quintana Roo tourist industry shows that the market of non-timber forest resources can be very fragile, especially when linked with multinational companies. The exploitation of this type of resource thus becomes seen as an economic activity of poor viability, meaning that, in many cases, it is merely complementary, or even marginal, to the subsistence economy of Mayan farmers. As shown by the case of the Xmaben Ejido, the persistence of local cultural traditions can also limit the development of forms of commercial use of forest resources, especially when commercial use competes with local use. Toledo *et al.* (1985) suggest that the rationality of the rural economy in indigenous areas of Mexico gives more value to use than to change so that the rural producer tends to carry out production that does not threaten the possibility of renewing ecosystems.

NOTES

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4. *Palapa* is a rustic construction with no walls. Its roof, used to protect from the sun, is made of plant materials.
5. So far we have only been able to collect sterile specimens of these plants, which means that the botanical species have not yet been identified.

REFERENCES

- Annis, S. 1987. God and production in a Guatemalan town. University of Texas Press, Austin, TX.
- Arias Reyes, L.M. 1980. La producción milpera actual en Yaxcaba, Yucatán. In: Hernández Xolocotzi, E. and Padilla Ortega, R. (eds.) Seminario sobre producción agrícola en Yucatán, pp. 25-50. Gobierno del Estado de Yucatán, Mexico.
- Bernard, H.R. 1994. Research methods in anthropology: qualitative and quantitative approaches. SAGE Publications, Thousand Oaks, CA.
- Caballero, J. 1991. Use and management of *Sabal* palms among the Maya of Yucatan: a case of technological innovation based on the folk biological knowledge. In: Rhoades, R.E., Sandoval, V.N., and Bagalanon, C.P. (eds.) Best Paper Awards 1990, pp. 13-23. International Potato Center (CIP) and Users' Perspectives With Agricultural Research and Development (UPWARD), Manila, Philippines.
- Caballero J. 1992. The Maya home gardens of the Yucatan Peninsula: past, present and future. *Etnoecológica* 1(1): 35-54.
- Caballero J. 1993. El caso del uso y manejo de la palma de guano (*Sabal* spp.) entre los Mayas de Yucatán. In: Leff, E. and Carabias, J. (eds.) Cultura y manejo sustentable de los recursos naturales, pp. 203-248. CII-Universidad Nacional Autónoma de México (UNAM) and Grupo Editorial Miguel Angel Porrua, Mexico.
- Caballero J. 1994: Use and management of *Sabal* palms among the Maya of Yucatan. PhD dissertation. University of California, Berkeley, CA.
- Carabias, J., Arriaga, V., and Cervantes, V. 1994. Los recursos naturales de México y el desarrollo. In: Moncayo, P.P. and Woldenberg, J. (eds.) Desarrollo, desigualdad y medio ambiente, pp. 303-345. Cal y Arena, Mexico.
- Challenger, A. 1998. Utilización y conservación de los ecosistemas terrestres de México: Pasado, presente y futuro. Comisión Nacional para el Conocimiento y Uso de la Biodiversidad (CONABIO), Universidad Nacional Autónoma de México (UNAM), and Agrupación Sierra Madre, Mexico.

- Colunga, P. and May, F. 1992. El sistema milpero y sus recursos genéticos. In: Zizumbo, D. *et al.* <<these editors' names ideally should be spelled out>> (eds.) La modernización de la milpa en Yucatán: Utopía o realidad, pp. 97-134. Mérida, Yucatán, Mexico.
- García, E. 1973. Modificaciones al sistema de clasificación climática de Köppen. Instituto de Geografía, Universidad Nacional Autónoma de México (UNAM), Mexico.
- Gutiérrez, J.A. 1993. Agricultura de roza y dinámica demográfica en una comunidad Maya. *Etnoecológica* 1(2): 35-47.
- Haberman, S.J. 1973. The analysis of residuals in cross-classified tables. *Biometrics* 29: 205-220.
- Hernández Xolocotzi, E. 1992. Racionalidad tecnológica del sistema de producción agrícola de roza-tumba-quema en Yucatán. In: Zizumbo, D. *et al.* (eds.) La modernización de la milpa en Yucatán: Utopía o realidad, pp. 187-194. Mérida, Yucatán, Mexico.
- Hernández Xolocotzi, E., Arias, L.M., and Pool, L. 1990. El sistema agrícola de roza-tumba-quema en Yucatán y su capacidad de sostenimiento. In: Rojas, T. (ed.) Agricultura indígena: Pasado y presente, pp. 59-68. Ediciones de la Casa Chata and Centro de Investigaciones y Estudios Superiores en Antropología Social (CIESAS), Mexico.
- Herrera, N.D. 1994. Los huertos familiares Mayas en el Oriente de Yucatán. *Etnoflora Yucatanense*, 9. Universidad Autónoma de Yucatán, Mérida, Yucatán, Mexico.
- Herrera, N.D., Gómez-Pompa, A., Cruz Kuri, L., and Flores, J.S. 1993. Los huertos familiares Mayas en X-iulub, Yucatán: Aspectos generales y estudio comparativo entre la flora de los huertos familiares y la selva. *Biotica*, Nueva Época 1: 19-36.
- INEGI (Instituto Nacional de Estadística, Geografía e Informática). 2001. Quintana Roo: Tabulados básicos, resultados definitivos censo general de población y vivienda 2000. Mexico.
- Ku, R. 1992. La milpa yucateca y sus innovaciones técnicas. In: Zizumbo, D. *et al.* (eds.) La modernización de la milpa en Yucatán: Utopía o realidad, pp. 267-280. Mérida, Yucatán, Mexico.
- Martínez-Ballesté, A., Caballero, J., Gama, V., Flores, S., and Martorell, C. 2001. Sustainability of the traditional management of *xa'an* palms (*Sabal* spp., Arecaceae) by the lowland Maya of Yucatán, Mexico. *Proceedings of the VII International Congress of Ethnobiology*. University of Georgia Press, Athens, GA.
- Pérez Toro, A. 1942. La milpa. Publicaciones del Gobierno de Yucatán, Mérida, Yucatán, Mexico.
- Quero, H.J. 1991. *Sabal gretheriae*, a new species of palm from the Yucatán Peninsula, Mexico. *Principes* 35(4): 219-224.
- Quero, H.J. 1992. Las palmas silvestres de la Península de Yucatán. *Publicaciones Especiales* 10. Instituto de Biología, Universidad Nacional Autónoma de México (UNAM), Mexico.
- Re Cruz, A. 1996. The two milpas of Chan Kom: a study of socioeconomic and political transformations in a Maya community. State University of New York Press, NY.

- Redfield, R. and Villa Rojas, A. 1962. Chan Kom: a Maya village. University of Chicago Press, IL.
- Rico-Gray, V., García-Franco, J.G., Chemas, A., Puch, A., and Sima, P. 1990. Species composition, similarity, and structure of Mayan home gardens in Tixpeul and Tixcacaltuyub, Yucatán, Mexico. *Economic Botany* 44(4): 470-487.
- Terán, S. and Rasmussen, C. 1992. La milpa bajo roza-tumba-quema en el siglo XVI. In: Zizumbo, D. *et al.* (eds.) *La modernización de la milpa en Yucatán: Utopía o realidad*, pp. 29-52. Mérida, Yucatán, Mexico.
- Thompson, R.A. 1974. *The winds of tomorrow: social change in a Maya town*. University of Chicago Press, IL.
- Toledo, V.M., Carabias, J., Mapes, C., and Toledo, C. 1985. *Ecología y autosuficiencia alimentaria*. Siglo XXI Editores, Mexico.
- Vara, A. 1980. La dinámica de la milpa en Yucatán: El solar. In: Hernandez Xolocotzi, E.J. and Padilla y Ortega, R. (eds.) *Seminario sobre producción agrícola en Yucatán*. Gobierno del Estado de Yucatán, Mexico.
- Villa Rojas, A. 1945. *The Maya of east central Quintana Roo*. Pub. 559. Carnegie Institution of Washington, DC.
- Villa Rojas, A. 1962. Notas sobre la distribución y estado actual de la población indígena de la Península de Yucatán, México. *América Indígena*, 22(3): 209-240.
- Villa Rojas, A. 1978. *Estudios etnológicos: Los Mayas*. Universidad Nacional Autónoma de México (UNAM).
- Zona, S. 1990. A monograph on *Sabal* (Arecaceae: Coryphoideae). *Aliso* 12(4): 583-666.

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Chapter 20

Amate, Mexican bark paper:
resourceful harvest strategies to meet
market demands

Citlalli López¹



(*Trema micrantha*)

Common name	Product part used	Dominant form of management	Degree of transformation	Commercial scale	Geographic distribution
Jonote	Bark	Managed	Average/ middle/half	International	Wide

ABSTRACT

The indigenous handmade paper amate has been manufactured in Mexico since pre-Hispanic times and is being distributed as handicraft since the end of the 1960s. Otomi artisans living in the mountainous Sierra Norte de Puebla manufacture amate, while numerous traders commercialise it nationally and internationally. Right from the early days of commercialisation, a persistent market demand has driven distinct changes from the constant diversification of paper types and trading options, to involvement of new and more social actors engaged in bark harvest and paper manufacture, decoration, and trading, to the constant adaptation to new forms of work organisation.

As market demand rises there are increasing pressures on tree resources so as to augment the bark supply. Three main processes have occurred in the Sierra Norte de Puebla in order to satisfy the demand for bark raw material: a) incorporation of an increasing number of harvesters; b) constant search for, and adoption of, new tree species to supply bark; and c) the gradual spatial expansion of the harvest area. The survival of this indigenous industry, previously expected to disappear because of the scarcity of raw material, is now based on a new tree resource use strategy that relies on the exploitation of *Trema micrantha* growing as shade trees in coffee plantations, the third most important land use of the Sierra Norte de Puebla.

INTRODUCTION

Production of handmade bark paper for commercial purposes started at the end of the 1960s through the merger of two indigenous traditions, that of the Otomi people, who produce the bark paper, and that of the Nahua people, who decorate it with colourful paintings (Plate 1). A number of qualities make amate one of the best known Mexican souvenirs: the paper sheets are easy to transport, they are fairly inexpensive compared to other handicrafts, and they meet popular tastes, particularly of tourists attracted to their texture and the colourfulness of the paintings.

Otomi artisans are settled in San Pablito, a village located in the Sierra Norte de Puebla (Figure 1). Traditionally the Otomi debarked trees growing within their territory. Today, however, the supply depends on harvesters of the Sierra Norte, who gather the resource from an expanding harvest area of around 1500 km². In the early stages of amate commercialisation, the entire Otomi paper production was sold to Nahua artisans living in Guerrero state (Figure 1), but in recent years, has greatly diversified in terms of variety and market opportunities. Nahua artisans still consume about half of all Otomi bark paper, while the other half is sold in different markets. At present, amate is sold directly to end-consumers by Otomi and Nahua artisans and indirectly through a great array of arrangements with wholesalers and intermediaries at local, regional, and national levels.

Throughout the production of this handicraft, only the Otomi of San Pablito, the sole bark paper producers in Mexico, have manufactured amate. Paper painting has spread to eight Nahua villages, all of which are actively involved in the decoration of bark paper. If the whole amate commodity chain is observed, it appears that, while the two extremes of the chain—

Figure 1. Bark harvest area and handicraft processing areas



Source: ESRI Data and Maps 2002.

bark extraction and paper trading—have diversified, the Otomi of San Pablito continue to control the manufacture. No other village in or in other states, has imitated this Otomi commercial endeavour. Perhaps the hurdle of initial investment, the high level of commercial competition, and especially the Otomi's keen protection of their knowledge and traditions have played major roles in this aspect.

Bark paper has two distinct values in San Pablito: as a market product and as a sacred object. Both types of paper, commercial and ritual, are manufactured in the same way, but they are used distinctly. Paper figures acquire sacred value only when Otomi shamans confer strength to them through the cutout technique and their word. The paper figures represent different Otomi divinities or, in the case of healing ceremonies, the person to be treated (Galinier 1987). The ritual use of bark paper is keenly preserved but at the same time also dynamically reinterpreted for commercial purposes, so that, within the new Otomi paper diversification, cutout paper figures representing the divinity of the spirits of seeds from tomato to coffee to orange are sold in the market (Plate 2).

Historical background of amate

The manufacture and use of amate by Maya people in the south of Mexico's Yucatan dates back to about 500 A.D. (Lenz 1973). Between 1100 and 1300 the Aztecs, a flourishing pre-Hispanic culture, used it extensively in rituals, decorations, offerings, ceremonial costumes, and as tribute (Seeman 1990). Amate constituted the base, being the actual paper, of the pictorial manuscripts called *Codice*, in which history, religion, and culture were recorded and described. Annually Tenochtitlan, the centre of the Aztec nation, received about 48,000 sheets of amate produced in 42 tributary villages (Lenz 1973).

When the conquest territory started, the Spaniards forbade the elaboration and use of amate so as to suppress historical records and ritual traditions. Their domination, however, could not achieve a homogeneous imposition of Spanish laws, traditions and religion. Some ethnic groups, like the Otomi, showed resistance and covertly preserved their rituals. The Otomi of the Sierra, one of the few indigenous groups not dominated by Aztecs, were independent before the arrival of the Spanish. The Spaniards eventually overcame Otomi resistance as well as the significant geographical obstacles found in the Sierra Norte de Puebla.

The Sierra Norte de Puebla continually received migrants from various ethnic groups throughout the fifteenth century and the early years of the Spanish colonial period. Around 1500, when the Aztecs started to overwhelm the eastern part of the Mexican territory, the Otomi established themselves in this region. During the Spanish period the sierra became a refuge for indigenous people who lived in independent villages claiming the right to their own lands. A long time passed before the Spaniards could control the region and establish the first parochial churches.

It is unknown how the Otomi came to manufacture bark paper but, according to some colonial chronicles and studies (Galinier 1987), they used cutout amate figures profusely in rituals, especially for health cures. The

Otomi reputation as practitioners of sorcery made them feared by neighbours both before and after the Spanish conquest (Christensen 1963, Sandstrom and Sandstrom 1986).

Background of the study

The results presented here form part of a doctoral research focused on bark harvest strategies. The initial questions include the sources of bark, who the harvesters are, and how they carry out their work. The information was obtained during one year (1999-2000) of fieldwork in San Pablito and several bark harvest sites. A combination of methods derived from ethnography, ethnobotany, and forest sampling techniques was applied. Since this study focuses on bark harvest strategies, only some directly linked aspects of Otomi amate production were taken into account, and later phases of the commodity chain were not considered. Therefore, for the current quantitative analysis, the data related to marketing, trading, and processing phases are rather partial, especially regarding the total trade in finished products and the number of traders. If the whole commodity chain were taken into account, these would definitely reach higher proportions. Quantitative estimates are based largely on field observations, interviews, crosschecks of social actors' testimonies, and, whenever possible, bibliographic sources.

For the quantitative analysis of the World Comparison of NTFPs-CIFOR, the entire bark harvest area of approximately 1500 km² was considered. Bark harvesters display a variety of harvest strategies and move across extensive areas that are difficult to delimit. The selection of a sub-area would have confined the research to one form of harvesting, so it appeared more appropriate to estimate average conditions rather than set a limit of one sub-area. Yet it is unlikely that the entire range of strategies displayed by harvesters and Otomi artisans is reflected in the quantitative analysis. From the 13 species used as source of bark raw material only the most extensively used, *Trema micrantha* (L.) Blume, was included in the quantitative analysis.

AMATE PRODUCTION

Regional environment

The bark harvest area and San Pablito are located in the Sierra Norte de Puebla. This region lies along the eastern slopes of Sierra Madre Oriental Province. Physiographically this province consists of folded ridges, elongated intermontane valleys, and plateaus of sedimentary origin. The Sierra Norte de Puebla is a transitional region between the high central plateau of Mexico and the low-lying lands towards the coast of the Gulf of Mexico, presenting great variations in elevation, relief, temperature, and vegetation. The Sierra Norte is subdivided into three subregions (Fuentes 1972), and the harvest area lies between the rugged high sierra, consisting of deep, narrow valley depressions and steep slopes highly subjected to erosion, and the low sierra (Declive del Golfo), consisting of hills and plateaus sloping towards the

coastal plains. In the high sierra, above 1200 m above sea level, montane pine forests dominate, while cloud and semi-evergreen forests dominate at lower altitudes of around 1000 m with 2000 mm annual rainfall and humid and subhumid climates. In the low sierra, lying between 1000 m and 500 m elevation and having annual rainfall values of 1200 mm and a climate varying between warm subhumid and warm humid, the characteristic forest cover is a low to medium semi-evergreen forest (Fuentes 1972; Rzedowski 1978).

The Sierra Norte de Puebla is predominantly rural, but the low and high sierra subregions where the harvest area is located present contrasting socio-economic conditions. Three main urban settlements are located in the low sierra, while agglomerated indigenous villages are common in the high sierra. More than 90% of the land is privately owned, the remainder being communal lands. Most of the remaining mature forest patches stand on communal lands. Over 80% of private holdings average 1 ha in size but account for only 14% of all privately owned land. Holdings larger 5 ha, on the other hand, represent 17% of the total number but occupy 86% of the total area. The majority of larger holdings are located in the low sierra, where large coffee plantations and cattle ranches are the most important land uses. The smaller land holdings are mostly in the high sierra, belonging to the rural and indigenous population and used for subsistence agriculture and shaded coffee plantations (Masferrer and Báez 1995).

The Sierra Norte de Puebla, a highly diverse and contrast-rich region in natural and social terms, is populated by various indigenous groups who are among the poorest inhabitants of the sierra and have limited access to land, resources, and economic opportunities, while a small number of non-indigenous people have seized much economic and social power and continue to expand their holdings based on the introduction of intensive land use systems. This situation has led to social conflicts between indigenous and non-indigenous populations and, in the last 30 years, to the search by the poorest population for temporary or permanent work opportunities outside the sierra.

Bark harvesters and Otomi artisans

The amate commodity chain developed following continuously increasing demand at national and international levels. Numerous social actors from raw material producers to artisans, traders, transporters, and private and governmental agencies are involved in this commodity chain. The participation of growing numbers of local Otomi artisans and regional social actors reflects the ongoing social and economic changes at both national and regional levels.

At the national level the decline of agricultural activities, stemming from the lowering of subsidised prices of staple goods, is generating massive migration and intensification of off-farm activities (de Janvry and Helfand 1990; IFAD 1993). Extractivism and handicrafts are emerging as new commodities and activities, as part of a reorganisation of domestic economic strategies. In the Sierra Norte de Puebla, forest extraction activities play an important role in the subsistence of an increasing number of people.

Extraction of forest resources such as medicinal, decorative, and edible plants is expanding throughout the region, increasingly combined with other economic activities such as seasonal labour in agriculture activities, construction work, commercial activities, and temporary migration to the United States (Beaucage 1974; Masferrer and Báez 1995).

Bark harvesters are peasants from various villages, both indigenous and non-indigenous, who have diversified their income activities in recent years and have gradually become involved in this activity. Up to the end of the 1980s the bark supply largely depended on four main harvesters (Urbina 1990), but 15 years later, around 200 harvesters participated in this activity. During fieldwork it was observed that none of the harvesters base their entire income on bark harvesting and that some harvesters lack their own land for agricultural production or possess only small plots (averaging 1 ha), mostly under coffee. Harvesters who extract bark more regularly commented in interviews that, although bark harvesting is a risky activity, as will be further explained below, it is preferred to labour from which less income is obtained.

The Otomi have also diversified their income activities. San Pablito accommodates 4179 inhabitants; about 70% of the economically active population is involved in craftwork, 18% in agricultural activities, and the other 12% is linked to other activities (Censo Programa IMSS 1999). Illegal migration to the United States began around 20 years ago and is rapidly increasing, although precise statistics are lacking. Today the majority of Otomi households base their subsistence on craft production and migrant labour. The general trend is that the vast majority of women get involved in craft production, for which they obtain earnings used for daily expenses, while men are the majority of migrants, receiving higher incomes, which they devote to special projects and events (marriage, treating illness, house building, car purchase).

Resource base

Before the Spanish conquest amate production was based on several species of *Ficus* (Urbina 1903; Miranda 1946; Christensen 1963; Lenz 1973). A number of pre-Hispanic codices were analysed to recognise the characteristics of fibres and to determine the type of resources used for their production (Lenz 1973). These studies, as well as the etymology of the word amate, confirmed that *Ficus* species were used in the past. Indeed, the name amate derives from the Aztec word *amatl*, which means both fig and paper (Lenz 1973).

At present, 13 species are used for bark paper manufacture. While the traditional species correspond mainly to the *Ficus* genus, a number of other species from different families have been adopted over the last 30 years (Table 1). The collection of specimens was carried out in San Pablito and at various harvest sites. The specimens were identified at the Herbarium of the Instituto de Ecología, A.C. in Xalapa, Veracruz, where the respective vouchers are deposited.

Trema micrantha (L.) Blume has been the primary preferred species for the last 25 years. About 90% of the raw material used for bark paper

production is extracted from *T. micrantha*, most of it from shade trees in coffee plantations. Harvesters and Otomi artisans find several advantages of *T. micrantha* over other species. First, bark can be harvested throughout the year. Second, *T. micrantha* among *Ficus* species and *Morus celtidifolia* H.B.K. constitute the tree species easiest to debark and to manage for paper production. Third, the harvest sites of *T. micrantha* are accessible, in contrast to species such as *Brosimum alicastrum* Swartz., *Ulmus mexicana* (Liebm.), *Sapium oligoneuron* K. Schum., and *Sapium aucuparium* Jacq., whose distribution in forest patches on mountain tops and in ravines represents a limiting factor. While *T. micrantha* is the most important species for bark paper production, the other species are still important resources, particularly at times when access to *T. micrantha* harvest sites is limited. This is especially when coffee beans are being gathered and harvesters cannot enter the coffee plantations since debarking *T. micrantha* may damage coffee plants. Distribution and ecology.

T. micrantha are fast growing heliophile trees common in early successional fallows, in forest gaps, and in disturbed sites (Ackerly 1997; Vázquez-Yanes 1998). The short-lived, small- to medium-sized trees have ample distribution. They can be found from the tropical moist forests of southern Florida to northern Argentina. In Mexico, they grow in several vegetation types ranging from tropical lowland evergreen rainforest and moist semideciduous forest to mountainous mesophilous forest (Vázquez-Yanes 1998). *Trema* is particularly abundant along the south-eastern coastal plains of the Gulf of Mexico with an altitudinal distribution from sea level up to 1500 m (Ackerly 1997).

The ecology and reproductive biology of *T. micrantha* is typical of pioneer species. Trees grow fast, flower after nine months, and reach adult size after seven years (Ackerly 1997; Vázquez-Yanes 1998). In secondary forests *T. micrantha* are replaced by longer-living trees after about 30 years (Vázquez-Yanes 1998). Abundant inflorescences with small monoecious flowers are produced once a year during the reproductive season, which in the northern hemisphere commonly starts in May and frequently lasts until December (Vilamajo 1985 cited in Vázquez-Yanes 1998). Birds effectively disperse the seeds. Indeed, *T. micrantha* are second only to *Ficus* in terms of the number of bird species that feed on their fruit (Ackerly 1997).

The National Academy of Sciences (1980) recommended *Trema* species for amelioration of degraded lands, because they are suitable for the afforestation of denuded and disturbed areas. *T. micrantha* produce abundant litter that improves soil quality. These trees continuously develop buds, forming new heliophile foliage, and replace shadowed leaves. The fast growth and acquisition of a crown shape generates a shade that soon changes the microclimate beneath to more stable soil moisture conditions adequate for the growth of shade tolerant seedlings and saplings (Vázquez-Yanes 1998).

Distribution of *Trema micrantha* in the harvest area

In the harvest area, *T. micrantha* trees are called 'jonote' and bark harvesters are identified as 'jonoteros'. *T. micrantha* trees occur within all vegetation

Table 1. Species used for bark paper production

	Species Family	Common names*	Harvest period	Ecological distribution*
Traditionally used tree species	<i>Ficus pertusa</i> L. f. Moraceae	Xalama limon negro (n) Buo mous hi (o) Amate (s)	April-July	0-1500 m above sea level (masl) Wide distribution
	<i>Ficus padifolia</i> H.B.K. Moraceae	Xalama limon blanco (n) Tshax moushi (o) Amate (s)	March-June	Semi-evergreen forest
	<i>Ficus cotinifolia</i> H.B.K. Moraceae	Xalama hoja gruesa (n) Buo popotz ha (o) Amate (s)	June-December	Evergreen and semi-evergreen forest Wide distribution
	<i>Ficus calyculata</i> Miller Moraceae	Xalama hoja redond a (n) Buo popotz ha (o) Amate (s)	March-June	Semi-evergreen forest
	<i>Ficus goldman ii</i> Standl. Moraceae	Xalama hoja pahua (n) Popotzha xibahua (o) Amate (s)	July-August	
	<i>Morus celtidifolia</i> H.B.K. Moraceae	Tzhazucua (o) Mora (s)	April-May	500-900 masl Cloud forest
Newly adopted tree species	<i>Trema micrantha</i> (L.) Blume Ulmaceae	Coni (o) Jonote, chaca (s)	Year round	Secondary for est Very wide distribution
	<i>Ulmus mexicana</i> (Liebm.) Planch. Ulmaceae	Sxifi-tzha (o) Tortocal, cueruda (s)	February-May	500-900 masl Cloud for est Evergreen and semi-evergreen forest
	<i>Brosimum alicastrum</i> Swartz. Moraceae	Uini coní (o) Ojite (s)	August-October	0-600 masl Wide distribution Abundant in rocky soils and on slopes
	<i>Sapium oligoneuron</i> K. Schum Euphorbia ceae	Coni pathi (o) Palo brujo (s)	August-October	
	<i>Sapium aucuparium</i> Jacq. Euphorbia ceae	Coni pathi (o) Palo brujo (s)	August-October	
	<i>Urera caracasana</i> (Jacq.) Griseb. Urticaceae	Tzhanna (o) Chichicaxtle (s)	July-November	Very wide distribution Secondary vegetation
	<i>Myriocarpa cordifolia</i> Liebm. Urticaceae	Husna (o) Hortiga (s)	April-May	Very wide distribution Secondary vegetation

* (n) Nahua, (o) Otomi, (s) Spanish

Sources: Rzedowski 1978; Puig 1991; Pennington and Sarukhán 1998.

types and on fallow lands, coffee plantations, and in home gardens. In coffee plantations they are tolerated and managed along with other shade tree species.

In Mexico five main coffee production systems are distinguished according to management level and vegetational and structural complexity types (Moguel and Toledo 1999). In the Sierra Norte de Puebla two main types can be identified: in the high sierra mixed coffee plantations are common averaging 1 ha in size and requiring low technological input with high to moderate density of native and introduced tree species; in the low sierra extensive plantations prevail with low density of a few or just one tree species and requiring high technological levels. The average density of *T. micrantha* in mixed shaded coffee plantations is 12.5 mature trees per hectare, whereas in plantations where these are the only shade trees, the density can be 20 to 30 mature individuals per hectare. In plots that have lain fallow for approximately five years about 50 to 100 trees per hectare may occur.

T. micrantha trees are removed from coffee plantations when they reach five to eight years of age. According to plantation owners, coffee plants growing next to *T. micrantha* trees show low productivity over the long term. The allelopathic effects of this species have not been studied, but *Trema* species have been observed to harbour insect pests that cause defoliation and can spread to other plants (National Academy of Sciences 1980). *T. micrantha* trees in the harvest area used to be girdled in order to avoid possible damage to coffee plants from felling them, but at present they are entirely debarked and left to rot on site; occasionally straight trunks are used as construction poles and dried wood is used as fuelwood.

Since the removal of shade trees is part of the current coffee plantation management practices, bark from coffee plantations did not fetch a market price until around seven years ago. Rather, coffee plantation owners allowed harvesters to freely debark *T. micrantha* trees. At present the price of bark in coffee plantations remains fairly constant throughout the year. It is controlled by coffee plantation owners and varies depending on the accessibility and distance of the harvest site to the nearest road or town, and on the personal link between harvesters and plantation owners. Prices are generally set by the standard load, called 'tanto' or 'tercio', which varies between 25 kg and 35 kg; only rarely is the bark weighed. The price may also be set according to the total number of harvested trees or the plantation size. Five years ago 1 kg of bark cost less than US\$0.01, and at present it lies between US\$0.10 and US\$0.20.

Ecological impact of bark harvest

While it is difficult to assess the ecological impact of bark harvesting without in-depth study of the population dynamics of the species, a first distinction may be made between the various species. In the case of long-living trees, especially *B. alicastrum*, *U. mexicana*, *S. oligoneuron*, and *S. aucuparium*, bark harvesting has a direct negative impact on the species and ecosystem of the harvest area. Their reproduction is threatened because of their ecological characteristics, their distribution being limited to a few scattered

remaining forest patches. The exhaustion of the *Ficus* species used for amate production and exploited for longer than other species is visible in areas close to San Pablito. Only mature, non-harvestable individuals of *Ficus* are common in forest patches and in mixed shaded coffee plantations.

T. micrantha grows wild and is tolerated in coffee plantations. Despite their abundant distribution and fast regeneration, overexploitation appears to have occurred in a number of instances, including the area around San Pablito (Torres 1983; Peters *et al.* 1987). The negative effect of harvesting on tree populations gradually diminishes with distance from San Pablito, yet even in the farthest harvest sites, localised exhaustion of trees was observed during fieldwork. As a result, harvesters complain of increasing difficulties in finding harvest sites and of their need to extend their search for harvest sites over greater distances. It appears that even when harvesters return to harvest sites after *T. micrantha* populations had a chance to regenerate, demand for bark is still greater than supply, which depends on the growth rate and the current density of harvestable trees. Although *T. micrantha* bark can occasionally regenerate after debarking in humid sites or when extraction is done during rainy months, Otomi artisans do not find the regenerated bark suitable for amate production, claiming that this type of bark is too hard for paper manufacture.

Harvesting methods

Bark of *Trema micrantha* is harvested from trees between three and eight years old, when the bark is thick enough to be used. Bark becomes difficult to remove from trees over 15 years old. Three- to five-year-old trees yield

Photo 1. Bark extractors called *jonoteros* in a coffee plantation
(Photo: Citlalli López)



an average of 5 kg of bark. Individuals in coffee plantations yield more bark, especially where fertilisers are applied.

For debarking a machete is utilised to pull and separate long bark strips from the base trunk up to the branches. On occasion some trees, mainly the taller ones, are debarked from the branches towards the base trunk, a method that requires great ability and expertise from harvesters. After the bark is collected, and still at the harvest site, the fibrous inner bark is separated from the outer bark. The bark strips are bent into small packages (5 kg to 10 kg) and then bound together into tight bundles called ‘tercios’, each weighing between 25 kg and 35 kilos (Plate 3). Because the bark loses weight over time, and because it is vulnerable to fungal infections, particularly during rainy and cold periods, bark is customarily delivered to processors no more than eight days after harvest. While Otomi artisans regularly dry the bark and store it for up to one year, they demand it fresh from harvesters. Only in this way they can assess the quality of the bark before buying it.

Bark harvesting strategies

From fieldwork observations and interviews with bark harvesters a picture emerged of the main patterns of how harvesters carry out their work. Three main harvesting strategies were identified: permanent, temporary, and intermittent (Table 2). Harvesters living in the surroundings of San Pablito, who were the first ones to engage in this activity, harvest on an almost permanent basis. For harvesters living in the low sierra, however, it is a temporary activity strongly determined by coffee plantation cultural practices. Harvesters who have become integrated in the last five years debark occasionally, especially a few weeks before the celebration of Easter in April and All Saints in November, when additional income is required for

Table 2. Type of harvesters and their bark harvest strategies

Harvesters	Kilos per harvest endeavour	Main harvest period	Harvest site	Tree species
Permanent (individual work)	50 kg min. 150 kg max.	Throughout the year but mainly December to February	Coffee plantations Fallow lands Secondary forests Gallery forests	<i>Trema micrantha</i> <i>Ficus</i> sp. <i>Ulmus mexicana</i> <i>Sapium oligoneuron</i> <i>Sapium aucuparium</i> <i>Brosimum alicastrum</i>
Temporary (mostly team work)	500 kg min. 3 tons max.	Only from July to September	Coffee plantations	<i>Trema micrantha</i>
Intermittent (individual work)	50 kg min. 200 kg max.	Especially before religious festivities in March and October	Coffee plantations Fallow lands	<i>Trema micrantha</i>

the objects and goods used in these festivities. Most of these harvesters are located in the distant and inaccessible northern part of the high sierra, but some live all along the actual harvest area.

Each bark-harvesting endeavour includes the search for potential harvest sites as well as transportation and trading of the raw material to San Pablito and has a duration of approximately one week. Although in most cases one member of each household carries out these activities, a wide array of arrangements may exist among harvesters. Harvesters who debark on a more permanent basis work as individuals. Depending on the distance of their villages to San Pablito, they transport the raw material on buses, rented cars, donkeys, or wheelbarrows. The average weight of bark extracted per harvest endeavour is between 50 kg and 150 kg. They debark throughout the year, but their activity increases during December, January, and February, a time when the other two types of harvesters do not debark. Permanent harvesters pursue a more diversified strategy than the other two types of harvesters in terms of tree species and types of harvest sites, a strategy that is linked to the diversity of land use systems along the scattered and small land holdings of the high sierra.

Temporary harvesters, settled in the low sierra where extended coffee plantations are widespread, work mostly in groups. Many of them are peasants involved the year round in labour temporarily required by large coffee plantations, fruit plantations, and cattle ranches. Their involvement in bark harvesting is strongly determined by coffee plantation cultural practices. Between June and September, when removal of shade trees occurs, harvesting team leaders contract 10 or 20 labourers who stay for 8 to 15 days on the coffee plantations in temporary accommodations also used for storing coffee beans. They may harvest up to three tons of bark per week, which is transported to San Pablito in rented trucks. Intermittent harvesters from the northern high sierra debark on an individual basis, but to transport the raw material they organise groups to rent small trucks. The average quantity of bark fluctuates between 50 kg and 200 kg per harvesting endeavour.

The supply of bark to San Pablito fluctuates over the course of a year. From the end of November until February bark harvest declines. During these months it is impossible to debark *T. micrantha* on coffee plantations because the coffee harvest is underway and the rainy and cold conditions of these months hamper bark harvesting tasks and transportation. Permanent harvesters who debark during these months exploit *T. micrantha* found in fallow lands and secondary forests and the species *Ficus*, *U. mexicana*, *S. oligoneuron*, *S. aucuparium*, and *B. alicastrum* found in various types of forests. From June till September, when shade management practices in coffee plantations are carried out, higher volumes of bark are supplied to San Pablito. During these months all types of harvesters participate, and the participation of temporary harvesters, who exclusively debark *T. micrantha* from coffee plantations, is relevant in terms of bark volume. The bark supply fluctuations have a large impact on the trading conditions of bark in San Pablito.

Because of the rugged terrain of the Sierra Norte de Puebla, accessibility and distance play a major role in harvesters' strategies. Transportation of raw

material from the harvest site to the nearest road or village, and from there to San Pablito, implies significant money and time investment. The journey to San Pablito may take from some hours up to two days for harvesters living in the more distant places. In fact, the integration of more harvesters is strongly determined by the viability of bark transportation to San Pablito.

Bark trading in San Pablito

Harvesters bring the bark raw material to San Pablito and sell it directly to mostly Otomi women artisans. Most bark is brought towards the end of the week, mainly Friday, Saturday, and Sunday, when regional markets are organised and when labourers receive their salary. Harvesters arrive at San Pablito very early, sometimes at three o'clock in the morning. Most harvesters attempt to sell their bark as early as possible and soon return to their villages or visit regional markets. Furthermore, by travelling at night harvesters avoid being stopped by forest guards, as will be further explained.

Bark is sold in 'tercios' and 'tercios dobles', or bundles of 25 kg to 35 kg and 55 kg, respectively. Otomi artisans demand bark that is fresh so that they can assess the bark's attributes for papermaking and assure good paper quality. Buyers carefully check the raw material in terms of colour, texture, and thickness and lift the packages to estimate the weight. Scales are never used. The encounters between artisans and harvesters are tense, prices are sometimes negotiated over a whole day, and communication is hampered by the use of two distinct languages, Otomi and Spanish. Otomi women now aged 30 or over did not attend school and therefore know few Spanish words. When bargaining over the price causes disagreements, this is sometimes a delaying tactic to pressure the harvesters, who have little time and are always eager to return to their villages, most of which are far from San Pablito. Experienced harvesters who have been involved in this activity for a long time anticipate this situation and take into account that they might spend the whole day trying to sell and that even at the end of the day they might be unsuccessful.

In contrast to the harvest sites, where bark prices remain fairly constant throughout the year, the price of bark in San Pablito varies over the year and even during the day. It changes according to internal and external factors, according to fluctuations in supply and external market prices linked to tourist seasons. In general, bark price changes show the following pattern. From June to September, when mainly temporary harvesters bring large volumes of bark to San Pablito, the average price of 1 kg of bark is US\$0.36. From the end of November to February, when bark harvest declines and only permanent harvesters bring bark to San Pablito, the average price is US\$0.84/kg. The higher amounts of raw material are supplied by intermittent and permanent harvesters some weeks before the Easter and All Saints holidays. The average price of bark during those two supply peaks is about US\$0.31/kg. When bark supply shrinks, Otomi artisans intercept the harvesters as far as 20 km down the road from San Pablito, but during times of plentiful bark supply, harvesters may accept less than half the original price at the end of the day after long negotiations with Otomi artisans.

Otomi paper manufacture

During pre-Hispanic times there were several methods of paper manufacture, and some of the main steps of early bark paper manufacture have remained in use (Christensen 1963; Lenz 1973). Stones with grooved surfaces used to beat bark strands constitute important archaeological evidence of the past of amate, confirming the past manufacture of paper and the involvement of the tributary villages where these pieces were found (Lenz 1973). Even today bark strands are macerated with the use of stone beaters, but Otomi artisans have modified other paper manufacture phases in their continuous search for alternative ways to shorten the time of paper manufacture.

Today bark is boiled in water in cooking pans of various sizes, normally with capacity for 80 litres of water and 60 kg of bark. Up to the mid 1990s, bark fibres were boiled with ashes and lime to soften and separate microfibrils and to remove the latex, but today artisans use caustic soda to accelerate the softening and separation of bark fibres and reduce the time of boiling. Boiling may take from three to five hours, consuming around 10 kg of fuelwood. To produce white or coloured paper with artificial dyes used for textiles, boiled bark is then soaked in Clorox (sodium hypochlorite) and, if required, also in artificial dyes. After boiling, the bark is rinsed and gently separated into thin strands that are laid out in grid formation on a wooden board. The bark strands are gently pounded into sheets using a stone beater (Plate 4). The wooden boards are placed in the sun until the paper sheets dry. Final decorative production phases depend on the type of product and market.

If the paper is sold in bulk, the sheets usually lack any end finishing. If paper is sold in small quantities the sheets are carefully smoothed by use of a blade to remove residual fibres. Glass bottles and vegetable glue extracted from the root of an orchid (probably *Epidendrum pastoris*) are used to fill small gaps with pieces of bark paper glued and pressed with the bottle. The

Photo 2. Otomí artisan beating the bark fibers with a volcanic stone (Photo: Miguel Torres)



paper may be decorated with dry flowers and leaves pressed in when the sheets are still moist. Other papers may be decorated with embedded fibres of various colours or painted with bright industrial colours using motifs of Otomi mythology. Other types of papers are made from bark of two or more different tree species in order to enhance contrasting colours and textures.

At present the Otomi paper manufacture largely depends on the acquisition of materials originating from various places. Otomi artisans buy fuelwood from peasants who bring it to San Pablito from the higher parts of the sierra. Other tools and substances such as Clorox, dyes, caustic soda, wooden boards, and industrial paints are obtained through local and external intermediaries, who bring the materials to San Pablito. Few Otomi artisans obtain the industrial materials directly in San Pablito stores or in more distant cities like Mexico City.

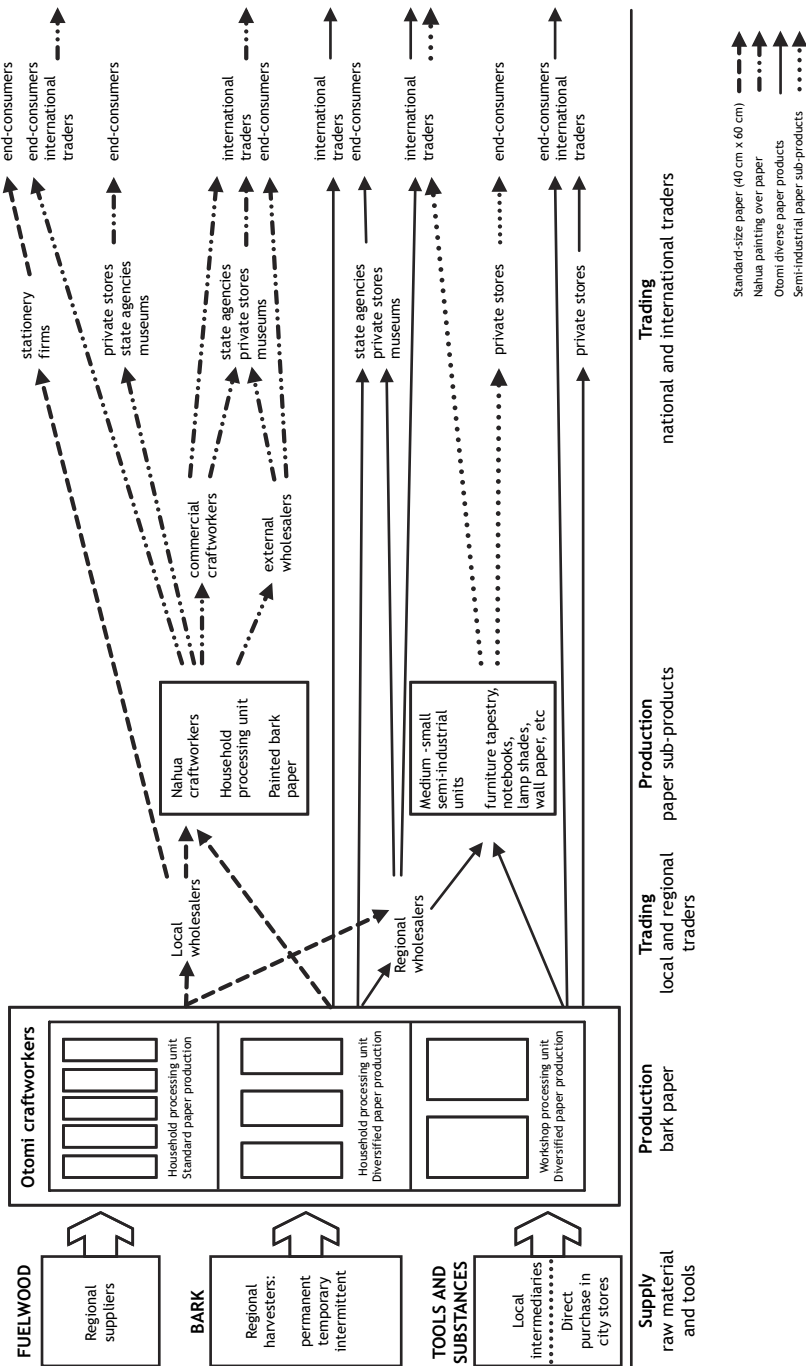
Otomi papermaking organisation

Papermaking is carried out mostly at the household level in San Pablito. Artisans combine craftwork with various daily domestic and economic activities such as production of other handicrafts, temporary migration, and handicraft trading activities. Paper manufacture is largely in the hands of Otomi women with the occasional participation of children during their free time and school holidays. There are periods during which all the household members participate in paper manufacture but others during which this activity stops.

Although it is difficult to generalise the forms in which Otomi artisans organise paper manufacture, three main types of papermaking units were identified during fieldwork: manufacture at household level involving only household members, manufacture at household level involving household members and temporary hired labour, and manufacture in workshops involving mostly hired labour. The latter activity corresponds to a few of the most recent papermaking organisation units. Among all artisans, hired labourers belong to the most deprived group, lacking the means to invest in materials and tools required for paper manufacture.

In general, individual papermaking units have access to different markets and their production output varies accordingly in terms of volume and paper types. The first type of papermaking unit are households that sell the paper only to local and regional wholesalers. Their production consists mainly of low-quality standard-sized (40 cm × 60 cm) sheets, manufacturing more than 200 sheets per week. The second type of papermaking unit are households that maintain partial or complete access to market channels outside San Pablito. They, too, manufacture standard-size sheets but also many other types of paper that vary in size, final touches, decoration, colours, and combination of textures. Their production may reach 100 sheets per week. In workshops, production is also diversified, mainly in terms of paper sizes and colours. In this case, groups of 10 to 20 workers may manufacture 1000 standard-sized sheets per week. Part of the workshop production is sold to semi-industrial processing units, which use the paper to produce lampshades, furniture and wall covers, floor mats, and the cover and interior pages of booklets (Figure 2).

Figure 2. Bark paper commodity chain



Otomi paper production fluctuates in terms of paper volume through the course of the year. Production reaches its maximum before the high tourist season, between May and July, the warmest and sunniest months, when more paper can be manufactured because paper sheets in wooden boards dry fast. This period coincides partly with the time during which harvesters supply larger amounts of bark. From December to February, when bark supply is at its lowest, paper production falls as adverse weather conditions also hamper papermaking. Two short high-production peaks occur before the Easter in April and All Saints celebrated throughout Mexico at the beginning of November. These festivities require a large investment in food and decorative objects, so Otomi artisans try to maximise their income through intensification of paper production. Besides seasonal fluctuations, daily paper production, which depends on weather conditions, also varies. During rainy, cold, and foggy days production diminishes since all available boards are in use with sheets waiting to dry. Production may even stop during extremely rainy and cold days, when the paper can spoil with fungus because of the high humidity.

Amate trade and marketing

The increasing diversification of market channels, actively promoted by Nahua and Otomi artisans, has been a constant factor since the start of amate commercialisation. Market diversification is based on papermakers' and paper decorators' continuous search for new paper uses, styles, and decorations.

During the first years of amate commercialisation, the final production consisted of painted bark paper of standard size (40 cm × 60 cm). The whole Otomi paper production was sold to Nahua painters. Through time, however, the Otomi have opened their own market channels and have diversified their production. They now produce envelopes, book separators, invitation cards, and papers of various sizes (e.g., 1.20 m × 2.40 m, 20 cm × 70 cm, or 60 cm × 80 cm) decorated with artificial colours, dried flowers, leaves, or combinations of bark types. Part of the Otomi paper production is used in secondary products like lampshades, booklets, floor mats, etc. Otomi paper has also attracted the attention of national and international sculptors and painters, who have used it as base material for their works of art. The Nahua painted paper production has also diversified in terms of colours, designs, and painting styles. At the start these consisted only of bright and colourful paintings of flowers and birds, but now new motifs are created and vivid scenes of rural life are depicted (Amith 1995).

From the start, commercialisation of amate has developed in a flexible and irregular way, mostly independent from state intervention. There are no registers or financial accounts concerning amate and paper products may be sold directly to final consumers or they may pass through five or more intermediate phases within the commercial chain before the final sale. Today, about half of the Otomi paper is sold to Nahua painters, and around 70% of the total Nahua and Otomi production is sold on the national market, the remainder reaching the international market (Figure 2).

Otomi paper and Nahua painted paper is sold either through local and

regional wholesalers or directly to end-consumers in streets and markets or to stationery firms, handicraft shops, museums, and art schools. The main market for Nahua painted paper are tourists, and Nahua artisans sell a large part of their production directly in streets, plazas, and open markets. The Nahua have apparently maintained more independent and direct market strategies (Good 1988; Goloubinoff 1994) than Otomi artisans. In San Pablito, the emergence of local wholesalers from almost the beginning of paper commercialisation has determined the conditions of a tight internal market system. Around 30% of the Otomi papermaking units described above maintain partial or complete access to market channels outside San Pablito, but most depend on local or external wholesalers. No more than 10 Otomi local wholesalers control the thousands of standard paper sheets made by the majority of Otomi papermaking units for Nahua decorators.

Bark paper prices vary greatly, whilst tending to increase along the commodity chain. Within the Otomi internal market, one standard-sized plain paper sheet manufactured by hired artisans is priced at US\$0.21, but it costs US\$0.40 when manufactured by artisans belonging to the second type of household production unit. Subsequently local wholesalers sell this paper to Nahua painters at about US\$0.57 per piece. After painting, the paper would cost around US\$3.60, when sold directly by artisans in streets or markets, and US\$15 in important tourist centres. A third tier of traders, such as museums or handicraft shops, may sell it at US\$30. Prices also change during the year, doubling during high tourist season. Another situation occurring between the Nahua (Goloubinoff 1994; Amith 1995) and the Otomi is the emergence of individual paper production by a few artisans who have obtained national and even international recognition. In this case, an Otomi decorated paper, like for example the application of Otomi cutout symbolical figures over a contrasting coloured paper, might cost about US\$500.

Policy environment

The National Ecology Institute of the Secretariat of Natural Resources and Environment sets policy norms that regulate the extraction and management of non-timber forest resources. According to these norms, extraction, transportation, and storage of NTFPs require official permission. Regulations regarding bark, stems, and complete plants state that the owners of resources should submit a notification to the state offices of the agency, which in turn grant the legal authorisations to harvest, if the notification meets the regulations. In the case of bark, the regulations indicate that whenever extraction causes the death of trees, a forestry management plan should be formulated. Regulations also indicate that for transportation of bark a commercial invoice issued by the owner of the resources to harvesters and containing the identification of the legal authorisation is required.

These legal procedures are not currently followed for bark used in amate production. In the case of bark extracted from shaded coffee plantations, the removal of *T. micrantha* trees is part of the plantation cultural practices. The use of a commercial invoice implies that official permission for exploitation should be requested. There is thus a serious gap between national norms and

the actual way in which bark harvesting for amate is carried out. There are no specific norms for tree species used for bark paper production, and NTFP norms remain unclear in the case of agroforestry systems. Knowledge of and information about NTFP norms is generally lacking among peasants in the harvest area.

Misinformation about NTFP norms and unclear situations have contributed to the emergence of conflicts among social actors. From the perspective of local and regional authorities, for example, bark harvesting is contributing to deforestation, and as such is frowned upon. As debarking of trees without permission is becoming a more common practice, coffee plantation owners become increasingly suspicious of harvesters. For harvesters, bark extraction is risky, as forestry guards frequently detain them to confiscate their bark loads and to fine them or encourage bribing. Because of misinformation harvesters think of bark extraction as an illegal activity and recognise the need for special permissions to safely carry out their work. The ambivalent legal status of commercial bark harvesting constitutes one of the factors limiting the involvement of more regional peasants in bark harvest activities.

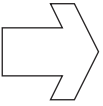
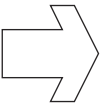
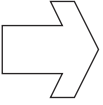
Within the harvest area, bark harvesting is regarded as a low-status activity, highly risky and hazardous. The search for potential harvest sites takes time and effort and may at times be unsuccessful, for the total bark harvested cannot be known until trees are debarked. Bark prices in San Pablito are highly irregular and change from day to day, and it is probable that forest guards might stop harvesters during bark transportation. Despite all these limitations, some harvesters, especially the ones extracting on a more permanent basis, prefer bark harvesting over lesser paid options, such as working as day labourers.

TRENDS AND RECENT DYNAMICS

Demand for amate handicraft has been on a constant rise since the beginning of its commercialisation, and this dynamic has provoked changes in each phase of the commodity chain. Raw material production involves the continuous expansion of the harvest area, the involvement of an increasing number of harvesters, and the adoption of new tree species for raw material. The Otomi paper manufacture phase is characterised by the emergence of new forms of artisan work organisation and by the permanent diversification of paper products to appeal to the taste of ever-more consumers. Marketing of Otomi and Nahua paper products is characterised by the constant expansion and diversification of trade channels at national and international levels.

The success of paper commercialisation has led to a major pressure on tree resources. Four main periods defining local and regional responses for bark supply can be identified (Figure 3). Originally, Otomi artisans harvested trees within their own territory. In the next period, both Otomi and a few regional harvesters supplied the raw material. Expansion of harvest area and involvement of more regional harvesters characterise the two more recent periods. Over the past 30 years or so, bark supply has been guaranteed by the adoption of new tree species. *T. micrantha* has most recently ensured the continuity of amate production. Its exploitation started in the early 1970s,

Figure 3. Local and regional responses for bark supply

Time-period		Bark suppliers	Harvest area	Tree resources
Start of craft commercialization End of 1960s		Otomi craftworkers	Otomi territory and surroundings	Traditional tree species (<i>Ficus</i> sp.)
End of 1970s		Otomi craftworkers Regional harvesters (around 8)	Otomi surroundings and High Sierra (around 10 km ²)	Adoption of secondary species (<i>T. micrantha</i> , <i>U. baccifera</i> , <i>M. cordifolia</i>)
1980 - 1990		Regional harvesters (around 100)	High and Low Sierra (around 250 km ²)	Adoption of long-living tree species (<i>U. mexicana</i> , <i>B. alicastrum</i> , <i>S. oligoneuron</i> , <i>S. aucuparium</i>)
Middle of 1990s till present		Regional harvesters (around 200)	High and Low Sierra Extended harvest area (around 1500 km ²)	Continuous search of new species Initial harvesters' tree management practices (<i>T. micrantha</i> cultivation)

when a serious shortage of bark material so curtailed amate production that even an extraction ban on bark trees was proposed (Stromberg 1976) and Nahua painters started to paint on board paper (Amith 1995). In recent years some harvesters owning shaded coffee plantations or semi-abandoned plots have started to collect *T. micrantha* seeds and cultivate them on their properties.

Future changes to the bark harvest system may include either expansion of the harvest area and integration of a major number regional harvesters or the intensification of bark production. Production intensification could include harvesters' systematic collection of *T. micrantha* seeds and cultivation in coffee plantations, home gardens, deforested land, and fallow plots. Up to now, tree planting for bark production has been economically unattractive for harvesters and coffee plantation owners, and the introduction of more *T. micrantha* trees to shaded coffee plantations does not represent a viable alternative since in the Mexican context the economic and ecological importance of shaded coffee plantations relies on the variety and combination of native and introduced tree species for multipurpose uses (Moguel and Toledo 1999).

Some aspects can be highlighted with respect to the amate production phase. Otomi papermakers and Nahua paper decorators have over time become full time artisans and their agricultural activities have mostly been abandoned. The Otomi increasingly combine craftwork with temporary labour at home and in the United States. As male temporary labour has increased,

the production of craft paper has largely fallen on Otomi women. Most Otomi artisans achieve only low profits, especially those working as hired labourers without their own means for paper manufacture and lacking direct access to external market channels. It appears that the tight internal market conditions have led to great economic stratification and unequal capacity among artisans. It is also hampering new alternatives for production market organisation and fairer agreements about prices and market opportunities.

Government actions have been irregular, partial, and without long-term continuity. Since the beginning of amate commercialisation a plan for sustainable production, including natural resources management to secure a longstanding supply of raw material, has not been proposed. During the early years government interventions concentrated on amate commercialisation. The Mexican government agency for promoting handicrafts (FONART), supported the distribution and commercialisation of Nahua painted bark paper. It bought the entire Otomi paper production to assure a constant supply to Nahua painters. Paper prices were set officially and credits were granted to local cooperatives. This support lasted a few years, after which the Nahua and Otomi began to trade their own craftwork. The National Indigenous Institute (INI) coordinated the next official support to Otomi artisans, but the effort ended in December 2000. For six years, the institute had supported a cooperative of almost 100 artisans, who benefited from credits. Several independent groups of people interested in handmade products and the artists, as well as some organisations, have supported the Otomi paper production for short periods, especially through the diffusion of Otomi work to national and international galleries, museums, and universities.

In the 1980s and early 1990s, the official agencies Instituto Nacional para la Educación de Adultos and Culturas Populares—Unidad Regional Puebla supported the implementation of *T. micrantha* nurseries in San Pablito with the objective that, over time, Otomi artisans would become self-sufficient in bark supply. The projects failed because of lack of sufficient technical advice and support, high threat of bark robbery, and lack of labour. An important aspect official agencies failed to foresee was that a large proportion of Otomi men work outside the village, and craftwork, as well as many domestic and communal activities, is in the hands of women, who find it difficult to get involved in tree nursery activities; besides that, within Otomi traditions, participation of women in field activities is limited.

The official local and national agencies normally dealing with aspects of handicraft production from extracted forest resources are totally unaware of the present forms in which bark supply for amate paper is carried out. In fact, the present conditions of bark production, bark supply, and paper production have not been assessed and the voices of harvesters and paper producers have not been listened to. Harvesters are interested in becoming involved in the management of trees for bark supply and seek support for bark transport from the harvest sites to San Pablito. They recognise that bark transport and the lack of legal harvest permits are limiting factors for ensuring a regular supply and higher profits. As far as the Otomi artisans are concerned, bark supply irregularities and price changes have great impact on profit margins for paper, which change not as a function of bark price but

of prices in the external paper market. Otomi artisans have expressed their desire to legally certify the bark paper manufacture as part of their cultural intellectual property.

CONSERVATION AND DEVELOPMENT IMPLICATIONS

One of the main findings of this study lies in the artisans' and harvesters' adoption of *T. micrantha* trees. These trees have two different use values, the original one as a shade tree in coffee plantations and, more recently, as a source of bark for Otomi paper production. The coffee plantations that currently constitute the main site sources of bark material cover around 19% of the total harvest area. This agroforestry system, especially the mixed coffee plantations, is remarkably important for the small landholders of the high sierra who obtain cash income and many resources, such as medicinal plants, construction materials, and fuelwood, from them. In the low sierra the substitution of shaded coffee plantations for nonshaded ones has started under the initiative of large-holding owners. Any land use change, like the removal of coffee plantations or substitution of coffee shaded plantations for open-sun plantations, can generate detrimental consequences for the rural people's survival and bark paper production. It appears that the future of coffee in the Sierra Norte de Puebla, and consequently that of amate production, is very much subject to the changes in coffee policies and prices determined at national and international levels.

Another relevant aspect is the role of shaded coffee plantations for the ecosystem, especially in deforested areas, where they constitute important repositories of biological diversity because of their vegetation composition and their role as habitats for many mammals and birds (Moguel and Toledo 1999). These attributes, as well as the potential role of *T. micrantha* trees for soil amelioration in disturbed lands and protection against erosion (Vázquez-Yanes 1998), are key aspects of the benefits of these tree species. These aspects should be considered in any plan for tree management for bark supply, especially in the Sierra Norte de Puebla, a region with high rates of deforestation and highly susceptible to erosion processes. The links between ecological, economic, and social aspects of coffee plantations and amate production still have to be explored.

The importance of amate production as well as other craft industries in Mexico lies in their economic role for the subsistence of an increasing number of rural people. These rural industries are very flexible and change rapidly in reaction to new local social and economic conditions and to external market forces. In the case of amate, several factors at local, national, and international levels point towards the permanence of this industry. Forces at the international level include the explosion in tourism since the 1970s and, more recently, the opening of new market niches for handmade products. At the national level, the decline of agricultural activities because of the lowering of subsidiary prices of staple goods and the termination of credits, among other new policies, are contributing to massive out-migration and to the intensification of extractive activities and handicraft production.

Considering that demand of amate is likely to increase and that this

industry represents one of the most important survival strategies for people involved in raw material production and craftwork, long-term support programs are needed. Amate production requires the development of sustainable production programs, including natural resources management, to secure supplies of raw material. It is necessary to carry out ecological surveys of tree growth, distribution, density, bark production, and harvesting capacity in relation to actual paper demand and the state of regional coffee plantations. In-depth studies are required on the age distribution of *T. micrantha* trees within various coffee plantation systems. Fuelwood is another resource used in large quantities, and any plan must include the management of trees for fuelwood supply, also considering alternatives such as fuel-efficient rural cooking stoves for bark boiling. Future studies should include an economic market study, a social anthropology study of the interactions among the various social actors, and the assessment of legal aspects.

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NOTE

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REFERENCES

- Ackerly, D. 1997. *Trema micrantha* (capulín). In: González, S.E., Dirzo, R. and Vogt, C.R. (eds.) Historia Natural de Los Tuxtlas, 156-58. CONABIO-UNAM, México.
- Amith, J.D. 1995. La creación de imágenes indígenas: de la pesadilla privada a la protesta pública. In: Amith, J.D. (ed.) La tradición del amate: innovación y protesta en el arte Mexicano, 41-100. Chicago Mexican Fine Arts Museum—La Casa de las Imágenes, México.
- Beaucage, P. 1974. Comunidades indígenas de la Sierra Norte de Puebla. Revista Mexicana de Sociología. Instituto de Investigaciones Sociales UNAM. Vol. XXXVI, Tomo 1, enero-marzo, 111-47.
- Censo Programa IMSS. 1999. Levantamiento de universo de trabajo en la comunidad de San Pablito. IMSS Instituto Mexicano del Seguro Social, México.
- Christensen, B. 1963. Bark paper and witchcraft in Indian Mexico. Economic Botany 17: 360-67.
- de Janvry, A. and Helfand, S. 1990. The dynamics of peasant agriculture in Latin America: implications for rural development and agroecology.

- In: Altieri, M.A. and Hecht, S.B. (eds.) Agroecology and small farm development, 61-69. CRC Press, Florida, USA.*
- Fuentes, A. 1972. Regiones naturales del Estado de Puebla. Instituto de Geografía UNAM, México.
- Galinier, J. 1987. Pueblos de la Sierra Madre: etnografía de la comunidad Otomi. Colección Clásicos de Antropología No. 17. Instituto Nacional Indigenista—CEMCA, México.
- Goloubinoff, M. 1994. Relations sociales et commerce chez les Indiens Nahuas du Balsas (Mexique). Ph.D. Thesis, Université de Paris X, France.
- Good, C.E. 1988. Haciendo la lucha: arte y comercio Nahuas de Guerrero. Sección Obras de Antropología. Fondo de Cultura Económica, México.
- IFAD. 1993. The state of world rural poverty: a profile of Latin America and the Caribbean. International Fund for Agricultural Development IFAD, Italy.
- Lenz, H. 1973. El papel indígena mexicano. Cultura Sep Setentas No. 65. Secretaría de Educación Pública, México.
- Masferrer, E.K. and Báez L.C. 1995. Los Nahuas de la Sierra Norte de Puebla. *In: Etnografía contemporánea de los Pueblos Indígenas de México. Región Oriental, 167-204. Instituto Nacional Indigenista—Secretaría de Desarrollo Social, México.*
- Miranda, F. 1946. Algunos comentarios botánicos acerca de la fabricación del papel por los Aztecas. Cuadernos Americanos 5: 196-204.
- Moguel, P. and Toledo, V. 1999. Biodiversity conservation in traditional coffee systems of Mexico. *Conservation Biology* 13(1): 1-12. National Academy of Sciences.
1980. *Trema* species. *In: Firewood crops: shrub and tree species for energy production, 68-69. Report of an Ad Hoc Panel of the Advisory Committee on Technology Innovation Board of Science and Technology for International Development Commission on International Relations.*
- Pennington, T.D. and Sarukhán J. 1998. Árboles tropicales de México: manual para la identificación de campo de las principales especies. Fondo de Cultura Económica—Instituto de Ecología UNAM, México.
- Peters, C.M., Rosenthal, J. and Urbina, T. 1987. Otomi bark paper in Mexico: commercialization of a pre-Hispanic technology. *Economic Botany* 41(3): 424-32.
- Puig, H. 1991. Vegetación de la Huasteca (México): estudio fitogeográfico y ecológico. ORSTOM, CEMCA, Instituto de Ecología A.C., México.
- Rzedowski, J. 1978. Vegetación de México. Editorial Limusa, México.
- Sandstrom, A.R. and Sandstrom, P.E. 1986. Traditional papermaking and paper cult figures of Mexico. University of Oklahoma Press: Norman and London.
- Seeman, E.C. 1990. Usos del papel en el calendario ritual Mexica. Serie Etnohistoria No. 207. Instituto Nacional de Antropología e Historia, México.
- Stromberg, G. 1976. The amate bark-paper painting of Xalitla. *In: Graburn, N. (ed.) Ethnic and tourist arts: cultural expressions from the Fourth World, 149-62. University of California Press, Berkeley.*
- Torres, B. 1983. El papel de amate: historia y significado. *In: El universo del amate, 12-29. Ediciones del Museo Nacional de Culturas Populares—Cultura SEP, México.*

- Urbina, M. 1903. Los amates de Hernández o higueras Mexicanas. Anales del Museo Nacional de México, Vol. VII, 93-114.
- Urbina, T. 1990. Impacto socioeconómico de la producción de papel amate en la comunidad de San Pablito, Pahuatlán. Tesis de Licenciatura, Ingeniería Agrícola, Facultad de Estudios Superiores Cuautitlán UNAM, México.
- Vázquez-Yanes, C. 1998. *Trema micrantha* (L.) Blume (Ulmaceae): a promising neotropical tree for site amelioration of deforested land. Agroforestry Systems 40: 97-104.
- Vilamajó, D. 1985. Comportamiento fenológico de especies de vegetación secundaria en Sierra del Rosario, Cuba. Ciencias Biológicas 13: 51-58.

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Chapter 21

Bursera Woodcarving in Oaxaca, Mexico

Silvia E. Purata¹, Michael Chibnik²,
Berry J. Brosi³ and Ana María Lopez⁴



(Bursera glabrifolia)

Common name	Product part used	Dominant form of management	Degree of transformation	Commercial scale	Geographic distribution
Copal, Copalillo	Wood	Wild	Average/middle/half	International	Average/middle/half

ABSTRACT

We present the case study of copalillo (*Bursera* spp.) wood extraction, used to make carvings known as alebrijes, in the Valles Centrales region of Oaxaca, México. These woodcarvings are a relatively new tradition, having been produced only since the late 1960s, but have been important in the international craft market since the mid-1980s. Because of strong demand for wood and of poor forest management, copalillo trees have become commercially extinct around the principal woodcarving villages, and wood vendors are extracting from an increasingly larger area to supply those villages with primary materials. In this chapter, we describe the history of the Oaxacan woodcarving industry and the production to consumption system, presenting data on the species used, the demand for wood in the principal artisan villages, the craft production process and the commercialization of wood and figures. We also discuss a project to reduce the impact of *Bursera* harvests, which has culminated in the development of a village-based management plan for producing wood on a sustainable basis. Finally, we present the conservation and development lessons of our case study, emphasizing the possibility of developing a certification scheme that could contribute to better management of *Bursera* wood while fostering positive social and economic trends in the Oaxacan woodcarving market.

INTRODUCTION

The Valles Centrales (Central Valleys) region of the state of Oaxaca in southern Mexico is the source of carved wooden figures known as *alebrijes*, which are distinguished by their bright colors and intricate motifs and designs. The carvings generally represent fantastic animals, mythic figures like mermaids and dragons, and human-animal hybrids. The wood used to carve these figures comes from various species in the genus *Bursera* (Burseraceae), locally known as *copal* or *copalillo*, and found in dry tropical forests in this and other regions of Oaxaca and neighboring states.

Alebrijes are produced principally in family workshops and sold directly in artisan villages, markets and craft stores in the city of Oaxaca, other cities in Mexico, the United States, and Canada. A smaller number of figures are exported to Europe and Japan. The commercial success of these figures and the unsustainable extraction of wood have provoked the localised depletion of *Bursera* trees over the last 10 years. The growing demand has created a market for the wood in various parts of Oaxaca state. Intermediaries buy wood from extractors, who cut it from communal lands, leading to resource depletion at an ever-increasing distance from the Valles Centrales region, where the principal artisan villages are located.

With the goal of creating a system of sustainably extracted wood and promoting the conservation of dry forests, we conducted a series of studies in a village with a history of communal forest management (Brosi *et al.* 2000). We also conducted a diagnostic study of the region, providing us with insights into the utilised species, the extractor and artisan communities, and the principal routes of commercialisation of the wood (Peters *et al.* 2003; Purata *et al.* 2004). In parallel studies, we have investigated the demand for wood

Photo 1. Figures of animals on bicycles. Artisans: Martín Melchor and Hermelinda Ortega (Photo: Fidel Ugarte)



in the principal artisan villages and have estimated the quantities of wood used at the regional level (López 2001). Most of the data for this case study was collected during the year 2000. Mexican forestry law requires authorized management plans for commercial extraction of forest products, making current wood harvesting illegal and the collection of sensitive information difficult. As a result, the information on wood collectors and vendors was often obtained indirectly, via interviews with wood vendors, local people in extractor communities, artisans in woodcarving villages, and local authorities. Other sections of this report are based on fieldwork carried out since 1994 on the history, production, and marketing of Oaxacan woodcarvings. This latter research has focused on the commodity chains linking artisans in rural Oaxaca to consumers from the upper and middle classes of Mexico, the United States, Canada, and Europe (Chibnik 1999, 2000, 2001, 2003).

History of Oaxacan woodcarving

Carving of *Bursera* wood figures has a short history, which began almost simultaneously in three localities in the Valles Centrales region: San Antonio Arrazola (hereafter referred to as Arrazola), San Martín Tilcajete (San Martín) and La Unión Tejalapam (La Unión) (Figure 1). Each of the three areas developed a distinctive artistic style, allowing an observer familiar with *alebrijes* to identify the village of origin of most figures on appearance alone. Woodcarving in Arrazola, San Martín, and La Unión does not fit the stereotype of a Mexican handicraft industry in two important respects. First, the carvers are monolingual in Spanish and do not identify themselves as

indigenous people. Second, the woodcarvings are novel creations without longstanding cultural significance.

The woodcarving boom originated in the activities of Oaxaca-based shop owners and three particular carvers—Manuel Jiménez of Arrazola, Isidoro Cruz of San Martín, and Martín Santiago of La Unión. Jiménez, born in 1919, began carving wooden figures as a boy to pass time while tending animals. He sold a few carvings in the Oaxaca marketplace over the years. In the late 1950s and early 1960s, owners of craft shops in the city of Oaxaca began buying Jiménez's carvings and showing them to folk art collectors such as Nelson Rockefeller (Serrie 1964; Oettinger 1990; Peden 1991). By the late 1960s, Jiménez was giving exhibitions in museums in Mexico City and the United States. His carvings were later featured in books and films about Mexican art. Tourists and collectors started to visit Jiménez's workshop in Arrazola during the 1970s. The master kept his techniques secret and for a long time the only carvers in Arrazola were Jiménez, his sons, and a son-in-law. In the early 1980s, however, other carvers in Arrazola began offering pieces for sale to people who came with the intention of buying figures from Jiménez.

The second carver, Isidoro Cruz, was 13 years old in 1947, when he learned to carve during a long illness. While working as an ox cart maker in the city of Oaxaca in 1968, Cruz met Tonatiuh Gutiérrez, who worked for the National Council of Expositions at the Tourism Secretariat (Consejo de Exposiciones, Secretaría de Turismo). Gutiérrez found out that Cruz knew where to find the types of crafts the council was interested in. Gutiérrez hired Cruz to buy pieces for the council and encouraged him to sell his own carvings, which included animals, clowns, and masks. Cruz did not hide his methods and about 10 men in San Martín began to carve various types of wooden figures. In 1970 Gutiérrez became head of a government agency aimed at increasing craft sales. He named Cruz head of the agency's buying office in Oaxaca in 1971. During the four years Cruz ran the buying office, he was able to purchase many carvings from his friends and neighbours.

The third carver, Martín Santiago, made seven trips to the United States between 1952 and 1967, working as an agricultural laborer in California, Arizona, and Texas. During this time, Santiago also farmed small plots in La Unión and worked in construction around Oaxaca. When the *bracero* programme (the U.S.-Mexican agreement that sponsored Santiago's seasonal agricultural migration) ended, Santiago found that wage labour and subsistence agriculture provided meager support for his growing family. In 1967 Santiago began selling woodcarvings to a shop owner in Oaxaca, who had stopped buying from Jiménez after a complex, bitter dispute. Santiago taught his four brothers how to make wood figures and for many years the only carvers in La Unión were members of his extended family. In the past decade, a number of other families in La Unión have also begun to carve.

In the 1970s and early 1980s, carvers in the three villages sold their pieces mostly to store owners in Oaxaca. Only Jiménez supported his family primarily by making wood figures; other carvers earned more from farming and wage labour. Woodcarving was a part-time occupation for a few adult males during that time; women and children occasionally helped with sanding and painting. Many carvings were of human figures, oxen teams, angels, and

Figure 1. Location of the study area



Source: ESRI Data and Maps 2002.

skeletons.

In the mid 1980s, wholesalers and store owners from the United States began to buy directly from carvers in Arrazola, San Martín, and La Unión. The weakening peso made trading in Mexican folk art more lucrative for dealers in the United States. Wholesalers could earn significant sums of money by selling carvings in the United States at five times their cost in Mexico. As more dealers visited the three villages, carvers developed new styles in an effort to attract clients. Animal carvings sold best and soon dominated the trade. By 1990 most households in Arrazola and San Martín earned part of their income from the sale of carved figures, which became more ornate both in carving and painting, as artisans competed to show their skills. Because artisans in La Unión have been less successful in attracting dealers and tourists, woodcarving households there remain a minority, while La Unión became known for simpler carvings often painted with aniline.

Interest in the wooden figures was further stimulated by Shepard Barbash's widely-read magazine article, published in Smithsonian magazine, and his book on the carvings (Barbash 1991, 1993). Barbash's writings also had a significant effect on carving styles, as dealers and tourists sought out artisans whose work was featured in his publications. Although Barbash (1993: 40-42) feared that the carving boom would soon fade as dealers moved on to other crafts, sales remained strong. The trade in woodcarvings had dramatic effects on the economies of Arrazola and San Martín. Carving families built houses and bought refrigerators, automobiles, and television sets. Many families now send their children to secondary school. In Arrazola some families have abandoned agriculture altogether and work as full-time carvers. Although most carving households in San Martín continue to farm, agriculture has become a secondary, subsistence-oriented activity. While the effects of the carving trade were less dramatic in La Unión, some artisan families in that community were able to significantly improve their material circumstances through craft sales. Woodcarving allowed many families in the Valles Centrales to improve their economic circumstances, but at the same time led to a reduction of the natural resource on which the industry is based on.

Definition of the study area

The communities involved in the woodcarving trade span the central and north-central areas of Oaxaca state, most of the activity being based in and around the Valles Centrales region (Figure 2). Based on our previous and ongoing research (Purata *et al.* 2004), we distinguish three types of communities involved in the Oaxacan woodcarving trade on the basis of raw material availability and woodcarving activities. These are named using the terminology used in the multivariate comparison of non-timber forest cases (Belcher and Ruiz-Pérez 2001).

Producer communities. This category includes the communities where most of the raw material is extracted. Information about these communities

came from field surveys and interviews with artisans who buy wood. This information could not be confirmed with collectors because none of them acknowledges being a copal extractor; even authorities deny this activity is taking place in their communities. Villages included in this category are San Pablo Cuatro Venados and Yaxe.

Producer-processor communities. These are communities where artisans still collect their own wood from communal village lands. There is no copal wood trade, and except for one village, San Pedro Taviche, woodcarving is not the main economic activity. Villages included in this category are La Unión Tejalapam, San Pedro Taviche, San Martín Toxpalam, and San Pedro Cajonos.

Processor communities. These are localities without raw material but with the greatest concentrations of artisans. They are the only localities where copal wood is bought. Two villages are included in this category, San Antonio Arrazola and San Martín Tilcajete.

As a result of the economic success of *alebrijes*, the carving industry has sprung up in many places where there are *Bursera* trees. The city of Oaxaca, the suburban municipality of Xoxocotlán, which includes Arrazola, and some villages near the coast of Oaxaca are cases in point. We have omitted these communities from our case study area for raw material production, because the activity there is incipient and of little economic significance.

THE PRODUCTION-TO-CONSUMPTION SYSTEM

Resource base

The raw materials used for woodcarving come from several trees of the genus *Bursera* L. in the frankincense and myrrh family (Burseraceae). *Bursera* consists of approximately 100 species distributed exclusively in the Americas, ranging from southernmost United States to Peru. Maximum diversity occurs on the Pacific slope of Mexico, where there are some 80 species, of which about 70 are endemic (Rzedowski and Kruse 1979). The genus is divided into the subgenera *Bursera* and *Elaphrium* (Gillett 1980), also referred to as sections *Bursera* and *Bullockia*, respectively (Rzedowski 1968; Toledo 1982; Becerra and Lawrence 1999). All species utilised in the production of *alebrijes* come from the section *Bullockia*, which is composed of species with smooth, non-exfoliating bark. In general, trees in this section are locally referred to as copal, a term derived from the Nahuatl word *copalli*, which refers to the aromatic resin, used as incense, that is produced by many of the species in the section (Standley 1923). The distributions of the species primarily used in woodcarving are shown in Figure 2. *Bursera* species in section *Bullockia* have significant cultural importance in Mexico, with a long history of ceremonial and medical use. In the nineteenth and early twentieth centuries, significant amounts of *Bursera* were harvested to produce linaloe oil, used in perfumes (Altamirano 1904, Standley 1923; Peters *et al.* in press; see also Hersch *et al.* this volume).

The trees in section *Bullockia* have a complex set of ecological characteristics with both positive and negative management attributes.

On the positive side, individuals of the genus *Bursera* are often a dominant constituent of Oaxacan dry forests. Many exhibit some degree of stump-sprouting, are pollinated by generalist insects, and have their small fruits dispersed by a variety of bird species. On the down side, *Bursera* species in section *Bullockia* are relatively slow-growing. Their population structures may have a low percentage of seedlings relative to management ideals, and stump-sprouting responses are somewhat unpredictable (Brosi *et al.* 2000). As is the case for any biotic resource without a history of management, the population response to harvesting is unknown, though we have initiated studies addressing this issue.

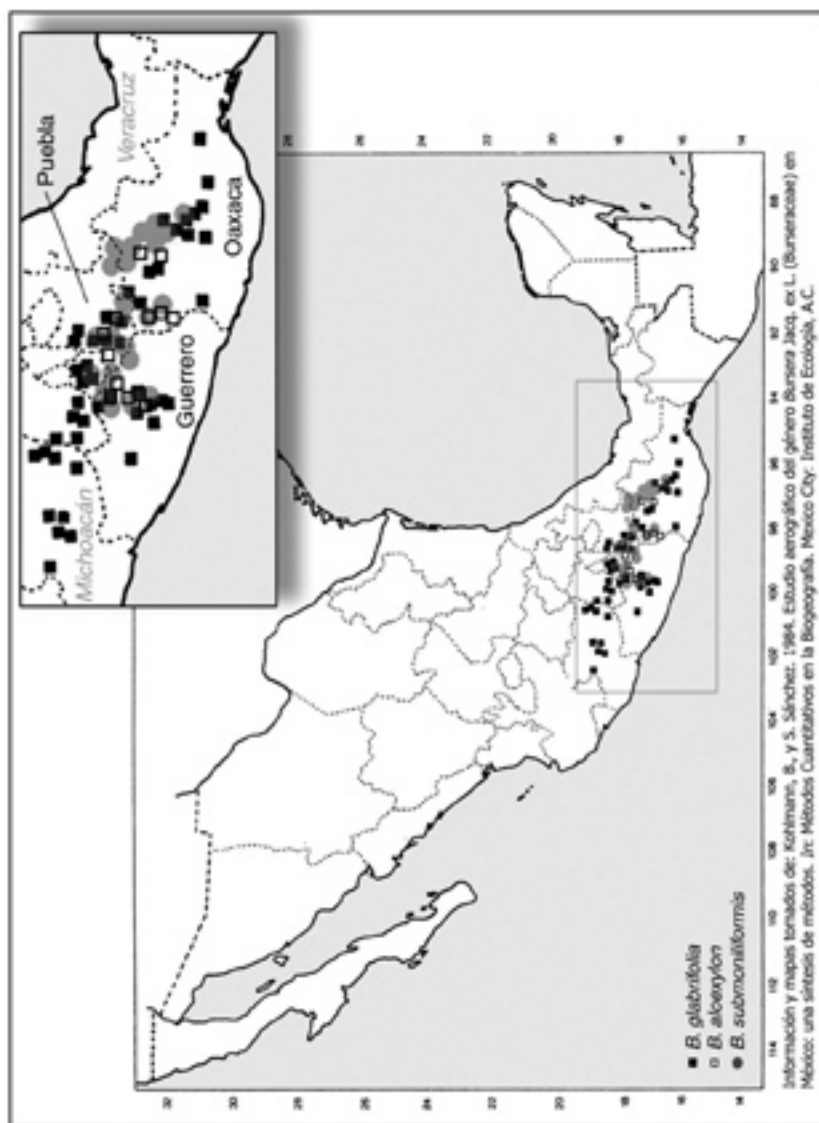
All of the harvested species of *Bursera* occur in dry forests known as low deciduous forest, or *selva baja caducifolia* (Miranda and Hernández Xolocotzi 1963), and tropical deciduous forest, or *bosque tropical caducifolio* (Rzedowski 1978). These forests are characterised by a marked dry season, lasting between five and eight months, and a low canopy. Rainfall averages between 600 mm and 1200 mm per year, concentrated in a marked wet season, which in Oaxaca occurs between May and September. *Bursera* species, like most other trees in these forests, are deciduous, dropping their leaves at the beginning of the dry season and flowering at the end of it.

Species utilised

The artisans we interviewed have a number of criteria for selecting wood for carving *alebrijes*. The ideal wood is soft, contains few knots, does not split when dry, sands to a smooth finish, and has a relatively nonporous surface that does not absorb lots of paint. Many *Bursera* species in section *Bullockia* share these characteristics, which has led to their extensive utilisation in the Oaxacan woodcarving trade.

Based on interviews with carvers and our collection of botanical specimens, *Bursera glabrifolia* H.B.K. (Engl.), *B. submoniliformis* Engl., and *B. aloexylon* Engl. are the primary species used for woodcarving in Oaxaca. The species most favoured by far for carving, *B. glabrifolia*, has been preferentially exploited in San Martín and Arrazola and became locally extinct in the late 1980s due to overharvesting. As *B. glabrifolia* began to decline in Arrazola, artisans began to use *B. bipinnata*, which is much less desirable for carving because of the high density of knots in its wood. Despite being a less favourable carving wood, *B. bipinnata* ultimately experienced the same fate as *B. glabrifolia*, and its populations wiped out from around Arrazola. Recently, the artisans of Arrazola have adopted the use of *B. aloexylon* and *B. submoniliformis* for their work, as these are the species brought to the village by their suppliers. At times of need, as a stopgap measure, carvers may occasionally also use the branches of less preferred species, which are generally harder or knottier, especially for small figures. The trajectory of copal harvesting has been similar in San Pedro Taviche, where harvesting pressure is beginning to cause depletion of local stocks of *B. glabrifolia*. In response to this, some carvers have begun to use *Bursera heliae* Rzedowski & Calderón, which is locally used to obtain copal resin (López 2001; Servín 2002).

Figure 2. Map of distribution of species used for the manufacture of wooden figures in Oaxaca



Natural abundance

Bursera is generally the dominant genus in the dry forests of Oaxaca, though density of individuals varies between localities. Rzedowski (1978) listed *B. glabrifolia* and *B. submoniliformis* as two of the 16 dominant species in dry forests in the eastern part of the Balsas drainage basin. In the communal forests of the village of San Juan Bautista Jayacatlán, where we carried out rigorous inventories, we found a range between 71 and 382 and an average of 163 individuals, including seedlings, of utilised *Bursera* species per hectare—mostly *B. glabrifolia*. These numbers probably represent the upper range of the *Bursera* density spectrum in Oaxaca. We expect tree densities to be lower in the Valles Centrales, where the climate is drier and the impact of human activities is higher.

Little cultivation or other management of *B. glabrifolia* is currently taking place. A grant from the Rodolfo Morales Foundation, (from the endowment of the well-known Oaxacan artist) enabled the establishment of *B. glabrifolia* plantations in the processor community of San Martín Tilcajete. Most trees from plantations have died, however, because of a lack of maintenance (López 2001).

Raw material producers and socio-economic context

Agriculture has always been an activity of great importance in the subsistence and economy of the Valles Centrales region. At present, agriculture is still important for subsistence in most communities, though with the exception of irrigated areas, most monetary income derives from other activities, including wage labour, craft sales, and remittances from people who migrate to work in Mexico City and the United States.

The majority of land in Oaxaca is communal property and in most villages there are forested areas controlled by the community. This form of land tenure has prevailed for centuries and, though weakened by various recent legislative changes, it has held on in about 80% of Mexico's forested lands (Merino 1997; Snook 1997). In this property system, institutions of the local village assembly and the (usually) elected and rotating positions of local authorities, together regulate access to resources. Local authorities have the responsibility of making sure that community resources are utilised in a manner approved by the town assembly or which follows common agreement. In principle, every member of the community has the right to obtain resources from communal lands in perpetuity for subsistence, but not commercial, use. In communities where regulation is deficient, the extraction of natural resources may be almost totally uncontrolled. In contrast, there are villages with strong local regulatory institutions, where access to natural resources is monitored and carefully controlled (Purata personal observation).

When *Bursera* trees disappeared from the villages of Arrazola and San Martín, artisans resorted to obtaining wood from neighbouring villages, some of which refused to sell their wood, foreseeing that the resource would disappear from their lands as well. In other villages, the extraction of wood continued until it became uneconomical or until the authorities opposed it. In San Juan Bautista Jayacatlán, for example, a few people began extracting

wood to sell to artisans in Arrazola until the communal authorities stopped the extraction by prohibiting the cutting of more trees until the village receives governmental permission for collective management, .

In villages where carvers are a minority, tensions tend to arise following the use of community resources for the benefit of only a few families. In contrast, in communities with many carvers- and where local authorities are frequently also artisans- such conflicts of interest tend not to emerge.

Until now, all of the *Bursera* wood utilised in carving has come from natural populations of these species. Commercialisation of the wood without an approved management plan is illegal according to Mexican forestry law and is therefore considered a clandestine activity. In order to elude the authorities, the majority of operations transporting wood use less-travelled routes, generally at night or very early in the morning.

COMMERCIALIZATION OF WOOD

We distinguish three types of production-to-consumption chains.

- 1) In producer-processor communities where carving is not the primary economic activity, or where the wood is still available, most carvers still collect their own wood. Many of these collector-carvers harvest tree limbs, which are needed for certain pieces and which are sometimes preferred over the entire bole.
- 2) In Arrazola and San Martín, the processor villages where carving is the dominant economic activity, carvers do not collect wood. Vendors, known as *copaleros*, come by donkey or truck to sell wood from other villages.

Photo 2. Copalero selling wood (Photo: Silvia Purata)



- 3) In San Martín, the community with the greatest number of carvers, artisans buy carved but unpainted figures, in addition to untreated wood. These carved pieces, named *figuras en blanco*, or 'blank figures', come from other villages but are painted in Tilcajete and bear the signature of the painter who finished it. In this manner the need to buy raw wood is somewhat reduced.

Processing industry

Making *alebrijes* woodcarvings is a multi-step process. After the wood is partially, but not completely, dried in the shade, artisans select a branch that roughly matches the shape of the carving they intend to make. A suitably sized piece is cut and stripped of its bark. Carvers then whittle the piece into its general form with a machete. Different carvers rely on different tools. Some use mostly gouges; others use chisels; still others work only with machetes and knives. Artisans acquire their basic carving skills from other carvers, but their individual choice of tools seems to be the outcome of individual experimentation over time. Many carvings have attachments such as ears, wings, and tails that are made from separate pieces of wood. Attachments are joined to the figure with either nails or glue or else fit into slots. The use of slots allows disassembly of the piece's often delicate attachments, facilitating its transport by tourists.

Pieces are sanded before being painted. Because carvings of green, uncured wood cannot be sanded properly, completed pieces are left in the sun to dry completely. The amount of time a piece is dried depends on both its size and the weather. In sunny weather, a small piece dries in a day or less and a medium-sized piece in two or three days. Especially large pieces can take as long as one month to dry. Sometimes, pieces are soaked in gasoline prior to drying, to reduce woodborer insect infestations.

Most pieces are painted in two stages. A solid coat is applied quickly before carvings are painstakingly decorated with dots, wavy lines, geometrical figures, or other designs. Artisans employ brushes of various widths when painting a piece. The base coat is ordinarily applied with a wide brush (*brocha*); thinner brushes (*pinceles*) are used to make finer decorations. The base coat is occasionally sponged on rather than painted with a brush. Artisans often apply the base coat twice to ensure that the piece is completely covered with paint. Applying the base coat is an easy task sometimes given to children or apprentices. Decorating is a much more difficult task, performed only by skilled artisans.

Until around 1985 most painters of woodcarvings used aniline powder paints mixed in water. While some carvers continue to use aniline, most have switched to glossier acrylic (vinyl) house paints introduced to Mexico in the mid-1980s. There are several reasons why most artisans and buyers prefer acrylic paint. Because acrylic paints are mixed with less water than aniline dye, they do not run as much. Aniline pieces often fade over time, especially when exposed to sunlight. Moreover, unlike acrylic paint, aniline sometimes eats into wood. Nonetheless, aniline pieces have a 'rustic' quality that some

dealers and consumers like. Perhaps because aniline tends to run, carvings painted with this dye tend to have simpler designs.

Organisation of the artisan subsector

When the demand for wood figures increased in the 1980s, male carvers asked their wives and children to help with sanding and painting. Carving quickly became a family activity carried out in workshops, in which adult men contributed much less than half the total labour. When woodcarving became a household enterprise at the start of the boom, families rapidly developed internal divisions of labour. Sanding, the simplest task, was reserved for those who were unwilling or unable to become skilled artisans. Some sanders were children; others were adults whose time commitment to other activities prevented them from learning more complex tasks. Although women quickly learned how to paint in the late 1980s, there has never been the cultural supposition that they are better suited to this task than men. Many adult men pride themselves on their painting and it is common to find men who paint better than they carve. Nonetheless, women do most painting, perhaps because carving has always been a predominantly male activity. Gender roles are not as clearly defined in San Pedro Taviche, where many women collect wood, carve, paint, and sell their figures just as men do.

The gender division of labour in woodcarving is partly related to how children are raised. From an early age, boys are responsible for gathering firewood. Boys also carve some of their toys, such as wooden tops. By cutting firewood and making tops, boys develop skills in the use of knives and machetes. Girls' tasks and games, in contrast, rarely involve woodworking.

Families are sometimes unable to fill large orders using only household labour and hire one or two workers to help with carving, sanding, and painting. At first, these workers tend to be close relatives living nearby, but as the operation expands family, friends, or even strangers from neighbouring communities are employed. At present, most hired workers are teenage boys and girls or young, unmarried adults, who are paid by the piece.

Many carvings are still produced in family workshops without the use of hired labour, however. Most families that began carving after 1990 cannot afford to pay piece workers. Some very successful carving families also refuse to use hired labour. They say that the quality of pieces from large workshops is poor and that such carvings are 'not art'. Furthermore, dealers often want assurance that the person who signs a piece was involved in its creation.

Teenagers who paint and carve for their parents without being paid often earn money by doing piecework for others. Girls work as hired painters for their neighbours, while boys sell unpainted carvings. Economic relations between parents and adult children can be complex. Grown children who continue to paint and carve with their parents after marrying expect to be paid for their work. Parents and children sometimes share workshop space but run essentially independent operations. Many households contain two or more workshops. Parents and unmarried children make figures in one workshop, while married children and their spouses carve and paint in the

others. Most married children eventually build houses and workshops away from their parents.

Several carving workshops, employing 5 to 20 workers, have been established in Arrazola over the past five years. Although the owners of these businesses sell some pieces to wholesalers, they concentrate on producing small, cheap carvings for tourists seeking souvenirs. Tourists buying a carving from a workshop pay two or three times what a dealer would pay for a comparable piece, though few tourists know or care about this difference. Retail prices in workshops are similar to those found in shops in the city of Oaxaca, but much lower than in stores in the United States. When the market for inexpensive pieces slowed in the year 2000, these workshops either scaled down or closed.

The owners of the Arrazola workshops often buy pieces from families who are unable to find other outlets for their carvings. These pieces, which come from both Arrazola and San Martín, are sold with a mark-up of 100 percent or more. Workshop operators also routinely buy unpainted pieces, which are then painted in the workshops and sold to tourists. The selling of unpainted pieces has become increasingly common since 1990. There are villages in Oaxaca state where men have elementary carving skills but no one can paint well. The most important of these communities is San Pedro Taviche. For the past decade, men from San Pedro Taviche have sold unpainted carvings to families in San Martín, who paint the pieces and resell them to dealers or tourists. Not all sellers of unpainted carvings live in communities off the main tourist trail. Many teenage boys and unmarried young men in Arrazola and San Martín sell such pieces. Some have learned to carve in large workshops and have not yet had the opportunity to paint much. Others simply lack the skill or the inclination to become good painters.

The relative importance of the various types of production units differs somewhat between Arrazola and San Martín. Merchant-entrepreneurs are much more important in Arrazola. San Martín has many more families that support themselves by buying, painting, and reselling carvings made in other communities. The differences between these two towns, however, are less significant than their similarities, and Arrazola and San Martín include many households earning substantial amounts of money from carvings made in family enterprises and employing little or no hired labour. These households are as well-off as any of the families that run the large workshops.

Both the prices paid for carvings and household incomes vary considerably. Prices for individual carvings in Oaxaca range from US\$1 to US\$1,200, depending on size, quality, and sometimes the prestige of the artisan who signed the piece. The average price wholesalers pay for small, simple carvings is about US\$3.50 and US\$8 to US\$10 for a medium-sized piece. Prices for large figures vary a lot, but in Oaxaca most cost US\$40 or less. Annual household income from carvings in Arrazola or San Martín is typically around US\$2,000, though many earn more and some but can be as high as US\$20,000.

Trade and marketing

Harvested wood is generally transported on bicycles and donkeys. Harvesters

who carve will take the wood directly to their workshop. If the wood is to be sold, it is transported to the nearest road, where it is picked up and transported by trucks or, in some cases, taken directly to a carving village. *Bursera* wood buyers arrive in communities where there is an abundance of *Bursera* trees and buy the wood from a person who has either felled a forest plot to plant crops or cut trees expressly to sell. This trade is unfortunate from the community's point of view, because the sellers are obtaining a private benefit from a public resource. This state of affairs, combined with the illegality of commercial harvesting of forest products without a permit, explains the reticence of many extractors to give any information about the origin of wood, or the methods used to obtain it. The data we have collected on this comes from artisans who cut their own wood in villages where there are still *Bursera* trees and from people who were formerly involved in the extraction of wood.

The first *copaleros* came from communities adjacent to artisan villages. When the wood became scarce or local authorities became hostile to its extraction, they extended to areas farther away from artisan villages. We identify two types of *copaleros*—collectors and transporters. Collectors cut wood with an axe or chainsaw and bring it directly to artisan villages. The quantity extracted depends on the method of transport, which is by either donkey or truck. Transporter *copaleros* buy cut wood from members of their community or other villages and truck it to artisan villages.

Based on interviews with artisans and on short talks with *copaleros*, we learned that no more than six persons control most of the wood trade in Arrazola and San Martín. This concentration is possible in part because a lot of wood enters the chain in these communities—especially San Martín—in the form of unpainted figures, *figuras en blanco*, most of which are carved in San Pedro Taviche.

San Pedro Taviche is a special case. Here, the demand for wood began in about 1992, with the arrival of wood buyers who supplied San Martín. About three people began to harvest wood with machetes or axes, transporting it by donkey to the entrance of the village, from where trucks would take it to sell in Tilcajete. After about one year, the town assembly decided to prohibit it on account of the low price and the fact that a few people in the community were benefiting from a communal resource, with most earnings going to intermediaries from outside of the community.

At the same time, the Morales Foundation—the same organisation that began the *Bursera* plantation project in San Martín—was advocating the carving industry as a means of economic development, particularly in light of the area's meagre agricultural potential and the lack of economic alternatives. As part of a strategy to add value to the wood, the foundation supported and financed a course in woodcarving. Currently there are about 150 carvers in Taviche, most of whom make unpainted figures to sell to workshops in San Martín. The carvers in Taviche that make finished, painted figures produce medium to low-quality *alebrijes*, which are sold in markets in the cities of Ocotlán and Oaxaca.

Despite the diverse paths that Oaxacan woodcarvings can take from collection of raw materials to their final destination on someone's shelf,

their journey from production to consumption can generally be outlined as follows: after the raw materials (mostly wood and paint) are obtained, the carving is made by a work group living in a small community near the city of Oaxaca. Although some pieces are sold directly to tourists, more are bought by intermediaries in the woodcarving trade, such as shop owners from Oaxaca and wholesalers from the United States. Some carvings are sold in stores in Oaxaca; others end up in markets and shops elsewhere in Mexico. Most Oaxacan woodcarvings, however, are ultimately sold in ethnic arts and gift shops in the United States and Canada.

Policy Environment

Mexican forestry law allows individual or family-based harvesting of forest products by indigenous groups, but only for subsistence or ritual use. Commercial forest resource extraction requires a permit, however, for which a management plan must first be approved. Preparing such a management plan takes time, money, and expertise, all of which are hard to come by in the Valles Centrales area. For that reason we believe that it is highly unlikely that a community could write a *Bursera* management plan without institutional support, such as the one we are providing to the inhabitants of San Juan Bautista Jayacatlán. From conversations with artisans, who have complained about unpredictable deliveries and poor wood quality, we believe that a legally approved supply of *Bursera* wood would be attractive to carvers because of its quality, stability, and predictability.

TRENDS AND ISSUES

Demand for *alebrijes* appears to have increased over the last decade, albeit at a slowing rate. With the rise in demand, more people in Oaxaca are getting involved in the woodcarving trade in various ways. This growth has meant an increase in the exploitation of *Bursera* species throughout the Valles Centrales of Oaxaca and beyond. As wood sources near carving villages have dwindled, carvers and suppliers have had to move farther and farther away to find *Bursera* wood suitable for carving. If demand continues and sustainable management techniques are not put into place, this trend will likely continue.

The immersion of Oaxacan wood carvers into the global folk art market has improved the standard of living of many artisan families. Artisans have specialized in particular types of pieces in an attempt to capture niches in a diverse and ever-changing market. Nonetheless, the woodcarving trade has led to considerable social stratification within artisan communities as some craft-producing families have prospered more than others.

Impact of Harvest

Lack of previous studies on *Bursera* populations in the Valles Centrales region of Oaxaca makes it hard to evaluate the exact impact of wood extraction. For example, we do not know the pre-existing stock of wood, or the rates of

population regeneration before woodcarving began. The evidence outlined above suggests, however, that the resource is being 'mined' from natural populations at an unsustainable rate.

Harvesting has had a dramatic impact on the *Bursera* populations near the two major carving villages. The species used for carving are essentially locally extinct in these areas. In the smaller carving villages, populations of *Bursera* have been reduced and will continue to decline in villages that have been increasing production. If enterprises in these areas persist, they may have a strong deleterious local effect on *Bursera* populations. Because the *Bursera* species used in woodcarving are relatively widespread and abundant in Oaxaca and surrounding states, there is currently little danger of them going extinct from harvesting pressure. However, if markets continue to grow and more villages become involved, this threat could become a reality in the future.

No studies have examined the effects of *Bursera* removal on dry forest ecosystems, but its harvest for woodcarvings could have serious direct and indirect ecological effects. Perhaps the most pressing of these concerns is that forests from which many trees have already been removed may be more attractive to slash-and-burn cultivators in their quest for new lands; these areas may experience a higher rate of conversion to agriculture than non-harvested areas. Since agriculture is undoubtedly the major competing land use for dry forest extractivism in Oaxaca, such conversion could be a potentially serious indirect effect of harvesting. Again, it must be stressed that ecosystem-level effects are purely conjectural, as we do not have sufficient experimental or observational data on this point.

We have been working on a project to improve the management of *Bursera* species used for woodcarving, primarily in the community of San Juan Bautista Jayacatlán (hereafter Jayacatlán), about 40 km north of the city of Oaxaca. We chose Jayacatlán because it has nearly 3,000 ha of land with dry forest, an infrastructure in place to allow community forest management, and an interest in sustainably managing its dry forests. We studied the distribution, abundance, and demography of the utilised *Bursera* species with residents of Jayacatlán, running a total of 33 km of 10 m-wide inventory transects, measuring tree growth with metal dendrometer bands, and calculating diameter-wood volume relationships by harvesting entire trees. Using these data we wrote a thorough, tree population-based management plan, which was approved in 2002 by the Secretaría de Medio Ambiente y Recursos Naturales (SEMARNAT, the Mexican Secretariat of Environment and Natural Resources) and which is currently in the first stages of implementation (Brosi *et al.* 2002; Peters *et al.* 2003; Purata *et al.* 2004). The management plan is the first ever dry forest management plan approved in Mexico, and calls for harvesting no more wood than grows in the forest—the defining feature of a sustainable harvest—which in this case is slightly more than one tree per hectare per year. No logging roads will be built in Jayacatlán's dry forest, and wood will be transported from felling sites to roads using donkeys. We estimate that sustainable harvests from this village alone will be enough to supply Arrazola, the second-largest carving village. Eventually, we hope to use Jayacatlán as a model for other wood-producing

villages, which will harvest *Bursera* wood in a thoughtful, sustainable, and planned manner.

FUTURE PROSPECTS

Only eight years after the woodcarving boom began, Barbash (1993: 40-42) was already concerned about the future prospects of the craft: 'How long will it last, this serendipitous interplay of market forces and creative spirit? Sales peaked in the late 1980s and have been hurt since by a sick U.S. economy . . . [and] a gradual revaluation of the *peso*.' Barbash's worries were unfounded in the short term as carving sales rebounded and remained good throughout the 1990s. The major devaluation of the peso in late 1994 made woodcarvings much cheaper for dealers; the U.S. economy became extraordinarily strong in the latter half of the decade. These economic factors alone, however, cannot account for the carvings' continuing popularity in the 1990s.

Even, or perhaps especially, in prosperous times, however, consumers' preferences can change rapidly. The carvers' success at the end of the twentieth century does not guarantee that sales will remain good in future years. One of the reasons for the woodcarvers' success was that their pieces fit in with the Southwestern style of home design that was fashionable in the United States in the late 1980s and early 1990s. Some dealers speculated that a decline in the popularity of this design style would weaken the demand for carvings. But Teotitlán rugs, which fit in even better with this style than the carvings, still sold reasonably well after the peak of the popularity of Southwestern design. By the end of the 1990s, *alebrijes* were featured prominently in guidebooks, videos, state tourist pamphlets, and websites about Oaxaca. They were sold in government stores, displayed in museums, and advertised in catalogues and over the Internet. The woodcarvings had become a 'typical' Oaxacan craft along with textiles, pottery, and tinware.

Although this invention of a craft tradition might help the sale of carvings, there is no way to predict the future of the woodcarving trade. If demand for inexpensive carvings had remained strong, the number of local intermediaries might have increased. Merchants from Teotitlán and Mitla specializing in textiles had already begun to buy woodcarvings in Arrazola and San Martín to take them to cities along the U.S. border and Mexican resorts such as Cancún.

At the beginning of the twenty-first century, the demand for high-end carvings remains strong, but the market for inexpensive pieces has diminished. The results of this shift have not been surprising. The large factory-like workshops have either shut down or greatly reduced the scale of their operations and woodcarvers in satellite villages have suffered. The woodcarving trade is dominated more than ever by families making high-end, specialized pieces.

Critics of globalisation could justifiably point to the uncertain future of the woodcarving trade as yet another example of the perils of local economies depending on unpredictable world market forces. Rural Oaxacan households, which know well the dangers of relying on only one source of income, have long pursued flexible economic strategies involving a mix of

agriculture, crafts, wage work, and emigration. If the market for expensive carvings also collapses, there is no question that many families will suffer in the short run. Still, the residents of Arrazola, San Martín, and La Unión are ingenious and resilient. Their first reaction will undoubtedly be to rely more on subsistence farming, seek additional sources of wage work, and migrate more often and for longer periods. But they will probably not give up craft production. Someone, perhaps, will think of a new art form that tourists might like.

CONSERVATION AND DEVELOPMENT LESSONS OF CASE

The development of a craft-based certification scheme may empower craft buyers to contribute to better management of *Bursera* wood while fostering more positive social and economic trends in the Oaxacan woodcarving market. The traditional forest certification process in its present form is unlikely to work in this case, because it costs several thousand dollars to certify a forest management operation, an upfront cost that would be difficult for wood-producing to bear. Additionally, the cost of certification is typically made up by increasing the price of the certified wood, which would make the raw material unattractive to the consumers, in this case village-based artisans who are unlikely to pay a premium for certified wood. However, if carvings can be certified and marketed as coming from both well-managed wood and a socially responsible work environment, the certified handicraft might command a significant price premium. This premium would likely more than make up the extra cost of certified wood. We are currently supporting a group of artisans from Arrazola to promote a new type of carvings, the *Ecoalebrijes*, made with the sustainably produced wood from Jayacatlán.

Though craft certification would be a socially and environmentally beneficial force in the Oaxacan woodcarving market, a certified market could not handle all of the demand for figures. Certified crafts will most likely find their largest market among educated consumers, especially those with a particular interest in collecting handicrafts. Many buyers, however, do not fit this profile and act spontaneously when they see a figure in a craft stall on the street in Oaxaca or in a store in the United States. If a craft certification system were developed, a consumer education programme should be worked out concurrently to insure a healthy demand for the certified product and thus keep the certification system economically viable. Chains of craft stores and catalogues that promote their wares as fairly traded may be a good place to begin.

Because certification will work only for a portion of the market, other measures are needed to ensure sustainable extraction of *Bursera* wood in Oaxaca. As mentioned previously, we have been working to develop San Juan Bautista Jayacatlán as a model wood-supplying community. If another village or two with significant *Bursera* populations and a potential for community management were to be developed in a manner similar to that of Jayacatlán, the wood demands of San Martín could be met almost entirely. If sufficient funding could be identified, it may also be possible to independently certify the forest management practices of this network of wood-supplying villages

at no cost to the communities, making forest certification a more feasible conservation application.

Even with the development of a network of wood-producing villages and forest and craft certification systems, there will probably always be a few *copaleros* who will transport a few loads of wood into one of the major carving villages and sell it for a price low enough to attract buyers. In the long run, however, they will be unable to compete with traders from organised communities with legal permission to sell their wood, who know what qualities artisans want in their raw material and who arrive to sell their wood on a regular, predictable schedule. What will happen to copal trees in these areas depends in large measure on the organisation of the community and their management practices for communal resources.

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REFERENCES

- Altamirano, F. 1904. Datos acerca de la preparación industrial de la esencia de Linaloe en el Edo. de Guerrero. *Anales del Instituto Médico Nacional* 6: 70.
- Barbash, S. 1991. These magicians carve dreams with their own machetes. *Smithsonian* (May): 119-129.
- Barbash, S. 1993. Oaxacan wood carving: the magic in the trees, with photographs by Vicki Ragan. Chronicle Books, San Francisco.
- Becerra, J.X. and Lawrence V.D. 1999. Nuclear ribosomal DNA phylogeny and its implications for evolutionary trends in Mexican *Bursera* (Burseraceae). *American Journal of Botany* 86(7): 1047-1057.
- Belcher, B. and Ruiz-Pérez, M. 2001. An international comparison of cases of forest product development: overview, description and data requirements. CIFOR Working Paper 23.
- Brosi, B., Peters, C., Ambrosio, M., Purata, S. and Aguirre, H. 2002. Plan de manejo forestal de copalillo, bienes comunales de San Juan Bautista Jayacatlán, Etla, Oaxaca. Secretaría de Medio Ambiente y Recursos Naturales de México.
- Chibnik, M. 1999. Popular journalism and artistic styles in three Oaxacan wood-carving communities. *Human Organization* 58(2): 182-189.
- Chibnik, M. 2000. The evolution of market niches in Oaxacan woodcarving. *Ethnology* 39(3): 225-242.

- Chibnik, M. 2001. Oaxacan wood carvers: global markets and local work organization. In: Rees, M. and Smart, J. (eds.) Plural globalities in multiple localities, New World borders. Monographs in Economic Anthropology no. 17. University Press of America, Washington, D.C.
- Chibnik, M. 2003. Crafting tradition: the making and marketing of Oaxacan wood carvings. University of Texas Press, Austin.
- Gillett, J.B. 1980. Commiphora (Burseraceae) in South America and its relationship to Bursera. Kew Bulletin 34: 569-587.
- López, A.M. 2001. Evaluación de la demanda y extracción de madera de copal (Bursera spp) para artesanía en comunidades de los Valles Centrales de Oaxaca, México. B.Sc. Thesis, Universidad Nacional Autónoma de México.
- Merino, L. (ed.) 1997. El manejo forestal comunitario en México y sus perspectivas de sustentabilidad. UNAM, SEMARNAP, CCMSS, WRI.
- Miranda, F. and Hernández Xolocotzi, E. 1963. Los tipos de vegetación de México y su clasificación. Boletín de la Sociedad Botánica de México 28: 29-179.
- Oettinger, M. 1990. Folk treasures of Mexico: the Nelson A. Rockefeller Collection in the San Antonio Museum of Art and the Mexican Museum, San Francisco. Abrams, New York.
- Peden, M.S. 1991. Out of the volcano: portraits of contemporary Mexican artists. Smithsonian Institution Press, Washington, D.C.
- Peters, C.M., Purata, S.E., Chibnik, M., Brosi, B.J., Lopez, A. and M. Ambrosio, 2003. The life and times of Bursera glabrifolia (H.B.K.) Engl. in Mexico: a parable for ethnobotany. Economic Botany 57(4):431-441.
- Purata, S. E., Peters, C. M., Ambrosio, M., Brosi, B. J. y A. M. Lopez. 2004. Los alebrijes de Oaxaca y el manejo de las selvas secas. Revista *Ciencia y Desarrollo*, Vol XXX. Núm. 174:52-60.
- Rzedowski, J. 1968. Notas sobre el género *Bursera* (Burseraceae) en el estado de Guerrero (México). Anales de la Escuela Nacional de Ciencias Biológicas de México 17: 17-36.
- Rzedowski, J. 1978. Vegetación de México. Editorial Limusa, México City.
- Rzedowski, J. and Kruse, H. 1979. Algunas tendencias evolutivas en *Bursera* (Burseraceae). Taxon 28(1, 2/3): 103-116.
- Serrie, H. 1964. The emerging artist in a society of craftsmen: three case studies. M.A. Thesis, Cornell University, Ithaca, NY.
- Servín, L. 2002. Evaluación de la extracción tradicional de resina de copal (tecomaca) *Bursera heliae* Rzedowski & Calderón (Burseraceae) y su efecto en las poblaciones de la especie en San Pedro Taviche, Oaxaca. B.Sc. Thesis, Universidad Veracruzana, Xalapa, Veracruz.
- Snook, L. 1997. Uso, manejo y conservación forestal en México. In: L. Paré, L., Bray, D., Burstein, J. and Martínez, S. (eds.) Semillas para el cambio en el campo. UNAM-IIS, Soc. de Solidaridad Sansekan Tinemi y Saldebas. México.
- Standley, P.C. 1923. Trees and shrubs of Mexico. Contributions of the United States National Herbarium 23: 542-552.
- Toledo M.C. 1982. El género *Bursera* (Burseraceae) en el estado de Guerrero en México. B.Sc. Thesis, Universidad Nacional Autónoma de México.

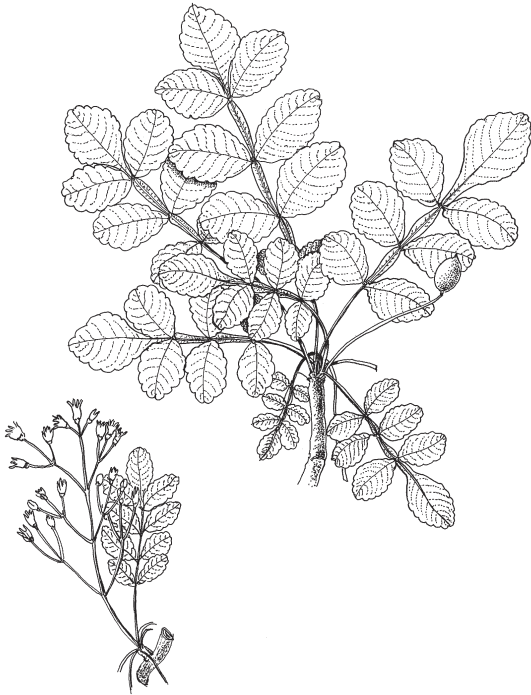
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Chapter 22

Linaloe [*Bursera aloexylon* (Schiede) Engl.]: An Aromatic Wood Caught Between Tradition and Economic Pressure

Paul Hersch Martínez¹, Robert Glass² and Andrés Fierro Alvarez³



(*Bursera aloexylon*)

Common name	Product part used	Dominant form of management	Degree of transformation	Commercial scale	Geographic distribution
Xochicopal, Copalcojtli, Linaloe	Wood	Wild	Average/ middle/half	Intentional	Average/ middle/half

ABSTRACT

We present an overview of linaloe, *Bursera aloexylon*, an aromatic species of traditional use in Mexico. This *Bursera*, from lowland deciduous forests, constitutes a non-timber forest product, the principal applications of which are use of its wood for handicrafts and its distilled essential oil for use in perfumery, also obtained from its wood or fruits. The study area lies in the watershed of the Upper Balsas River and its surroundings in the state of Guerrero, Mexico. Through literature reviews, field studies, and experiments that included interviews and meetings with collectors and processors, we examined the historical, cultural, socio-economic, botanical, ecological, technical, and commercial aspects of the species. On linaloe converge the survival strategies of rural dwellers living under precarious conditions and experiencing severe environmental problems, together with the evolution of a traditional craft product, the reality of a promising product that is insufficiently developed in its country of origin, and the current prospects of balanced and potentially optimal exploitation.

INTRODUCTION

The linaloe, *Bursera aloexylon* (Schiede) Engl., is a tree of the Burseraceae, or frankincense, family, originating in America. The Nahuas Indians⁴ know it as a part of the *copales* or *copalli* group, calling it *xochicopal* or *copalcojtl*. The *copales* group encompass more than 40 species of the genus *Bursera*, many of them valued for the aromatic quality of their resins upon being burned. Indeed, repeated allusions exist as to the ritual use, in ancient Mexico, of resins in incense braziers, or *sahumerios*, that would give off aromatic smoke. Even now, this tradition continues in various indigenous areas of the country and Central America (Sahagún 1577; Ruiz de Alarcón 1629; Galinier 1991; Chapman 1992; Baytelman 1993).

Since pre-Cortesian times, the linaloe tree has been in demand for the odour of its resin and the smooth texture of its wood, two significant attributes that give reason to its current use in the creation of handicrafts⁵ and extraction of essential oils. Given the constant and moderate fire that its wood produces on burning, it is popular as a fuel for bread-making in rural ovens. It is also used medicinally, particularly as a 'general tonic' and against scorpion bites, headaches, and neuralgias. Historically, this use was so extensive that it appeared in several editions of the Mexican pharmacopoeia, since it was first published in 1846. The major use of linaloe, however, even in pharmacopoeias, is derived from its aromatic character (Herrera *et al.* 1896; Tibón 1960; Martínez 1994).

Commercial history

On exploring the commercial background of this tree, it is worth describing other *Bursera* species similar to linaloe but producing more resin, such as *B. jorullensis* (HBK) Engl. and *B. gummifera* Jacq. These woods were systematically exported to Spain during Mexico's early colonial period for use in treating colds and other diseases attributed to the cold or moisture

(Monardes 1574; Martínez García 1991)⁶. In fact, the name 'linaloe', under which *B. aloexylon* is currently known, has commercial origins, being taken from *lignum aloes* or *leño aloe* (woody aloe), a term used for various species of medicinal use (Mortera Llano 1925; Laguna 1566). As happened with many plants, the term Europeans allotted to this type of *Bursera* dates from then and is of significant interest in the search for alternative sources of goods previously valued in Europe⁷.

Since the eighteenth century, references have been made to the aromatic quality of the woods, resins, and oils of several species of the *Bursera* genus, including linaloe. The Jesuit Francisco Javier Clavijero mentioned linaloe of the Mixteca in his *Historia Antigua de México* (Ancient History of Mexico), originally published in 1776, as did Antonio Pineda, member of the natural history expedition to Malaspina, which, in 1791, explored part of the region encompassing our study area (González Claverán 1993)⁸.

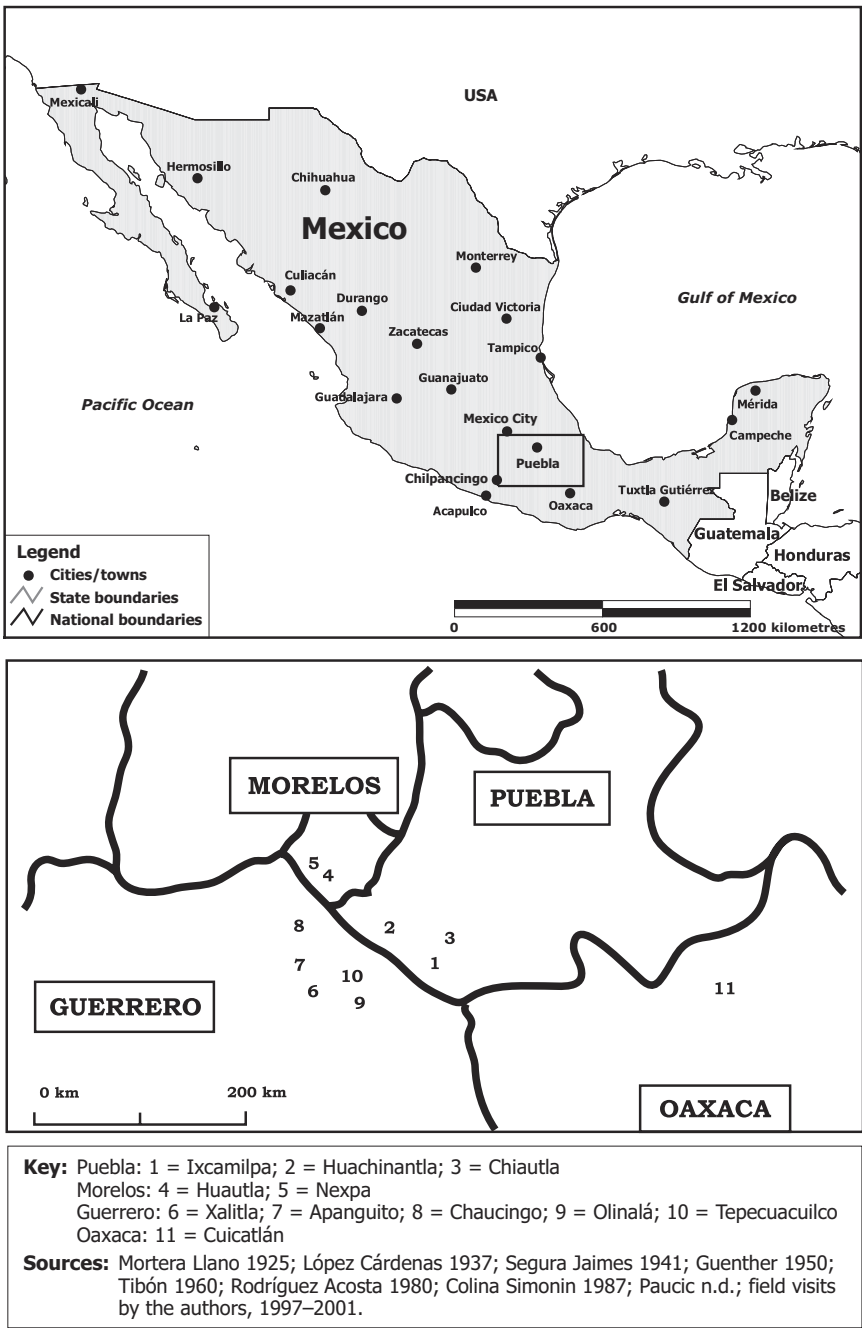
The handicraft industry currently using linaloe wood goes back to pre-Cortesian times, when various scraping, scratching, and painting techniques of wooden cups, bowls, and other pieces prevailed. This industry continued and developed during colonial times, including the making of chests (Sahagún 1577; Alzate 1791; Meave 1791; Tibón 1960; Medina 1997).

Explicit references exist on Mexican exports of linaloe from the second half of the nineteenth century, which describe wood being sent from the state of Colima for distillation in France and England (Mortera Llano 1925; López Cárdenas 1937). In 1910, an English tea-trading company sent agents to Mexico to explore for aromatic species. One P.J. Anderson collected seeds and examples of linaloe from various origins, together with climatic data and even soil samples, to introduce this species into India to begin cultivation for the first time. After several trials and tribulations, a plantation was established in 1920 in the province of Bangalore with a view to obtaining essential oil from the fruit. In 1927, oils from India began being used in Europe (López Cárdenas 1937; Vasconcelos Aldana 1939; Guenther 1972; Hussain 1993). India continues to be a major supplier for the international market (Hussain 1993), as the product is now well known among Indian forest producers (Raghavan Nair personal communication).

Meanwhile, in Mexico, since at least mid-nineteenth century, essential oil from linaloe wood was being distilled for domestic consumption and export to European and U.S. perfumery markets (Noriega 1902; Altamirano 1904b; López Cárdenas 1937; Vasconcelos Aldana 1939; Segura Jaimes 1941). Equipment in Mexico was rudimentary, and exploitation generally and plantations specifically did not benefit from modern techniques. Extraction procedures expended high levels of energy and resulted in suboptimal yields. Equipment was often located on open river plains in various sites, mostly in the states of Guerrero, Puebla, and Oaxaca. We recorded oral testimonies on the distillation of oil from linaloe in Ixcamilpa—begun after the 1918 flu epidemic—and Chiautla (Puebla), Papalutla and Mezquitalán (Guerrero), Nexpa and Chimalacatlán (Morelos), and Cuicatlán (Oaxaca).

During World War I, as distillation of linaloe intensified in the communities referred to (Figure 1), the trees gradually began to disappear in the absence of reforestation. The period between the world wars, particularly the end

Figure 1. Location of the study area and those ancient centres for distilling essential oil from *Bursera aloexylon* that are most frequently described in the literature and field visits, Mexico



Source: ESRI Data and Maps 2002; Hersch *et al.* 2003.

of the 1930s, marked the peak of the extractive industry in Mexico (López Cárdenas 1937; Segura Jaimes 1941). With World War II, oil production from linaloe dropped substantially (Guenther 1972). Warnings on the intensity of exploitation and the implications for the availability of linaloe trees were made at various times (Mortera Llano 1925; Martínez 1928; Segura Jaimes 1941) until, in 1948, the Mexican Forest Service established legal measures for protection. As elderly rural dwellers describe and other sources confirm (Guenther 1972), exploitation progressively diminished in Cuicatlán, Tecolapa, and Ixcamilpa, although a large quantity of fruit was available for distilling to permit continuity.

The almost total abandonment of extraction of essential oil was facilitated by the disappearing populations of trees, adulteration practices that damaged the product's quality and prestige (Segura Jaimes 1941; Guenther 1972), and external factors such as the introduction to world markets of oil from linaloe fruit grown in the plantations of India, of synthetic linalool—a terpenic alcohol that constitutes the principal component of the oil from this *Bursera* species—and of an ester, linalyl acetate. The conspicuous presence of both elements results in a substance highly similar to the essential oil from European lavender (Vasconcelos Aldana 1939; Segura Jaimes 1941; Guenther 1972).

Cultural importance

The cultural importance of linaloe resides in its native origins and its application to unique handicrafts in Mexico. Within this framework, wood with streaks or veins is highly favoured, because its aromatic quality and the repellent effect of its essential oil against moths made it a popular raw material for making boxes designed to keep clothing (Tibón 1960; Espejel 1976). Thus, chests of linaloe wood were used to protect traditional bridal apparel and to provide a place in the homes of numerous rural families to keep clothes well-conserved and scented.

Linaloe wood destined for handicrafts still constitutes today the most important component in the species' marketing chain. The effect of exploiting the wood as raw material for handicrafts and as a source of essential oil is limited to the communities of origin, and is currently less, given its decline through exploitation. Today, the wood goes to the artisans of Olinalá and to those who continue distilling the oil in Chiautla and Tecolapa. Linaloe represents, for the communities of origin, one of the few opportunities for market participation, constituting an additional cash income for some families, which, in the study area, is normally obtained through the collection of other wild species, mainly those of medicinal use such as *cuachalalate* (*Amphipterygium adstringens* Schl., Julianaceae) or brazil-wood (*Haematoxylon brasiletto* Karst, Fabaceae). The additional income from sales of linaloe wood helps some families, making it possible for them to pay for services and resources inaccessible through barter. Yet the differential importance of linaloe in the context of products that generate cash for the family economy is less than what it was at the peak of extractive activity, as much for handicrafts as for essential oil.

In addition, the impact of the handicraft industry on the Olinalá community is important, as it involves about 570 artisans—at least one of nine inhabitants—associated with 11 production groups. These groups are organised locally and perform their activities in the municipal capital. If the craft industry were not to exist, Olinalá would surely be a village like any other of the region, with fewer services and even unknown nationally.

The artisans of Olinalá operate in a social field that differs from that of those who extract linaloe wood. The former process wood, together with other materials, within the framework of a traditional activity, linked to a market that, formerly, comprised mainly regional fairs such as those of Tepalcingo (Morelos) or Xochitepec (Puebla), and which has now diversified to include tourist circuits and has succeeded in entering the Internet for exports. In contrast, the wood collectors are linked to a more reduced commercial network, without organisations, and conducting extractive activities within a framework of a series of subsistence activities that include the collection of wild species and seasonal cropping. With respect to oil, the impact of its current production is insignificant on the communities that continue distilling on a rudimentary basis, as it has become a marginal practice, residual from the times when it was important in the watershed of the Upper Balsas River.

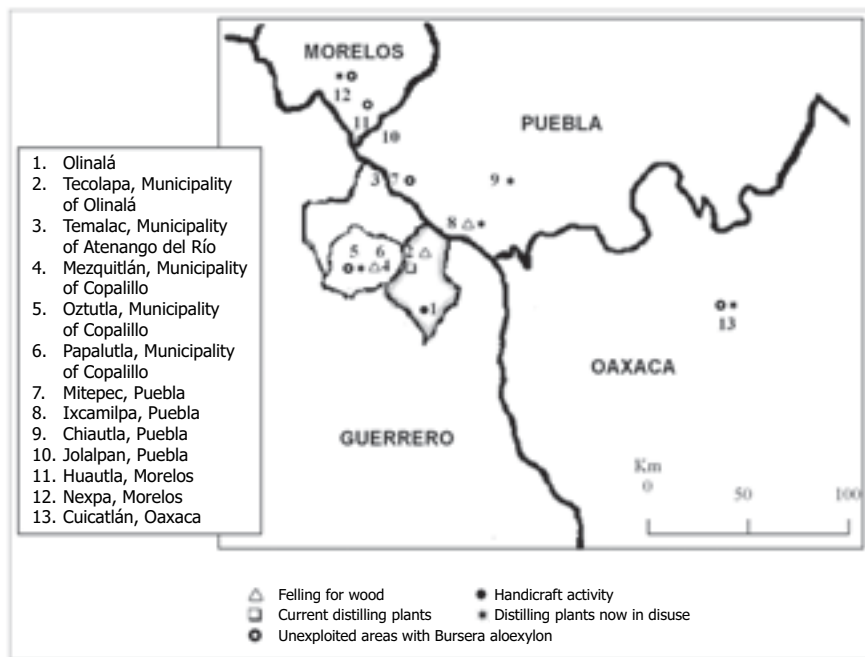
The case study

The study focused on a supply region for linaloe located in the municipalities of Olinalá and Copalillo in Guerrero state and Jolalpan and Ixcamilpa in Puebla. The work was centred particularly on the neighbouring communities of Tecolapa in Olinalá and Papalutla and Mezquitlán in Copalillo, lying in a region known as ‘Depresión del Balsas’. A complementary study was also made of the communities of Huautla and Nexpa (Morelos), and Cuicatlán (Oaxaca) (Figure 2).

The study presented here is part of a broad research project in the area of ethnobotanical and medical anthropology, with activities for organisational promotion and health. Instituto Nacional de Antropología e Historia (INAH; National Institute of Anthropology and History) started this project, entitled Social Actors in the Natural Medicine of Mexico, in 1996. Within the project’s framework, which has various research lines, linaloe is a theme in the line oriented towards local and regional collectors and wholesalers of wild medicinal flora. Because one of the project’s basic postulates is that of reciprocity, materials for consideration and dissemination have been prepared on this theme in terms of the exploitation of *B. aloexylon*. A proposal based on the study’s conclusions was made for its sustainable exploitation, to be operated by local committees already formed by the communities of the area. Discussion of this proposal, however, goes beyond the scope of this presentation.

In the communities described, interviews and meetings were carried out with linaloe collectors and processors according to their place in the species’ processing chain. The main sites where collectors were interviewed were Mezquitlán, Tecolapa, and Papalutla (Guerrero); Ixcamilpa, Zacacuautla, and Huachinantla (Puebla); Nexpa, Chimalacatlán, and Huautla (Morelos);

Figure 2. Location of the study area of the linaloe industry in southern Mexico



Source: Hersch *et al.* 2003.

and Cuicatlán (Oaxaca). Interviews and observations were also made with carpenters and artisans in Olinalá. For each community, we interviewed an average of 20 informants, who were selected for their local knowledge of the species, its current use, and background to its exploitation. Such knowledge was either indirect, from other sources, or through participation at a young age in obtaining wood for both artisans and distillers. The interviews also included themes relating to local conditions for collecting and marketing.

The available literature was analysed, including studies and theses generated since the end of the nineteenth century to the present. Bibliographic consultations encompassed automated means, old library collections, newspaper libraries, and the Paucic State Archives (Acapulco, Guerrero). Community meetings were also conducted to discuss the theme in the main study sites.

Field activities involved visiting collectors and conducting inventories of the species by observing its natural distribution, identifying endemic distribution spaces, and locating them on maps through the global positioning system. An inventory of the principal populations was carried out through quadrant evaluations (20 m × 20 m) and transects (2 m × 250 m), covering 0.2% of the area of each population. The transects were analysed as diagonals through the selected populations, adding, moreover, points selected randomly throughout the area. Overall, no significant differences were found between the results of the two methods. All *B. aloexylon* individuals

within this area were analysed in terms of density, age, proportion of male to female plants, growth rate, and natural productivity. We also carried out experimental distillations of the essential oil in Mezquitlán and Temalac (Guerrero), Chimalacatlán (Morelos), and at the project's headquarters at INAH, Cuernavaca, Morelos.

PRODUCTION-TO-CONSUMPTION SYSTEM

The resource base

Bursera aloexylon occurs naturally in the Mexican states of Colima, Guerrero, Michoacán, Morelos, Oaxaca, and Puebla (Martínez 1928; López Cárdenas 1937; Segura Jaimes 1941; Toledo Manzur 1982). Recently, David Espinosa, a Mexican botanist who specialises in *Bursera*, has suggested a fundamental change, namely that the type taken to Bangalore by Anderson in 1911 and known as *B. delpechiana* in India in fact corresponds to *B. citronella* rather than to *B. aloexylon*, the linaloe growing in our study area (D. Espinosa personal communication).⁹

Bursera aloexylon is a dioecious plant, endemic to the area. It grows to 7-8 m high in lowland deciduous forests (Miranda 1942), a type of vegetation that, in 1993, occupied almost 17% of Mexico's territory and included one fifth of its flora (Rzedowski 1998). The climate in which linaloe grows is warm and dry, or subhumid and warm, with an annual average precipitation of 780 mm to 1000 mm, and monthly maximum and minimum temperatures that fluctuate between 22°C and 30°C. Altitudes range from 600 to 850 m above sea level (García 1984).

Our samplings, carried out in disturbed primary forest around the communities of Huautla, Jolalpan, Mezquitlán, and Papalutla (Figure 2), indicated an average natural density from 50 to 100 individuals per hectare, although with variations that ranged from one to two individuals per hectare in old areas of exploitation to more than 1000. Birds, attracted by the fruit's red endocarp, disperse seed; and insects carry out pollination (Segura Jaimes 1941). Linaloe grows in Rendzina, Lithosol, and calcareous Regosol soils, and on slopes as steep as 60% (Toledo Manzur 1982).

A wild plant in Mexico, linaloe has nevertheless been used in reforestation activities, although not on a systematic basis, nor with success. The most successful propagation technique is to apply stakes 30 cm to 40 cm long with basal diameters of 1.5 cm to 3 cm (Castellanos *et al.* 1993). The stakes may even be longer, as they are in India for *B. delpechiana* (i.e., *B. citronella*). The stakes are buried from one quarter to one third of their length at the beginning of the rainy season (May-June) at a density of 400 to 500 individuals per hectare, that is, at distances between trees of 4 m to 5 m, or even as much as 6.5 m × 6.5 m (Hussain 1993).

In terms of conservation, planting by stakes points out that the tree has regenerative capacities, but according to interviewed community members and our observations of cut trunks and branches, surface wounds tend to be attacked by insects and wood borers, a phenomenon that needs subsequent study. The history of the species' exploitation should be taken

Photo 1. *Bursera aloexylon* or linaloe in Huautla, Morelos, Mexico (Photo: Paul Hersch Martínez)



into account when considering the total cut of trees, whether for handicrafts or distillation.

A traditional technique for managing linaloe is the *cala*, or boring, which is carried out to induce a reactive accumulation of essential oils in the wood in a formation of irregular reddish coffee-coloured spots known as ‘maps’ or ‘hearts’. *Cala* involves generating wounds by means of stepwise, diagonal incisions into the trunk. Incisions of 3 cm to 5 cm deep are made during August and September, under the full moon, at the end of the rainy season so that the trunk will not rot with the extreme humidity. The optimal time between the reaction taking place and exploitation, that is, between *cala* and felling the tree, is about 18 months (Altamirano 1904a; Segura Jaimes 1941). Traditionally, however, felling takes place in March to May, six or seven months after the *cala*. Even so, current *cala* practice has declined and trees are felled throughout the year, depending on their availability and on the collector’s cash requirements.

Trees are felled between 25 and 35 years of age, or even younger, to sell the wood to the Olinalá community, where lacquered handicrafts are made, such as boxes, trunks, trays, and frames. Usually, the entire tree is felled and, hence, has no viable possibility of regenerating, unless recommendations, such as those proposed by Segura Jaimes (1941), are kept.

Although currently of minor importance, linaloe trees are also felled to provide wood to artisans who then distil the oil to give aroma to the boxes and trunks they make. This practice developed as the use of pinewood in handicrafts increased, a result of reduced access to linaloe wood. Because *calada* wood is also in limited supply and is the most scented, oil is also

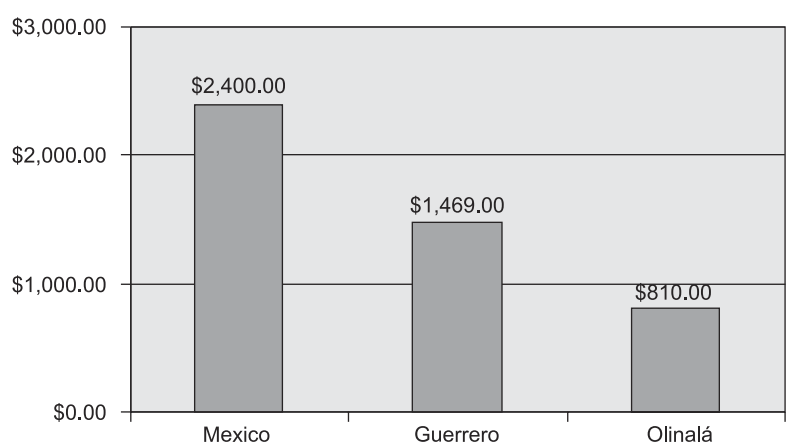
applied to boxes of unscented linaloe wood to give them the characteristic odour.

Producers and their socio-economic context

The exploitation of linaloe is part of an ancestral system of highly diversified production, capable of ensuring a rural subsistence that still maintains elements of extractive activities common to indigenous groups. In this framework, current extraction of linaloe wood occupies less than 10% of the labour activities of the rural dwellers involved in linaloe extraction, even though it constitutes one of the few sources of cash for their family economy, representing almost 10% of cash income. This mixed scheme of subsistence in which linaloe wood participates as a resource also encompasses, depending on the communities in the region, seasonal agricultural tasks, collection of wild species, hunting, fishing, creation of handicrafts and hammocks, and embroidery by commission.

The suppliers of wood for handicrafts in Olinalá are predominately indigenous Nahuas, unlike extractors of essential oil, which, traditionally, are mestizo. The living conditions of extractors that fell linaloe are precarious, given that conditions include a high proportion of land without irrigation, high indexes of stoniness and slope, and a general absence of basic services. Wood suppliers are extremely poor; they are individuals who have not even had the opportunity to migrate in search of better life opportunities. Guerrero is one of Mexico’s poorest states in terms of family income, and the average family income in the study area is even smaller than the state’s average (Figure 3). Thus, linaloe, together with other wild resources, assists the Guerrerense Nahuas in their struggle for survival, albeit with high rates of alcoholism and

Figure 3. Annual incomes (in U.S. dollars) per family are compared across the nation, State of Guerrero, and Municipality of Olinalá, Mexico, 1998



malnutrition that find expression in the country's highest rates of avoidable diseases and deaths¹⁰.

Linaloe wood does not generally represent an essential product in this difficult context, given the diversity of tasks and resources on which subsistence hinges. Its potential is undoubtedly wasted, however, as made evident by the contrast between the product's aroma and texture and the conditions of those who, even today, exploit it with rudimentary techniques.

Groups that resort to linaloe wood as a resource for survival are marginal to the country's modernisation. Their geographic location lies within the regions of refuge shaped during colonial times, and, in this marginal environment, their cultures have persisted. Generally, most of the population in these regions has not benefitted from Mexico's current economic policies, as attested to by a growing rate of poverty that shows no indication of slowing down (Boltvinik 1995). Hence, the producers of linaloe wood remain among the most disadvantaged groups.

Processing industry

The trunk of a linaloe tree is delivered to a carpentry in Olinalá, which makes it into small and medium-sized boxes, trunks, trays, and frames. These implements are then processed by artisans according to two basic and ancient techniques: the scratch or cut method, also known as *maque*¹¹, and decoration with a paintbrush, known as *dorado*, or 'golden' from its ancient use of gold in that technique. In both cases, the wood is covered with a paste that is a mixture of raw materials of mineral origin, described in Nahuatl as *tecoxtle* or *tecoztle*. The paste, which is slightly thick, has a sandy texture, is yellowish in colour, and is combined with oils from seeds of Mexican chia (*Salvia hispanica* L., Lamiaceae) or flaxseed (*Linum usitatissimum* L., Linaceae). Spread over the wood's surface, this paste forms the base for the following step, in which *tlalpilole*¹² is used. *Tlalpilole* is a mixture of *tesicalte* or *tesiscaltetl*¹³, a hard white stone collected from around the village of Huamuxtitlán, and is ground in a stone recipient, known as a *tlalmetate*, until it becomes a very fine powder. This powder is combined with the colour that will serve as the work's background. The mixture is applied with a deer's tail.

The next step consists of polishing the piece until almost all remains of the *tlalpilole* have disappeared, which is, in fact, its function—to facilitate the polishing. Then, the base colour is added to powder ground from <<add?>> another stone, known as *tolte* or *toltectl*, a white mineral of compact structure that probably belongs to the kaolin group. The resulting paste is plastered over the piece again and again until the new layer is smooth and glossy. The piece is left to dry for two or three days, after which it is polished. The second layer is applied, repeating the entire process step by step. It then receives the decoration known as *rayado* (lit. 'scratched'). The motifs most often used are urns, long-tailed rabbits, birds, and flowers (Tibón 1960; Espejel 1976; Romero Giordano 1995; Turok and Bravo 1997).

This handicraft involves a cottage industry based on family units, dedicated to carpentry, decoration, and marketing, or to some of these phases. Some artisans specialise in certain steps or carry out the entire process of decoration on commission for others.

Photo 2. Doña Filomena Pantaleón, artisan from Olinalá, southern Mexico, works on a piece made of wood from linaloe (*Bursera aloexylon*) (Photo: Paul Hersch Martínez)



Trade and marketing

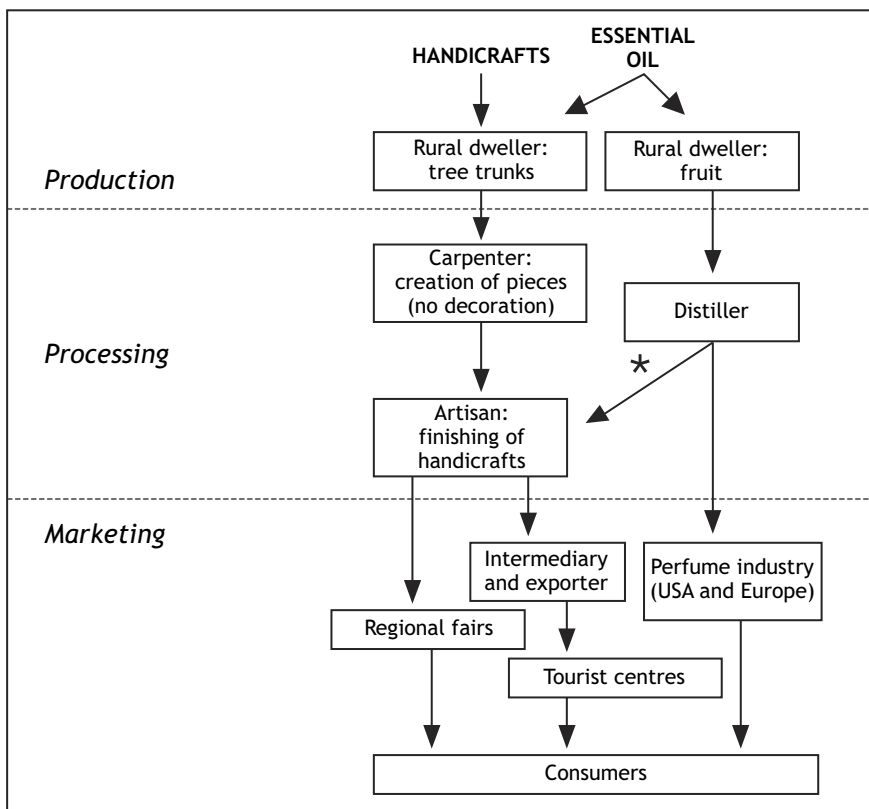
The marketing chain for the raw material, that is, the wood for handicrafts, begins in the supply areas, where it is collected. The wood is either commissioned and purchased by intermediaries (known as *coyotes*) or sold directly by the collectors in Olinalá. In the community of Mezquitlán (Municipality of Copalillo), for example, linaloe trees not only are cut for sale to intermediaries from Tecolapa, a neighbouring community in the Municipality of Olinalá, but are also surreptitiously felled by outside exploiters, which then sell to artisans.

We have confirmed that a medium-sized tree, yielding about 10 trunk segments, each 1 m long with a 20-cm diameter, can be sold in its entirety to an intermediary for the equivalent of one to two U.S. dollars, whereas the same tree can be sold in Olinalá at 10 times that price. The producer sells the oil to scent the crafted products directly to artisans in Olinalá. Small quantities are also exported to the United States and Germany for the perfume industry.

The marketing chain of the finished handicraft encompasses two levels: direct sale by artisans or through artisan groups in Olinalá, for example at the handicrafts fair conducted in October every year. At the second level, sales are made to merchants outside the region, which then sell the products, through various intermediaries, in the country's large urban and tourist centres or export them, mostly to Europe and the United States. A traditional marketing outlet is that of regional fairs in the states of Morelos, Oaxaca, and Puebla, where Olinalá handicrafts are valued. Other outstanding handicrafts come from Tepalcingo (Morelos) and Xochitepec (Puebla). At these traditional events, these handicrafts have had, for many years, farmers and pilgrims as their customers (Tibón 1960), but demand from urban middle and upper-middle classes, tourists, and overseas consumers is displacing traditional demand (Figure 4).

A very general appraisal by an accredited artisan of the locality suggests that, on an annual basis, handicrafts are sold at a value of almost US\$10 million. This amount does not imply a balanced distribution of the resources,

Figure 4. Social actors in the linaloe (*Bursera aloexylon*) marketing chain, southern Mexico



*Oil for strengthening the aroma of wood used to create handicrafts.

however, as the artisans themselves show significant differences in perspective and income.

Political and institutional aspects

As already mentioned, forest regulations already have norms to control the exploitation of linaloe. One norm is the Mexican Official Standard NOM-005-RECNAT-1997, which deals with the control of exploitation of wild trees and requirements for permission to extract (SEMARNAP 1997). No specific standard yet exists for linaloe, and it does not appear in the appendices to the Convention on the International Trade in Endangered Species of Flora and Fauna or on the list of threatened species of the International Union for Conservation of Nature and Natural Resources (Walter and Gillett 1998).

With respect to controlling exploitation, local conditions for effective control are far from ideal, given the lack of sufficient human resources and difficult communications. Sporadic efforts to promote reforestation with native species have been made, including with linaloe by means of stakes. These efforts have not been successful, however, because of logistic and technical reasons, lack of monitoring, and lack of educational and technical incentives to encourage the local population to become involved. Efforts include those carried out in the 1980s in south-western rural Mexico by the governmental agency Coordinación General del Plan Nacional de Zonas Deprimidas y Grupos Marginales (General Coordination of the National Plan for Depressed Zones and Marginal Groups), founded in 1977, and those by the state government of Guerrero in the Municipality of Olinalá.

Some policies favour the promotion of handicraft activities and marketing through the governmental agency Fondo Nacional para el Fomento de las Artesanías (National Fund to Promote Handicrafts), founded in 1974. Certain artisans say, however, that six-year changes do not permit sufficient continuity in the support programmes and, sometimes, the standardisation of products required by this agency and other intermediaries hinders the adequate evaluation of qualitative diversity. That is, products may be either of high quality in terms of rigorous use of materials and traditional techniques, including the use of *calada* linaloe wood and oil of Mexican chia, or of lesser quality where pinewood and flaxseed oil are used. No systematic policy exists to guarantee the protection of high-quality work, nor any incentive for artisans to produce such work. Consumers respond by buying accordingly, thus further discouraging artisans from dedicating time and resources to high-quality work that is unlikely to be sufficiently remunerated.

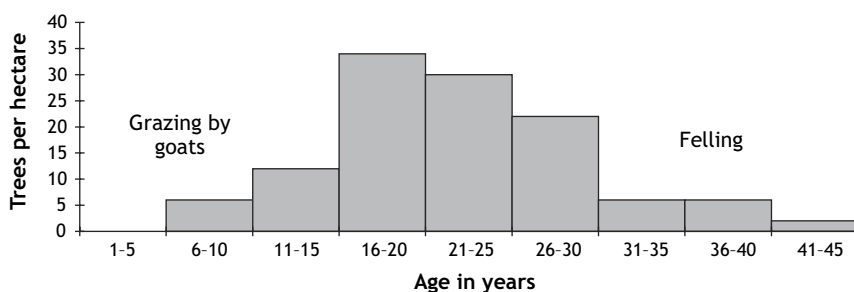
The application of prices and standard measures does not permit nor recognise such quality, nor has such application been demonstrated as useful because every piece is unique, in that many products have a certain individuality. Moreover, neither is a dynamic policy evident for supporting the design and marketing of products. For example, for clocks, although incorporating metallic hands, numbers of gothic style, and gilded colouring into frames with traditional motifs and colours may not necessarily result in harmoniously designed products, it does suggest a potential for design that has not been sufficiently explored.

The Olinalá handicraft industry also depends, to a certain degree, on the Governorship of the State as a decision-making agency for support policies. This support became relevant for exports, but has been impermanent. The policies that influence this productive activity include the changing availability of credit granted to groups of artisans. This uncertainty influences both the artisans' capacity for management and the degree of consistency in official policies of credit support.

Trends and key themes

The negative ecological effect resulting from the combination of grazing and extractive activity on linaloe is illustrated in Figure 5, which compares the age of trees with the number of individuals per hectare in Mezquitlán (Guerrero), which supplies wood to the artisans of neighbouring Olinalá. The proportion of trees that are more than 25 years old progressively declines the older the age group, disappearing entirely at 45 years, that is, 20 years before the limit of their natural life at 60 (Glass *et al.* 1997). Another determining factor is overgrazing by goats, which results in low numbers of individuals younger than 15 years.

Figure 5. Structure by age and hectare (across five samples) of a linaloe (*Bursera aloexylon*) population in Mezquitlán, Municipality of Copalillo, State of Guerrero, Mexico, 1997 (from Glass *et al.* 1997)



The absence of young individuals to replace those currently being felled implies an ominous situation in the short term, unavoidable if no appropriate measures are taken to reforest or otherwise ensure successful natural reproduction. Exploitation would be greater if linaloe was left for a longer life term of 40 to 50 years because of two factors, as quantified by us in the field: increased fruit production in the female, which is proportional in weight to the tree's age, and improved quality of *calada* wood in relation to the tree's size. Given the area's intense economic pressure, however, the inhabitants are tending to fell increasingly young individuals.

Access to market constitutes a key problem, as it differentiates between the Nahuas and mestizos in the study area. Access to marketing channels is

difficult for the indigenous collectors and they receive small payments for the wood they contribute. In contrast, the mestizos, more familiar with trading customs, obtain higher prices.

If the Nahuas were not to fell linaloe, the pressure caused by the need for income to ensure minimum subsistence would fall on other species. The reduced diversity of rural subsistence activities in the area implies an increase in the pressure towards this type of product.

The moderate level of extractive activity that underlies the diversified strategies for subsistence has, in the example of *Bursera aloexylon* wood, become a forced activity on community lands, *ejidales* or common lands, and even private lands, given the current marginal conditions of the rural dwellers. Because of poverty, it can manifest, moreover, as theft of trees in a manner similar to the 'green-apple-picking syndrome' that occurs in Nepal, where apples are robbed while still green (B. Boor personal communication). Likewise, the linaloe tree is harvested before it receives the *cala* treatment or before it is 50 years old to prevent clandestine exploiters taking advantage of it. Such premature harvesting, simply to prevent another from harvesting, affects the quality of the final product. According to local commentary, this phenomenon has only recently appeared and is increasing.

The commercial potential of the ecosystem for linaloe is not positive: the lack of programmes to generate a sustainable supply of wood and link it with handicraft production indirectly encourages current environmental degradation. Under such conditions, the greater the demand for handicrafts, the greater the degradation by exploitation.

For essential oil from linaloe, current trends suggest that demand is apparently growing again, a paradoxical effect of the decline in the availability of the wood and the incorporation of pinewood, which then must be scented with the essence. However, distillation technology has been stagnating for almost a century.

IMPLICATIONS FOR CONSERVATION AND DEVELOPMENT

The case of linaloe is significant for several reasons: first, it deals with a species with a potential for multiple use, demonstrated in at least three principal—and contrasting—ways: handicrafts, as a leftover from pre-Cortesian traditions that have continued to present times; industrial, for perfumes through its essential oil; and medicines, again through its essential oil. These applications are relevant in terms of commercial potential and amenability to greater development.

Linaloe is also significant because it constitutes a native species that has been more developed industrially outside its region of origin. That is, while oil extraction progressively declined in Mexico, a variant of linaloe was introduced into India, where the essential oil of its fruit was incorporated into the international market. Thus, a technical and agroindustrial project on this plant was successful outside its region of origin (Mexico), which, in contrast, was unable to develop its potential. Such incapacity becomes even more dramatic if we take into account the number of theses and studies on linaloe and its industrial potential that were generated during the twentieth century

(Altamirano 1904b; Mortera Llano 1925; López Cárdenas 1937; Vasconcelos Aldana 1939; Segura Jaimes 1941; Doelker Seiferling 1949; Rodríguez Acosta 1980; Toledo Manzur 1982; Colina Simonin 1987; Castellanos *et al.* 1993). Often academic in nature, and despite their quality, they did not result in concrete applications.

Even more dramatically, as the precarious situation of rural dwellers in Mexico dependent on the species became acute, the rudimentary industry of extracting the essential oil has almost disappeared, with the handicraft industry losing essential and valuable traditional elements. The species itself is in difficulties in areas where it had previously abounded.

The third lesson inherent in linaloe is that its physicochemical and cultural profile continues to highlight it as a plant worthy of attention, promising, amenable to new developments, and a potential source of resources in highly needy areas. Linaloe's current situation answers more to the social environment, and the development of its potential depends mainly on this dimension.

The linaloe case also emphasises the importance of diversifying sources of supply in the rural domestic economy of the study area, and shows the fundamental role of non-timber forest products in this economy.

Loss of traditional elements

The commercial use of handicrafts undoubtedly has generated resources in those communities where handicrafts are produced. Handicrafts have created local employment and generated income, with significant progress in infrastructure and changes in conditions of communication, as verified by Olinalá in recent years.

Already, however, linaloe is no longer used in many handicrafts, including those in which it was once considered indispensable. Although it is not a recent practice (Tibón 1960), the proportion of products in which linaloe wood is replaced with that of pine is growing, being no less, we estimate, than 35% or 40% of the articles. Not only is demand conforming to this change, but also the new consumer profile is such that the consumer does not know of the original properties of these handicrafts, particularly of the aroma of this type of *Bursera*. This ignorance, together with the higher price of the more aromatic *calada* wood, encourages certain of today's producers to reduce the quality of supply, nor require quality of demand. Thus, the presence of the aromatic vein in boxes made of *calada* wood or the quality of finishing with oil of Mexican chia and other traditional materials, both important criteria for evaluating traditional products, are being passed over in a way that may become irreversible. The disappearance of traditions that accompany such criteria because of costs implies a trend towards inexpensive, poor-quality products.

The emergence of pinewood as a substitute for linaloe is symptomatic of the difficulties in supplying linaloe and, undoubtedly, implies relief of pressure of demand for *Bursera*. This situation would favour a more intense use of linaloe oil for scenting crafted boxes, which oil can be obtained from the fruit without felling the tree. It would, however, ultimately lead to the

loss of the original profile of handicrafts, which is to use *calada* wood as the ideal aromatic source. This profile can be rescued if *calada* wood can be sustainably generated.

Great potential exists for using fruit as alternative source to the wood to extract essential oil, although its proportional content of linalool is less than that of oil distilled from wood, which contains more linalyl acetate. To take advantage of this potential, however, technological development and technical assistance are needed to create a distillation system that meets current requirements of yield and quality. Distillation equipment using advanced extraction technology exists, and it can obtain an essential oil from the fruit that has almost the same value as that obtained from the wood.

If no linaloe extraction activities existed, then the pressure on other wild species in the area would intensify, leading to worsening conditions for both rural dweller and environment. Artisans would be more strongly affected than carpenters, because linaloe in its non-*calada* form still departs from its traditional format. However, artisans are beginning to paint the inside of the pieces, thus hiding the wood's surface and its characteristics. While the lack of linaloe wood becomes less damaging, the piece still loses a substantial part of its authenticity and cultural value.

SUSTAINABLE MANAGEMENT

On addressing the prospects of conserving the tree, the strong competition from livestock is noteworthy. Although there was significant increase in raising goats and donkeys, including with technical support and assistance, the impact of the silvopastoral system on the ecosystem and other sources of income such as non-timber forest products was ignored by those responsible for promoting livestock projects. A sufficient number of studies exist to emphasise the need for developing alternative silvopastoral systems with improved management that does not affect natural regeneration by allotting areas or replacing feed sources for livestock.

Programmes for the sustainable management of linaloe are needed, including greater surveillance of extractive activities and increased technical advisory services for their application. Such programmes can draw even on old but still pertinent studies for recommendations, for example, the works of Segura Jaimes (1941) and Vasconcelos Aldana (1939). Within that framework, with a dioecious species, the male tree of which does not produce fruit, a mixed production of fruit and *calada* wood could be generated. In any case, placing attention on linaloe in production terms implies monitoring a significant species of a threatened ecosystem, the lowland deciduous forest. Such a follow-up requires putting a price on both the silvopastoral system and indiscriminate burning.

When developing the potential of traditional handicrafts for which both linaloe wood and essential oil are used, it is important that aggregate value be sought through recognition of the particularities of these products through some form of certification. Such a process for the handicrafts of Olinalá has already begun, although with some problems (J. Larson personal communication). With respect to linaloe oil, ways must be found to certify

origins, develop nomenclature, and even describe organic origins. The extractive process of the essential oil of linaloe must be developed in terms of more efficient and up-to-date distillation technologies, backed by promotion programmes offering credit and advisory marketing services. Activities have begun at the regional level, but their analysis is beyond the scope of this work.

When we consider local awareness of environmental deterioration, which is obvious in terms of the lack of linaloe trees in the study area, the extreme degree of precariousness of the living conditions of the indigenous population exceeds concern for the environment. Although their conditions are less severe, the mestizo groups are unconcerned with the environment as well. This situation means that even in limited trials of propagation, like the ones we carried out in Mezquitlán, rural dwellers express more concern in acquiring complementary income through selling generated plantlets than showing any ecological conviction. That is, we determined that conditions of misery do not intensify ecological conscience.

Several recommendations made above on the management of linaloe continue to be valid, although they were formulated more than 60 years ago, as in the example of Segura Jaimes's study (1941), in which he proposed various measures, including fiscal ones such as taxing the extraction of oil, to control exploitation. Other measures included limits for minimum trunk diameter for felling (20 cm at chest height), replanting techniques with stakes with fines imposed if exploiters fail to comply, leaving 'grain-carrying' trees appropriately distributed, and partially or totally closed seasons. All these proposed measures therefore imply recognising the need to increase the number of surveillance personnel to carry out frequent visits to inspect and label exploitable trees and prevent fraudulent exploitation and clandestine felling. The technical problems of propagating the tree have already been resolved, as studies have been made of different viable methods (Castellanos *et al.* 1993; INAH 1999).

These conservation measures were insufficiently followed up, and they were unacceptable because, apparently, the problem of conserving linaloe is more political and social than technical. That is, it is related to a lack of will on the part of decision makers and lack of organisation among collectors, because of either interests or apathy, rather than of basic ignorance of methods for containing excessive exploitation. Hence, appropriate technical studies were irrelevant to the economic and cultural framework of the people dependent on the species.

Such a lack of context, in turn, meant that, despite their quality and relevance, the academic research projects resulting in theses and published articles did not result in industrial applications. That is, there is a continuing lack of articulation among academic institutions and the country's economic and industrial reality. Addressing the problem as a technical matter is clearly necessary, but it is insufficient. This case repeats the known principle that states that a law enunciated is not a law implemented. While the technical recommendations for linaloe are adequate and have been confirmed as such for more than half a century after contributions of authors such as Segura Jaimes and Vasconcelos Aldana, their sociopolitical context is determinant.

This non-timber forest product, as so many others, depends on the population, and its precariousness reflects the same precarious conditions of its exploiters. Any proposal that today intends to optimise the sustainable exploitation of linaloe must take into account social aspects. These aspects, constructed on the product, are, in this case, more determining than the product itself.

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NOTES

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4. The Nahuatl ethnic group in Mexico is currently the most numerous of the indigenous groups, having had the largest political domination when the Spanish arrived in the sixteenth century.
5. Another use of linaloe is found in the wood carvings of fantastical animals known as *alebrijes*, complementary to those of other *Bursera*, as described in Chapter 21, this volume.
6. The Jesuit Joseph de Acosta also mentions in 1590 the diversity of balsams, oils, and aromatic gums from Nueva España (1962 reprint).
7. This naming happened for numerous medicinal plants of popular use in Mexico such as the gordolobo (*Gnaphalium conoideum* Kunth), the doradilla [*Selaginella lepidophylla* (Hook. & Grev.) Spring], and the Mexican arnica (*Heterotheca inuloides* Cass.), all different species given common names that were prevalent in Spain.
8. 'In the region of Tlalcala [Tlalcala], Copalillo, Balsas, and Sitatlán, resinous and aromatic trees were not scarce. . . . [T]he natives extracted several useful resins and gums; hence, trunks were seen with knife marks

and scars “of the bleedings that they make”. . . . [I]n Jolalpa [Jolalpan], we observed that the natives exploited brazil-woods and obtained copals of different classes. And in Mitepeque (Mitepec), the copalillo [with designated name of *B. fagaroides* (Kunth) Engl., a species similar to *B. aloexylon*] was used, of which resins were surely also obtained’ (González Claverán 1993, p. 156).

9. The name *Bursera delpechiana* is currently used in India to refer to linaloe. Anderson collected linaloes from various regions of Mexico in 1910, including samples from the study area, and found *B. citronella* as able to acclimatise and produce in India.

10. For example, the official infant mortality rate was 55.36 per 1,000 live births in Guerrero, exceeding the national average of 40.33 in 1990. Nearly 80% of its population lacked social security in 1995 (INEGI 1990, 1998).

11. The so-called ‘Mexican *maque*’ consists of manually applied layers of calcareous earths and quartzes that have been finely ground. In the last layer, pigments are added (Turok and Bravo 1997).

12. The term corresponds to the Nahuatl *tlapilolli*, which means hanging or suspended (Siméon 1885, 1994 reprint).

13. The term is composed of the Nahuatl words *teci* (to pound, to grind), *tetl* (stone), and, possibly, also *caltenti* (surface of a house’s outer wall) (Siméon 1885, 1994 reprint).

REFERENCES

- Altamirano, F. 1904a. Datos para el estudio del árbol de lináloe y su esencia. *Anales del Instituto Médico Nacional (Mexico)* 6: 69.
- Altamirano, F. 1904b. Datos acerca de la preparación industrial de la esencia de lináloe en el Edo. de Guerrero. *Anales del Instituto Médico Nacional (Mexico)* 6: 70.
- Acosta, J. de. 1590. *Historia natural y moral de las Indias*. Fondo de Cultura Económica, Mexico. (1962 reprint.)
- Alzate, J.A. 1791. *Gaceta de Literature (Mexico)*, 28 June.
- Baytelman, B. 1993. *Acerca de plantas y de curanderos: etnobotánica y antropología médica en el estado de Morelos*. Instituto Nacional de Antropología e Historia, Mexico.
- Boltvinik, J. 1995. La pobreza en México II. Magnitud. *Salud Pública de México* 37(4): 298-309.
- Castellanos, J.F., Gómez, M., and Ruiz, M. 1993. Producción y plantación de tres árboles nativos en los valles centrales de Oaxaca. Folleto Técnico 2. Centro de Investigación Regional del Pacífico Sur, Secretaría de Agricultura y Recursos Hidráulicos, Etlá, Oaxaca, Mexico.
- Chapman, A. 1992. Los hijos del copal y la candela: ritos agrarios y tradición oral de los Lencas de Honduras. Universidad Nacional Autónoma de México, Mexico.
- Colina Simonin, M. 1987. Estudio de una población natural de linaloe *Bursera aloexylon* en Chaucingo. Thesis, Universidad Nacional Autónoma de México, Mexico.

- Doelker Seiferling, J. 1949. Obtención del aceite esencial de linaloe. Thesis, Universidad Nacional Autónoma de México, Mexico.
- Espejel, C. 1976. Olinalá. Secretaría de Educación Pública e Instituto Nacional Indigenista, Mexico.
- ESRI and Maps. 2002.
- Galinier, J. 1991. La mitad del mundo: cuerpo y cosmos en los rituales otomíes. Universidad Nacional Autónoma de México, Mexico.
- García. 1984.
- Glass, R., Fierro, A., Hersch, P., Rodríguez, T., and Salazar, L. 1997. Análisis de la población de linaloe (*Bursera aloexylon*) y su explotación en la comunidad de Mezquitlán, municipio de Copalillo, Guerrero. Paper presented at the III Simposio Internacional and IV Reunión Nacional de Agricultura Sustentable, Universidad de Guadalajara, Mexico.
- González Claverán, V. 1993. La expedición científica de Malaspina en Nueva España 1789-1794. El Colegio de México, Mexico.
- Guenther. 1950.
- Guenther, E. 1972. The essential oils, 2nd ed. Krieger Publishing Co., Miami, FL.
- Herrera, A., Herrera, A.L., Uribe, A., Lasso de la Vega, J.M., de Jáuregui, M.F., Calderón, J.B. and Pérez, S. 1896. Nueva farmacopea de la Sociedad Farmacéutica de México. Oficina Tipográfica de la Secretaría de Fomento, Mexico.
- Hersch, Glass, Fierro. 2003.
- Hussain, A. 1993. Linaloe (*Bursera depelchiana* Poisson ex Engl.; Family: Burseraceae). In: Essential oil plants and their cultivation, 11-13. Central Institute of Medicinal and Aromatic Plants, Lucknow, India.
- INAH (Instituto Nacional de Antropología e Historia) 1999. Informe interno sobre propagación de especies de selva baja caducifolia. Invernadero del Proyecto Actores Sociales de la Flora Medicinal en México, Cuernavaca, Mexico.
- INEGI (Instituto Nacional de Estadística, Geografía e Informática) 1990. La mortalidad infantil en México. Mexico.
- INEGI (Instituto Nacional de Estadística, Geografía e Informática) 1998. Anuario estadístico del estado de Guerrero. Mexico.
- Laguna, A. 1566. Dioscórides: acerca de la materia médica medicinal y de los venenos mortíferos. Ed. Doce Calles and Fundación de Ciencias de la Salud, Madrid, Spain. (1999 reprint.)
- López Cárdenas, C. 1937. Estudio del aceite esencial de linaloe. Thesis, Universidad Nacional Autónoma de México, Mexico.
- Martínez, M. 1928. Plantas útiles mexicanas. Self-published, Mexico.
- Martínez, M. 1994. Las plantas medicinales de México, 2nd ed. Ed. Botas, Mexico.
- Martínez García, C. 1991. Drogas importadas desde Nueva España (1689-1720): estudio estadístico fármaco terapéutico. Universidad de Sevilla, Spain.
- Meave, J.A. 1791. Memoria sobre la pintura del pueblo de Olinalán, de la Jurisdicción de Tlapan. Gaceta de Literatura, Mexico.
- Medina, I. 1997. ¿Maque prehispánico? Una antigua discusión. In: Lechuga,

- R. *et al.* (eds.) Lacas Mexicanas, 21-27. Museo Franz Mayer and Artes de México, Mexico.
- Miranda, F. 1942. Estudios sobre la vegetación de México III: notas generales sobre la vegetación del suroeste del estado de Puebla, especialmente de la zona de Itzocan de Matamoros. *Anales del Instituto de Biología (Mexico)* 1(13): 417-459.
- Monardes, N. 1574. *Herbolaria de Indias*. Instituto Mexicano del Seguro Social, Mexico. (1990 reprint.)
- Mortera Llano, C. 1925. *Linaloe*. Thesis, Universidad Nacional Autónoma de México, Mexico.
- Noriega, J.M. 1902. *Curso de historia de drogas*. Instituto Médico Nacional, Mexico.
- Paucic, A. n.d. Registros 471 AP 745.5 LAC and 395 AP 634.956 EXP. V.1. Archivo Estatal Paucic, Chilpancingo, Guerrero, Mexico.
- Rodríguez Acosta, M. 1980. Estudio de la variación de los componentes del aceite esencial de *Bursera aloexylon* Schiede (linaloe) en el estado de Guerrero. Thesis, Universidad Autónoma de Guerrero, Chilpancingo, Mexico.
- Romero Giordano, C. 1995. Lacas de Olinalá. *México en el Tiempo* 8: 51-56.
- Ruiz de Alarcón, H. 1629. *Tratado de las supersticiones y costumbres gentílicas que hoy viven entre los indios naturales de esta Nueva España*. Secretaría de Educación Pública, Mexico. (1988 reprint.)
- Rzedowski, J. 1998. Diversidad y orígenes de la flora fanerogámica en México. *In: Ramamoorthy, T.P. et al.* (eds.) *Diversidad biológica de México: orígenes y distribución*. Universidad Nacional Autónoma de México, Mexico.
- Sahagún, B. 1577. *Historia general de las cosas de la Nueva España*. Consejo Nacional para la Cultura y las Artes and Alianza Editorial Mexicana, Mexico. (1989 reprint.)
- Segura Jaimes, J. 1941. *El linaloe y su industrialización*. Thesis, Escuela Nacional de Agricultura, Chapingo, Mexico.
- SEMARNAP (Secretaría de Medio Ambiente, Recursos Naturales y Pesca) 1997. Norma oficial Mexicana NOM-005-RECNAT-1997. *Diario Oficial de la Federación (Mexico)*, 20 May.
- Siméon, R. 1885. *Diccionario de la lengua nahuatl o mexicana*. Ediciones Siglo XXI, Mexico. (1994 reprint.)
- Tibón, G. 1960. *Olinalá*. Ed. Orión, Mexico.
- Toledo Manzur, C.A. 1982. El género *Bursera* (Burseraceae) en el Estado de Guerrero (México): biología. Facultad de Ciencias, Universidad Nacional Autónoma de México, Mexico.
- Turok, M. and Bravo, C. 1997. Patrimonio artesanal en riesgo. *In: Lechuga, R. et al.* (eds.) *Lacas Mexicanas*, 53-63. Museo Franz Mayer and Artes de México, Mexico.
- Vasconcelos Aldana, M. 1939. El aceite esencial de linaloe: su estudio químico y proyecto de fábrica para su obtención. Thesis, Universidad de Puebla, Mexico.
- Walter, K.S. and Gillett, H.J. (eds.) 1998. *IUCN red list of threatened plants*. World Conservation Union, Gland, Switzerland.

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Chapter 23

Use of Paja Toquilla (*Carludovica palmata* Ruiz & Pavon) for the Production of Panama Hats in Three Communities of Manabi Province, Ecuador

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(*Carludovica palmata*)

Common name	Product part used	Dominant form of management	Degree of transformation	Commercial scale	Geographic distribution
Paja toquilla, Sombrero de Panamá, Panama hat	Leaves	Wild/cultured	Average/middle/half	International	Wide

SUMMARY

Paja toquilla (*Carludovica palmata* R&P) plays an important role in the local economy of various ethnic groups of the tropical forests of Ecuador, where it is used for building, for making local crafts, and for medicinal purposes. This study refers specifically to its use in making Panama hats using fibres from young leaves, an activity dating from pre-Columbian times. The international demand for Panama hats started during the colonial period, increased during the 17th century, and reached a peak in the 18th century. Since then global demand has decreased, and although there have been occasional increases, the market has never again reached the levels of its best period. Currently, hat-making is a family industry in more than 20 communities of Manabi province; three of these communities are the focus of this study.

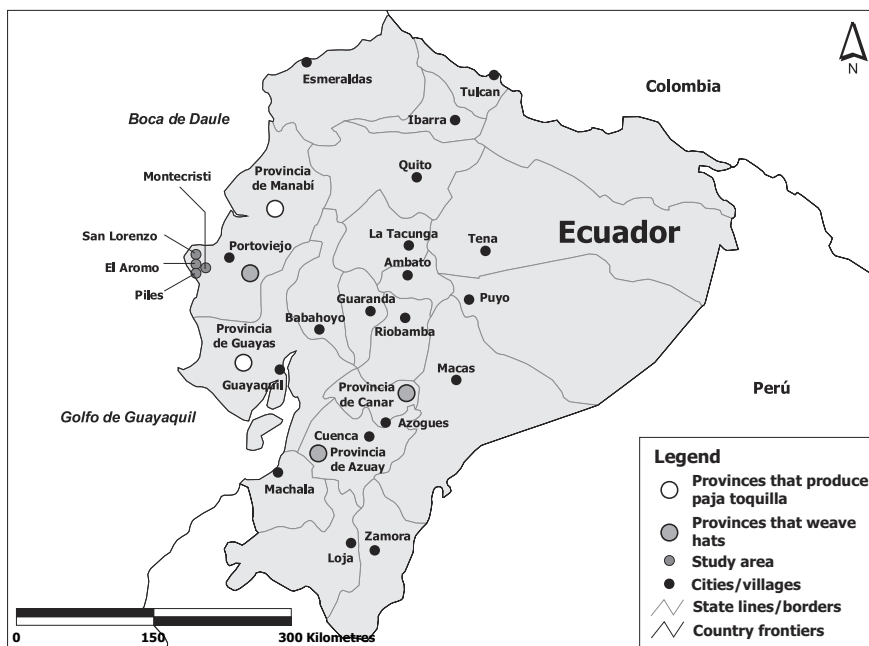
Within the community, men are responsible for plant management and cultivation, while women process the raw materials and make the hats. Between the producers and the wholesale buyers in Quito, Guayaquil and the international market, lies a long chain of middlemen. The final price of a quality hat ranges from US\$50 to US\$100. Ninety percent of the hats produced are made from cultivated plants. Although the species is not in danger, the production system is threatened by the unequal distribution of profits along the production chain, with low profit margins accrued among weavers, and by the growth of competing land-use systems.

INTRODUCTION

Paja toquilla *Carludovica palmata*, R&P (*Cyclanthaceae*) is widely distributed in tropical and subtropical forests on both sides of the Andes. It is used for building, for making local crafts, for food, and for medicinal purposes in areas extending from Mexico to Peru (Lescure *et al.* 1987). In Ecuador it is used by the inhabitants of the Pacific coast, in the provinces of Manabi and Guayas (Buchet 1990).

There are two distinct production to consumption chains using the plant, one using the fibres extracted from young leaves or shoots to make Panama hats, and another using the fibres extracted from the petioles for making mats, bags, wallets, etc. The latter are made in different parts of the country to the hats, and are not as commercially important. Currently, the production and marketing of the raw materials for hats takes place only in the communities of Manabi province, while processing is also done in communities in the provinces of Austro, Azuay, and Cañar (Figure 1).

There are three types of markets for the hats. Average quality hats, made mainly in Austro, are destined for the international summer hat market. These hats, with simple designs and weaving, are easily and cheaply made, and can compete in the foreign market with other hats, such as Chinese paper hats or Mexican *cabuya* hats. Better quality hats are made in Austro and Manabi, while the finest quality hats are made only in Manabi province, especially in the community of Piles. These hats do not have much competition in the international market (Vega 1999). Our study focuses only on hats produced in Manabi, as these are in demand in national and international markets and fulfil quality, fashion, and seasonal criteria.

Figure 1. Location of the study area

Source: ESRI Data and Maps 2002.

History of paja toquilla

A number of small pottery and stone figures dating from AD 500 to AD 1,500 (Meggers 1966) indicate that the plant fibre was already used for making cloth during the period of integration of the Manteña Confederation³. Until fairly recently, the hats, worn by men as protection from the sun, could be used to identify the region a man came from (Aguilar de Tamariz 1988). For women, on the other hand, paja toquilla plantations formed an important part of the dowry, and the production of hats represented a significant source of independent income. Older people recall that when young people received their inheritance, in addition to a piece of land, it was important to receive a number of paja toquilla plants, or of plantations, *pajales*, which in turn guaranteed a source of future income (Alarcon and Burbano 2000).

A number of factors contributed to the popularisation of Panamahats and their subsequent expansion into the international market. Beginning in the 16th century and continuing until the 17th century of the colonial period, Panama hats were used exclusively by members of the elite and were highly valued as an exotic item in Europe: Indeed, King Charles IV of Spain sent Napoleon Bonaparte a Panama hat from Montecristi as a gift (Dominguez 1991). Already in 1810, Panama hats were one of the main products exported in brigs to Spain (Dominguez 1991). Between the end of the 18th century and beginning of the 19th century, hat production became industrialised and standardised. In 1830, they became part of the uniform worn by Republican

soldiers in the Cuenca barracks, with 2,500 hats woven per year to cover this demand. The first official school of weaving was set up in the Azuay province in 1845, and in 1855, the first international exhibition of Panama hats was held, which resulted in the sale of two hats for the equivalent of US\$193- an exorbitant amount at the time. In this exhibition, Panama hats competed with the renown *Mackinaw* straw hats woven by Canadian Native American women (Dominguez 1991). By the end of the 19th century, the use of hats was popularized even more by their use by workers in the Panama Canal by the revolutionary fighters in the Cuba's war of independence, and by soldiers in the Spanish-American war (Dominguez 1991).

Over this period, the hat market was in the hands of a number of families living in Guayaquil and Manabi, who travelled around the supply areas. Prior to the establishment of the Republic of Ecuador in 1830 and from then onwards, the trade routes ran via Panama—hence the hats became mistakenly known as Panama hats (Buchet 1990)—to the United States and then to Europe; southern routes were via Peru, Chile, Argentina, and Brazil (Dominguez 1991).

The Panama hat industry and the production of raw materials were an important economic activity for the regions of Azuay, Cañar, and Manabi, providing a source of wealth for a few families rather than benefiting the general population. During the eighteenth and nineteenth centuries the hat industry involved a great number of people. It is estimated that in 1778, between 10% and 20% of the 88,000 inhabitants of Cuenca were involved in the production of hats (Dominguez 1991). In 1863 the National Academy of Ecuador recorded the export of 500,000 hats from various regions through the port of Guayaquil (Aguilar de Tamariz 1988). In 1862 paja toquilla was second in importance only to cacao as an export product from Ecuador (Aguilar de Tamariz 1988).

At the end of the nineteenth century and beginning of the twentieth century, market demand began to decrease, stabilising at a lower level around the middle of the twentieth century. Statistics show that in 1996 the area harvested for paja toquilla was 200 hectares, with a production of 1.2 metric tons. In 1997, the area harvested was 1,000 hectares with a production of 2.7 metric tons, and the approximate number of people involved in the processing and weaving of hats was about 40,000 (Vintimilla 1998).

During the last eight years hats have been exported to 46 countries, 83% of exports going to the United States, Brazil, Mexico, and Great Britain, and the remainder to Japan, Italy, France, and Germany (Vega 1999). Nowadays there is a stable market generating an income of US\$2 million per year (Central Bank of Ecuador 2000). Throughout the history of this product in Ecuador, however, the communities that are financially dependant on the commercialisation of plant fibre and hats have never benefited from a fair distribution of the income generated.

The study area

This case study includes three communities that grow paja toquilla and weave hats: El Aromo, Piles, and San Lorenzo, all located in Manta canton,

Manabi province, in the coastal region of the country. The communities are connected to neighbouring villages by means of a paved road that crosses the region to Manta, the main city of Manabi and second most important port in the country, and to Montecristi, which is the final destination of the crafts and where they are marketed (Figure 1).

The community of San Lorenzo is situated on the coast. The paja toquilla is grown in *fincas* along with other agricultural and wild products. The other two communities are located inland at 50 metres above sea level. In the community of El Aromo large tracts of land are used to grow paja toquilla. The community of Piles has farms with paja toquilla and other non-timber products, but also buys the plant fibre from other communities. Each community consists of about 500 people⁴. The birth rate in the rural areas of Manabi province is about 2.2%, slightly lower than the national rate of 2.7% and much lower than the urban rate of 4.1% of the province (SIISE-INEC 1995). This difference stems in part from the high rate of emigration, especially of women, to other countries and to the city of Manta, where the tourist industry and a U.S. military base generate jobs.

The three communities are located in an area of transition from the Peruvian desert to the biogeographic Choco, presenting vegetation typical of desert scrub, dry (tropical) forest, and wet/humid (tropical) forest (Arguello and Chiriboga 1998). There are few areas of natural forest in the three communities, covering only about 10% of the total area. The remaining area consists of an ecological mosaic that includes crop-growing areas of multiple use—called *fincas*—and large areas of secondary forest and pasture.

The average annual rainfall is 1,000 mm; the highest rainfall occurs in winter, from January to May. Two factors contribute to extreme changes in the climate, vegetation, and economy of the region: the El Niño current and the loss of forests in the province. El Niño typically causes heavy rain and floods or droughts (Burbano and Londoño 1999), while the loss of tree cover results in drastic climate changes. Both factors complement each other and have an adverse effect on the level of production and quality of the paja toquilla plant.

Method

The study began in 1997, as part of a project on conservation and management of paja toquilla in three communities⁵. The communities were selected based on differences in plant management and in the quality of hats produced. Using interviews, quadrates for biological monitoring, market analysis, and bibliographic research, we evaluated various social (ethnicity and gender), biological (habitat), and economic aspects associated with the production of paja toquilla.

Based on this work we organised a series of workshops in the communities, during which the results of the research were shared and a number of topics discussed. These topics included the conservation, use, and commercialisation of paja toquilla, including improvement in the quality of weaving, the formation of possible communal businesses and co-operatives, and the development of new contacts at national and international levels (Vega 1999).

PRODUCTION SYSTEM

The raw materials

C. palmata, the commonest species within this genus, is a perennial tropical grass that looks like a small palm (Ceballos 1998). This species, known as *palma jipi* in Mexico, *junco* in Honduras, *toquilla* in Ecuador and Panama, *iraca* in Colombia, and *atadero* or *bombonasa* in other places, is widely used in tropical America (Bennet and Alarcon 1991; Perez 1996; Alarcon and Londoño 1997; Ceballos 1998). In Ecuador the names vary according to local indigenous groups and languages (Alarcon 1994).

C. palmata has a wide distribution from subtropical to rainforest areas, from Mexico and Panama to Brazil. In Ecuador it grows at elevations ranging from 20 metres above sea level to 2,000 metres, on both sides of the Andes, in open areas or disturbed soils. When mature, the petioles are 2 to 3 metres long, with leaves 1.5 to 4 metres long and 1 metre wide, in the shape of a fan. The inflorescences sprout at the base of the plant, next to the petioles. The flowers are unisexual and the fruit is multiple, composed of berries fused together or semi-separate (Heywood 1985) with seeds stuck to a type of cob. Seed dispersal may be by rain and ants (Bennet *et al.* 1992). In the Ecuadorian Choco region, observations indicate birds called *pichos* (Thraupidae: *Rhamphocelus flamigerus*) may be involved in seed dispersal (Alarcon *et al.* 1999).

The plant grows in colonies, each consisting of 40 to about 300 petioles. Like many typical colonising species, paja toquilla is found in areas with disturbed soils along with families such as *Heliconaceae*, *Poaceae*, *Arecaceae*, and *Cecropiaceae*. In agricultural areas or agroforestry systems, it grows near fruit trees, some crop plants, and timber trees.

The biological and ecological characteristics of paja toquilla facilitate its cultivation and management. In Manabi, where most of the natural forests have been cut down, there are different methods of management for *fincas*, agroforestry systems, and small traditional plantations called *pajales*. The latter originated over a century ago in response to the market demands of the time. There are still *pajales* in certain villages and communities such as El Aromo, Barcelona, and Valdivia. Up to 500 colonies of toquilla can be grown in a one-block *pajal*⁶, each colony containing plants aged 2 to 70 years old⁷. Nowadays, *pajales* account for 90% of the plants produced. Finally, wild colonies of toquilla plants are commonly seen on the edges of patches of remaining forest, next to *esteros*, or bodies of fresh water in the forests, or in *fincas*.

Cultivated paja toquilla is transplanted when six months old and reaches sexual maturity one year later. The young leaves are harvested when the colonies are two and one half years old, after the first flowering. As a rule, growers rarely harvest shoots before the first flowering because this practice can have an adverse effect on the plant population. The young leaves must be cut or harvested every 15 to 20 days or the plant will not increase in height or increase the production of shoots and plantlets; the shoot venation also becomes thicker, making fibre extraction harder. Only about half the leaves in each colony are harvested, to prevent the colony from dying. After the

first harvest of shoots, the plant starts *amateando*, forming daughter plants or runners and increasing the number of shoots.

Shoot production doubles in winter compared to the summer. Sowing takes place year round, and consists of transplanting the runners. The level of *paja toquilla* management varies according to the production system. In the *pajales* and agroforestry systems runners are planted and cared for in the same way as the rest of the crops. On the other hand, runners that appear spontaneously in *fincas* are freed from brush, an action known as protection, while those that appear in uncultivated areas are simply considered an inheritance and allowed to grow without any special care. Fibre producers developed different management and production systems in response to the dearth of raw materials caused by an increase in demand during certain periods of history. These systems are maintained as cultivated, *pajales*, and linked to agriculture in response to the modern market (Table 1).

Table 1. Management and use of *paja toquilla*

Period	Management system	Use or market
Precolonial, fourteenth century	Wild populations	Local use
Colonial, fifteenth to eighteenth centuries	Wild and managed populations	Regional use
Republican, nineteenth century	Cultivated and managed populations	National and international use
Current, twentieth and twenty-first centuries	Cultivated and managed populations	Global use

Producers of raw materials and socio-economic context

Most members of the three communities are descendants of the peoples that colonised the region around 4,000 BC (Aguilar de Tamariz 1988); they are now known as ‘cholo fishermen’ and speak only Spanish. Each family receives a piece of land for subsistence farming as an ancestral right. Legal ownership of the land is recognised by means of individual property titles negotiated over the last 15 years, when community members realised their land was in danger of invasion by migrants, colonisers, and speculators⁸.

Each community consists of about 500 people and is administered by a committee recognised by the national government. The committee comprises five people—usually men—elected annually by the community. The committee is in charge of security, controlling public order, organising festivities, and resolving possible litigation. It is also the obligatory point of contact when establishing relations with governmental and nongovernmental organisations.

Ninety percent of community members generate their own income from activities such as agriculture, commercialisation of timber and non-timber

products, fishing, animal husbandry, and hunting. Some members also have grocery shops, bazaars, food stalls, or work as civil servants.

Agricultural activities include growing cacao (*Theobroma cacao* L.), coffee (*Coffea* spp.), maize (*Zea mays* L.), pepper (*Capsicum* spp.), a variety of fruits (including plantain, a major source of food), yucca (*Manihot esculenta* Crantz), sweet potato (*Ipomoea batatas* L. Lam), and paja toquilla. Each *finca* has the capacity for about 100 colonies of paja toquilla, which is grown with other products. The *fincas* also contain patches of forest that are harvested for tagua (*Phyttelephas macrocarpa* Ruiz y Pav.), paja toquilla, cane (*Bambussa* spp.), and wood.

Daily chores are highly gender-specific: women work inside the house, men outside (Table 2). The men are in charge of cultivating, managing, and harvesting the paja toquilla, as well as for selling it to middlemen or transporting it to fibre processors. The women process the toquilla fibre and weave hats. Traditionally, they begin learning how to weave at the age of six, so that they will be able to earn a living later on and raise and educate their children. In the past this activity provided women with an economic means for survival.

Table 2. Gender in the production and commercialisation of paja toquilla fibre and hats

	Women	Men
Toquilla management		X
Harvesting shoots		X
Transport		X
Selling and buying shoots		X
Fibre extraction	X	
Fibre refinement	X	
Fibre commercialisation		X
Hat making	X	
Buying/selling hats	X	X

In 1954 the per capita income of a rural weaver was no more than US\$27 per year (Aguilar de Tamariz 1988). Today, total income is much higher, about US\$400 per year, but the economy has deteriorated considerably because of the loss of purchasing power of the national currency. Although the income from fibre and crafts represents 22% of the family income per year, at the moment this income is not as significant as it once was (Table 3). The total annual income⁹ of those communities that still produce and work with paja toquilla is less than US\$3,000 (Alarcon and Burbano 2000), while the national average for a family is nearly US\$4,000 (SIISE-INEC 1995).

Although Panama hats are famous, the people that produce them do not enjoy a privileged economic or social status relative to the rest of the

Table 3. Annual income of families that produce paja toquilla in three communities

Income source	Annual income (US\$)	
<i>Pajal/finca</i>	120	
Fruit orchards	100	
Cane	168	
Tagua	33	
Chickens	50	
Pigs	450	
Cow milk (3 litres per day for 6 months)	324	
Goats	30	
Goat milk (1 litre per day for 6 months)	108	
Woven crafts, hats	480	
Fishing (10% local consumption)	60	
Fishing (90% market)	540	
Coffee (10% local consumption)	1.6	
Coffee (90% market)	14.4	
Salary	300	
Producer (mean)	2,779	
National mean income	3,948	
National mean income 1998 (projected)	3,693	
Local consumption producer families	389	14%
Market	2,390	86%

National dollar exchange rate used US\$2,860.00

Source: SIISE-INEC 1995.

community. As a result they have to find additional income even when they are still young enough to be at school. Some move to other parts of the country or to other countries, such as Venezuela or Spain, in search of work that is better paid.

Most of the community members cannot cover their basic needs. There is a lack of electricity, sewage disposal, potable water, and health services, and they are often affected by tropical diseases including dengue and malaria. The working conditions, especially those of the weavers, have adverse effects on health: bad indoor lighting affects their eyesight, and the poor standard of nutrition and hard work associated with weaving are linked to a high incidence of tuberculosis (medical personnel of San Lorenzo Health Centre personal communication).

The production of raw materials

Farmers harvest the *pajales* twice a month, sometimes hiring helpers. Under optimum conditions, up to 60 bundles per month may be harvested in the winter and up to 30 bundles per month in the summer. The average yearly harvest is usually about 480 bundles, as there are always problems in production levels stemming from changes in climate, quality of shoots, or lack of time to harvest them. Surplus harvest has to be sold or processed as otherwise the unprepared fibres will spoil. Maintenance takes seven days and harvesting four days. About two months per year are needed to harvest one block of paja toquilla, producing around 20 tons of fresh raw material. The average annual income is US\$480. In exceptional cases when the owners hire extra help, the maintenance cost of the *pajal* increases to US\$300 per hectare per year.

Processing the raw materials

Processing or refining the toquilla fibre

If farmers take the bundles home, the women process the fibre. The *picuaceros*, who come from the village of Picuaza, also bring fibre to the women in the communities to refine it, especially in Aramo. The women are paid a percentage per bundle for this work. To refine the fibre first the venation is removed from the young leaves, a process called *despichado*; then the fibre is cooked, hung from wires, and spread out. The fibre is dried using special methods so the colour is not affected by excess sun. Finally, it is *sahumada*, or bleached with sulphur vapours. Processors rate fibre into three levels of quality according to its colour, length, and thickness, all of which affect the quality of the final product.

Hat weaving

In Manabi villages, the women that weave hats belong to the same families that grow the fibre. Hats are made using fibre that has been refined and bleached, using a design called *cangrejito*, with the help of a wooden mould for shaping the crown and brim of the hat. The moulds are based on the current fashion or on the sizes specified by vendors and shops. Each hat is unique in that it is made according to the technique used by a particular weaver. The quality of a hat is based on the number of rounds, or *carreras*, used by the weaver when making the brim, in turn determined by the quality and thickness of the fibres used. Fine and highest quality hats require between 18 and 22 shoots and 66 to 85 rounds; the fewer the rounds the lower the quality of the hat. Weavers grade hat quality on a scale of one to ten. Fine hats range from one to five points, highest quality hats from six to ten points; this grading system is also used by the middlemen and exporters.

Most of the 50 women interviewed in the three communities can weave from one to three hats per month depending on quality. The women weave the hats taking into account two factors: atmospheric humidity, which determines fibre flexibility, and available time. The best hours for weaving—

Photo 1. Woman weaving a paja toquilla hat



based on atmospheric humidity—are between 5 AM and 10 AM and from 4 PM to 10 PM. Women who make more hats probably have a higher total income, but those that produce higher quality weave or maintain the traditional design, as is the case with women in the village of Piles, sell their hats at a higher price.

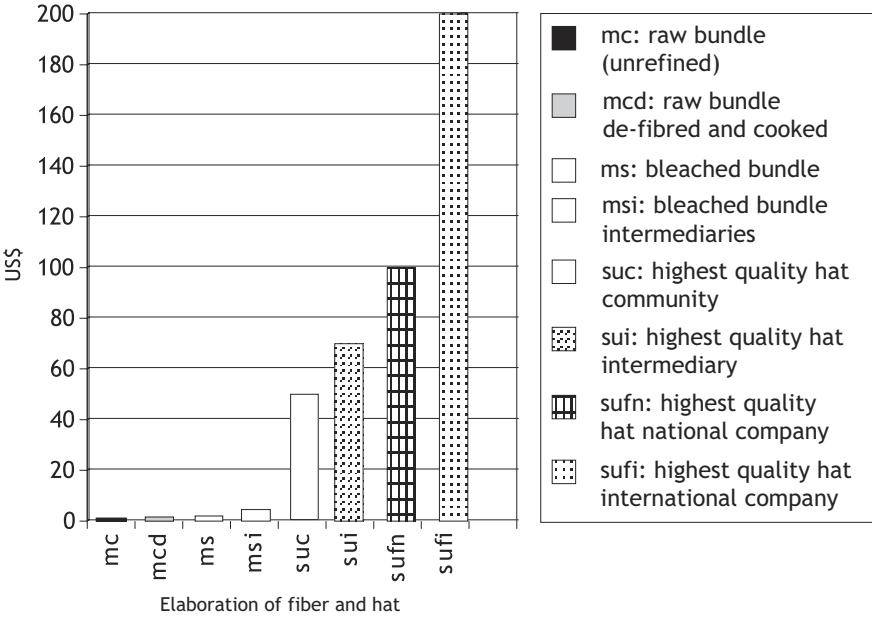
In each community there is an average of 35 family units that produce fibre and weave hats. Production units that include more women produce more hats. In Piles, where the highest quality hats are produced, between 15 and 20 hats are made per month.

Commercialisation and marketing sectors

Commercialisation of the fibre

Harvested shoots can be sold to the *picuaceros* waiting on the side of the road with their trucks. Once the fibre is dry it is taken to the local market in Montecristi or sent south to be bought by weavers in Azua and Cañar provinces for making hats and other crafts. The *picuaceros* tend to store the surplus paja toquilla, bleached or unbleached, for up to two years with no adverse effect on the quality of the fibre. This provides them with bigger profits when supplies are scarce. Within the community there are set rates for the bundles; US\$1.2 unprocessed, US\$1.6 de-fibred and cooked, and US\$2.0 bleached and ready to be woven (Figure 2).

Figure 2. Stages and costs of processing raw materials and hat production in communities, middlemen, and businesses



The three processes described can be done by the *picuaceros* by means of contracts with women from El Aromo community or in their homes in Picuaza. *Picuaceros* sell a bundle ready for weaving on average at US\$3.84, although the price varies according to fibre quality. During the buying and selling process, *picuaceros* may adulterate both quantity and quality of fibre by mixing fibres of different lengths and thickness, of different bleaching quality, or reducing the number of shoots in each load sent for sale to the southern part of the country¹⁰.

The system of selling fibres to *picuaceros* has existed for many years. Mutual trust results from the continuous presence of *picuaceros* who also offer other services including loans and supply certain consumer products and transport. This interaction has established a local network to market fibres and hats. The men in the communities prefer to maintain this system rather than trust outside agents who offer better prices but do not guarantee sales year-round.

Commercialisation of the hats

Depending on circumstances, hats may be sold by men or women. In general, women are in charge of selling hats to intermediaries within the community and men to buyers from outside the community. In Piles hats are bought by women from the community who act as intermediaries, by agents from shops in Montecristi, or by agents from international companies. In Aromo and San

Photo 2. Paja toquilla products

Lorenzo the intermediaries—mainly women—visit the community at intervals during the year and buy hats directly from the women that weave them. Therefore weavers store the hats until intermediaries come around. One way of guaranteeing the sale of hats is through family ties and friendships between the women that make the hats and the intermediaries. These relationships mean that buyers will show preference towards certain weavers and in turn will be guaranteed the best quality hats. Intermediaries may buy unfinished hats from weavers at an average price of US\$10 for fine hats and US\$50 for highest quality hats. As a result weavers earn US\$0.40 per hour of work.

When men travel to cities like Montecristi, they sometimes take hats to sell to shops or warehouses, but the profit made is not really significant. Under these conditions, the person selling the hat benefits from the sale.

Intermediaries may sell unfinished hats to bulk buyers in Montecristi or they may hire a group of experts to finish making the hats. This process includes *añadidos* (increasing or decreasing rounds), *pasar pajas* (removing bad fibres and adding good ones), *rematar* (finishing the brim edging), *azocar* (tightening the knots along the edging), *sahumar* (bleaching to improve colour), and *planchar* (ironing). All this costs US\$4 per hat. Finally, the hats are taken to Quito or Guayaquil to be sold for US\$30 or more per hat, depending on the style, size, fibre quality, and weave. In city commercial centres and in the foreign market, the price range is highly variable; in general, the farther the market from the production site the more variable the price range and the greater the costs.

Some brands or designers prefer to buy unfinished hats and add the final touches themselves (Jenny Tzaig personal communication) (Figure 2). In

this case hats are sold in bulk to exporters. This practice affects vendors at the end of the consumer chain, who are unable to choose the quality of the product because they receive an order containing hats of differing qualities but priced as highest quality. Nowadays, some export companies are showing interest in mediating the process and paying fairer prices at various links of the production chain.

Market demand is dependant on seasons, fashion, and national and international consumers; the period of highest demand in the communities, however, is between January and May, coinciding with spring in the United States and Europe. At the national level the demand is highest in August, September, and December. Between 1990 and 1997, total exports of hats was 1.2 tons equivalent to slightly more than US\$35,000 FOB. The main buyers are Brazil, United States, Mexico, United Kingdom, Italy, Germany, and Japan, accounting for 95% of the production (Vintimilla 1998).

Political and institutional aspects

A number of factors have affected the management and commercialisation of paja toquilla over its 300 years of existence in local, national, and international markets. The viability of the production system is not threatened by ecological factors, but by legislative and socio-economic factors. Paja toquilla generates relatively little income because of the following general factors: political instability, international policies, customs tariffs and taxes, and low demand.

Political and economic instability

During the colonial and republican eras, various revolutionary and divisive movements produced economic instability in Ecuador, causing weavers from various parts of the country to leave their homes in search of other sources of work and income. For example, before 1941 there were 100,000 weavers in the two provinces, but following the economic crisis of that period the number dropped to 12,000 (Dominguez 1991). The pattern has repeated itself with each new economic and political crisis until the most recent migration, which took place this decade. Although production demand increases when the market is good, prices, especially of the fibre, do not. The current crisis discourages investment in the sector, with an adverse effect on the paja toquilla industry. In addition, the conversion of the national currency to the dollar in 2002 caused a flight of capital, which has also affected the craft industry.

Weak laws and decrees

Historically, a few specific decrees have favoured paja toquilla, such as the 1835 ban on fibre export, but in general government intervention in the sector had no effect or a negative impact. The few laws that do exist are not widely known or enforced. In Ecuador the Law of Forestry and Conservation of Protected Areas (1981) regulates the commercial use of non-timber

products in general terms, without differentiating between species or taking into account their economic importance or their conservation. Under this law, *paja toquilla* is considered a wild species and thus is protected. From the ecological point of view, *paja toquilla* is not an endangered species and has a lot of potential for sustainable development. State legislation should not control *paja toquilla* management, as such regulation could increase costs by requiring management systems available only to individuals who are economically solvent, but not the communities.

International policies, customs tariffs, and taxes

Customs tariffs and taxes have a considerable impact on the demand for many non-timber products, including *paja toquilla*. For example, a trade agreement with the United States between 1930 and 1955 included a special customs tariff favouring *paja toquilla*. The later tariff increase from 12.5% to 25% had a negative impact on the international demand for hats (Dominguez 1991).

Presence of nongovernmental organisations and private companies

Over a certain period, nongovernmental organisations (NGOs) facilitated training, certification of products, and price and quality control of *paja toquilla*. Thanks to their intervention, small businesses and cooperatives formed by producers and weavers were established, causing an increase in the number of buyers. The initiative ended when funding for the NGO finished and it left. Although the cooperative continues to function, it is still unable to cover certain costs, for example contact with new markets. Although NGO initiatives have opened new arenas for discussion between the various participants in the production chain, including women, the general feeling in the community is that this type of outside intervention is too specific and fails to respond to local needs. Some of the NGOs concentrated their support on power groups within the community that have better contact with outside resources. In contrast, most of the weavers, especially the women and those that know the most about *paja toquilla* and local techniques, do not receive the support they need. As a result, there is a lack of trust in NGOs, and villagers prefer to work with intermediaries and middlemen that pay less but are trusted and well-known by the community.

CONCLUSIONS

There is a well-established market for *paja toquilla*, with a production chain that has allowed introduction and commercialisation of products in the national and international markets for centuries. The use of Panama hat has changed over the years from its origins when it was a symbol of local identity and of art exclusive to Manabi province. The hat industry then passed through a stage of local and regional production in response to a wider demand in the country. The next stage was the appearance of Panama hats in the international market: hat production became an industry, involving mass training in the art of weaving in the south of Ecuador (Austral region).

Hats began to be worn throughout the country, and in other countries, as a symbol of elegance (fine and high quality hats) and as part of a worker's uniform (regular hats). Through a market monopoly, a strong national and international market developed allowing the hat industry to flourish in a short time. One effect of the transition from local to global demand has been the loss of traditional customs and skills in the management and weaving of hats, in turn associated with the dehumanisation of the market and the loss of artisan values and product quality.

The existing monopoly in the hat industry results in unfair distribution of benefits along the production chain and has caused qualitative and quantitative changes in hat production. Qualitatively, the diversity of local weaves and patterns seen nowadays is determined by outside demands, the traditional designs having been relegated for a number of years. Given the global trend towards natural and traditional crafts and products, however, the Panama hat can be considered an item of natural and cultural origin. Traditional designs could be revived and used to create a new approach to the industry.

A general trend, resulting from the work done in collaboration with NGOs has been legal recognition of small businesses and cooperatives in the communities. Within the community, the legal bodies uphold labour rules and working conditions in agreement with all the participants. They offer guaranteed quality in fibre processing and artisan weaving to companies and their clients as well as continuous training to maintain traditional knowledge and to meet fashion demands. The patterns are being recognised as an intellectual traditional property and as such are seen within the communities as cultural values that should be acknowledged economically.

Biological research is essential to determine strategies of sustainable management and for initiatives such as obtaining green market certification (Panayotou 1993). During the development of the sector, only the hat was considered as the object of market supply and demand, but not the working conditions of the farmers and weavers or the gender related roles that have allowed the development of a predictable local market, although unfair in payments.

NOTES

1. Brookfield Road, Market Harborough, Leicestershire, LE16 9DU, UK. E-mail: r.viteri@btopenworld.com

2. Ecolex, Quito-Ecuador, Gaspar de Villaroel E4-50 y Amazonas, Quito, Ecuador. E-mail: maria_bb2000@yahoo.com.mx

3. During this period, various groups integrated and formed political units, based on similar life styles, forming a confederation that lived in the Manta region (Enciclopedia Ecuador 1999).

4. Information from community leaders.

5. The project was designed by the NGO EcoCiencia and funded by Esquel and the Ecuadorian Fund Populorum Progreso (FEPP).

6. One block is equal to 0.7 hectares.

7. Local information.
8. In recent years, land invasion in the area has been encouraged by popular campaigns and rumours of construction of a coastal road. This has forced the local people to find ways of protecting their land by means of private property deeds and titles.
9. The figure includes monetary and nonmonetary income, the latter linked to the economy of self-consumption.
10. Each load contains 31 bundles, that is 2,976 shoots.

REFERENCES

- Aguilar de Tamariz, M. 1988. Tejiendo la vida. Las artesanias de la paja toquilla en el Ecuador. CIDAP.
- Alarcon, R. 1994. Etnobotanica y valoracion economica de los recursos floristicos silvestres. In: Alarcon, R., Mena, P.A. and Soldi, A. (eds.) Etnobotanica, valoracion economica y comercializacion de recursos floristicos silvestres en el Alto Napo, Ecuador, 13. EcoCiencia, Quito.
- Alarcon, R. and Burbano, M. 2000. Informe general sobre manejo y artesanias de toquilla en las comunidades de Piles, El Aromo y San Lorenzo. EcoCiencia.
- Alarcon, R., Burbano, M. and Trujillo, L. 1999. Monitoreo biologico de la paja toquilla (*Carludovica palmata*) en la comunidad chachi de Loma Linda. Proyecto SUBIR. EcoCiencia, Quito.
- Alarcon, R. and Londono, T. 1997. Manejo en vivero de la paja toquilla, *Carludovica palmata* (R&P), en la zona de influencia del Parque Nacional Yasuni. In: Mena, P.A., Soldi A., Alarcon R., Chiriboga C. and Suarez L. (eds.) Estudios Biologicos para la Conservacion, Diversidad, Ecologia y Etnobiologia, 376-381. EcoCiencia, Quito.
- Arguello, M. and Chiriboga C. 1998. Diagnostico de la zona del bosque de Pacoche. Informe EcoCiencia, Quito.
- Bennet, B. and Alarcon, R. 1991. Common useful plants of Amazonian Ecuador. EcoCiencia, Quito.
- Bennet, B., Alarcon, R. and Ceron, C. 1992. The ethnobotany of *Carludovica palmata* (Ruiz y Pavon) (*Cyclanthaceae*). In: Buchet, M. Amazonian Ecuador. Economic Botany 46(3): 233-235.
- Burbano, M. and Londono, T. 1999. Mejoramiento de la produccion y comercializacion de la paja toquilla. Un producto no maderable del bosque de Pacoche y San Lorenzo. Informe de consultoria, componente de Investigacion. EcoCiencia, Quito.
- Ceballos, J. 1998. Elementos para la conservacion y manejo de *Carludovica palmata* en Centroamerica. Turrialba, Costa Rica.
- Dominguez, M. 1991. El sombrero de paja toquilla. Historia y economia. Banco Central del Ecuador.
- Enciclopedia Ecuador 1999. MMI Oceano grupo editorial, SA.
- Heywood, V.H. 1985. Las plantas con flores. Editorial Reverte, Madrid.
- Lescure, J.P., Balslev, H. and Alarcon, R. 1987. Plantas utiles de la Amazonia Ecuatoriana. ORSTOM-PUCE-INCRAC-PRONAREG, Quito.

- Meggers, B.J. 1966. Ecuador. Thames and Hudson, London.
- Panayotou, T. 1993. Green markets: the economics of sustainable development. ICEG, California.
- Perez, E. 1996. Plantas utiles de Colombia 5th ed. Cargraphics, Bogota.
- SIISE-INEC 1995. Encuestas de Condiciones de Vida 1995 en Sistema Integrado de Indicadores Sociales del Ecuador, SIISE.
- Vega, E. 1999. Estrategias de comercializacion de PNMB y estudio de factibilidad de productos de paja toquilla en las comunidades de San Lorenzo y Pacoche, provincia de Manabi. EcoCiencia, Quito.
- Vintimilla, M. 1998. Analisis comercial de la paja toquilla. EcoCiencia, Quito.

Chapter 24

‘Vegetal Leather’: Latex (*Hevea brasiliensis* Müll. Arg.) in style

Mariana Ciavatta Pantoja¹



(*Hevea brasiliensis*)

Common names	Part used	Management	Degree of transformation	Scale of trade	Geographic range
Rubber tree, seringueira, seringá	Exudates (latex)	Wild	Medium	International	Large

ABSTRACT

This article intends to analyse some characteristics and peculiarities of the production system of 'vegetal leather', a non-timber forest product inspired by a local handcraft ('*saco encauchado*', or rubber bag), which appeared on the market in Brazil in the 1990s. Cotton fabric bathed in latex collected from *Hevea brasiliensis*, smoked and vulcanised, gains an appearance similar to animal leather. Vegetal leather is an initiative of the Brazilian company *Couro Vegetal da Amazônia S.A.* (CVA), which established a commercial partnership with associations of indigenous people and *seringueiros* (rubber tappers) located in the Brazilian states of Acre and Amazonas. CVA and other national and international companies use vegetable leather to make clothes, wallets, and accessories. Families of extractors process vegetable leather almost entirely within the forest, which aggregates value to the product but also significantly increases the cost of production. To make a product such as this possible in the demanding market of fashion requires that the company assume risks and additional incumbencies, and that it broaden support for the venture. In addition, the partnership with local associations of extractors, another peculiarity of the production, requires dialogue between distinct cultural universes, and has required a more entrepreneurial behaviour from the local producers. These and other issues related to vegetal leather determine the research agenda and demand reflection. The present case study is based on the experience of the Extractive Reserve of Alto Juruá, an area of 500,000 hectares with a high incidence of *H. brasiliensis* located in the extreme west of the state of Acre and inhabited by rubber tappers for 100 years.

INTRODUCTION

An impermeable and highly flexible resin, which native peoples of the South American continent had long known and manipulated, awoke the attention of the countries of the northern hemisphere in the eighteenth century. Only after 1840, however, with the discovery of the vulcanisation process and the increasing expansion of the automobile industry, did rubber become a strategic product (La Condamine 1922 [1745]; Pinto 1984; Martinello 1988). At the end of the nineteenth century, the Brazilian Amazon saw a large influx of non-native population and intense commercial activity. Rubber, processed from the latex obtained from rubber trees, was the coveted product.

The international demand for rubber stimulated a new occupation in Brazilian forests where rubber trees were abundant, that of *seringueiro*, or rubber tapper. *Seringueiros* are extractive workers that extract latex and make rubber in *seringais*, land units with a high incidence of rubber trees, where latex extraction and rubber production is located. The establishment of *seringais* was possible only after the systematic expulsion of the native peoples from their territories, and the concomitant migration of workers coming from north-eastern Brazil in search of a better life in the Amazon (cf., for example, Costa 1940; Castello Branco 1961; Wolff 1999).

RUBBER: CRISES AND ALTERNATIVES

Until 1912, the Brazilian Amazon was the principal exporter of rubber in the world, but then the production of rubber trees in plantations in Malaysia began to dominate the international market—and continues to do so today.² Rubber extraction in Brazil, therefore, has gone through successive crises. In the 1940s, the Brazilian government implemented a series of measures aimed at guaranteeing the price and market for Brazilian rubber, but, by the 1980s, this protectionist policy began to be altered, drastically affecting the native *seringais* of the Amazon.³

The effects of the continued crisis were felt in the interior of the forest, but did not express themselves in the dramatic form of a mass exodus of rubber tappers toward nearby cities. At least in the state of Acre, a diversified regional market formed under the effect of the rubber market instability throughout the twentieth century, whereby rubber continued as a principal commercial product, but agricultural production increased and started to supply cities and villages, stimulating the regional economy. Activities complementary to the extraction of rubber, like hunting, fishing, and agriculture, began to occupy an important place in domestic planning and to contribute to the improvement in the quality of life of the rubber tappers and their families (Almeida 1993; Wolff 1999).

But in the 1970s, the military government⁴ offered advantageous conditions and long-standing owners of the *seringais* (the ‘bosses’, or *patrões*) began to sell their properties to entrepreneurial and financial capital groups. The extraction of rubber, which for about 100 years had been a principal economic activity with very low impact on the forest, began to give way to activities with large environmental impacts, such as creation of pasture for cattle and extraction of valuable timber. Many rubber tappers, expelled from the *seringais*, migrated to urban centres or to the margins of larger rivers, whereas others and their families opted to remain in the interior of the forests. While ‘bosses’ sold or gave new direction to the old *seringais*, rubber tappers throughout the Brazilian Amazon began to mobilise themselves, aiming at obtaining rights over the forest territories (Paula 1991; Esterci 1991; Almeida 1993). As a result of years of struggle, in 1985 the National Council of Rubber Tappers (*Conselho Nacional dos Seringueiros*) was created and Extractive Reserves⁵ were proposed as a policy of access and land distribution as well as for the preservation of the forests. In the state of Acre, in an initiative that became known as the Forest Peoples Alliance (*Aliança dos Povos da Floresta*), rubber tappers joined forces with the indigenous peoples that, since the previous decade, had organised themselves to legalise their territories. Through the creation of Indigenous Lands, Projects of Extractive Settlements, and Extractive Reserves rubber tappers and native Brazilians were guaranteed a total of more than 4 million hectares and thus enabled to meet the challenge of finding economic alternatives that provide better living conditions to the inhabitants of the forest while keeping it standing.⁶

VEGETAL LEATHER: THE CASE STUDY

This article intends to analyse the production of vegetal leather and some of its peculiarities and implications through the experience of the Extractive Reserve of Alto Juruá (Figure 1). Created on 23 January 1990, the reserve covers an area of 506,186 ha consisting of rivers and forests in which high biodiversity indexes have been found (Carneiro da Cunha and Almeida 2002). Vegetal leather—cotton fabric bathed in latex collected from *Hevea brasiliensis*, smoked, and vulcanised gains an appearance similar to animal leather—began to be produced in 1991 in a rubber tree plantation located in the city of Boca do Acre, state of Amazonas. Since 1994, production began in another four forest areas with a natural occurrence of rubber trees in the states of Acre and Amazonas. These are Mapiá-Inauini National Forest in the state of Amazonas, Extractive Reserve of Alto Juruá, Indigenous Land Kaxinawá do Rio Jordão, and Indigenous Land Yawanawá do Rio Gregório in the state of Acre.

The development of vegetal leather as a commercial product of high quality is an initiative of the Brazilian company Vegetal Leather of Amazonia S.A. (*Couro Vegetal da Amazônia S.A.*, CVA), whose members have acted in the 'green market' since the end of the 1980s. The product is the result of improvements to the traditional rubber tapper handcraft known as '*saco encauchado*', or rubber bag, and was adapted to fit the needs of the fashion market as an ecological alternative to animal leather. Vegetal leather is not intended to be an alternative to rubber, but aims to increase the breadth of possibilities that generate income and good business associated with extraction and to contribute to the improvement of the quality of life of the local population and to the preservation of the forest.

In 1998, in the Extractive Reserve of Alto Juruá, the price paid for vegetal leather was 5.2 times more than the price paid to rubber tappers for 1 kg of rubber.⁷ While the proportion of families involved in the production of vegetal leather is still small, this number has been increasing and there has also been an increase of 22% in the average income of producing families compared to others.⁸

VEGETAL LEATHER: THE SYSTEM FROM PRODUCTION TO CONSUMPTION

The rubber tree: producer of raw material

In the Extractive Reserve of Alto Juruá, the presence of various types of rubber trees has been observed, but it is the 'royal rubber tree', *Hevea brasiliensis*, that is principally responsible for the production of rubber in the region.⁹ Rubber tappers affirm that its latex is of the highest quality. While it is not currently the subject of a management plan, it has the potential to be sustainably managed.

Even when 'bled' periodically over decades, the rubber tree continually renews its supply of latex. This resistance and longevity is not a natural property of the species, however, but is sustained by the specialised knowledge of the extractor—in this case, the rubber tapper. The cutting of the bark of

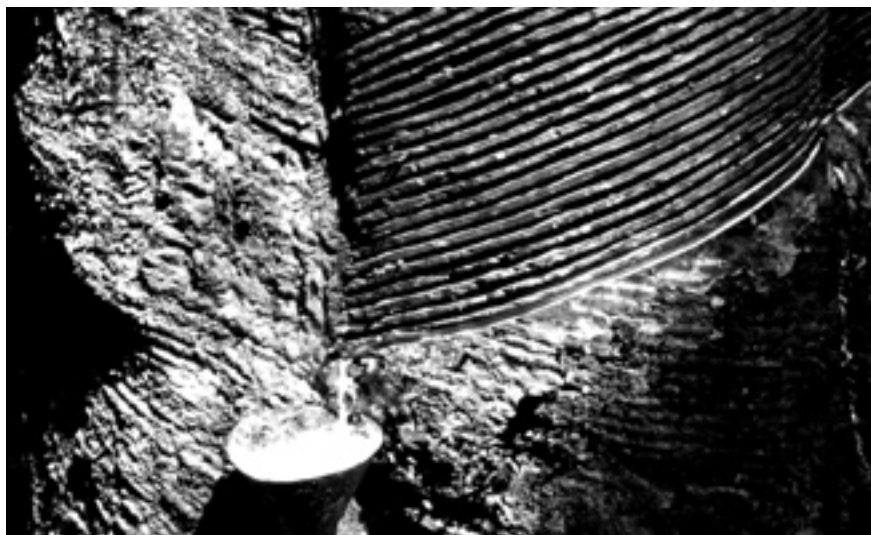
Figure 1. Location of the study area



Source: ESRI Data and Maps 2002.

the rubber tree is a highly specialised technical activity, one that requires knowledge of the ecological characteristics of the species (Emperaire 1997; Carneiro da Cunha and Almeida 2002). The 'cutting calendar', for example, must be followed in order not to risk losing the productive capacity of trees cut in the wrong period, as is the case in the months of August and February, when rubber trees are flowering and fruiting, respectively. Each tree must be cut 60 times (60 days in a year), and the cut must not be so deep that the tree bleeds unnecessarily and is exposed to the risk of borers, a pest. There are appropriate instruments to cut the rubber tree and to collect the latex ('knife' and 'bucket') and to process the latex into rubber ('smoker' and 'press'). In the past, there were specialists, the *mateiros*, who went around the *seringais*, regulating the activities of the rubber tappers and guaranteeing that health and productivity of trees were being preserved.

Photo 1. By the traditional technique for latex extraction, the tree receives a cut twice per week and the latex runs into a small bowl (Photo: N. Benedicto)



The productivity of rubber trees in natural conditions is not homogeneous, as tends to be the case with rubber trees under cultivation. In the native *seringais*, the productivity of trees is strongly heterogeneous, the oldest and widest trees being the most productive. In relation to the population structure of rubber trees, a high degree of regeneration has been observed, but it is accompanied by high mortality of new seedlings. The rubber tree is a typical species of the primary forest, which is the only environment in which it germinates and develops. The density of rubber trees in the Extractive Reserve of Alto Juruá is low (one per hectare, on average), but it can vary from one area to another, as their spatial distribution is clustered. As a result, rubber tappers need to cover long distances between trees along the 'rubber tree road'.¹⁰

Rubber tappers: local producers of 'vegetal leather'

The close to 6,000 dwellers of the Extractive Reserve of Alto Juruá are descendants of pioneer immigrants that, at the end of the nineteenth century, migrated from north-eastern Brazil to work in the nascent Amazonian *seringais*. Many of them were single when they migrated; others came with their families. Many of those who were single when they arrived got married while working in the *seringais*. The first-generation rubber tappers married girls and women either from their homeland or born in the Amazon, or native women kidnapped in armed expeditions that chased and killed the native inhabitants of the forests coveted for the incidence of *H. brasiliensis*. (For a description of this process in the state of Acre, see Aquino and Iglesias 1994; Wolff 1999; Pantoja, 2004)

In the *seringais*, the main economic activity was latex extraction and rubber production. During the twentieth century with its crises resulting from the instability of the rubber market, rubber tappers started to dedicate more time to subsistence activities. These activities were marginal from the financial point of view, as rubber was still the main source of income. In spite of the difficulty in assessing the precise contribution of these activities, they nevertheless did serve to increase household income. Examples of these subsistence activities include: cassava cultivation to make *farinha* (manioc flour) for the family's consumption, corn cultivation to feed chicken and ducks (to be consumed by the family), hunting of wild animals and fishing for the family's consumption, collection of palm fruits, etc. The whole process of diversification of the local economy, and of the extractive activity itself, was fundamental in keeping the *seringais* in activity through a century punctuated by crises in the price of rubber.

Since the 1990s, which saw the end of protectionist measures that had shielded the native *seringais* of the Amazon, the local rubber prices have plummeted and many rubber tappers have started to dedicate a greater part of their time and effort to agriculture. Products such as *farinha*, beans, and tobacco began to be more intensely commercialised. The raising of pigs and of small flocks of cattle increased significantly during the 1990s (Costa *et al.* 1998). A migration towards the margins of larger rivers occurred, and many locations that had traditionally produced rubber were abandoned. On the other hand, contrary to simplistic forecasts, every increase in the price of rubber or announcement of measures to stimulate its production is, until today, followed by a noticeable increase in rubber production in the region. Rubber tappers return to the activity even knowing that it is no longer their only source of income.

With the establishment of the Extractive Reserve in January 1990, a series of projects and actions began to be implemented. Health and disease prevention, education, leadership formation, and scientific research were some of the fields that received human, material, and financial investment. The search for new economic products that could conciliate development and conservation was also included in the agenda of the Rubber Tappers and Farmers Association of the Extractive Reserve of Alto Juruá (Asareaaj) and of its partners and allies. Consequently, in 1994, CVA proposed the establishment of a partnership with Asareaaj with the intention of promoting the production

and trade of vegetal leather. This proposal was promptly accepted and the first five production units were implemented.

Production units: processing in the forest

In April 1994, after meetings with local leaders and agreements with Asareaj, a team from CVA travelled to the Extractive Reserve of Alto Juruá for the establishment of five production units, each located in a *colocação*¹¹, under the responsibility of a rubber tapper, usually the head of a domestic group. All heads of the production units are members of Asareaj.

The role of the heads of the units is to locally lead and manage the activity, buy latex, and organise the necessary labour for the production of vegetal leather. In 1998, each production unit, on average, contained five domestic groups and, on average, one person (usually a man) per household was involved in the production of vegetal leather. The domestic groups that participated in the production were almost always related.

Vegetal leather is produced as follows. First, it is necessary to obtain latex, which needs to be fresh or, at the most, one day old. The rubber tapper adds a stabiliser to the latex. In the production unit, the latex is strained in order to remove impurities that may compromise the product's final texture. It is then slightly warmed (under controlled temperature) and a chemical mixture of sulphur and a vulcanisation accelerator is added. At this moment, cotton bags, which were previously stretched on a wooden grate, are individually dipped in the latex. From 8 to 10 latex baths are necessary, alternated with smoking (see below), for the vegetal leather to obtain the ideal consistency and texture. The rubber tapper responsible for this part of the process must pay attention to the homogeneity of the distribution of latex over the fabric. Meanwhile, the 'smoker'—a kind of clay volcano, fed through the mouth with firewood or fruits of *cocão* (*Scheelea phalerata*)—is already lit and has started to produce the ideal smoke for smoking the bags bathed in latex.

The bags smoked in one working day are put inside a vulcanisation oven, a structure made of asbestos that handles high temperatures. A good smoker-rubber tapper can smoke an average of 10 bags per day. When the capacity of the oven is reached, more firewood will be added and the fire will be lit for the bags to be 'baked', i.e., dried and vulcanised. This baking is a relatively long process, and the temperature of the oven must be controlled by using a thermometer. The grates with the smoked bags—already practically vegetal leather—are removed from the oven, as are the residuals left by the process, and they are subjected to a last drying. The bags are removed from the grates and divided into two blades, i.e., two sides. Talc is put on the surface of each blade so they can be put in piles of up to 200 units. The blades are stored in a dry place until they are transported to market.

The rubber tapper responsible for the production unit transports the blades to the town of Cruzeiro do Sul, a distance that can take from three to seven days by boat. During the rainy season (Amazonian winter) the blades are transported from this town by river on larger ships (ferries) to Porto Velho, which is a 20-day trip. In Porto Velho they are transferred to trucks

and taken to CVA's headquarters in Rio de Janeiro, which takes 15 days. If the transport is done during the dry season (Amazonian summer), and if the road connecting Cruzeiro do Sul to Rio Branco is in good condition, the blades can be sent by truck directly to Rio Branco, which takes four days, and from there to Rio de Janeiro.

Upon arrival at the supply sheds of CVA, the blades go through vulcanisation tests, then are washed again and put to dry on lines. After that, they are waxed and then go through quality control, where they are classified: they can be of first or second quality, or be rejected.

Meanwhile, in Cruzeiro do Sul, CVA pays the managing rubber tappers for the production in their units. The managers return home, where they pay for the working days agreed upon with the neighbouring rubber tappers for the various functions required for the production of vegetal leather: latex collection, smoking of the bags, collection of firewood or *cocões*, and control of the oven temperature. Many times, this payment, or part of it, has already been made with industrialised goods that the managing rubber tapper keeps in supply. This merchandise may have been bought with part of the funding that the rubber tapper manager receives to produce vegetal leather.

In 1998, CVA paid the rubber tapper manager US\$3.80 for each bag of vegetal leather. This price included payment for the managing of the production unit, the smoking of the bags, the control of functioning and temperature of the vulcanisation oven, the transportation of the blades to Cruzeiro do Sul, and the latex delivered by the rubber tappers. The highest partial payments are for the latex (US\$0.87, or 23%)¹² and for the smoking of the bags, the latter being the task that involves the largest amount of labour (straining the latex, warming it, bathing the bags, and smoking). Many producers claim, however, that providing firewood for smoking the bags and for vulcanisation in the oven is one of the hardest jobs in the production process.

CVA: product marketing and trade

The production of vegetal leather began in 1991, when rubber tappers from the state of Amazonas established a commercial partnership with EcoMercado, a store established that same year in Rio de Janeiro with the objective of commercialising ecological products and reaching as well as developing a 'green' market in Brazil. Problems with quality, however, challenged the expansion of production and the market for vegetal leather, in spite of the product being well received. The first supply of 500 pieces (handbags and folders), released during the Earth Summit in Rio de Janeiro in 1992, immediately sold out, but one month later the buyers started to return them: the latex that covered the pieces was 'sticky'.

Since then, businesspeople began to invest in the improvement of the product. In 1993, the first patent was requested, which was the result of research into quality improvement. In 1994, with the objectives of continuing to develop vegetal leather as a high-quality product for the demanding market of fashion, bags, and accessories, of consolidating and expanding the production capacity, and of opening the market for these products, João Fortes and Beatriz Saldanha, former owners of EcoMercado, created CVA.

Funding in the amount of US\$1 million from the National Bank for Economic and Social Development made the new enterprise viable. Cooperative agreements were established between the new business and four associations, namely Asareaj, Apas (Association of the Producers of *Seringa* Handcraft, the pioneer association of Boca do Acre), Asakarj (Rubber Tappers Association of Kaxinawá do Rio Jordão), and Oaeyrg (Organisation of Farmers and Extractors Yawanawá do Rio Gregório). As part of this agreement, the requested patent was shared with the partner associations. CVA also created a registered trade mark—Treetap—for commercialisation of the product, and began to search for commercial partnerships.

From the first time the product was put on the market, the business realised that the buyers of vegetal leather should also be allies in the development of the product. In 1993, the shoe company Deja Shoe funded and developed a manual for quality control to evaluate the blades of vegetal leather as soon as they arrived in Rio de Janeiro. Later, CVA expanded the quality control to the production areas. Apas, which works in the Mapiá-Inauini National Forest, turned into a laboratory for quality control and improvement of field production technology. The oldest producers in Apas became supervisors, travelling for training and production monitoring in the other areas (Silberling *et al.* 2002).

Photo 2. A line of bags, suitcases, and accessories with the trademark Treetap was developed from blades of vegetal leather (Photo: R. Azoury)



When a partnership and commercial contract were established with the French business Hermès Sellier in 1998, the Apas production units were the ones primarily designated to produce the blades of vegetal leather for this international buyer, which demanded a high-quality product. The blades produced for Hermès have unique characteristics, and the firm pays a premium

price to CVA for these blades. CVA passes this profit to the producers. In order to supply vegetal leather to Hermès, the Apas production units have increased from 4 to 30, and the families involved in production from 80 to 200. In 2000, CVA joined the Internet site AmazonLife.com in order to expand its area of operation, diversify its line of products using new raw material from the Amazon forest, increase distribution channels, and, mainly, act in a specific manner in the online market.

GOVERNMENT POLICY

There are no specific incentive policies for the production of vegetal leather. Rubber, on the other hand, was a target of protectionist public policies (price, market) until the 1980s, when it started to be dealt with within a neoliberal perspective of the market. More recently, federal and state governments have been trying to adopt measures aiming at guaranteeing prices and improving product quality. Consequently, the state government of Acre created a subsidy for each kilogramme of rubber produced, which has benefitted rubber tappers associations and cooperatives. The federal government has supported technical initiatives that aim at improving the product, such as the 'liquid smoked sheet' (*folha defumada líquida*, FDL), but there is no official policy that aims at protecting latex extraction and rubber production in the native *seringais*, which compromises the effectiveness of initiatives such as FDL.

Through CNPT/IBAMA¹³, a part of the federal government, funding was obtained for the improvement of the production of vegetal leather including training for the producers and research aiming at improving the product's quality. Within the Secretariat for Amazonian Coordination, part of the Ministry of the Environment, policies have been discussed and announced in relation to support for extractive activities. The program 'Businesses for a Sustainable Amazon' (*Negócios para Amazônia Sustentável*) was recently initiated in order to, among other objectives, 'stimulate the business sector to invest in sustainable business opportunities in the Amazon, disseminating successful experiences and making possible technical support for enterprises of this nature'.¹⁴

In 1997, as an initiative of representatives of the state of Acre, the Program to Support the Development of Extractive Activities (*Programa de Apoio ao Desenvolvimento do Extrativismo*, Prodex) was created, which provides a line of credit for agro-extractivist producers in northern Brazil. Prodex funds the extraction and collection of forest products, low-impact forest management, agroforestry systems, forest enrichment with valuable species, primary processing of extractive production, and family production of basic foods. Prodex financed the producers of vegetal leather in the Extractive Reserve of Alto Juruá in 1998 through a line of credit guaranteed by Asareaj and CVA (Andrade 1998).³⁰

TRENDS AND ISSUES

Unfolding of events

Around 1996, CVA realised that, as a business, the time had come to reduce its participation in funding the production of vegetal leather, in training local producers, and in the development of the product, because this kind of support was economically impracticable. The Nawa Institute for the Development of Sustainable Extraction (*Instituto Nawa para o Desenvolvimento do Extrativismo Sustentável*) was then created in 1996, in the Amazon, as a not-for-profit nongovernmental organisation, with the immediate objective of giving institutional support to the production of vegetal leather, training tappers in production technologies and management, establishing partnerships for the improvement of the quality of the product, and contributing to the development of policies of incentives for production. But the mission of Nawa Institute is broader, as it involves the identification and development of extraction products other than vegetal leather for the market as well.

Also in this context of rearrangements and changes in business strategy, Prodex began to fund the vegetal leather producers from the Extractive Reserve of Alto Juruá, as well as those from the Indigenous Land Kaxinawá do Rio Jordão. Through the Amazonian Bank, which was responsible for the distribution of funding, rubber tappers obtained loans guaranteed by Asareaj and CVA. These loans provided the working capital necessary for the functioning of the production unit: buying latex, paying for the work of other rubber tappers and, principally, supplying the raw materials necessary for production, i.e., vulcanisation mixture and virgin cotton bags. (CVA, however, reimbursed the producers for the expenses with cotton bags and chemical products used in the production.) They became micro-businesspeople, funding their own production through a financial institution, administering the application of resources, and managing the production in order to honour their commitments.

ISSUES AND PROBLEMS

In the course of a decade of production, the struggle to establish vegetal leather as a commercial product has been observed. Innumerable quality problems had to be solved and significant amounts of financial resources had to be applied to research and experience. Bank loans, financial investments from commercial partners, and investment of personal resources from the company owners made possible the creation and survival of CVA and of vegetal leather as a successful business. The company became profitable only in 1999, six years after it was created.

The facts that a large part of the production of vegetal leather is done almost entirely in the forest and that extractive producers are the first point of the production chain are distinguishing characteristics of the final product and have important marketing appeal in the sales strategies of the company. On the other hand, this characteristic of the production process results in high production costs. Large distances in space (around 4,000 km of road crossing the country from north to south) and time (six months) must be

covered from the time the raw material is extracted until the final product is purchased by the consumer. The final product (e.g., bags, backpacks, folders, and jackets) is not cheap; it is, on average, 20% cheaper than animal leather, but is more expensive than synthetic leather.

Working with extractive associations, generally with little administrative experience and almost no commercial experience, was one of the difficulties encountered by CVA. On the other hand, from the point of view of these associations, working with a company located in a large and distant city, with administrative procedures culturally distant, in a commercial partnership in which the knowledge about the market and its mechanisms is unequal (with the associations at a disadvantage), was also a difficulty. It is still ideal for both parts to establish fair contracts, from the economic and ethical points of view. Conflicts of interest will, from time to time, reshape and give new direction to the company and the associations.

Local producers in the production units also regret the physical and cultural distances. For one, they often feel poorly represented by their associations, especially when production needs to be stopped for lack of material. They believe that in such a case, for example Asareaj should take immediate action to solve the problem, but it, they say, does not generally happen. Asareaj, from its view, disagrees with the criticism and transfers responsibility to CVA. Producers also complain about the difficulty in communicating with the company, which communication is more sporadic than they would desire. In this sense, Asareaj's intervention, even when efficient, would not replace direct contact with CVA representatives.

Finally, a last problem deserves to be mentioned. Of the vegetal leather producers from the Extractive Reserve of Alto Juruá that received funding from Prodex in 1998, one did not honour his commitments. Currently, this producer is in default to the bank and runs the risk of being sued. This producer, according to the other producers and confirmed by Asareaj, did not know how to administer the money he received. Being the legal guarantor of the producer, Asareaj also is in default and has more difficulties in gaining approval for other projects with Prodex. CVA was not directly affected, even though it paid the first instalment of the producer's debt. This experience demonstrates the fragility of these producers when confronted with the rules of the market. If, for the production of vegetal leather, the rubber tapper must receive specific training, he also needs to absorb a new productive culture, that of a micro-businessperson. The familiarity with managerial methods becomes increasingly necessary to have success in this activity.

CONSERVATION AND DEVELOPMENT LESSONS

In the history of vegetal leather as a quality product for an internationalised and demanding market, and based on the principle of 'ethically and economically fair trade', the dynamics of the partnership established with local producers associations need to be highlighted. In these 10 years of working together, there has been a constant process of negotiation between the parties. Consequently, patent rights on the technology developed and criteria for the establishment of prices paid by CVA, volume and quality of

production, administration of resources and payments of accounts, planning of trips and trainings, etc., are some of the topics over which consensus must be built. It is not always a peaceful process—there are more critical disputes and moments—but it is a necessary challenge that cannot be delayed for projects that intend to build long-lasting partnerships between companies and extractive populations.

The effort of CVA to make vegetal leather a successful commercial product has had the support of a diversity of partnerships, forming a network of relationships that are necessary to develop a project such as this, i.e., one of undeniable economic risks. Besides the local associations, banks and companies, nongovernmental and governmental agencies are also among the partners that CVA obtained during the 10 years of production and commercialisation of vegetal leather. Without this pool of partnerships, business in the Amazon that proposes to contribute to a new model of development that values the forest and its peoples becomes more difficult. To these partnerships, we would still add a subjective factor consisting of willpower and ideological militancy from the businesspeople and vegetal leather producers that feeds, on a daily basis, their spirits in the face of difficulties and rewards their efforts when good results are obtained.

The history of the product and of the construction of the market for its commercialisation makes vegetal leather an undeniably innovative proposal within the scope of the discussion about conservation and development (Belcher and Ruiz-Pérez 2001). Vegetal leather is a product in which the extraction of raw material (latex) proved to be sustainable and compatible with the conservation of the ecosystem in which *Hevea brasiliensis* occurs. It is true that the commercial value of the main product derived from latex extracted from rubber tree plantations in the Amazon—rubber—faces an unfavourable situation. But it is also true that vegetal leather confers value to the forest where it is produced, which is recognised by the families involved in its production and by the buyers of the product.¹⁵

The issue of the viability of vegetal leather as a successful commercial product, we saw, involves variables and conditions not only economic but also ecological (incidence of *Hevea brasiliensis*), historical-cultural (traditionally extractive population with an interest in continuing to remain so, social organisation compatible with the sustainable use of natural resources) and political (alliances and partnerships, public policy, institutions). It should also be asked how the transformation that the production of vegetal leather brings affects the well-being and way of life of those that are directly involved in it. In a future investigation, the way in which families associated with a production unit are organised should be thoroughly described, clarifying which relations exist among them (kinship, religious, and/or neighbourhood) and how these relationships change after families become involved in the vegetal leather production process. A study that monitored the production units could reveal in more detail who does what kinds of work, at what frequency and at what salary. The participation of women, at first nonexistent, may appear in tasks such as sweeping and cleaning the smoker and the vulcanisation oven.

Another series of relevant questions is related to the distribution, fair and equal (or not), of the benefits from the vegetal leather production: how

is this distribution made? Is there a concentration of wealth and power among the families involved? Finally, a survey, combined with field observations, could provide data on the impact of vegetal leather production on the quality of life of the families involved: were there positive changes in the areas of health and education? Is there higher material well-being? Was there a change in the social and moral values, and in what sense? What is the degree of satisfaction and happiness of the families involved in the production?

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NOTES

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2. More than one third of the 15 million metric tons of rubber produced in the world are of natural origin. From this one third, 75% comes from small producers, probably from Asian plantations, while the contribution from Latin America in the production of natural rubber is approximately 1%. In Brazil, 91% of the 285,000 metric tons of rubber produced are of synthetic origin; of the 9% remaining, about one quarter comes from the native rubber trees of the Amazon (Emperaire 1997).

3. In Tejo River (in Alto Juruá, state of Acre), traditionally known as the 'rubber river', the price of one kilogramme of rubber, which had reached US\$1.80 in 1982, was US\$0.40 in 1991 (Almeida 1993).

4. In March of 1964, a military coup installed a dictatorship in Brazil. In 1984, direct elections for president were conducted.

5. Extractive Reserves are conservation units of direct use, located on land that was dispossessed for ecological interest. The property is of public domain and is ceded through Real Concession of Use (*Concessão Real de Uso*) to the inhabitants and their representative entity, which have co-management duties. In the Extractive Reserves there are no individual lots: mode of occupation and land use by the extractive populations must be respected (Allegretti 1987; Almeida 1995).

6. If an adjacent ecological station and a national park are added to these 4 million hectares, the total is almost 5 million hectares preserved by the federal government in the state of Acre that forms an 'ecological corridor' (Iglesias 2001).

7. A 'bag' (or two 'blades') of vegetal leather cost US\$3.83 in 1998. A bag of vegetal leather uses on average one 'can' (or 2 litres) of latex, corresponding to approximately 1 kg of rubber, which cost US\$0.51 in 1998. Observation: all values used in this article were calculated based on the average value of the U.S. dollar in 1998, which was R\$1.566.

8. Of the approximately 850 families (domestic groups) that resided in

the Extractive Reserve of Alto Juruá in 1998, only 2.9% could be considered producers of vegetal leather. In relation to the producers' income, the following points should be considered: (1) that the income is internally unequal because there are families that participate in only one part of the production process and, consequently, obtain a lower income from the activity, while others participate in all stages and receive a higher income; (2) that the data are from 1998, and that annual variations, per harvest, can happen; and (3) that these data are not valid for other vegetal leather production areas.

9. From now on, when we refer to the rubber tree, we will be talking about *Hevea brasiliensis*.

10. 'Rubber tree roads' are wide paths in the forest, between 6 km and 13 km long, that are maintained by rubber tappers, who travel along these trails to extract latex from rubber trees. A rubber tree road can give access to 300 ha. In one working day, the rubber tapper covers it twice: once to cut the tree and insert the container (bowl, or '*tigela*') into which the latex will run, and another time to collect the latex. A rubber tree road connects, on average, 120 rubber trees (Emperaire 1997).

11. '*Colocação*' is the residency and work unit in the *seringais*. One *colocação* can shelter one or more houses (domestic groups), each house having its own 'chief'.

12. The same amount of latex, if transformed into rubber, which demands an additional labour investment, would cost US\$0.51.

13. The National Centre of Traditional Populations and Sustainable Development (CNPT) is part of the Brazilian Institute for the Environment and Renewable Natural Resources (IBAMA), and is responsible for the management of Extractive Reserves throughout the country.

14. Businesses for a Sustainable Amazon is an initiative that involves the Ministry for the Environment, through its Secretariat of Amazon Coordination (coordinated by Mary Allegretti), and The Netherlands, within the scope of the Pilot Program to Conserve Brazilian Tropical Forests.

15. Currently, the Nawa Institute, with funding from the Ford Foundation, is developing a project aiming at certification of vegetal leather. For this certification, the need is foreseen for a management plan for the fuel used in the smoking and vulcanisation of vegetal leather, especially the firewood.

REFERENCES

- Allegretti, M. 1987. Reserva Extrativista. In: IEA. Reservas extrativistas: uma proposta para a Amazônia. Curitiba.
- Almeida, M. 1993. Rubber tappers of the upper Juruá river, Brazil: the making of a peasant economy. Ph.D. Thesis, University of Cambridge.
- Almeida, M. 1995. O estatuto da terra e as reservas extrativistas. *Reforma Agrária* 25(1): 153-167.
- Andrade, A.G. de 1998. Um novo produto florestal não-madeireiro: o 'couro vegetal': estudo de uma situação extrativista. Research Report. Fapesp, São Paulo.
- Aquino, T.T.V. and Iglesias, M.P. 1994. Kaxinawá do rio Jordão: história, território, economia e desenvolvimento sustentável. CPI, Rio Branco.

- Belcher, B. and Ruiz-Pérez, M. 2001. An international comparison of cases of forest product development: overview, description and data requirements. Working Paper 23. Cifor, Bogor.
- Carneiro da Cunha, M. and Almeida, M. (eds.) 2002. Enciclopédia da floresta. O Alto Juruá: práticas e conhecimentos das populações. Cia. das Letras, São Paulo.
- Castello Branco, J.M.B. 1961. O povoamento da Acreânia. Revista do Instituto Histórico e Geográfico 250. Departamento de Imprensa Nacional, Rio de Janeiro.
- Costa, E., Postigo, A. and Gesteira, M. 1998. Cenários futuros para a Reserva Extrativista do Alto Juruá: gado. Unicamp/Cifor, Campinas.
- Costa, J.C. da 1940. A conquista do deserto ocidental. Cia. Editora Nacional, São Paulo.
- Emperaire, L. 1997. L'exploitation des héveas dans la Réserve Extractiviste du Haut Juruá (Acre, Amazonie brésilienne). JATBA, Revue d'Ethnobiologie 39: 109-132.
- Esterici, N. 1991. Sindicalismo e luta por terra. Cadernos do Cedi 21, Rio de Janeiro.
- Iglesias, M.P. 2001. Assuntos indígenas. In: Programa de desenvolvimento sustentável do Estado do Acre. Rio Branco, mimeo.
- La Condamine, C.M. de 1922 [1745]. Viagem ao Amazonas (1735-1745). Nova Fronteira, Rio de Janeiro.
- Martinello, P. 1988. A batalha da borracha na segunda guerra mundial e suas consequências para o vale amazônico. UFAC, Rio Branco.
- Pantoja, M. C. 2004. Os Milton. Cem anos de história nos seringais. Editora Massangana, Recife.
- Paula, E. 1991. Seringueiros e sindicatos: um povo da floresta em busca da liberdade. Master's Thesis, Universidade Federal Rural do Rio de Janeiro, Rio de Janeiro.
- Pinto, N.P.A. 1984. Política da borracha no Brasil: a falência da borracha vegetal. Hucitec, São Paulo.
- Silberling, L., Franco, M.C.P. and Anderson, A. 2002. Couro vegetal: desenvolvimento de um produto artesanal para o mercado In: Anderson, A. and Clay, J. (eds.) Esverdeando a Amazônia: comunidades e empresas em busca de práticas para negócios sustentáveis. IIEB, São Paulo, Peirópolis, Brasília.
- Wolff, C.S. 1999. Mulheres da floresta: uma história: Alto Juruá, Acre (1890-1945). Hucitec, São Paulo.

Forest products, livelihoods and conservation

Case Studies of Non-timber Forest Product Systems

VOLUME 3 - LATIN AMERICA

Non timber forest products (NTFPs) provide important sources of subsistence, income and employment everywhere there are forests (and sometimes even where there are none). With new emphasis on poverty alleviation and livelihood improvement in national and international development agendas, this group of products seems to offer means to increasing welfare in an environmentally sound way. And yet, despite more than a decade of research and targeted development projects, systematic understanding of the economic behaviour of NTFPs, and their role and potential in conservation and development, remains weak.

To help fill this gap, a large group of researchers combined efforts to compare and contrast individual cases of commercial NTFP production, processing and trade from throughout Asia, Africa and Latin America. The cases represent a range of product kinds, geographic, biophysical, social, and economic conditions. As a part of the research process, the cases were described in narrative reports.

This book, along with the companion volumes, presents the full set of 61 cases from Asia (Vol. 1: 21 cases), Africa (Vol. 2: 17 cases) and Latin America (Vol. 3: 23 cases). The reports are organized to present a standard set of information to support comparative analysis, but the authors also included rich detail, idiosyncrasies and analyses of issues and opportunities in their own cases. Individually, the cases provide a wealth of interesting and useful information. Collectively, they offer an invaluable resource for researchers, development practitioners and conservation workers interested in understanding the links between commercialisation, livelihoods and forest conservation.